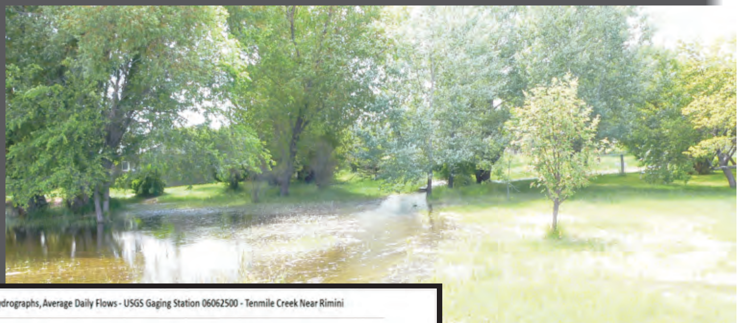
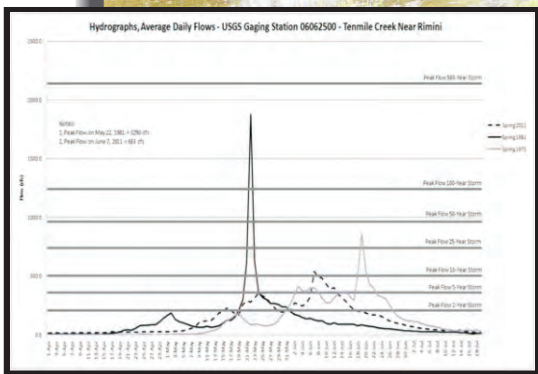
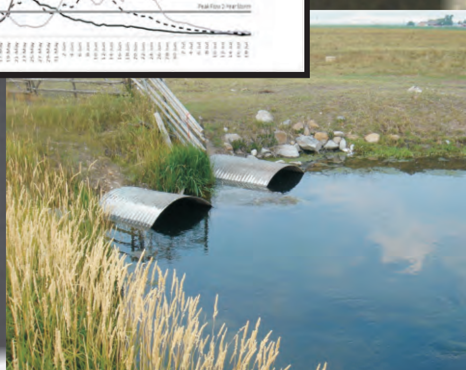


LEWIS AND CLARK COUNTY





Flood Mitigation Master Plan

for the Helena Valley

Prepared By:

Anderson~Montgomery
CONSULTING ENGINEERS

April, 2013

FINAL DRAFT

Lewis & Clark County

Helena Valley Flood Mitigation Master Plan

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Executive Summary

CHAPTER 1 – EXECUTIVE SUMMARY

A. Purpose And Scope

1. Purpose – Following the flooding events of 2011, Lewis & Clark County sought to explore solutions to alleviate flooding impacts within the Tenmile Creek, Silver Creek and Prickly Pear Creek drainages in Helena and East Helena.

   Catastrophic flooding from these drainages in 1981 resulted in an estimated $3.2M in residential and commercial damages. Estimates from the 2011 flooding were significantly less at $234,000, although the magnitude of the flooding was also considerably smaller *and* many of the flood-related problems cannot be quantified in terms of monetary value. Still, flooding from Tenmile, Silver and Prickly Pear Creeks has an adverse effect on Helena Valley occupants and Lewis & Clark County is interested in solving those problems.

2. Scope – Lewis & Clark County contracted with Anderson-Montgomery Consulting Engineers, Inc. (AMCE) in August 2011 to undertake this Master Planning effort. The project scope was defined by the following applicable specific task orders:

   a) Public Information – Attend a series of public meetings to obtain input from affected stakeholders and to disseminate information on flood mitigation findings and recommendations.

   b) Conduct a topographic survey of the storm conveyance infrastructure in the Helena Valley, including culverts, ditches, structures and retention basins. Utilize the survey data to determine hydraulic capacity of existing features.

   c) Data Collection & Analysis – Collect information on characteristics of previous flooding events; compare to the 2011 event; determine reasonable design flood frequency; assess spatial extent of 1981 and 2011 flooding from aerial photographs; calculate hydraulic capacities of critical flood conveyance infrastructure; identify hydraulic restrictions.

   d) Develop and analyze alternatives to minimize flooding impacts to existing residences, businesses, transportation systems and natural resources within the Helena Valley study area. Develop cost estimates for all feasible alternatives and compare cost/benefits of each alternative.

   e) Generate a prioritized list of recommended infrastructure projects to mitigate the impacts of flooding in the Helena Valley, identify possible funding sources and develop project implementation strategies.

   f) Prepare a complete application to FEMA's Hazard Mitigation Grant Program (HMGP) for the proposed Helena Trap Club Retention Pond project, explained further in Chapter 2 of this Master Plan.

B. Goals And Objectives

1. Goal – The primary goal of this Flood Mitigation Master Plan is to ultimately implement an overall floodwater management system that will reduce or eliminate

flooding impacts to residents, businesses, infrastructure and natural resources in the Helena Valley. The goal can be achieved by confining floodwaters to discrete conveyance channels, increasing the speed at which floodwaters are conducted out of the valley, increasing floodwater retention, or any combination thereof.

2. Objectives – To achieve the overall goal of flood water mitigation in the Helena Valley, AMCE and Lewis & Clark County seeks to accomplish the following objectives:
    a) Quantify the 2011 flood event, characterize the extent of damages and risks, derive design criteria for infrastructure improvements to minimize flooding;
    b) Quantify the conveyance capacity of existing hydraulic infrastructure in the Helena Valley and compare to the established design criteria;
    c) Identify hydraulic restrictions within the infrastructure and develop feasible alternatives to increase capacity and/or provide floodwater retention;
    d) Develop a prioritized list of infrastructure improvement projects considering: effectiveness; implementability; land acquisition; timing; regulatory implications; and technical considerations,
    e) Develop unit price cost estimates for feasible alternatives and assess the relative benefits;
    f) Seek funding sources for project implementation.

C. Findings

1. The 1981 Tenmile Creek (TMC) flood represents the 500-year frequency event. The 2011 Tenmile Creek flood equates to a recurrence interval of approximately 22 years.
2. While flooding clearly occurred, the 2011 Silver Creek flood is non-quantifiable due to the lack of flow measurement gauging stations on this stream.
3. Tenmile Creek floodwaters that most affect the study area originate just east of where Tenmile Creek crosses under Green Meadow Drive. Floodwaters leave the established stream channel when the USGS gauging station at Rimini reads approximately 300 cfs. Sevenmile Creek joins Tenmile Creek approximately one mile upstream of where it crosses under Green Meadow Drive and contributed an estimated 400 cfs during the peak of the 2011 flood event.
4. Seven culverts under the Helena Valley Irrigation District (HVID) supply canal act as regulators, controlling the amount of Tenmile Creek flood flow that is delivered to the TMC Study Area. This flow volume equates to 594 cfs.
5. The calculated cumulative capacity of the seven culverts under the HVID supply canal (594 cfs) , plus the calculated capacity of Tenmile Creek's channel (395 cfs) is roughly comparable to Tenmile Creek's 50-year flood flow of 963 cfs.

6. Inadequate capacity of the main roadside ditches, culverts and catchments leads to overland sheetflow, and flooding of streets, yards and structures within the TMC Study Area.
7. Silver Creek's drainage basin contributing flow to the Sewell subdivision is approximately 44 square miles. The 1982 Flood Study prepared by Morrison-Maierle calculated the 2-year, 10-year, 50-year and 100-year peak discharges for Silver Creek at 140 cfs, 340 cfs, 560 cfs, and 660 cfs, respectively.
8. Calculated capacity of the Silver Creek channel as it passes through Sewell is approximately 30 cfs. Comparing the calculated peak flows above, to the channel capacity, it would seem that Silver Creek should flood more often than it does - leading the engineer to question the peak flow calculations.
9. The D2 Drain Ditch (the "D2") represents the lowest channel in the Helena valley. As such, it currently receives a portion of the floodwaters that eminate from the Tenmile and Silver Creek drainages. The D2 is approximately 4.5 miles long and is owned by the U.S. Bureau of Reclamation. The HVID operates the D2.
10. In order to provide a dependable and comprehensive solution to the Helena Valley flooding, it will be necessary to utilize the D2 for ultimate disposal of the flood waters. Furthermore, it will be necessary to make improvements to the D2 in order to provide capacity for Tenmile and Silver Creek flood mitigation improvements. Improvements to the D2 will require authorization from the USBOR as well as the HVID.
11. Estimated cost to provide mitigation for the approximate 50-year flood frequency for the Tenmile Creek Study Area is $4,980,000 (2012 dollars).
12. Estimated cost to provide mitigation for the approximate 100-year flood frequency for the Silver Creek Study Area is $2,244,400 (2012 dollars).
13. Estimated cost to improve the D2 Drain to handle flood runoff from Tenmile Creek and Silver Creek Study Areas is $2,476,400 (2012 dollars).

D. Recommendations

The following provides a summary of the engineer’s recommendations for each specific element of the Helena Valley Flood Mitigation Plan:

1. D2 Drain
    a) The County should open discussions with the Helena Valley Irrigation District and U.S. Bureau of Reclamation to investigate whether runoff can be directed to the D2 during major flood events. The engineer has held preliminary discussions (August 2012) with HVID and provided a potential scope of impacts.
    b) The County should hold additional public meetings to discuss directing additional flows to the D2 and seek cooperative solutions to minimize impacts to properties adjacent to the D2.

c) As noted in Chapter 4 of this Master Plan, significant improvements in the D2 would be necessary in order to provide capacity for expected runoff flows. Approximately $2.5M in needs have been identified in order for the D2 to accept the estimated 600+ additional cfs that would result from the TMC and Silver Creek flood mitigation projects.

2. Tenmile Creek (TMC)

a) The County should proceed with the Helena Gun Club project for which a 2012 FEMA Hazard Mitigation Grant has been applied. This project will: improve hydraulics along North Montana, north of Forestvale Road; provide retention for flood peaking events, and; improve conveyance of TMC floodwaters around Rossiter School to the I-15 ditch.

b) The County should expand the volume of the Forestvale Cemetery retention pond by allowing its use as a borrow source and/or gravel operation. Current volume of the pond is approximately 4.1 million ft^3. Expansion to 13 million ft^3 would further reduce the frequency and intensity of floodwater impacts to the D2.

c) Chapter 2 of this Master Plan identifies approximately $4.98M in needs for the TMC Study Area. These improvement projects include: improving the Hilger Ditch to the Forestvale Retention Pond; channelizing flows to the intersection of Mill/McHugh; improving ditch hydraulics along the west side of McHugh from Mill to the Forestvale Retention Pond and D2; installing four bridges and numerous squash-pipe culverts at road and approach crossings; channelizing overland flow from McHugh to Kerr Drive south of Forestvale Rd; two new outlets to the D2 Drain.

d) ***The Master Plan was amended in December 2012 to reflect a revision to the overall drainage strategy for HVID Culverts #1, #2, #3 and #4. The "alternate" plan involves directing the flow from these four HVID culverts to the Hilger Ditch, improving the Hilger Ditch to handle the combined flow of 462 cfs, and directing HVID Culvert #5 to McHugh, Forestvale/Kerr, N. Montana and the Trap Club Pond. This alternate strategy is preferred by the landowners south of Mill and west of McHugh.***

e) The County should invest in overall stormwater modeling for the TMC Study Area to further refine the flow behavior and to more properly size necessary infrastructure improvements. A preliminary cost estimate to provide hydraulic modeling for the TMC Study Area, flow characterization and alternative analysis is $55,000.

3. Silver Creek

a) It would be prudent to conduct further analyses of Silver Creek's hydraulic characteristics to determine reasonable design parameters for mitigation improvements. With no USGS gauging station on this waterbody, it may be necessary to conduct an hydraulic model of the drainage basin to derive expected flood flows.

b) The Master Plan identifies two alternatives to reduce flood impacts to the Sewell Subdivision. The lowest cost alternative would improve Silver Creek's channel through the subdivision and expediting floodwater conveyance to an existing retention pond and/or on to the D2 Drain. This alternative would not be designed to handle Silver Creek's projected 100-year flood since this would be hydraulically infeasible. The estimated cost would be $515,400. Since Silver Creek appears to be completely de-watered during the late summer of most years, it is expected that the Sewell portion of this alternative could be implemented relatively easily and would yield significant benefits.

c) Directing Silver Creek's floodwaters to the D2 would necessitate improvements to D2 itself. There are seven crossings as well as 2.8 miles of open D2 ditch that would need to be improved. These improvements are considered in item D.1 above.

4. Funding

a) Lewis & Clark County should continue to seek funding sources for floodwater management projects in the Helena Valley. Currently the County has a $518,669 application under consideration by FEMA's Hazard Mitigation Grant Program for the "Trap Club Emergency Detention Pond" project. Generally, the HMGP provides 75% funding for projects that "reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster".

b) The County is encouraged to consider formation of a Rural Special Improvement District (RSID) or Districts for the Tenmile Creek Study Area and/or Sewell. A RSID would provide a mechanism for local initiative and control of flood mitigation improvements. It would also provide the authority to generate funds that could be utilized as local match for state and federal grant programs.

c) Other grant program funds may be available if it can be demonstrated that flooding creates a documented public health hazard or adverse impacts to water quality or natural resources. Possible funding sources could be the Montana Department of Commerce's Treasure State Endowment Program (up to $750,000) or the Montana Department of Natural Resources & Conservation's Renewable Resources Grant Program (up to $100,000).

E. Public Comment

During the course of the Floodplain Master Planning project, Lewis & Clark County conducted a series of public hearings and public information efforts. The public demonstrated significant interest in the process and provided well-informed and thoughtful comments on the preliminary and draft Master Plan documents. Verbal comments were documented during the public hearings and appropriate changes or corrections were made to the document. Written comments have been received and are included in Appendix G. A summary of the written comments and the engineer's responses are as follows:

1. Roger LaVoie (1/28/13) – recommended that a retention pond be constructed on the south side of the HVID supply canal, and that all of the floodwater from canals #2 thru #5 be directed to the improved Hilger Ditch and the enlarged Forestvale Cemetery pond.

   Response: In response to these comments, the engineer evaluated the feasibility of constructing a retention pond on the 34-acre parcel south and west of the HVID canal. It should also be noted that the suggestions of directing the flood flow from canals #2 thru #5 has been considered as discussed in section D.2.d. above. With regard to the retention pond recommendation, on 1/31/13 the engineer evaluated the available land, elevation differences between Tenmile Creek and the HVID canal embankment, and the prevailing groundwater elevations at the proposed pond site. A more detailed discussion of this analysis is provided in Appendix G. To summarize, the engineer determined that the proposed pond's maximum volume would be approximately 9MG. With no ability to control flows into the pond due to spatial and topographic constraints, Tenmile Creek floodwaters would necessarily begin entering the pond as soon as the creek bank is overtopped. At the 2011 calculated flood flow of 688 cfs, a 9MG retention pond would fill in approximately 3.7 hours. Furthermore, at the point when the flood flow peaks, the pond would likely already be full and therefore, ineffective. Further evaluation of a retention pond north of the HVID canal could be conducted as future projects approach the design phase.

2. The Helena Trap Club Executive Committee (3/7/13) – provided responses to the County's inquirey about utilizing the Trap Club's property for floodwater retention. During the 2011 flooding event, the County and Trap Club worked cooperatively to direct and retain Tenmile Creek floodwaters into an existing pit on the Trap Club's property NE of Forestvale and N. Montana Ave. The County sought to explore the possibility of improving the pit and utilizing it for future flood control measures. After considering the County's solicitation, the Trap Club expressed significant concerns about: land de-valuation; long-term easements; environmental impacts; liability issues; and re-configuration of the pit to better accommodate the Club's operations. The Trap Club proposed that the County construct a new retention pond, fill and grade a portion of the existing pit, reclaim Pb within the pit, and compensate the Trap Club for any loss of land value. Complete comments from the Trap Club's D.J. Bakken are included in Appendix G.

   Response: The County will continue to pursue the FEMA Hazard Mitigation Grant that proposes to implement the Trap Club retention pond project. At the same time, County officials will continue negotiations with the Trap Club to determine whether a cost-effective retention pond project can be established. At face value, the Trap Club's stipulations have a considerable cost that was not accounted for in the FEMA/HMGP grant application. The County will need to re-visit project budget and funding sources to accommodate the Trap Club's concerns.

3. Helena Valley Flood Committee (3/14/13) – Mr. Archie Harper, writing on behalf of the HVFC expressed a recommendation that floodwaters from culverts #2 thru #5 under the HVID canal be directed to an enlarged Hilger Ditch – rather than taking flow from culverts #4 and #5 to the corner of Mill & McHugh. This recommendation duplicates that of Roger LaVoie and others discussed earlier.

   Response: The engineer evaluated this alternative prior to the January 2013 Master Plan Draft and modified the document accordingly. This alternative has measurable cost-effective benefits and warrants serious consideration as the overall plan moves toward the design phase.

4. Lyle Lallum (2/25/13) – Mr. Lallum expressed significant concerns about the D2 Drain Ditch's ability to handle existing and future Tenmile and Silver Creeks' flood flows. The 2011 flood event revealed hydraulic capacity problems in the D2 which would definitely be compounded in a lower-frequency flood. Mr. Lallum also pointed out that the 50-year and 100-year calculated flood flows for Tenmile and Silver Creeks (respectively) were used in the Master Plan, and that any Flood Mitigation Plan should consider improving the hydraulic capacity of Tenmile Creek's stream channel itself.

   Response: The Draft Master Plan provided a planning-level analysis of the D2 Ditch and identified approximately $2.5M in improvements that would be necessary to upgrade its capacity. As the D2 represents the conveyance for much of the Helena Valley's flood flows to Lake Helena, it is imperative that the D2 undergo significant improvements *before* any flow enhancements are made within the upper Tenmile or Silver Creek drainage basins. The County and its engineer have had a series of discussions and information exchange with the HVID and Bureau of Reclamation in an effort to keep communications open and each side aware of progress. No modifications to the D2 or contributing flows can be made without the express approval of the District and BoR.

   The discrepancy between flood frequencies for Tenmile and Silver Creeks is primarily due to the hydraulic capacity of the HVID culverts. The combined capacity of these culverts (#1 thru #7) along with the calculated hydraulic capacity of the Tenmile Creek channel closely approximate the 50-year flood frequency. Tenmile Creek's 100-year flood flow would have minimal effect upon the amount of water exiting the HVID canal culverts but would likely result in floodwaters leaving the streambank along a greater length between Green Meadow Drive and I-15. While this would affect the D2, there would be diminished effects on the Master Plan study area.

   Channel clearing for Tenmile Creek was considered in a 1982 study conducted by Morrison-Maierle. This study indicated that channel improvements could increase the stream's hydraulic capacity to handle between the 5-year (820 cfs) and 10-year (1,260 cfs) flood frequency. Further improvements to the stream crossings at Green Meadow, McHugh, Montana would increase capacity by an undetermined amount. Annual costs to conduct stream channel clearing were estimated at $6,700 in 1982 dollars – not considering the permitting that must be obtained. Using a cost indexing comparison (ENR) between 1982 and 2013, the estimated *current* annual cost would be approximately $28,300/year. Since there have been minimal channel clearing operations conducted since 1975, a weighted ENR comparison yields a current, one-time cost to clean Tenmile Creek's channel of approximately $664,500, not considering any issues with private property access, permitting and environmental impacts. It should be noted that the County implemented a limited amount of debris removal from Tenmile Creek in 1994-95, including fallen trees, car bodies, fencing, etc. During that project, crews encountered numerous adjacent landowners who would not allow work to be done on the creek banks. It is presumed that a more comprehensive sediment-dredging project would be met with similar resistance.

5. Neil Horne (2/6/13) – Mr. Horne expressed his agreement that the westernmost culvert under Mill Road needs to be upsized as provided in the Master Plan. He also wanted to make clear that the alternate proposal to direct flood flows from culverts #2 - #5 must be adequately sized to assure that his property is not adversely impacted. Mr. Horne also clarified that the Hilger Ditch is abandoned through his property (south of Mill Road) and that Skeeter Baertsch has a water right on the flow from culvert #2. He proposed that a control structure be placed at the headgate for old Hilger Ditch and culvert #2 in order to manage floodwaters and still allow Mr. Baertsch access to his irrigation water right.

   Response: The County and its engineer acknowledge Mr. Horne's concerns and anticipate configuring the ultimate project design to accommodate his recommendations.

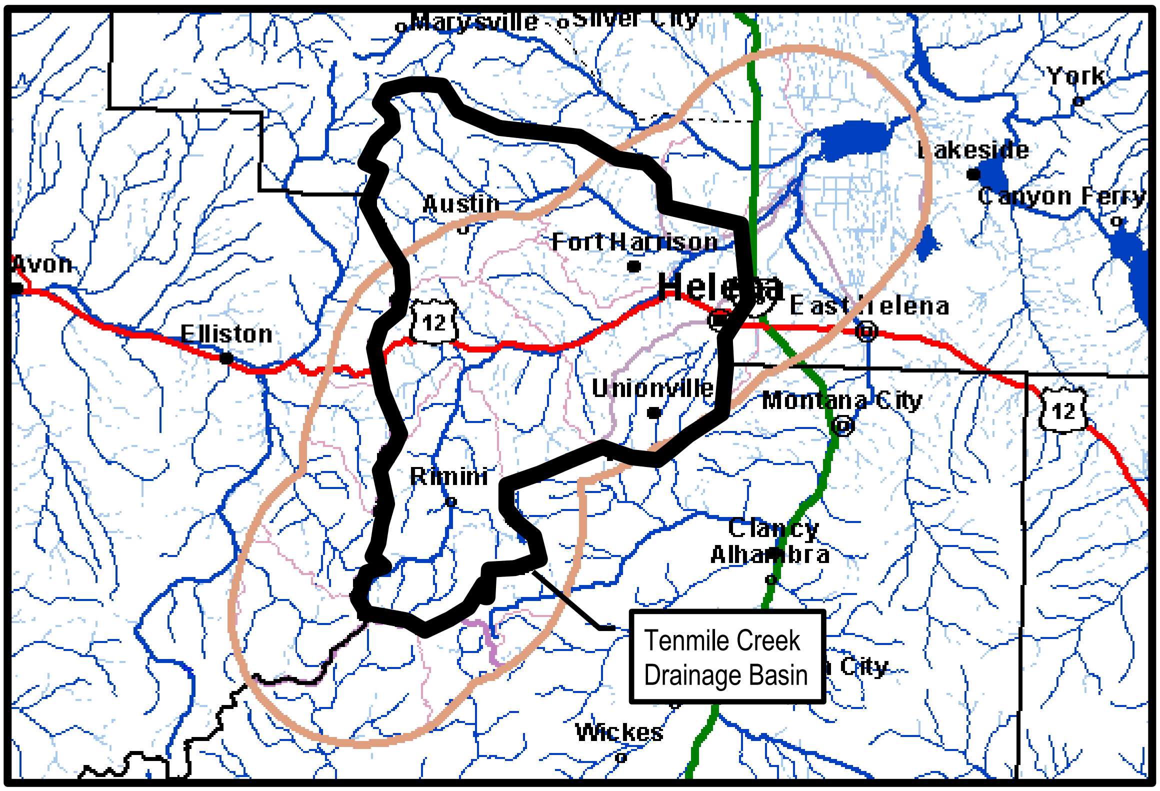
CHAPTER 2

Tenmile Creek Drainage

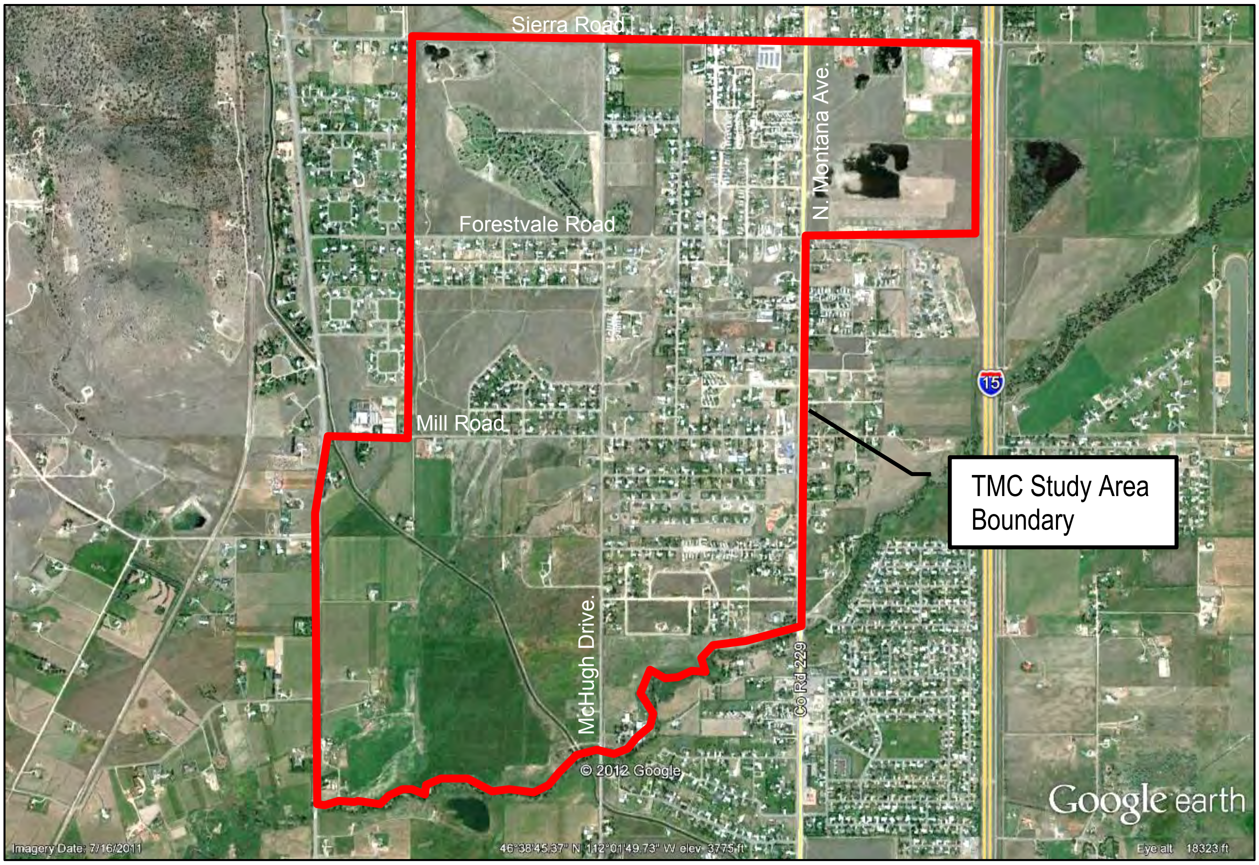
CHAPTER 2 – TENMILE CREEK DRAINAGE

A. <u>Drainage Basin Characteristics & Study Area</u>

Tenmile Creek (TMC) originates in the mountains adjacent to the Continental Divide approximately 20 miles southwest of Helena. The total drainage basin incorporates 161 square miles (at the confluence with Prickly Pear Creek), 32 mi^2 of which is in the upper drainage, prior to the crossing of Tenmile Creek under Highway 12 West. Sevenmile Creek contributes to Tenmile Creek approximately 0.6 miles west of Green Meadow Drive. Please see the following map of TMC's drainage basin.



As TMC enters the Helena Valley, the gradient becomes shallower and the channel shows signs of historic modifications. While flooding in the upper reaches of TMC, on Hwy. 12 and in the southwest (upper) part of the Helena Valley occurs routinely, the primary concern of this evaluation is to address flooding issues that impact the area north of TMC between Green Meadow Drive and Interstate 15. This Study Area is approximately 2.84 square miles. From the point where flood waters leave TMC in the southwest, to where it exits in the northeast is approximately 2.6 miles. Please see the following map of the TMC Study Area.



B. Flood Events and Flows

The first step in evaluating existing flood conveyance infrastructure or planning for improvements, it is necessary to consider the historic flooding events and determine the target design parameters. TMC has a gauging station (the "Rimini Station USGS 06062500) located 13.6 miles upstream of the Hwy. 12 crossing which has been monitored since 1915 up to and including the flooding event of 2011. The data collected by this station has been summarized and is included in Appendix A of this report.

1. 1981 Flood - Tenmile Creek has a well-documented history of flooding the Helena Valley Study Area. The most significant documented event occurred in 1981 when peak flows reached 3,290 cfs. (at the Rimini gauging station) and was estimated to equate to a 500-year event. During the 1981 flood, aerial photographs were taken during the height of the event and are shown in **Figure 1**, superimposed over the current aerial photographs. Also included on Figure 1 is the aerial extent of the 2011 flooding, shown in yellow. A comparison of these two events clearly shows that the 1981 flood was of significantly higher magnitude.

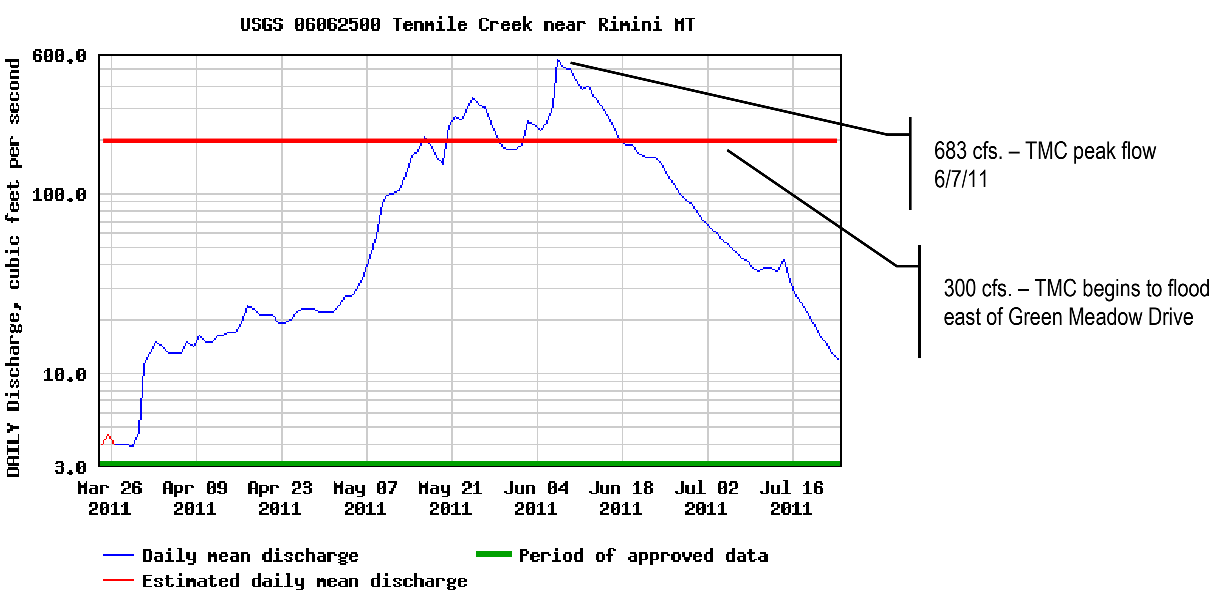
   After the severe flooding in 1981, Morrison-Maierle prepared the April 1982 Flood Drainage Study for Tenmile Creek which also calculated the flood flow and frequencies for upper Tenmile Creek. Both the 1982 Flood Study and the USGS flood flow computations are included as follows:

Tenmile Creek Flood Frequencies & Flowrates		
Flood Frequency	1982 Morrison-Maierle Calculated Flood Flow (cfs)	USGS Calculated* Flood Flow (cfs)
2 yr.	215	**205**
5 yr.	435	**359**
10 yr.	660	**501**
25 yr.	1080	**737**
50 yr.	1515	**963**
100 yr.	2090	**1240**

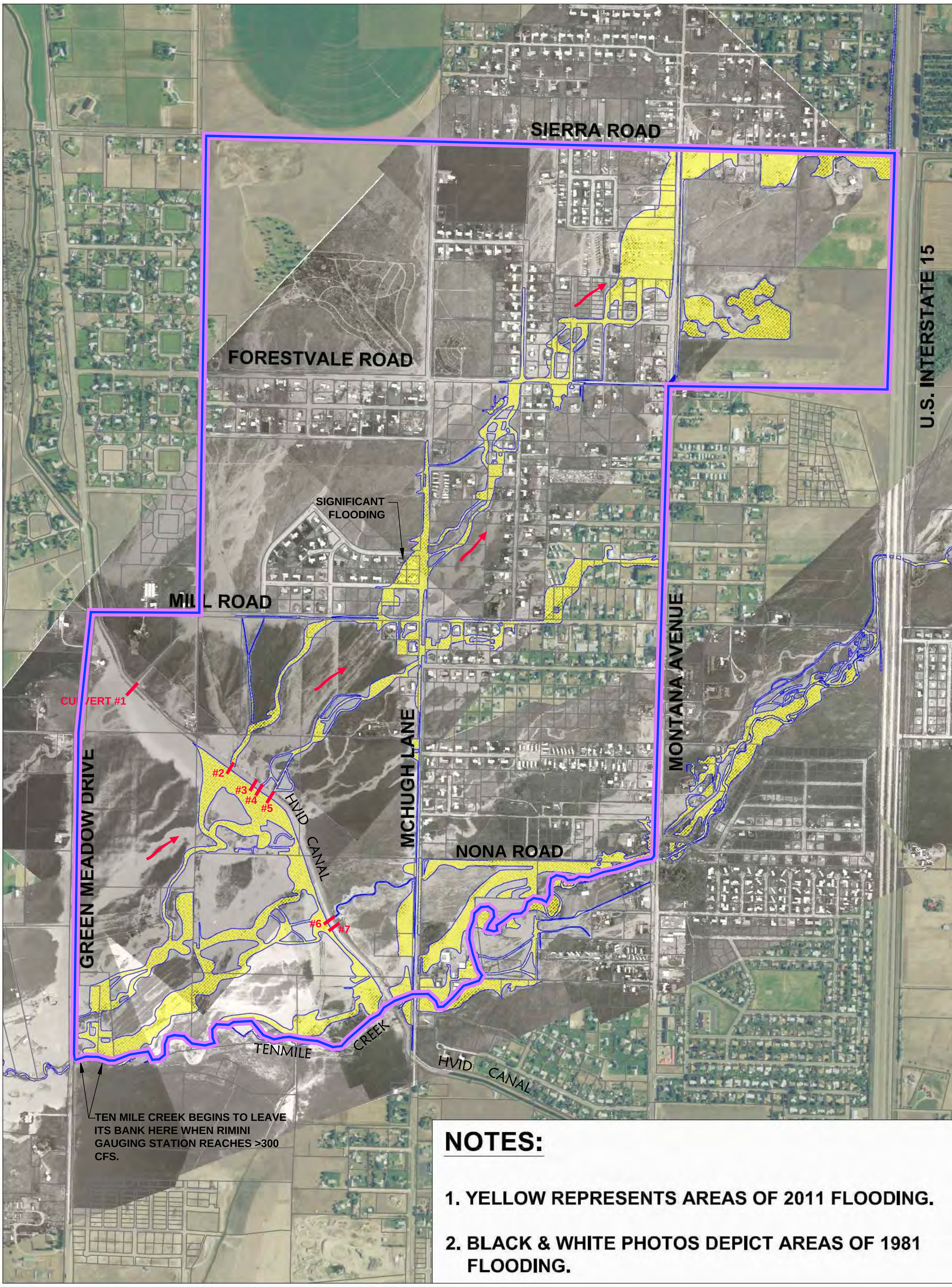
* - based on data up to and including 1998.

The USGS flood frequency figures take into account all of the data of the 1982 flood calculations, plus all of the flow data between 1981 and 1998 and should therefore be more representative. For the purposes of this Flood Study, the USGS flood frequency estimates will be utilized when comparing proposed infrastructure with the expected runoff flows.

2. 2011 Flood - According to observations of the Lewis & Clark County Public Works Director between June 4th & 7th, 2011, flood waters began leaving the TMC channel just east of Green Meadow drive (and impacting the Study Area) when the USGS Rimini gauging station recorded flows of approximately 300 cfs.



Comparing the 2011 TMC hydrograph with the USGS flood frequency calculations, it appears that the 2011 event is somewhere between the 10-yr and 25-yr recurrence interval. Interpolation from the table above provides an estimated interval of 22 years, meaning there is a 1 in 22 chance of this magnitude flood occurring in any given year.



NOTES:

1. YELLOW REPRESENTS AREAS OF 2011 FLOODING.
2. BLACK & WHITE PHOTOS DEPICT AREAS OF 1981 FLOODING.

TENMILE CREEK STUDY AREA BOUNDARY

N
Not to Scale

Project: **Lewis and Clark County - Helena Valley Flood Mitigation Master Plan**

Figure Title: **Study Area HVID Canal Culverts & 1981 and 2011 Flood Areas**

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Figure: 1

Ordinarily, an engineering professional would design infrastructure systems to survive flooding events of significantly higher flows (and much lower frequencies).

Bridge over Tenmile Creek @ McHugh Drive – June 8, 2011.

With the 2011 peak measured discharge in TMC (at the Rimini gauging station) of 683 cfs, and Sevenmile Creek contributing an estimated 400 cfs between Rimini and the Study Area (see calculations in Appendix B), it can be reasonably concluded that TMC flows entering the Study Area in June 2011 were approximately 1,083 cfs.

In order to calculate the amount of flow *leaving* TMC's channel during the peak of 2011's flooding, it is necessary to estimate the flow volume that remained in TMC channel through the Study Area. The McHugh bridge provides a suitable opportunity to estimate flows since it is a hydraulic constriction with an easily-calculated cross section and velocity, and there did not appear to be any significant flood flows that were bypassing the McHugh bridge.

The channel width at the McHugh Bridge constriction is approximately 23 feet wide. Distance between the bottom of the bridge deck and the stream channel varies between 3' and 4½', with an overall cross-sectional area of roughly 76 ft². The photograph above shows that the flow channel was completely full and the upstream water level was approximately 12" above the bottom of the bridge, essentially utilizing the entire cross-sectional area of flow at the bridge constriction. Measurements conducted on June 27, 2011 estimate an average flow velocity of approximately 5.0 feet/second immediately upstream of the bridge. This velocity estimate is further validated by the Stage Discharge Calculations in the 1982 Flood Study (included in Appendix B) which estimated the average velocity at 5.2 fps using a frictional coefficient of 0.5; and an average stream channel slope of 0.0085 ft/ft. Using the average velocity, the cross-sectional area and noting that:

$Q = VA$ where: Q = flow in cfs.
V = velocity in feet/sec.
A = cross sectional area in ft²

The estimated flow through the McHugh bridge constriction was approximately 395 cfs., representing an estimate of TMC's flow capacity through the Study Area. Therefore, the estimated amount of flow exiting TMC's channel within the Study Area would be:

Total Q entering Study Area – Q capacity of TMC @ McHugh = Q flooding Study Area east of McHugh

1,083 cfs – 395 cfs = 688 cfs

An examination of the 2011 aerial flood images in Figure 1 indicates that flood flows exited TMC's channel at two locations between Green Meadow Drive and McHugh Drive. These locations are: immediately east of; and 0.4 miles east of Green Meadow Drive. With the limited amount of data available, it is not feasible to estimate the amount of flow that was exiting TMC's channel at each specific location, only that the cumulative amount was likely near 688 cfs.

C. Flow Restrictions and Capacity of Existing Hydraulic Structures

When Tenmile Creek floods, it creates significant hazards in the Helena Valley Study Area depicted in Figure 1. The 2.8 mi² area is generally bounded by: Tenmile Creek to the south; Interstate 15 to the east; Sierra Road to the north and; Green Meadow Drive to the west. In order to quantify the existing flood conveyance capacity within the Study Area, a survey was performed on all the major road/ditch and stormwater piping infrastructure. Elevation information was collected on all ditch cross-sections, slopes, pavement sections, culvert invert elevations and sizes within the Study Area. Using this data along with the Manning's Equation (for open-channel flow conditions) and textbook friction coefficients, the maximum capacity for each existing flood conveyance channel was calculated. The results of these calculations for the Tenmile Creek Study Area are presented in **Figure 2**. A close examination of Figure 2 will reveal that numerous hydraulic restrictions exist throughout the basin. This will be further discussed in upcoming sections of this Chapter.

The primary source of the flood waters is when TMC runoff breaches the north stream bank immediately east of Green Meadow Drive. Once flow leaves TMC at this breach point, it travels northeasterly in shallow channels and sheet flow until it encounters the SE to NW-oriented Helena Valley Irrigation District (HVID) Canal. There are a total of seven concrete box culverts that conduct TMC flood flow northeast *under* the HVID canal. Open-channel flow capacity calculations show the combined capacity of all seven culverts is approximately 594 cfs. It is interesting to note that the total capacity of these culverts (594 cfs) combined with the carrying capacity of TMC itself (≈395 cfs) is comparable to the USGS 50-year flood frequency flow for TMC of 963 cfs. This *may* indicate that the designers of the HVID canal were anticipating a 50-year Tenmile Creek flood frequency when sizing the underdrain culverts. Please see Figure 1 for the locations, nomenclature and calculated capacities for these seven HVID underdrain culverts.

Figure 1 also shows the routing of storm water flows as well as areas of inundation within the Study Area. The ponding on the up-gradient (southwest) side of the HVID canal indicates that all seven culverts under the canal were at maximum capacity during the 1981 flood and likely close to maximum capacity during the 2011 flood. The culverts under the canal act as a regulator to control the amount of runoff that enters the developed properties within the Study Area, and it is the capacity of these seven culverts that will be used as a target for all down-gradient infrastructure design in the Study Area. The calculated capacities and down-gradient routing for each of the seven culverts is provided in the following table:

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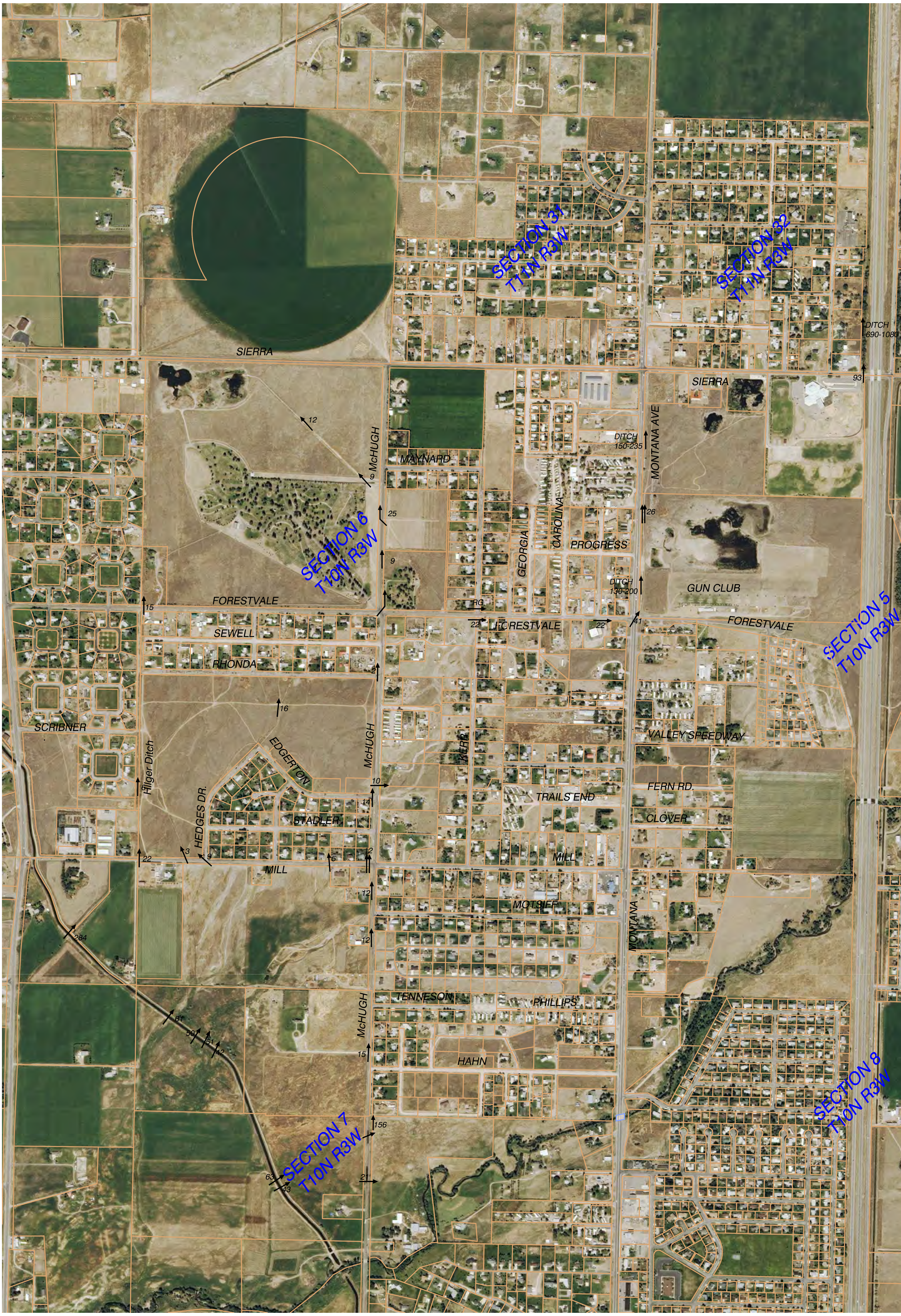
SAVED: 8/9/12 PRINTED: 3/27/13 BY: BARB



LEGEND:

22 → EXISTING CULVERT & CAPACITY IN CFS

N

0' 500' 1000'

Scale In Feet

Project:

Lewis and Clark County - Helena Valley Flood Mitigation Mater Plan

Figure Title:

Existing Culverts and Ditches

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Figure:

2

Storm Culverts under HVID Canal – (Between Green Meadow & McHugh

Culvert No.	Capacity (cfs.)*	Downstream Route	Downstream Impacts
#1	284	NE to intersection of Mill & Hilger Ditch	Due to undersized Mill Road culvert and poor condition of Hilger Ditch: floods Mill Rd; sheet flow west of Big Sky Subdivision and floods neighborhood at Ronda and Sewell Rds.
#2	61	Sheet flow NNE to Mill Rd. then east to McHugh or north to two culverts west of Mill/Hedges.	Due to undersized culverts at Mill/McHugh and Mill/Hedges and no ditch south of Mill Rd: floods 3 homes south of Mill Rd and several lots/homes within Big Sky Subdivision.
#3	50	Sheet and channel flow ENE to McHugh Rd. ditch, cross under Mill, north along west side of McHugh	Due to undersized culverts on west side of McHugh: floods 2 homes on McHugh and contributes to flooding several lots/homes within Big Sky Subdivision.
#4	51		
#5	42		
#6	63	Sheet and channel flow NE to McHugh Rd. ditch. Flows east under McHugh @ Nona. Ponds south of Nona and most returns to stream channel east of Montana Ave.	During high runoff conditions, some flow bypasses culvert under McHugh @ Nona. This flow contributes to flooding of 2 homes on McHugh and several homes within Big Sky Subdivision due to undersized Mill Road Culverts
#7	43		

*- presuming open-channel flow conditions

D. Recommended Solutions to Minimize Flooding

This section describes the proposed alternatives and solutions for addressing flooding within the Study Area. The overall goal of this analysis is to provide for more effective and faster conveyance of the TMC flood waters through the Study Area so that impacts to residents, homes, transportation and infrastructure are minimized. Generally, the objectives will be to enhance roadside conveyance ditches, improve storm culverts and crossings and provide retention and flow-buffering for larger flooding events. Recommended infrastructure improvements will generally be described starting with upstream (southwest) to downstream (northeast) within the TMC Study Area.

Flooding of the Study Area typically begins with TMC leaving its channel immediately east of Green Meadow Drive. Traveling in a northeasterly direction for 0.6-0.7 miles, flow encounters the HVID canal embankment where it will flow through the seven existing culverts and/or become impounded. The southwest HVID canal embankment in the Study Area is 4' to 6' higher than surrounding topography and Figure 1 shows runoff being impounded by the HVID canal in 1981 and 2011.

The triangular-shaped portion of the Study Area southwest of the HVID canal (approximately 186 acres) is mostly agricultural with 7-8 homes that could be impacted by flooding. No provisions to mitigate the effects of flooding were considered in this area other than to channelize flow where possible and reduce pooling. In order to construct ditches for flow channelization and protection of these homes, the County should approach the individual landowners to seek cooperation.

Starting with the westernmost culvert (HVID Culvert #1) and ending with the easternmost (HVID Culvert #7) the following sections 1 thru 3 describe recommended improvements for the flood flows passing through each. Sections 4 thru 6 describe recommended improvements for downgradient drainage segments.

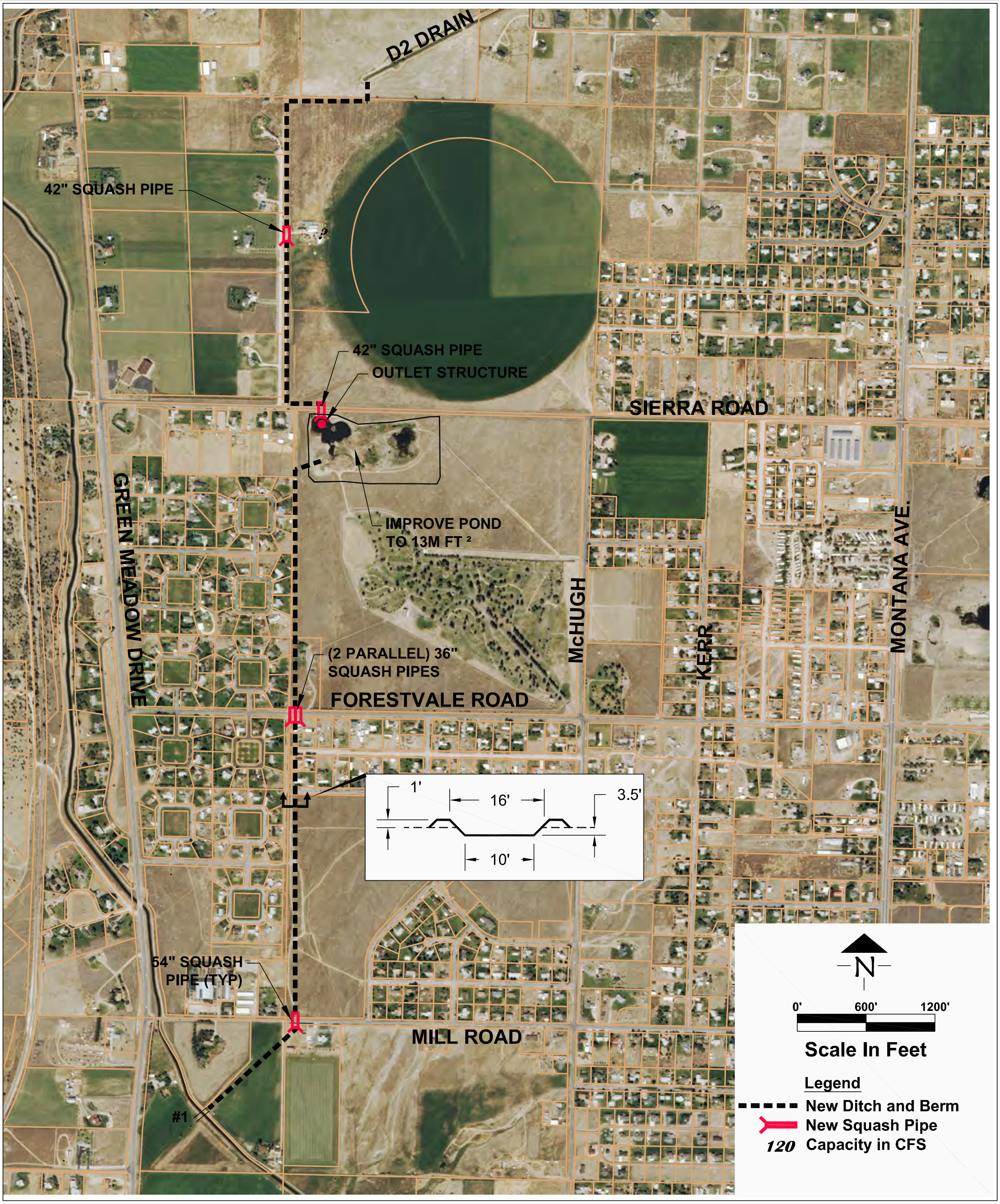
1. HVID Culvert #1 – Capacity = 284 cfs.

   Problem: This culvert has the largest capacity of any under the HVID canal in the Study Area, and appears to collect a large portion of the flow that exits TMC immediately west and east of Green Meadow Drive. Downstream of this culvert, flows impact: the Big Sky Subdivision; Mill, Ronda, Sewell and Forestvale Roads; and numerous homes.

   Proposed Solution: See **Figure 3 – Improved Hilger Ditch, Forestvale Cemetery Pond and outlet to D2 Drain**

   - Improve the channel from the culvert outlet to the intersection of Mill Road and the Hilger Ditch;
   - Install 75 lineal feet of 54" equivalent concrete squash pipe under Mill Road from SW to NE quadrants and intersect Hilger Ditch;
   - Improve 2,640' of Hilger Ditch to 15' wide, 3.5' deep, 3:1 vegetated side slopes from Mill to Forestvale on new easement and existing right-of-way;
   - Install two parallel 72' lengths of 36" equivalent concrete squash pipe under Forestvale Road;
   - Install 2,300' of new ditch from Forestvale Road to the Forestvale Cemetery retention pond;
   - Install outlet structure on NW corner of Forestvale Cemetery retention pond;
   - Install 3,000' of new ditch from Forestvale Cemetery Pond outlet structure directly north to the D2 Drain.
   - Install 42' of 42" equivalent concrete squash pipe under Sierra Road for pond outlet;
   - *OPTIONAL*: excavate/berm Forestvale Cemetery retention pond to increase volume from from current 4.1 million ft^3 to 13 million ft^3. Local well logs indicate a static water level between 14' and 20' bgs. (See Appendix D) Survey data indicates that the existing impoundment is 8' to 14' deep.
   - *This alternative provides an outlet to the D2 that matches the capacity of HVID culvert #1 (284 cfs)*

   Engineer's Estimate of Cost: See Project Cost Estimate HVID Culvert #1 in Appendix C. The base estimated cost for this project element is $666,860. If the excavation/improvement of the Forestvale Cemetery Pond is included, the estimated cost is $2,159,780. These estimates include a 10% contingency and engineering services, as well as the acquisition of approximately 3 acres of easement to site the improved Hilger Ditch and ditch to Forestvale Cemetery pond.



Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Plan	**Improved Hilger Ditch, Forestvale Pond and Outlet to D2 Drain**	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	**3**

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to address flows coming through HVID Culvert #1:

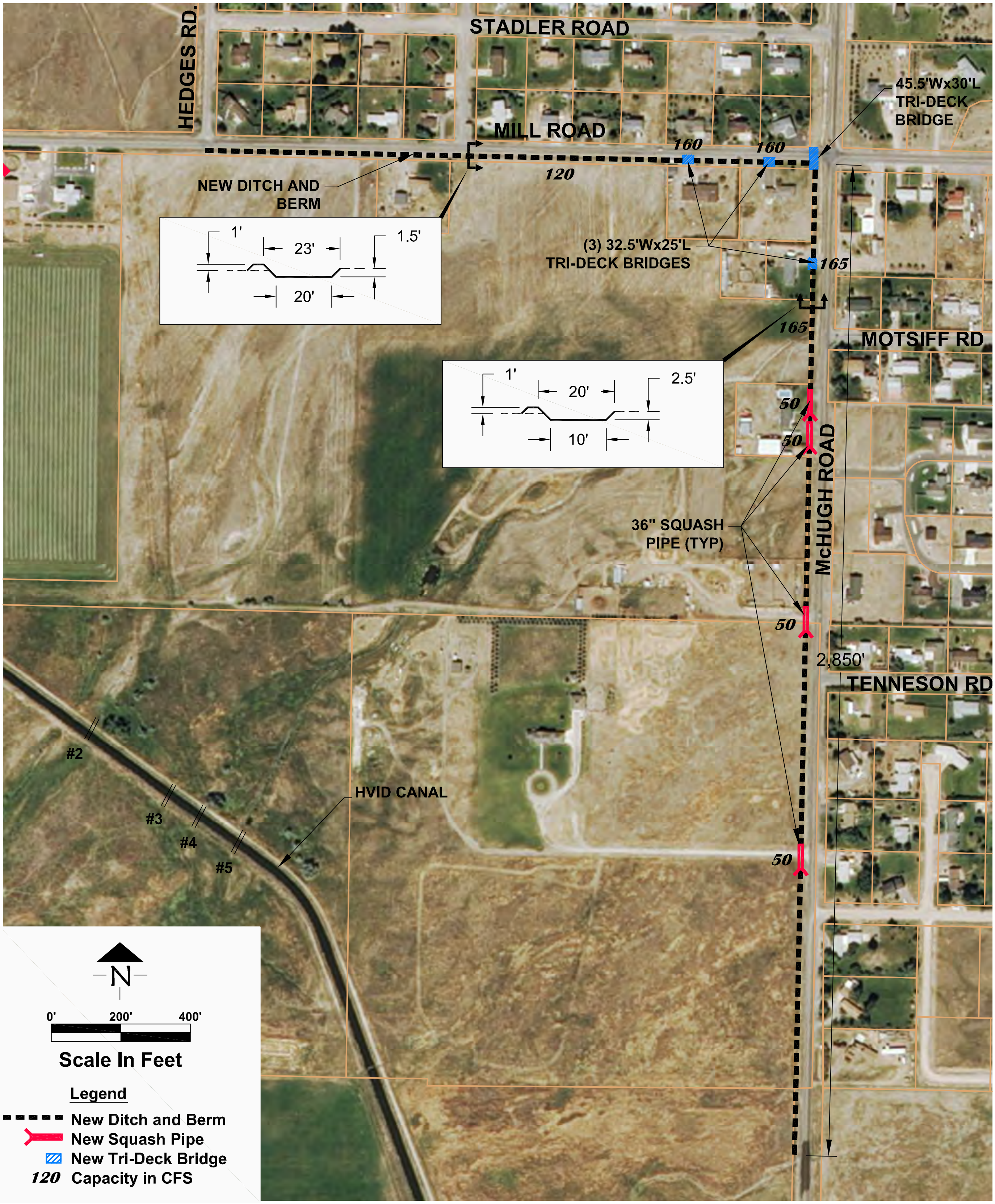
a. Approach the Helena Valley Irrigation District to determine whether storm flows can be introduced into the D2 Drain at its furthest upstream open-ditch point. This will require coordination with the Bureau of Reclamation and downstream landowners. These discussions should also include maintenance or improvement of the D2 drain infrastructure in order to mitigate the effects of higher flows.
b. Explore methodologies for funding improvements
c. Contact affected landowners (including Bruce Mihelish) to begin the process of acquiring easements for the proposed ditch improvements.
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary.
e. Approach the Montana Department of Transportation to ascertain jurisdictional issues with crossing Mill, Forestvale and Sierra Roads. Determine specific requirements that must be observed for those crossings.
f. Identify and clear the proposed ditch corridor Right-of-Way between Ronda and Forestvale Road.
g. Expand the volume of the Forestvale Cemetery pond by allowing/promoting excavation and use of the material as a borrow source. Groundwater wells in the vicinity indicate a static water level of between14' and 20' below ground surface.
h. Final Design
i. Bidding and Construction

2. HVID Culverts #2, #3, #4, #5 – Combined Capacity = 204 cfs.

   Problem: The combined flow from these four culverts contribute to sheet and shallow-channel flow to Mill Road and McHugh Drive where it generally pools at the intersection of Mill & McHugh. Two undersized N-S-oriented culverts at this intersection under Mill Road restrict flow to the north, causing significant ponding and flooding of several homes in the area as well as Mill Road itself.

   Proposed Solution: See **Figure 4 – Ditches at Mill and McHugh**

   - Improve channelized flow from culvert outlet north to Mill Road and Northeast to McHugh;
   - Improve roadside ditches on south side of Mill and west side of McHugh, slope toward intersection of Mill & McHugh;
   - Install 36" equivalent concrete squash pipe culverts for four approaches to McHugh – south of Motsiff;
   - Install precast bridges/abutments at two residential approaches on south side of Mill 160' and 400' west of McHugh;
   - Install precast bridge/abutments at one residential approach on west side of McHugh - 280' south of Mill;



Project:
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Figure Title:
Ditches at Mill Road and McHugh Drive

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Figure:
4

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- Install precast bridge/abutments for Mill Road crossing of improved N-S ditch along west side of McHugh

Engineer's Estimate of Cost: See Project Cost Estimate HVID Culverts #2 thru #5 Ditches to Intersection Mill & McHugh in Appendix C. The base estimated cost for this project element is $791,000. These estimates include a 10% contingency and engineering services, as well as the relocation of utilities both parallel to and crossing the ditches/culverts.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to address flows coming through HVID Culverts #2 thru #5:

a. Contact affected landowners south of Mill and west of McHugh to begin the process of acquiring easements for the proposed ditch improvements.
b. Explore methodologies for funding improvements.
c. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in both Mill and McHugh Roads.
d. Evaluate the traffic loading demands for Mill Road and for the private approaches on Mill and McHugh where bridge crossings are proposed. Confirm that Tri-Deck Bridge technology is appropriate.
e. Identify and clear the proposed ditch corridor Right-of-Way between Ronda and Forestvale Road.
f. Expand the volume of the Forestvale Cemetery pond by allowing/promoting excavation and use of the material as a borrow source.
g. Final Design
h. Bidding and Construction

2A. HVID Culverts #1, #2, #3, #4 to Hilger Ditch, HVID Culvert #5 to McHugh➔Forestvale➔Trap Club Pond

Problem: The combined flow from these five culverts contribute to sheet and shallow-channel flow to Mill Road and McHugh Drive where it generally pools at the intersection of Mill & McHugh. Two undersized N-S-oriented culverts at this intersection under Mill Road restrict flow to the north, causing significant ponding and flooding of several homes in the area as well as Mill Road itself.

Proposed Solution: See **Figure 4A – HVID #1 - #4 All to Hilger, HVID #5 to McHugh**

- Improve Hilger Ditch (30'-wide, 3'-deep) from Mill Road to Forestvale Cemetery Pond to handle flood flows from HVID culverts #1 thru #4 (446 cfs.)
- Improve channelized flow from culvert #2, #3, #4 outlets north to Mill Road through Baertsch property;
- Install three 36" equivalent concrete squash pipe culverts under Mill Road, 225' west of Hedges;

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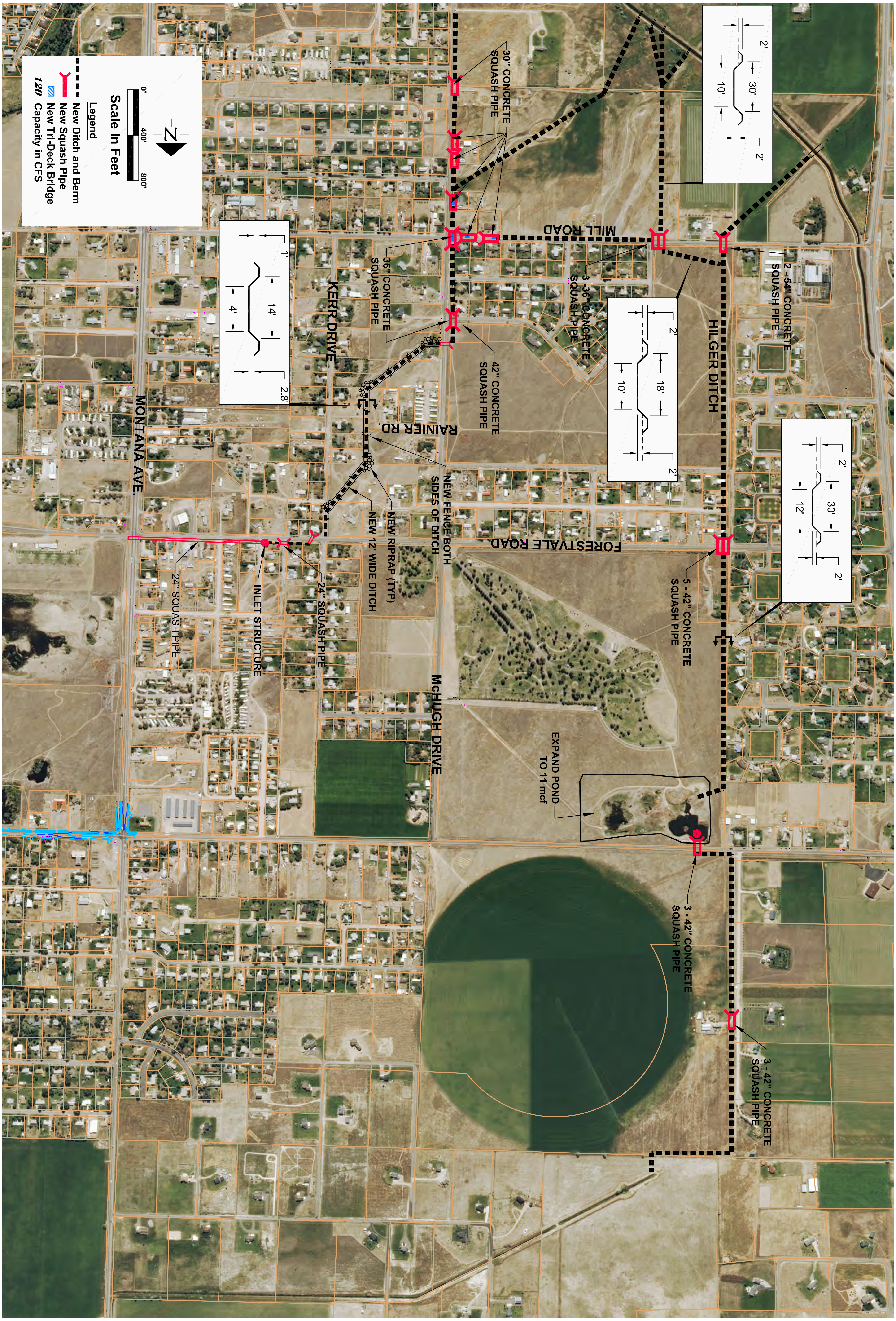

Project:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan

Figure Title:
Mill Road, McHugh Drive and Hilger Ditch

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Figure:
4A

- Construct 530' lineal feet of (18'-wide, 3'-deep) ditch from culverts under Mill to Hilger Ditch;
- Improve roadside ditches on south side of Mill and west side of McHugh, slope toward intersection of Mill & McHugh;
- Install 30" equivalent concrete squash pipe culverts for eight ditch crossings on Mill and McHugh – up to and including Mill @ McHugh;

Engineer's Estimate of Cost: See Project Cost Estimates: 2A Parts 1, 2 and 3: Improved Hilger Ditch; HVID Culverts #1 thru #4 to Hilger, HVID #5 to Trap Club Pond, all in Appendix C. The combined estimated cost for this project is $1.57M. These estimates include a 10% contingency and engineering services, as well as the relocation of utilities both parallel to and crossing the ditches/culverts.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the "alternate" project to address flows coming through HVID Culverts #1 thru #5:

i. Contact affected landowners south of Mill and west of McHugh to begin the process of acquiring easements for the proposed ditch improvements. Preliminary discussions with local landowners indicates that the "alternate" plan is preferable.
j. Explore methodologies for funding improvements.
k. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in both Mill and McHugh Roads.
l. Evaluate the traffic loading demands for Mill Road and for the private approaches on Mill and McHugh where bridge crossings are proposed. Confirm that Tri-Deck Bridge technology is appropriate.
m. Identify and clear the proposed ditch corridor Right-of-Way between Ronda and Forestvale Road.
n. Expand the volume of the Forestvale Cemetery pond by allowing/promoting excavation and use of the material as a borrow source.
o. Final Design
p. Bidding and Construction

NOTE – this "alternate" for HVID Culverts #1 thru #5 can be substituted for Projects D.1, D.2, D.4, D.5 and D.6 in this section (cumulative cost ≈ $3.37M)

3. HVID Culverts #6 & #7 – Combined Capacity = 106 cfs.

Problem: The combined flow from these two culverts contribute to shallow-channel and sheet flow approximately 1,000 ' ENE to a culvert crossing under McHugh Drive. The capacity of the McHugh culvert is 156 cfs which is adequate to carry the HVID Culverts #6 & #7 capacity. Once the flow crosses under McHugh, it is impeded from further movement to the north by the embankment of Nona Road. Flood flows then generally travel directly east and will either re-combine with TMC or flow over the east end of Nona Road and on to the ditch on N. Montana Ave. Figure 2 shows that while these HVID culverts contributed to flooding of several properties in the 1981 event, they did not appear to cause any measurable flooding problems in 2011.

Proposed Solution: See **Figure 5 – Improved Ditch & Berm South of Nona Road**

- Re-grade the 400' ditch between the McHugh crossing culvert and the intersection of Nona and Carol
- Construct 850' of roadside ditch (sloped toward the east) along the south side of Nona Rd to the intersection of Nona & Christine Drive.
- Construct 1,250' of ditch with elevated north berm from the intersection of Nona & Christine east to the TMC channel near N. Montana Avenue.

Engineer's Estimate of Cost: See Project Cost Estimate HVID Culverts #6 & #7 in Appendix C. The base estimated cost for this project element is $116,600. These estimates include a 10% contingency and engineering services, as well as the acquisition of approximately 0.3 acres of right-of-way to obtain legal access to the ditch between McHugh and Nona/Carol.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to address flows coming through HVID Culverts #6 and #7:

a. Contact affected landowners south of Nona and east of McHugh to begin the process of acquiring easements for the proposed ditch improvements.
b. Explore methodologies for funding improvements.
c. Clean and maintain the crossing culvert under McHugh, south of Nona.
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in McHugh Road.
e. Final Design
f. Bidding and Construction

4. Intersection of Mill/McHugh north 3,860' to 36" squash culvert under McHugh north of Forestvale (the Cemetery Diversion)

Problem: Once the flood flow (from HVID Culverts #2 - #5) has been conveyed north under Mill Road in the McHugh ditch, the capacity of the McHugh ditch itself and downgradient culverts are inadequate. This results in flooding of several properties in the Big Sky Subdivision (on Stadler and Edgerton) as well as further north on Ronda, Sewell and Forestvale. Flood flow also inundates portions of McHugh Drive north of Mill Road.

Proposed Solution: One alternative is to improve the ditch along McHugh from Mill to the 36" squash culvert under McHugh 570' south of Maynard (the "Cemetery Diversion"). See **Figure 6 – Improved McHugh Ditch Mill Road to Cemetery Diversion**

- Re-grade and expand the ditch on the west side of McHugh Drive between Mill and Forestvale;

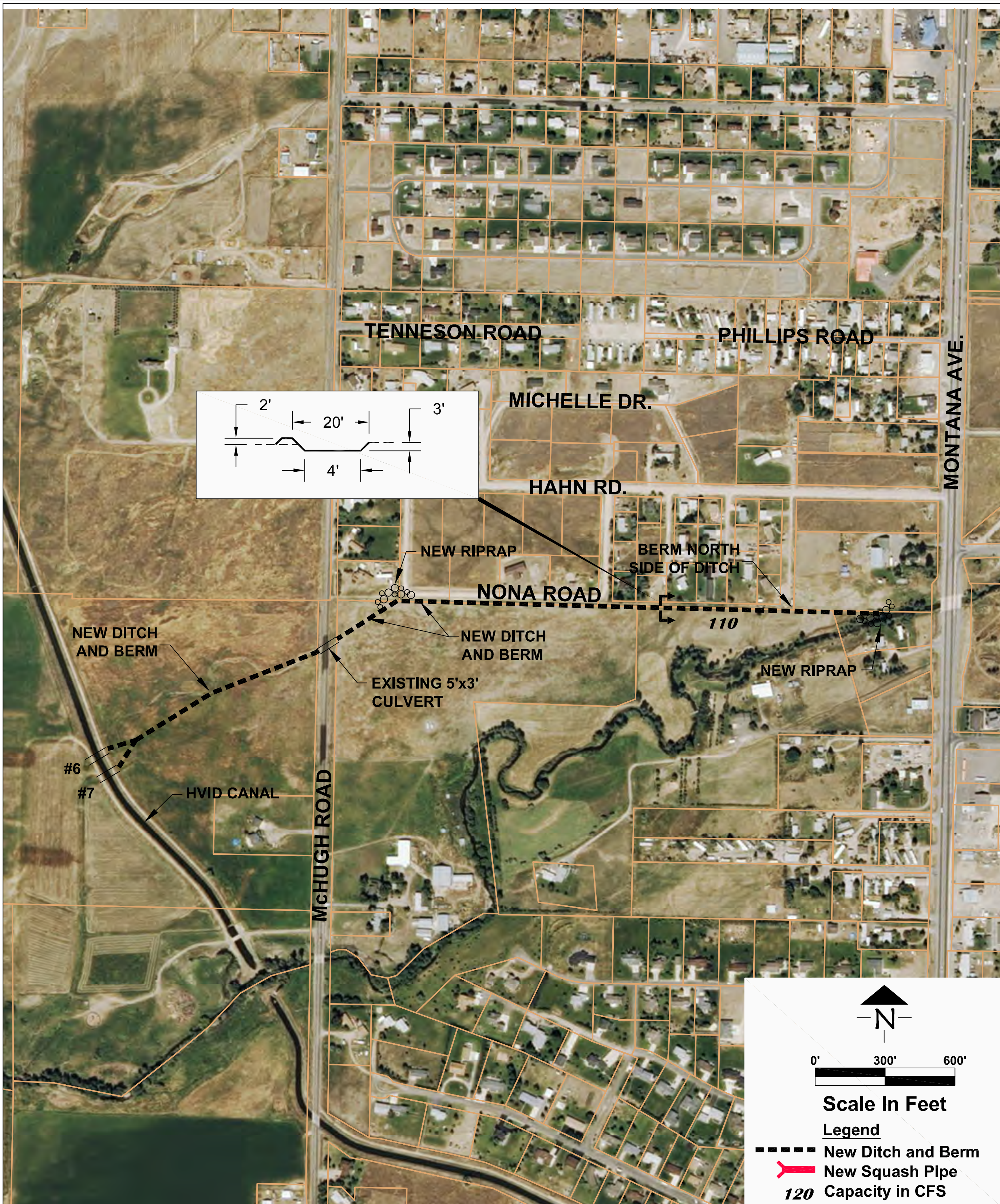

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Figure Title:
Improved Ditch/Berm South of Nona Road

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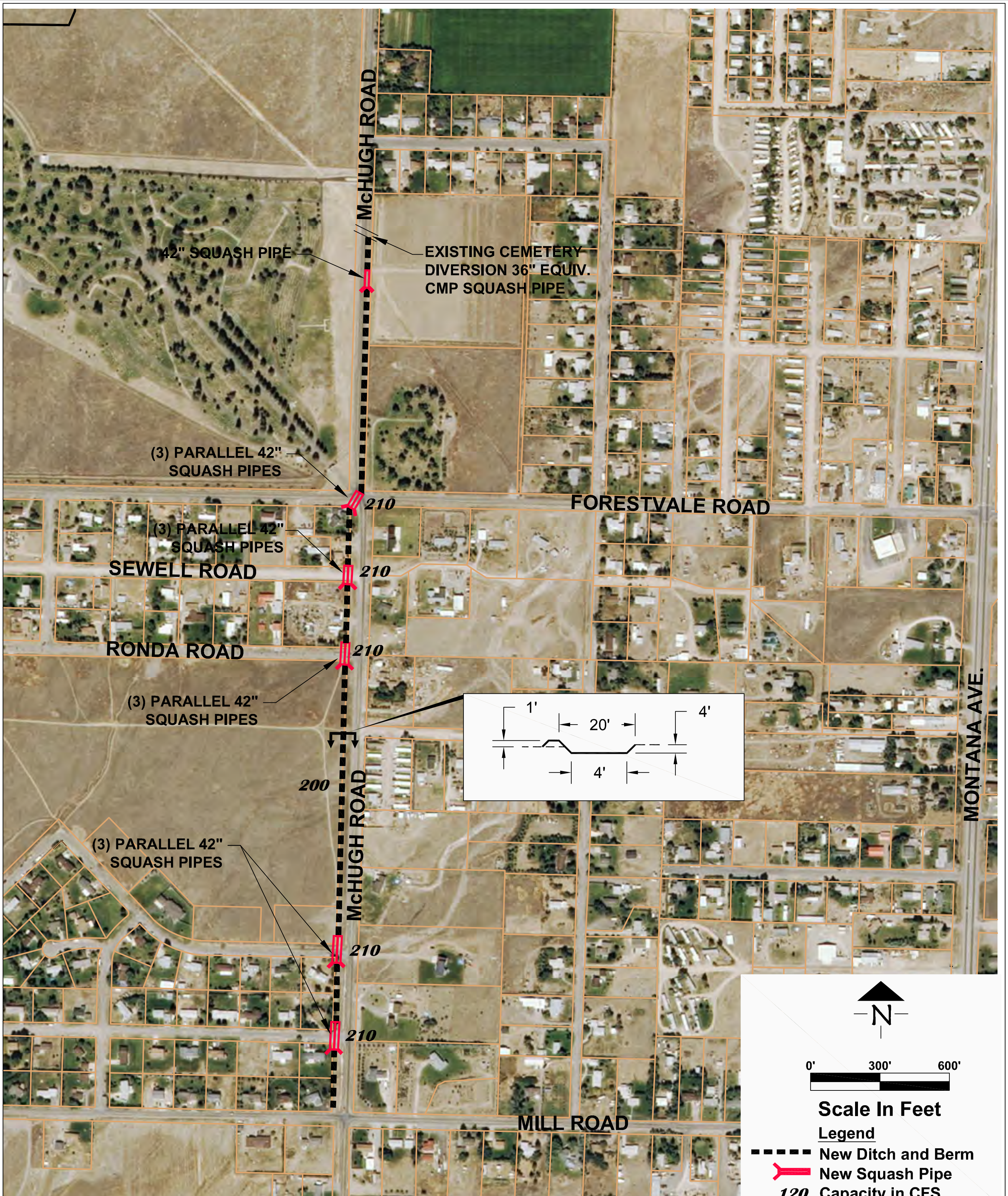
Figure:
5



Project:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan

Figure Title:
Improved Ditch on McHugh-Mill Road to Cemetery Diversion

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Figure:
6

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- Re-grade and expand the ditch on the east side of McHugh between Forestvale and approximately 570' south of Maynard St. (existing crossing under McHugh);
- Install three parallel segments of 42" equivalent concrete squash pipe for each crossing of the McHugh ditch at: Stadler; Edgerton; Ronda and; Sewell
- Install three parallel 50' segments of 42" equivalent concrete squash pipe under the west driveway approach between Sewell and Forestvale;
- Install three parallel 80' segments of 42" equivalent concrete squash pipe under Forestvale & McHugh – from SW to NE quadrant

Engineer's Estimate of Cost: See Project Cost Estimate: McHugh from Mill to 36" "Cemetery Diversion" under McHugh (570' south of Maynard) in Appendix C. The base estimated cost for this project element is $547,000. These estimates include a 10% contingency and engineering services, as well as flared-end transition sections for the upstream end of all culverts and rip rap at critical sections of the ditches.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to implement the McHugh ditch improvements between Mill and the Cemetery Diversion:

a. Explore methodologies for funding improvements
b. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in McHugh, Forestvale, etc.
c. Approach the Montana Department of Transportation to ascertain jurisdictional issues with crossing McHugh and Forestvale Roads. Determine specific requirements that must be observed for those crossings.
d. Final Design
e. Bidding and Construction

From this point (McHugh/36" metal squash pipe crossing or the "Cemetery Diversion") flood flow crosses under McHugh to the west and then northwesterly 2,000' to the existing Forestvale Cemetery retention pond. During the 2011 flood event, this ditch had adequate capacity to carry flow to the retention pond. During the 1981 event, flood flows continued directly north along the west side of McHugh, over Sierra Road and further north.

To provide an outlet for flood flows beyond this point, one of the alternatives is to improve the McHugh crossing and McHugh's westerly ditch to the north, cross under Sierra Road and construct a new ditch directly north to the D2 Drain. That alternative is described as follows:

5. McHugh Ditch from 36” squash pipe crossing (Cemetery Diversion) to D2 Drain

Problem: Under extreme flooding conditions, the flow from McHugh ditch *alone* has the potential to fill the Forestvale Cemetery Pond within 1-2 days. If the HVID Culvert #1 flow is directed to the Forestvale Cemetery retention pond (see Alternative 1 above) the capacity of the retention pond is further limited.

Proposed Solution: See **Figures 7 and 8 – McHugh Ditch from Cemetery Diversion to D2 Drain**

- Replace existing 36” equivalent metal squash pipe crossing under McHugh with three parallel 64' segments of 42" equivalent concrete squash pipe;
- Improve 1,500' of ditch along the west side of McHugh between the culvert crossing and Sierra Road
- Replace the existing 15" CMP culvert (for the Cemetery approach) with three parallel 64' segments of 42" equivalent concrete squash pipe.
- *This alternative provides an outlet to the D2 that matches the capacity of HVID culverts #2 thru #5 (204 cfs)*

Engineer’s Estimate of Cost: See Project Cost Estimate: McHugh ditch from 36" “Cemetery Diversion” crossing under McHugh to the D2 Drain in Appendix C. The estimated cost for this project element is $472,000. These estimates include a 10% contingency and engineering services, as well as flared-end transition sections for the upstream end of all culverts and rip rap at critical sections of the ditches.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to implement the McHugh ditch improvements between Sierra Road and the D2 Drain:

a. Approach the Helena Valley Irrigation District to determine whether storm flows can be introduced into the D2 Drain near its origination point. This will require coordination with the Bureau of Reclamation and downstream landowners. These discussions should also include maintenance or improvement of the D2 drain infrastructure in order to mitigate the effects of higher flows.
b. Explore methodologies for funding improvements
c. Contact affected landowners to begin the process of acquiring easements for the proposed ditch improvements.
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in McHugh, and Sierra Roads.
e. Approach the Montana Department of Transportation to ascertain jurisdictional issues with crossing Sierra Road. Determine specific requirements that must be observed for those crossings.
f. Final Design
g. Bidding and Construction

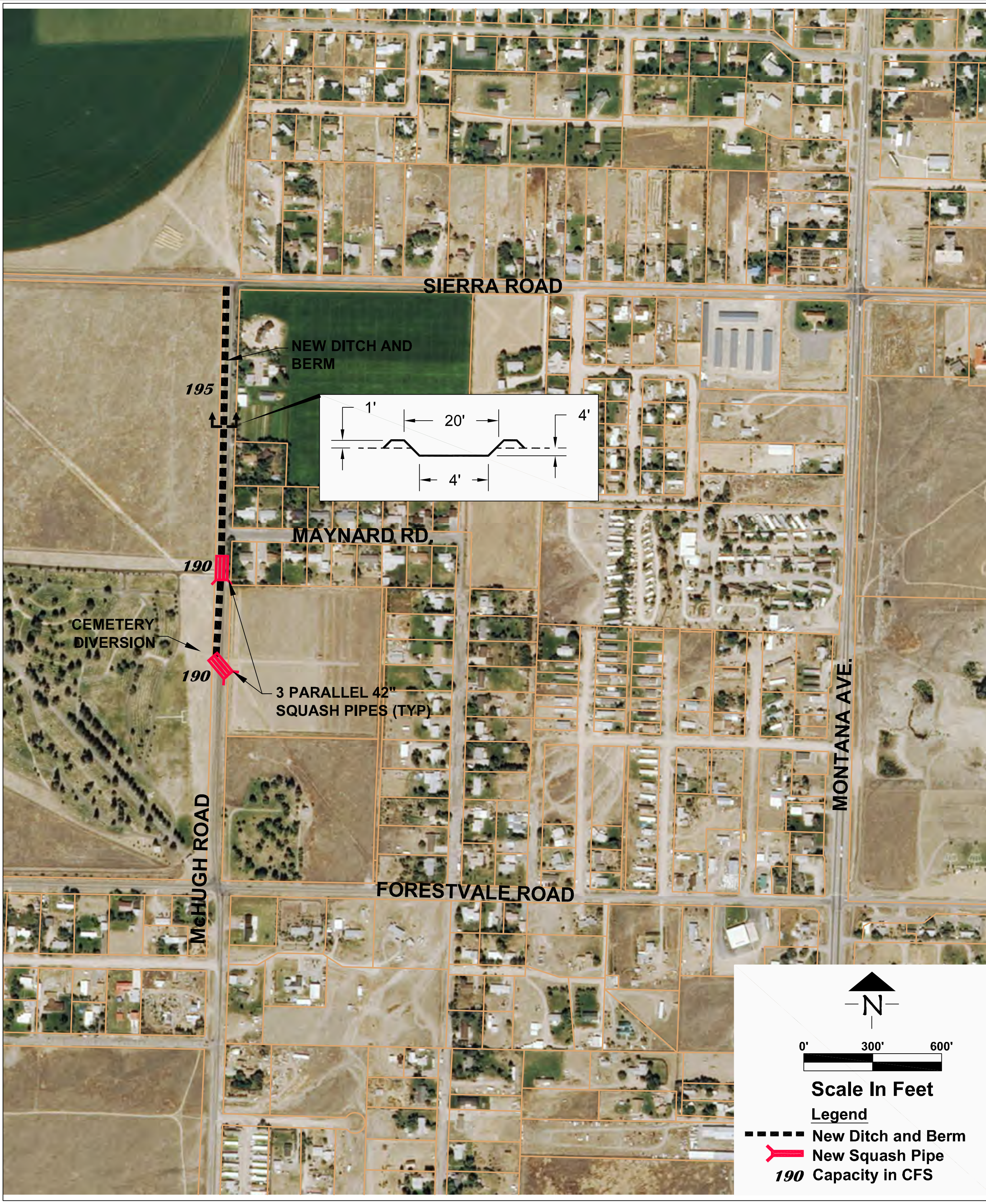

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Figure Title:
Improved McHugh Ditch, Cemetery Diversion to Sierra Road

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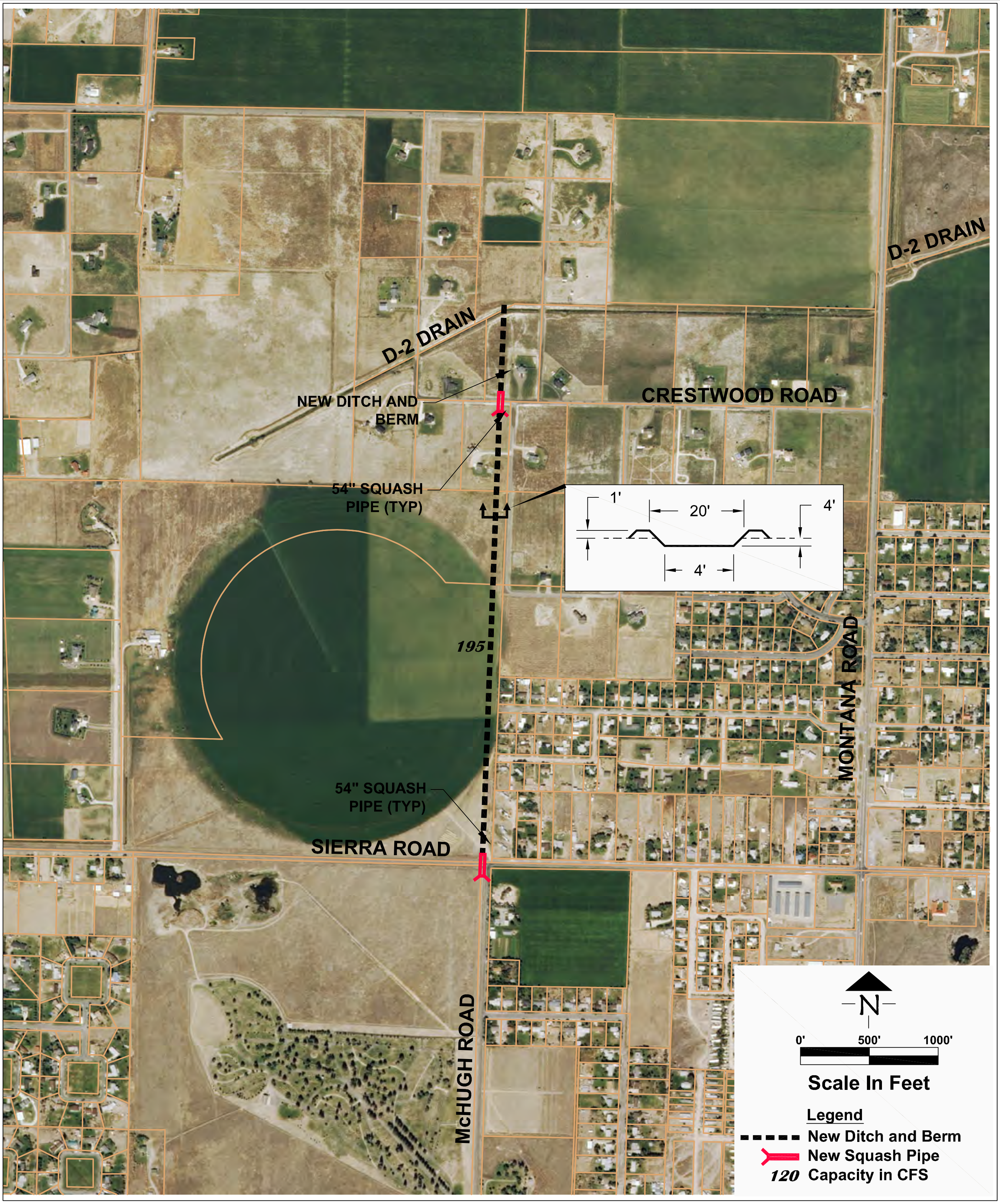
Figure:
7



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Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan	**New Ditch at McHugh Drive/Sierra Road to D2 Drain**	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	**8**

6. Ditch from Mill & McHugh to McHugh & Edgerton to Kerr & Forestvale

Another alternative to the problem discussed in item 4 above, is to direct a portion of the flood flow east under McHugh (approximately 130' north of Edgerton) through the existing floodplain to the intersection of Kerr & Forestvale. The County recently installed two 36" equivalent diameter CMP culverts under Kerr at this location with a combined capacity of 44 cfs.

Problem: Once the flood flow (from HVID Culverts #2 - #5) has been conveyed north under Mill Road in the McHugh ditch, the capacity of the McHugh ditch itself and downgradient culverts are inadequate. This results in flooding of several properties in the Big Sky Subdivision (on Stadler and Edgerton) as well as further north on Ronda, Sewell and Forestvale. Flood flow also inundates portions of McHugh Drive north of Mill Road.

Proposed Solution: See **Figure 9 – Ditch from McHugh/Edgerton to Kerr/Forestvale & New Culvert to N. Montana Ditch**

- Replace the existing 24" CMP culvert crossing under McHugh with 48' of 54" equivalent concrete squash pipe with flared-end section on upstream end;
- Construct 2,150' of 12'-wide ditch from the new McHugh culvert crossing to the intersection of Kerr & Forestvale, rip rap at all changes in alignment;
- Install 75' of 36" equivalent concrete squash pipe under Forestvale, from the first approach east of Kerr;
- Improve 400' of ditch on the north side of Forestvale between Kerr and Georgia Drive, including 60' of 36" equivalent concrete squash pipe for one driveway approach;
- Install a stormwater inlet structure at the NW quadrant of Forestvale and Georgia and approximately 1,220' of 36" equivalent concrete squash pipe directly east to the east side of N. Montana Avenue.
- *This alternative provides an outlet to the proposed Trap Club retention pond and/or D2 drain. Note that the County submitted an application to FEMA in June 2012 to implement $691,669 in improvements to the Trap Club Pond, inlet & outlet and conveyance to the existing Interstate 15 drainage ditch that flows to the D2 Drain. Initial rankings indicate that the FEMA application is likely to get funded.*

Engineer's Estimate of Cost: See Project Cost Estimate: Ditch Mill/McHugh/Edgerton to Kerr/Forestvale to N. Montana Ditch in Appendix C. The estimated cost for this project element is $893,800. This estimate includes a 10% contingency and engineering services, as well as flared-end transition sections for the upstream end of all culverts and rip rap at critical sections of the ditches.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to implement the ditch improvements between McHugh/Edgerton to Kerr/Forestvale and on to the ditch on the east side of N. Montana Avenue:

Project:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan

Figure Title:
Ditch from McHugh/Edgerton to Kerr/Forestvale and New Culvert to North Montana Ditch

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Figure:
9

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a. Approach the Helena Valley Irrigation District to determine whether higher storm flows can be introduced into the D2 Drain through currently-utilized conveyance channels. This will require coordination with the Bureau of Reclamation and downstream landowners. These discussions should also include maintenance or improvement of the D2 drain infrastructure in order to mitigate the effects of higher flows.
b. Explore methodologies for funding improvements
c. Contact affected landowners to begin the process of acquiring easements for the proposed ditch improvements. As many as nine or more landowners would be affected.
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary. Utilities are known to exist in McHugh, Kerr, Forestvale Roads.
e. Approach the Montana Department of Transportation to ascertain jurisdictional issues with crossing Montana with a new culvert. Determine specific requirements that must be observed for those crossings.
f. Final Design
g. Bidding and Construction

7. D2 Ditch Improvements

   Several of the preceding project elements include a direct discharge of up to 600 cfs into the D2 Drain Ditch, during the 25 to 50-year storm event. The D2 Drain is owned by the U.S. Bureau of Reclamation and is operated by the Helena Valley Irrigation District. The D2 currently receives direct stormwater discharge from a ditch on the west side of Interstate 15. This I-15 ditch currently collects virtually all of the runoff from the Tenmile Creek Study Area.

   Problem: As many as five D2 culverts west (upstream) of Interstate 15 are currently undersized to handle the expected flow contributions from proposed Tenmile Creek project elements. If the proposed project elements were to be implemented, the likely result would be flooding of the D2 at the Crestwood and Silverwood crossings as well as at the culverts directly west and east of N. Montana Avenue. **Figure 10** shows the existing crossings of the D2 between its origin and N. Montana Avenue.

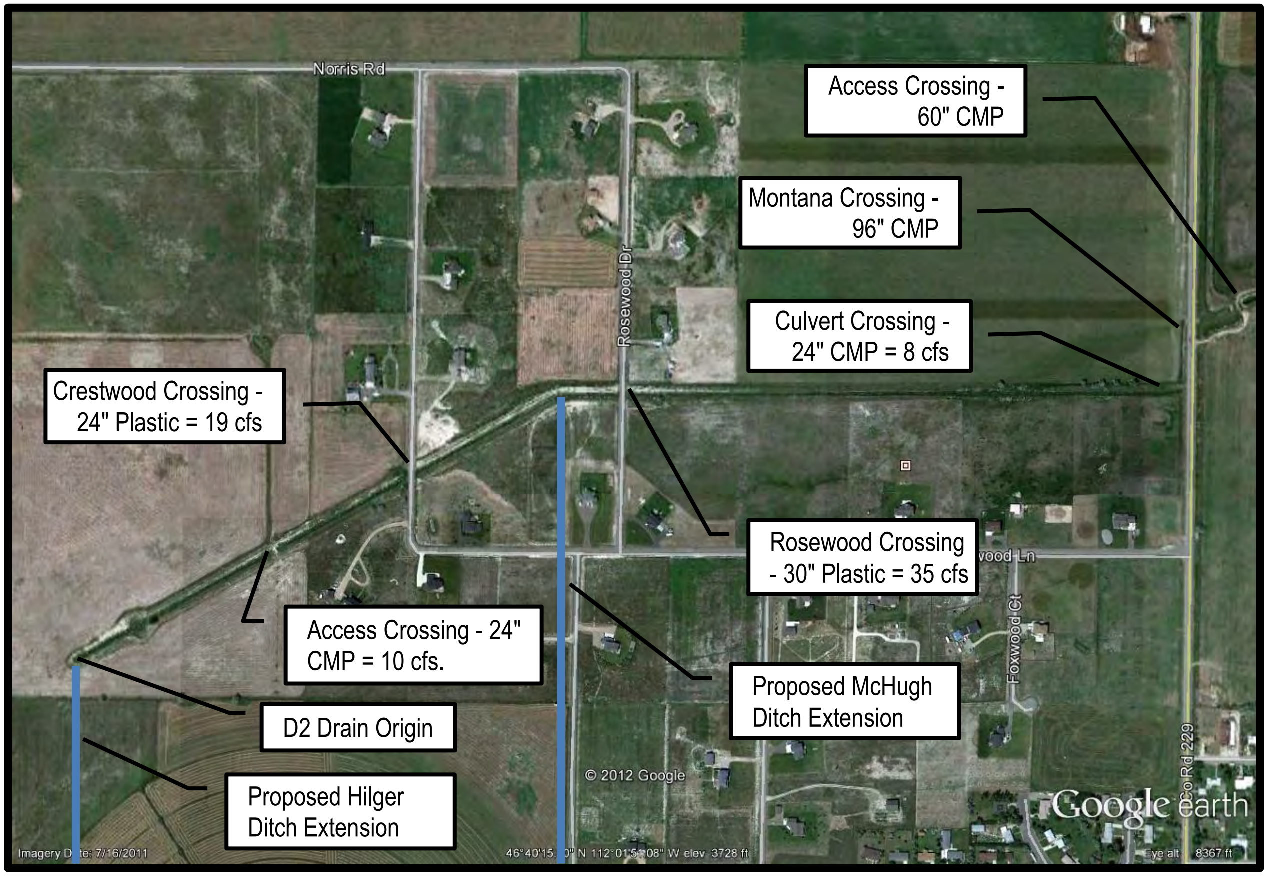


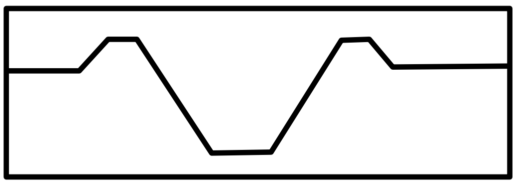
Figure 10 - D2 Drain Ditch Crossings

The Hilger Ditch improvement (section D.1 above) proposes to introduce up to 200 cfs. into the D2 at its origination point, affecting all downstream crossings of the D2. The McHugh Ditch improvement (combined sections D.2, D.4 and D.5 above) proposes to introduce up to 200 cfs. into the D2 just west of Rosewood, affecting the Rosewood crossing and all crossings/culverts downstream to Lake Helena. In order for the D2 to handle these additional flows, it would be necessary to increase the capacity at all of the crossings downstream of the Hilger and McHugh ditch extensions. Hydraulic calculations included in Appendix B indicate the following improvements are needed to provide the D2 with enough capacity to handle the expected flood flows.

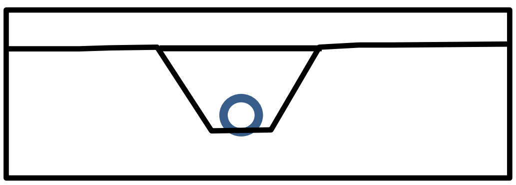
Culvert	Size & Mat'l	Exist. Capacity (cfs)	Needed Capacity (cfs)	Proposed Size & Mat'l
Access	24" CMP	14	220	60" Equiv. Conc. Squash Pipe
Crestwood	24" Plastic	16	220	60" Equiv. Conc. Squash Pipe
Rosewood	30" Plastic	29	540	84" Equiv. Conc. Squash Pipe
N-S West of N. Montana	30" CMP	9	540	84" Equiv. Conc. Squash Pipe
E-W East of N. Montana	48" CMP	29	540	84" Equiv. Conc. Squash Pipe

It should also be noted that the Crestwood and Rosewood crossings of the D2 have also compromised the capacity of the ditch itself. From the point of the D2's origin, the bottom of the ditch is approximately 6' to 7' below the surrounding ground surface, with a 2'-3' berm on both sides. The crossings at Crestwood and Rosewood are at the natural ground surface and the berms have been cut down. The following cross section provides a graphic description of the D2 crossings at Crestwood and Rosewood.

Crestwood Crossing – Note berm compared to road elevation



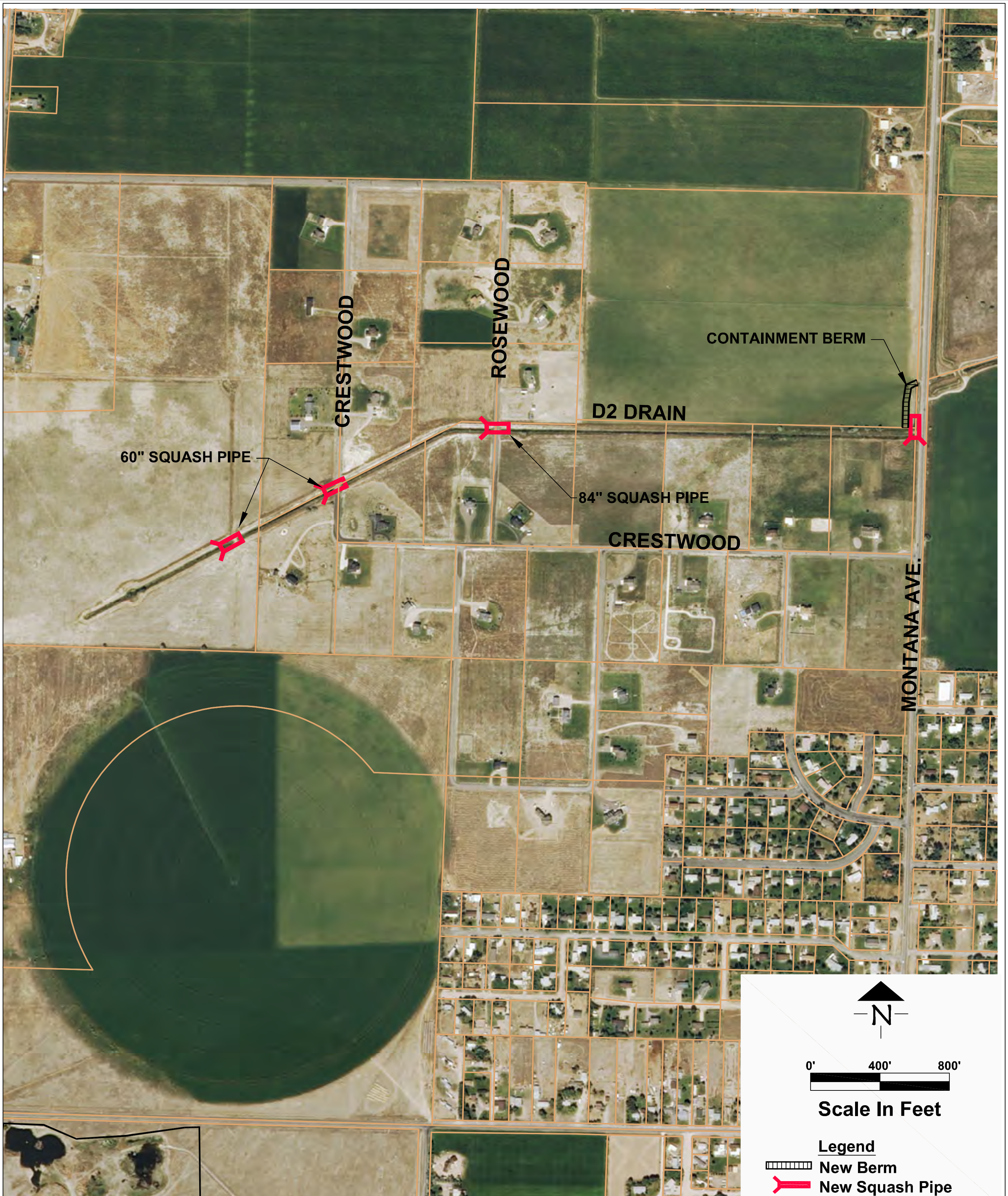
D2 Drain typical cross section: bottom of ditch 6' to 7' below ground surface with 2' to 3' berm both sides.



D2 Drain cross section at Crestwood and Rosewood: bottom of ditch 6' to 7' below ground surface, with no berm.

Proposed Solution: See **Figure 11 – Improved Crossings of D2 Drain (Origin to N. Montana Ave.) to Accommodate Hilger and McHugh**

- Replace the existing 24" CMP culvert crossing under the access with 40' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 24" corrugated plastic culvert crossing under Crestwood with 50' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 30" CMP culvert crossing under Rosewood with 50' of 84" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 24" CMP culvert crossing west of N. Montana Avenue with 25' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 60" CMP culvert crossing the access road east of N. Montana Avenue with 60' of 84" equivalent squash pipe with flared-end section on both ends;
- Raise the D2 approaches at both Crestwood and Rosewood to re-establish the berm height of the original ditch



Project:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan

Figure Title:
D2 Drain

Engineer
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Phone (406) 449-3303
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Figure:
11

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- Earthwork and berm to contain flow west of N. Montana Avenue to avoid flooding agricultural field

Engineer's Estimate of Cost: See Project Cost Estimate: D2 Drain Improvements in Appendix C. The estimated cost for this project element is $318,000. This estimate includes a 10% contingency and engineering services, as well as flared-end transition sections for both ends of all culverts and gravel road reconstruction.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to implement the D2 Drain Improvements:

a. Approach the Helena Valley Irrigation District to determine whether higher storm flows can be introduced into the D2 Drain through currently-utilized conveyance channels. This will require coordination with the Bureau of Reclamation and downstream landowners. These discussions should also include maintenance or improvement of the D2 drain infrastructure in order to mitigate the effects of higher flows.
b. *NOTE: this project element only provides upsizing the five westernmost D2 crossings. There are an additional ten D2 crossings down-gradient that must be analyzed along with the anticipated flows being contributed by Silver Creek/Sewell in Chapter 3 of this Study*.
c. Explore methodologies for funding improvements
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary.
e. Approach the Montana Department of Transportation to ascertain jurisdictional issues with installing a new culvert in N. Montana right-of-way. Determine specific requirements that must be observed.
f. Final Design
g. Bidding and Construction

E. Summary of Recommended Improvements for Tenmile Creek Flood Control

Section D provided a series of project elements that would help mitigate flooding in the Helena Valley due to Tenmile Creek. The objective of each project element is to convey a portion of the flood flow that exits TMC's channel east of Green Meadow Drive. Generally, the overall goal of the combined project elements is:

- to channelize and control flood flows – up to the capacities of the seven culverts under the HVID canal. This capacity is empirically comparable to the 50-year flood frequency of TMC;
- to minimize flooding impacts to residences, commercial properties, transportation corridors, emergency vehicle routes, utilities, etc., by conveying flood waters out of the Helena Valley as rapidly as possible;

Figure 12 shows a summary of the project elements discussed in Section D, along with their respective flow capacities. The following table provides a summary of the estimated costs to implement each TMC project element.

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Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan	Tenmile Creek Proposed Improvement Projects Summary	Anderson-Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	12

Project Element	HVID Culvert No. and Design Capacity	Flood Conveyance Destination	Engineer's Estimate of Probable Cost
Hilger Ditch: HVID Canal to D2 Drain	HVID Culvert #1 = 284 cfs.	Retain in Forestvale Cemetery Pond, outlet to D2	$666,860 ($2.16M including expansion of pond volume to 13M ft^{3})
McHugh Ditch: Hahn to D2 Drain	HVID Culverts #2 - #5 = 204 cfs.	Outlet to D2	$1,809,900
McHugh Ditch: Edgerton-Kerr-Forestvale-Montana	HVID Culverts #2 - #5 = 204 cfs.	Trap Club Pond	$894,000
Nona Ditch: McHugh to TMC	HVID Culverts #6 & #7 = 106 cfs	TMC channel @ N. Montana Ave.	$116,700
D2 Drain Improvements (Origin to N. Montana Ave.)	HVID Culverts #1 thru #5 ≈ 520 cfs	D2 to Lake Helena	$318,000

It is important to note that in order to achieve the goals of minimizing the impacts of flooding, the aforementioned solutions depend upon the availability of the Bureau of Reclamation's (BOR's) and HVID's D2 Drain ditch to receive these flows. The D2 Ditch represents the lowest channel in the Helena Valley and much of the current storm flows end up in the D2. By improving conveyance infrastructure through the Study Area, it is very likely that flood flowrates will significantly increase, while the *duration* of the flooding will be reduced. This will be mitigated by improving and using the two retention ponds (Forestvale Cemetery and the Trap Club) as proposed. Higher D2 flows present some challenging problems for the HVID and BOR. Landowners downgradient from the Study Area on the D2 have expressed concerns that if flood flows increase to the D2, then their property will experience flooding and there could be legal ramifications. Flooding of these properties has apparently occurred in the past, due in part to poor maintenance of much of the D2's infrastructure in this area.

Before improvements can be made to accommodate the Tenmile Creek and Silver Creek flood issues, it would be prudent to evaluate the D2 Drain's capacity to accept additional flows. Otherwise, additional flows of the magnitude anticipated for Hilger, McHugh and Sewell flood mitigation projects could cause significant flooding along the D2. ***Chapter 4*** *of this Study provides an analysis of specific lengths of the D2 ditch as well as calculated hydraulic capacities of the constriction points (culverts) between its origin and Lake Helena.*

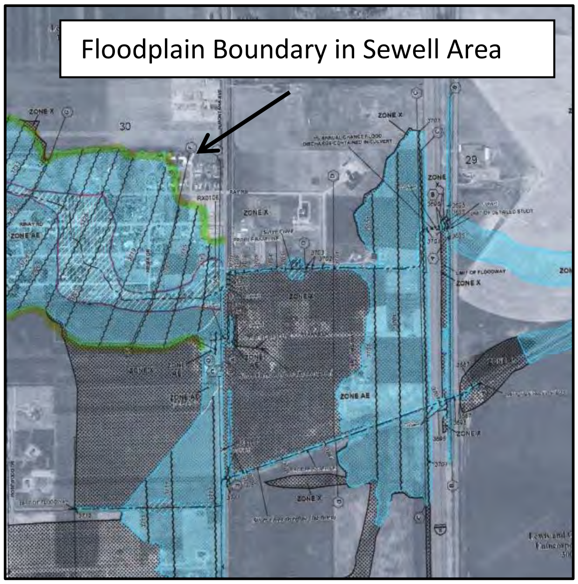
CHAPTER 3

Silver Creek Drainage & Sewell

CHAPTER 3 – SEWELL AREA

A. Drainage Basin Characteristics & Study Area

The Sewell subdivision is located north of Sierra Road and just west of Montana Avenue with an estimated 65 residential units with an estimated population of 160 residents. The area is served with individual septic systems and individual wells for water supply. As shown in the photo, the area is found entirely within the floodplain of Silver Creek and has been subject to several flood events. Studies by Lewis and Clark County have indicated that groundwater is high in the area (Erikson), generally within a few feet of the surface. County health officials have limited the ability for existing residents to replace failed septic systems due to high groundwater and potential flooding. Replacement systems now allowed are restricted to holding tanks.


Floodplain Boundary in Sewell Area

Silver Creek originates in the hills above Marysville, generally flowing southeast towards Lake Helena. The drainage basin above the Sewell area is approximately 44 square miles. Review of aerial photographs indicate that the creek would braid during high flow events east of Green Meadow Drive, as the stream hits the flat valley floor. During lower flows the creek runs in a distinct channel which crosses under several bridges and over the Helena Valley Irrigation Canal before it enters Sewell at the Northwest corner of the development, visible on the floodplain map shown above. The creek flows through the area in a small channel with relatively straight sidewalls approximately 3-4 feet wide and 2-3 feet deep. The stream channel typically dries up in the summer and shows characteristics more similar to a ditch rather than a natural stream. Estimated capacity is approximately 30 cfs. When flows exceed this amount, shallow flooding occurs throughout the area resulting in damage to roads, difficult access and inundation of both water supply wells and septic systems. A severe flood event would impact structures in the Sewell area although there are several trailers in the development that rest on elevated foundations which would limit flood damage.

Flows leave the Sewell area via a 4’ by 10’ rectangular box culvert under Montana Avenue flowing east to a small detention pond built by the Soil Conservation Service. As shown in the photo to the left, the Montana Ave. culvert is severely plugged with sediment and will only pass about 100 cfs under current conditions. It has been estimated in previous studies that the box culvert could pass as much as 360 cfs if the culvert was fully open. During the 2011 flood, flows backed up at this culvert eventually resulting in an indirect southward flow to the D2 drain, as relief.

The photo to the right, taken in June of 2011, is looking west into Sewell from the box culvert. Flow from the SCS detention pond flows east through a small 24” culvert under the interstate or alternatively, through the D2 drain before it passes under the highway in a 96” culvert.

The 1982 Flood Drainage Study for Silver Creek prepared by Morrision Maierle estimated flood flow rates in Silver Creek by extrapolating data from studies for Little Prickly Pear Creek, a similar drainage basin with much better measured data. Minimal actual data on flows in Silver Creek is available. The study identified the following peak flows, estimated to occur where Green Meadow Drive crosses the stream:

Frequency	**2-Year**	**10-Year**	**50-year**	**100-year**
Peak Discharge (cfs)	**140**	**340**	**560**	**660**

It is recommended that further analysis of flood flow rates be performed before these numbers are used for design purposes. Given the capacity of the ditches and hydraulic structures throughout the area, these discharge rates would suggest that Sewell should flood more frequently than observed. The 1982 study indicated that a bypass channel around Sewell sized sufficiently to carry the suggested 100 year flood event in Silver Creek would require a Right of Way of 130 feet in width and a channel built 94 feet wide and 13 feet in depth. A channel of this size would obviously require large dedicated land area, significant expense and is likely not a practical solution.

B. Flood Mitigation

There are several means to mitigate the impacts of flooding in the Sewell area with a wide range of effectiveness as well as associated costs. Both non-structural and structural options will be considered, with the difference being that a non-structural alternative will generally reduce the consequences or risk associated with flooding without actually altering or reducing pathways or discharge rates of flood waters. Non-structural alternatives that may have application in the Sewell area are considered as follows:

Non-Structural Flood Hazard Mitigation

1. **No-Action** – This option essentially would keep the status quo, with minor maintenance of existing drainage systems and impacted roadways. Use of sandbags would be applicable to this option to reduce damage during flood events. This approach does not address identified problems and, given the expected frequency of flood events in the area, is not a recommended approach. Public health hazards associated with the periodic flooding of water supply wells and septic systems would continue. As existing drainage systems deteriorate or

are filled in, flooding will become a greater problem. This option has the benefit of low cost.

2. **Flood Insurance-** Flood insurance is available to help mitigate the costs associated with flood damage. The cost of the insurance premium is function of flood risk as determined by the flood hazard rating shown on FEMA FIRM maps. Given the risk in the Sewell area, the annual cost of flood insurance may be quite expensive. The coverage is limited and damage due to rising groundwater levels is not covered.

3. **Control Floodplain Development and Floodproof Existing Structures –**This approach would preclude new development in the floodway and limit development in the floodplain. It has limited applicability in Sewell because the area is nearly fully developed. Mobile homes could be elevated and put on foundations above anticipated flood elevations. Note that most of the mobile homes in Sewell are already supported on elevated foundations. Basements, if they exist, could be filled and made flood resistant. Public water and sewer systems could be installed to reduce the risk of system failure and or system cross contamination. However, central water and sewer systems are not free from problems during flood events. The Sewell area residents rejected the option of forming a sewer district which is the first step in installing a central sewer system.

4. **Flood Plain Purchase and Relocation-** This alternative would allow for the purchase of existing homes in the area and relocating residents. The purchased structures would either be relocated or demolished. This process would be quite expensive. If each property is worth $100,000 and there are 65 properties, the cost would be $6.5 million dollars plus the cost of demolition and site restoration.

Structural Alternatives for Flood Hazard Mitigation

The following two options were evaluated to reduce the impacts of flooding through the Sewell area. The first option is relatively low cost and allows for use of existing drainage channels and hydraulic structures, with improvements.

1. Improve Existing Drainage Infrastructure

a. Improve Silver Creek Channel through Sewell -The conveyance capacity of the Silver Creek channel could be improved to handle an increased storm event, ideally the 100 year flood event. Work would include improving the hydraulic capacity of the existing channel in conjunction with berms and improved culvert capacity. Additional easements may also be required for the construction and maintenance of this improved channel.

b. Clean Montana Avenue Culvert-The existing culvert is composed of reinforced concrete with approximate inside dimensions of 10 feet wide by 4 feet tall and is significantly restricted by deposition of scoured soil, plant growth and debris. Additionally, the grade from the culvert is minimal which limits drainage away from the structure. Estimated capacity from the structure is restricted to about 100 cfs whereas the capacity could be much greater, up to 360 cfs, if the accumulated materials could be removed and the downstream drainage improved.

c. Improve Drainage East of Montana Avenue-Currently, storm drainage crosses Montana through the rectangular culvert and flows north about 180 feet were it turns east eventually crossing the interstate through a 24” culvert. A small waterfowl pond is located along the ditch heading east to the interstate. At that culvert discharge point on the east side of the highway it enters a large ditch which flows south to the D2 drain ditch. Capacity is limited by the clogging of the rectangular culvert as previously discussed and the limited capacity of the downstream channel and undersized culvert under the interstate. This need can be addressed in two different manners or a combination of the two, described as follows:

Alternative 1 – This option allows for use of the existing ditch and conveyance system to move drainage to the east. The critical limitation is the 24” culvert under the interstate which can now carry roughly around 50 cfs (estimating slope) maximum. This culvert would need to be replaced or a second built to convey reasonable surface flow away from the Sewell area and downstream. The culvert now discharges into a side channel which parallels the east side of the interstate, flowing into the D2 drain. This channel has ample capacity. Conveyance ditches between Montana Avenue and the interstate would require cleaning and regrading of the existing channels. Discussion with local landowners verifies that water accumulates near the interstate crossing, indicating lack of capacity. Other than the new culvert, this option utilizes much of the existing infrastructure thereby causing minimal adverse impacts in the immediate area. Downstream effects on the D2 drain should be further considered.

Alternative 2 – After crossing Montana Avenue, sufficient grade exists to split flow between the current flow channel to the north and a new channel to the south following Montana Avenue on the east side until the new ditch intersects the D2 drain. This option would require the construction of a new drainage ditch, two new culverts for existing access roads coming off Montana and an upgrade of an existing undersized culvert located in the D2 drain.


Undersized Culvert in D-2 Drain

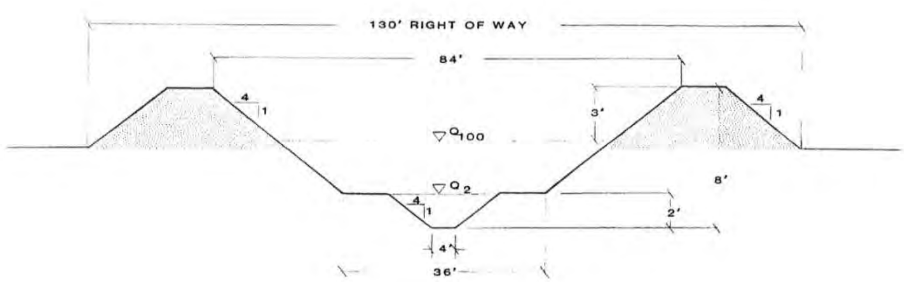
Figure 13 provides a drawing showing location of proposed improvements

Estimated costs for the improvements, including engineering and a contingency are **$515,400**, detailed in Appendix E. The costs for each alternative would be very comparable. Any work in Sewell to improve drainage should be considered in conjunction with other projects that may impact the middle reaches of the D2 drain. For example, the improved conveyance of stormwater flows from Ten Mile Creek may also require improvements to the D2 drain, consequently, this work could also benefit drainage for Silver Creek.

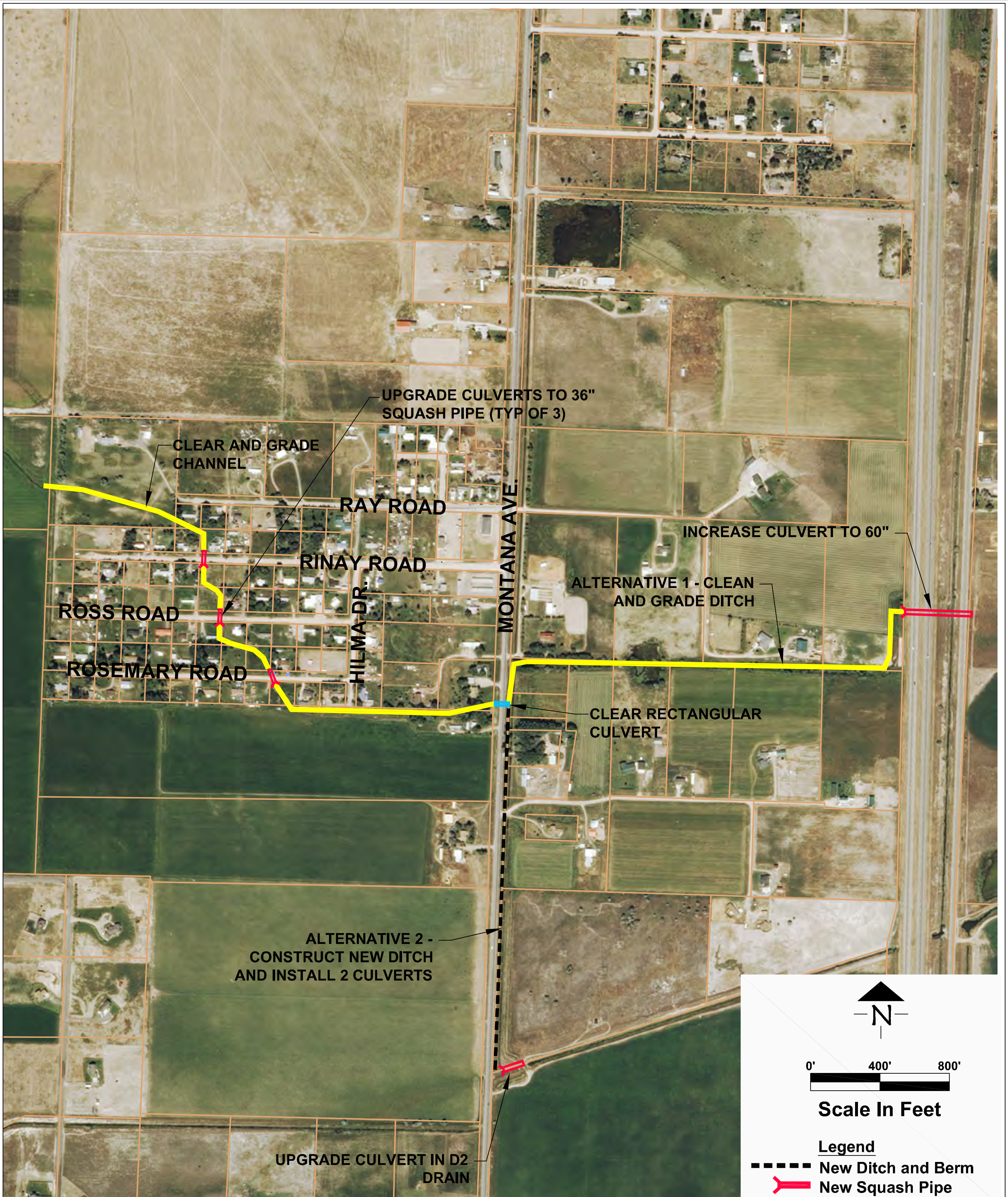
2. Modify Flood Flows through the Sewell Area

This option would reduce flood hazards to the Sewell area by construction of an overflow bypass channel that would divert flood events in Silver Creek around the developed area. The diverted flow would eventually be collected in the D2 drain to flow towards the east to Lake Helena. Figure 14 provides a drawing showing potential location of proposed improvements. Estimated costs are shown in Appendix E for the improvements, including engineering and a contingency, are **$2,244,400** excluding the costs of downstream improvements to the D2 drain. Need project components are described, as follows:

> **a. Construct Bypass Channel-** A bypass channel would carry flood flows around the development thereby eliminating potential for flood damage. Depending on the capacity of the channel, the area could be effectively removed from the floodplain. The conveyance capacity of the existing Silver Creek channel through the subdivision is approximately 30 cfs, while the 100-year event is now estimated to be 660 cfs. The bypass channel would be sized to handle the excess flow of approximately 630 cfs. The installation of a bypass channel would reduce the need to make drainage improvements within the Sewell area but would likely require downstream improvement including an expanded crossing of Montana Avenue, larger channel to the east and improved or new crossing under Interstate 15. New easements would be necessary for installation of the bypass.



Drawing from 1982 M&M Flood Study



Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan	**Improve Existing Sewell Area Drainage Infrastructure**	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	**13**

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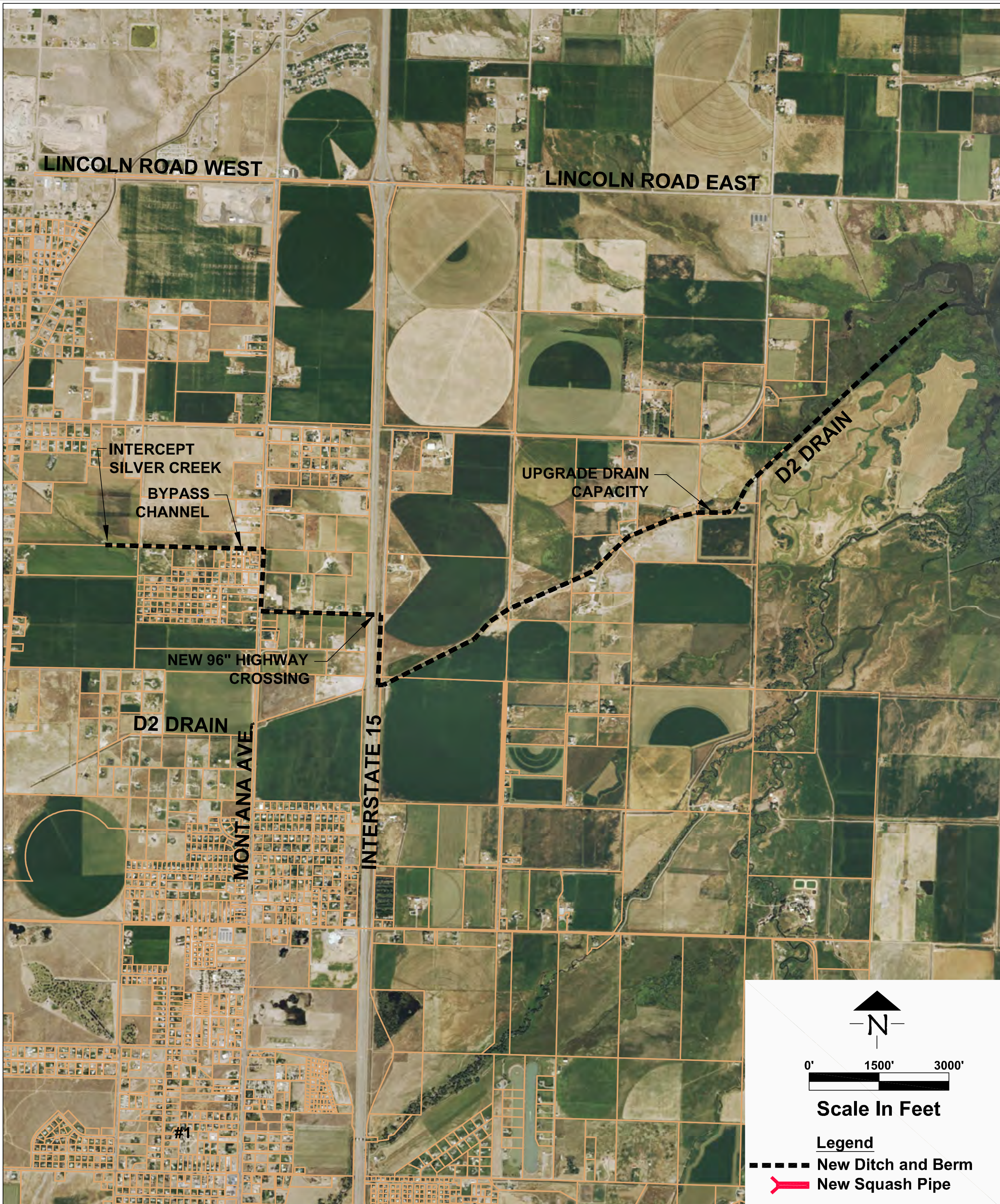

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Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Plan	Silver Creek Bypass Alternative	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	14

The drawing section shown previously depicts a cross section of a channel sized to carry a flow of 630 cfs. The resultant channel is quite wide in section, requiring 130 feet in right of way. Before committing to a design of this magnitude, further studies to verify flood flow discharge rates would be warranted. A significant easement through private land would be needed to build a channel capable of carrying 630 cfs.

b. Improve Drainage East of Montana Avenue

Currently, storm drainage crosses Montana through the rectangular culvert and flows north about 180 feet were it turns east eventually crossing the interstate through a 24” culvert.   At that culvert discharge point on the east side of the highway it enters a large ditch which flows south to the D2 drain ditch. Capacity is limited by the clogging of the rectangular culvert as previously discussed and the limited capacity of the downstream channel and undersized culvert under the interstate. To handle the flows in the bypass channel, it is necessary to add a second culvert under Montana Avenue, increase the existing flow channel which currently handles Silver Creek and install a new culvert under the Interstate. The critical limitation is the 24” culvert under the interstate which can now carry roughly around 50 cfs (estimating slope) maximum.   The culvert now discharges into a side channel which parallels the east side of the interstate, flowing into the D2 drain. This channel has sufficient capacity but as the flow enters the D2 drain east of the highway, the primary channel of the drain to Lake Helena should be upgraded to handle anticipated drainage flows, storm water discharge from other areas and this flow. Improvements to the D2 drain are considered in the following Chapter. Estimated costs for this option are $2.24 million dollars. An alternative to expanding the Silver Creek crossing under the Interstate would be to direct flow to the D2 drain near Montana Avenue. This option would require improvements to the D2 drain crossing under the Interstate. Improvements to the drain are considered in the next section of this report.

C. <u>Conclusions and Recommendations</u>

The Sewell area is located within the floodplain and floodway of Silver Creek and can be expected to be exposed to flood events on a frequent basis. Several residents have made accommodations to their homes and outbuildings to mitigate the impacts of a flood, primarily by raising the floor elevation of their structures. Existing infrastructure exists to carry typical flows in Silver Creek through the area as well as limited storm runoff. The stream follows a channel through the area that should be cleaned out, obstructions removed and larger culverts installed under the three road crossings. Driveway access culverts should be maintained by removing any blocking material, grass and general debris. The photo above shows an excellent example of a well-maintained drain ditch and culvert in the Sewell area, taken care of by the adjacent landowner.

Stormwater accumulates along Montana Avenue and then along the interstate due to the limited capacity in the crossings as a result of accumulated solids or undersized conduits. To effectively increase flow away from Sewell, these crossings must be upgraded to reduce the accumulation of water and increase the flow capacity of existing conveyance systems. Alternatives to installation of a new culvert under the interstate where evaluated previously, utilizing a connection to the D2 drain near the east side of Montana Avenue. As discussed, all stormwater ultimately enters the D2 drain and downstream improvements to this ultimate drainage system must be considered in conjunction with work in the Sewell area. The D2 drain improvements are included in the following Chapter 4.

Improvement of local infrastructure could occur in a staged process but it is recommended that downstream improvements to the D2 and the interstate crossing being prioritized. Increasing flow away from the Sewell area will increase accumulation of floodwaters near downstream control points, increasing potential flood hazards. Undersized or poorly maintained culverts in Sewell and under Montana Avenue are also key control points that should be prioritized for implementation.

The ultimate long-term solution for the protection of the Sewell area would be to construct a bypass channel around the developed areas plus implementation of downstream improvements. This option is very expensive, exceeding $2.2 million dollars plus the cost of improvements to the D2 drain. This alternative would likely exceed the ability of the local residents' capability to repay the costs of work, financed through a local improvement district. An infusion of grant funding or Federal assistance would be needed for this project to proceed.

CHAPTER 4

D2 Drain Ditch

CHAPTER 4 – D2 DRAIN IMPROVEMENTS

A. D2 Purpose, Capacity and Condition

Helena was established in 1864, following the discovery of gold in Last Chance Gulch, and was a thriving gold camp by 1865. Many of the miners, disappointed in their quest for gold, took up homesteads in the valley. By 1865, the water from Prickly Pear, Tenmile, Silver, and McClellan Creeks was appropriated for irrigation purposes concurrently with the land claims, and shortages of water were noted as early as 1866.

From 1910 to 1920, Lewis and Clark County was rather heavily settled. As agriculture yields and prices dropped rapidly after 1919, farm bankruptcies, foreclosures, and attractive industrial opportunities in other sections of the country induced people to leave the area. In 1905-1906, a preliminary investigation by the Reclamation Service proposed diversion of Madison River waters to supply irrigable land in the Helena Valley by a canal. In 1912, The Montana Reservoir and Irrigation Co., a subsidiary of the former Montana Power Company, developed an irrigation system to serve an area similar to that planned by Reclamation and erected pumping plants on the north and south shores of Lake Helena. The Montana Reservoir and Irrigation Co. contract expired in 1942, but the company operated the pumps and served the land on the same basis beyond that time. Reconnaissance investigations of the Helena Valley Basin by the U.S. Bureau of Reclamation (BOR) were reported in 1940 and 1943. Various reservoir sites and other alternatives were investigated. The recommended plan involved pumping irrigation water from Canyon Ferry Reservoir. This plan was outlined in Senate Document 191, 78th Congress, 2nd session. Concurrently with the establishment of supply water for agriculture in the Helena Valley, it was also necessary to lower the existing groundwater levels in order to provide the vadose zone to support healthy root growth and agricultural production. In the late 1960’s, this goal was accomplished by the installation of 26.6 miles of open drain ditches (including the primary root ditch, the D2) and a 29.9-mile network of buried drain pipes that feed into the open ditches. Ultimately, all of the drainage water reports to the open D2 Drain which flows into the west end of Lake Helena. According to the BOR website *http://www.usbr.gov/projects/Project.jsp?proj_Name=Helena%20Valley%20Unit*, construction of the entire irrigation supply and drainage infrastructure was completed in 1958. Various alterations have been made to the D2, primarily as a result of crossing the drainage ditch with highways, roads, and approaches. A total of 15 crossings occur between the beginning of the D2 open ditch and its termination at Lake Helena. All crossings consist of culverts ranging in size from 24" to 96".

In order to determine the D2 Drain’s ability to accept additional flood flows from the Study Area(s), it is necessary to calculate the capacity of the various open ditch segments as well as all the crossing constrictions. Applying a simple Manning’s formula for open-channel flow to the ditch and its culverts, it is possible to estimate the current capacities and determine whether and where any hydraulic restrictions exist. Hydraulic restrictions would increase the frequency and magnitude of localized flooding upstream of the restriction. The Table below shows the calculated capacities of specific segments of the open D2 Drain and its culverts as shown in **Figure 15**.

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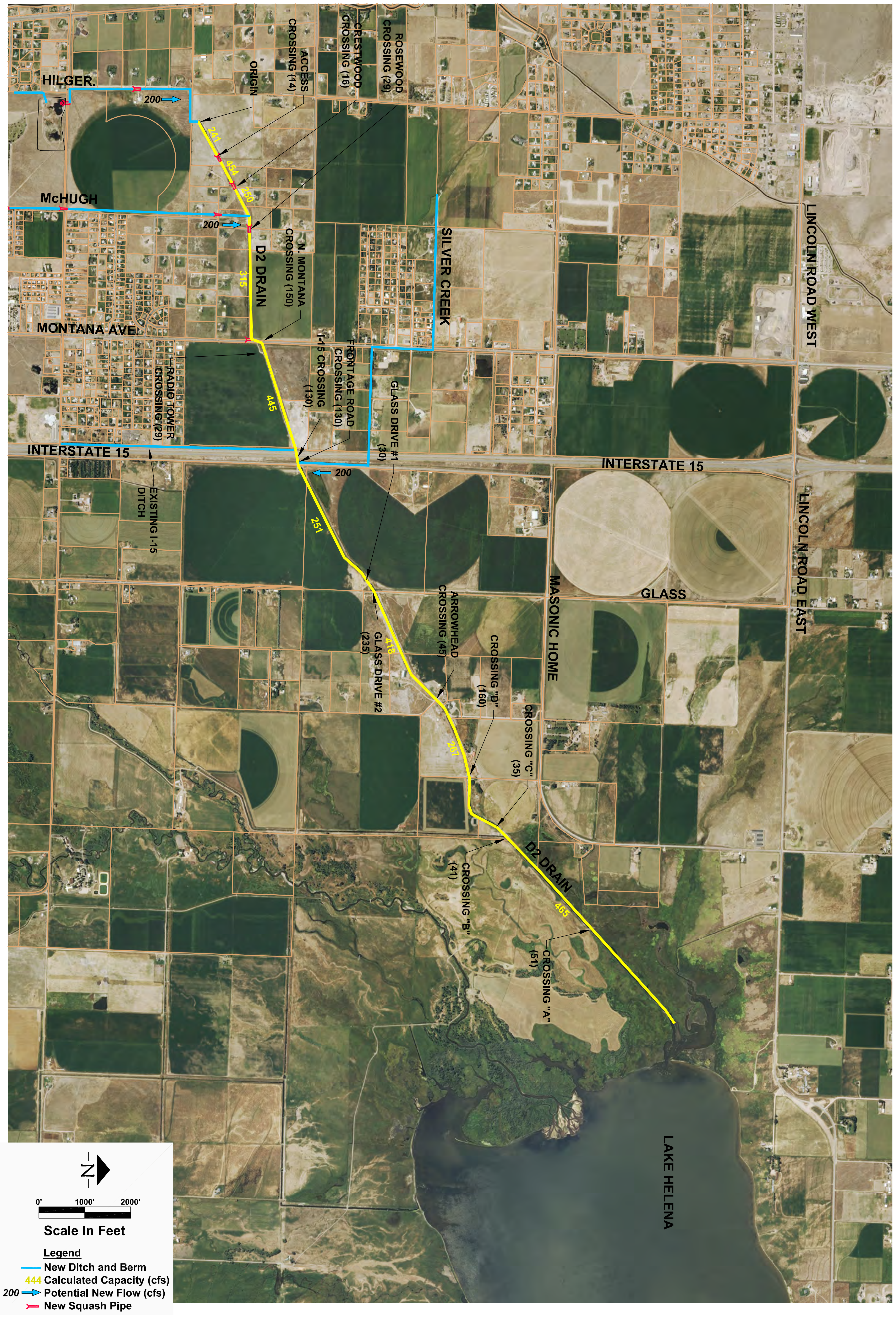


Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan	D2 Drain to Lake Helena Existing Capacity	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	15

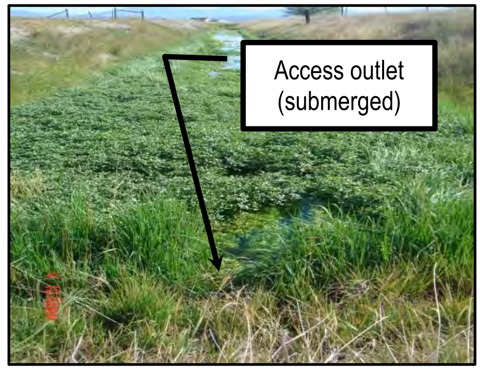
Segment/Feature	Length (ft)	Dimensions	Slope (ft/ft)	Capacity[1] (cfs)	Notes
Origin to Access crossing	965	14' top width 8' bottom width 7' depth	0.0032	241	Choked with vegetation during 8/12 site visit. Shallow gradient and slow flow. No defined channel.
Access crossing culvert	35	36" (estimated) corrugated metal pipe	0.0035	14	Access crossing culvert (original) completely submerged – likely due to downstream hydraulics and shallow slope.
Access to Crestwood	630	14' top width 8' bottom width 7' depth	0.0034	454	Abundant vegetation although there is an open water channel with observable flow.
Crestwood crossing culvert	52	24" corrugated plastic pipe	0.0035	16	
Crestwood to Rosewood	950	22' top width 10' bottom width 6' depth	0.0034	230	Capacity limited by dike breaches at both roads
Rosewood crossing culvert	64	30" corrugated plastic pipe	0.0035	29	
Rosewood to N. Montana	2,655	25' top width 3' bottom width 7' depth	0.0035	315	Undersized crossing before N. Montana culvert – NW field must flood before NMT crossing is fully used.
N. Montana crossing culvert	62	96'' CMP	.0035	150	Installed way too high – calculated at half of full-pipe flow.
N. Montana to radio tower access	146	16' top width 3' bottom width 7' depth	0.01	360	Lateral enters from N. (flowing). Steep: head wasted.
Radio tower access culvert	205	60'' CMP	0.0035	29	Half full of dirt. 8½" freeboard, v ≈ 1 fps.
Radio tower access to I-15	2,230	30' top width 3' bottom width 8' depth	0.0035	445	I-15 ditch enters from S.
I-15 & Frontage crossing culverts	390	96'' CMP	0.0035	130	48" freeboard. v ≈ 0.5 fps. Currently flowing 12.6 cfs.. Lateral enters from S.
Frontage Road to Glass Drive #1	2,915	22' top width 2' bottom width 7' depth	0.0035	251	
Glass Drive #1 crossing culvert	65	72'' CMP	0.001	30	V ≈ 1.09 fps. 58'' full – currently flowing 27 cfs.
Glass Drive #1 to Glass Drive #2	188	25' top width 2' bottom width 7' depth	0.0035	286	Lateral enters from N.
Glass Drive #2 crossing culvert	30	84''x84'' concrete box culvert	0.015	235	V ≈ 5.1 fps. 10'' full – currently flowing 40 cfs.

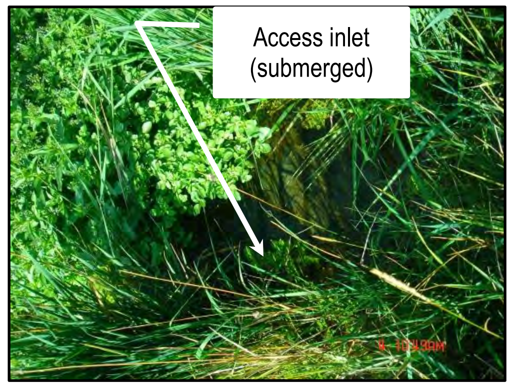
Segment/Feature	Length (ft)	Dimensions	Slope (ft/ft)	Capacity[1] (cfs)	Notes
Glass Drive #2 to Arrowhead	2,700	28' top width 3' bottom width 8' depth	0.0035	418	
Arrowhead crossing culvert	60	60'' CMP	0.0035	45	15½" freeboard v ≈ 1.7 fps
Arrowhead to crossing "D"	1,856	28' top width 3' bottom width 6' depth	0.0035	267	
Crossing "D" culvert	65	72'' CMP	0.01	160	V ≈ 5.8 fps. 36'' full – currently flowing 82 cfs.
Crossing "D" to Crossing "C"	1,400	26' top width 3' bottom width 6' depth	0.0035	249	
Crossing "C" culvert	56	72'' CMP	0.0006	38	V ≈ 1..3 fps. 55'' full – currently flowing 30 cfs.
Crossing "C" to Crossing "B"	417	26' top width 3' bottom width 7' depth	0.0035	315	Lateral enters from S.
Crossing "B" culvert	40	Twin 72'' CMP	0.0002	41	V ≈ 0.8 fps. 60'' full – currently flowing 38 cfs. cumulative
Crossing "B" to Crossing "A"	2,364	28' top width 20' bottom width 6' depth	0.0035	236	Heavily vegetated, berms shallower than upstream.
Crossing "A" culvert	50	Twin 72'' CMP	0.0003	51	V ≈ 0.9 fps. 58'' full – currently flowing 46 cfs..cumulative
Crossing "A" to Lake Helena	2,800	45' top width 30' bottom width 4' depth	0.0035	465	Berms largely gone. Shallow, wide channel.

[1] - based on: Manning's Open-Channel flow equation; presumed friction coefficients; generalized topographic data and, where available; field measurements. Capacities were not arrived at based on computerized hydraulic modeling, which should be considered by Lewis & Clark County prior to design of D2, Tenmile and Silver Creek flood mitigation improvements.

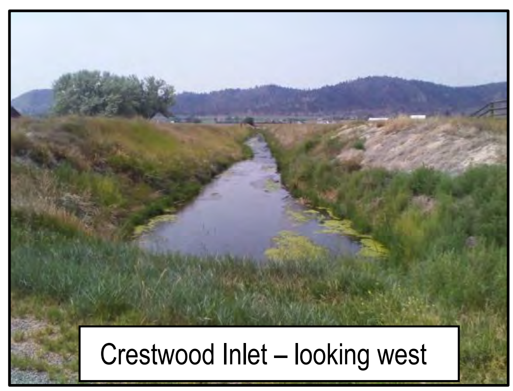
The measurements recorded in the table above were collected during observations in August 2012. The entire ditch length was toured, flow depths and velocities were estimated and each of the 15 crossings were photographed. Beginning with the origin at D2's west end, the following narratives and photographs provide a description of each of the existing 15 crossings prior to Lake Helena:

Access – The Access Crossing is the first crossing east of the D2's origin. At the time of the evaluation, the entire pipe under the crossing was submerged and choked with vegetation so a direct size measurement was not possible. The pipe appeared to be a 36" CMP and there was visible current exiting the downgradient end east of the crossing. This installation appears to be relatively old. The D2 in this area is virtually choked with aquatic vegetation and sediment accumulation and has a very flat gradient.

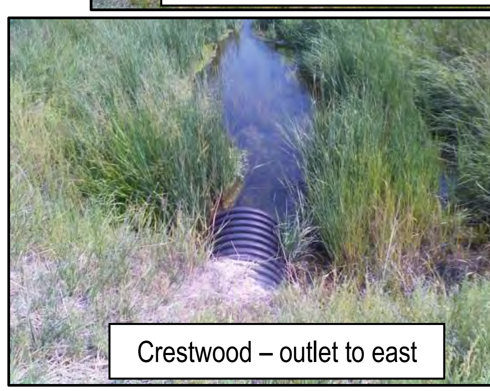




Crestwood - The Crestwood crossing is a 24" corrugated plastic pipe that was apparently installed when Crestwood Road was installed. The D2 in this area is relatively deep and well-defined although the vegetation suggests the accumulation of sediments. The typical 3' to 4' berms on both ditch banks are absent at Crestwood – limiting ditch capacity.


Crestwood Inlet – looking west


Crestwood Outlet – looking east


Crestwood – outlet to east

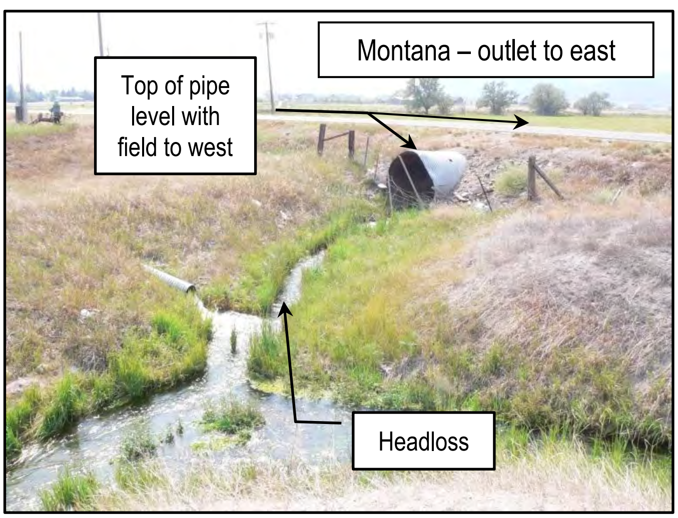
Rosewood - The Rosewood crossing is a 36" corrugated plastic pipe that was apparently installed when Rosewood Road was installed. The D2 in this area is relatively deep and well-defined although the vegetation suggests the accumulation of sediments. The typical 3' to 4' berms on both ditch banks are absent at Rosewood – limiting ditch capacity.


Rosewood – outlet to east


Rosewood – inlet from west

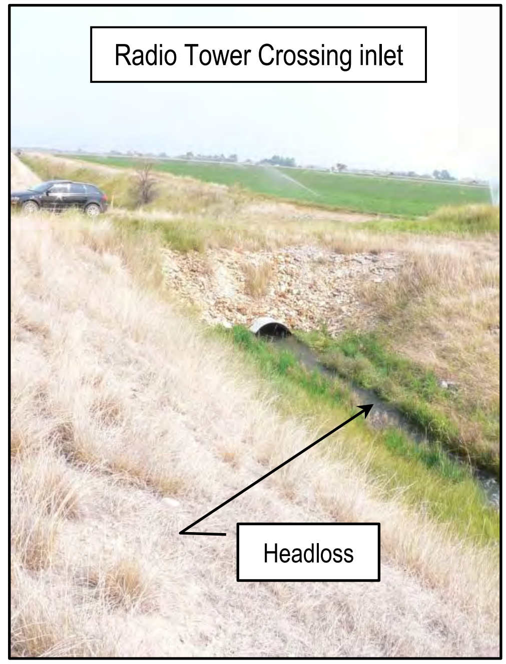
North Montana – The D2 goes through a 36" CMP just west of N. Montana Avenue, parallels Montana for 300' then crosses under Montana in a 96" CMP. The 96" CMP appears to be installed too high since there is rapid flow below the culvert (steep slope) and very slow flow above. In order to utilize the entire pipe capacity, there would need to be significant ponding west of Montana as the top of the pipe is roughly level with topography approximately 0.4 miles west of the crossing culvert.

Montana – outlet to east



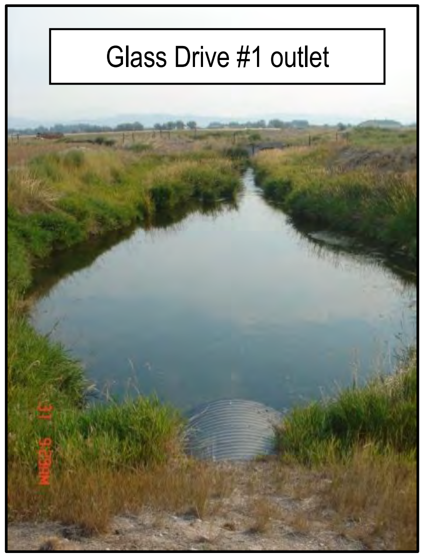
Montana – outlet to east

Radio Tower – The Radio Tower crossing is a 60" CMP installed when the radio towers were installed to the east of Montana. There is a significant amount of wasted headloss in the 140' between Montana and the Radio Tower crossing that could be utilized to provide more consistent flow characteristics in the ditch itself.

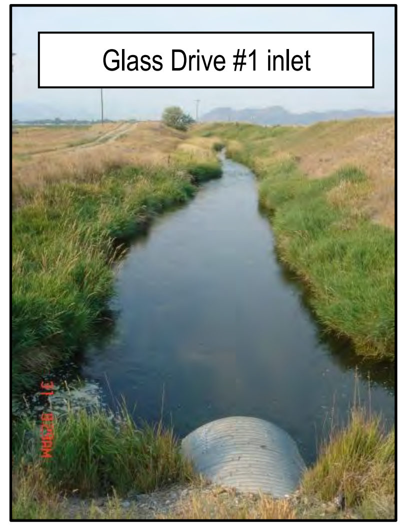


I-15 and Frontage Crossings – These crossings consist of a 215' segment of 96" diameter CMP and a 100' segment of 96" diameter CMP under Interstate 15 and Frontage Road, respectively.

Glass Drive #1 – The first crossing of D2 directly south of Glass Drive is a 72" CMP. At the time of the site visit this culvert was near capacity. The D2 in this area is 8' to 11' deep with heavy riparian vegetation on both banks.



Glass Drive #1 outlet



Glass Drive #1 inlet

Near Full at outlet

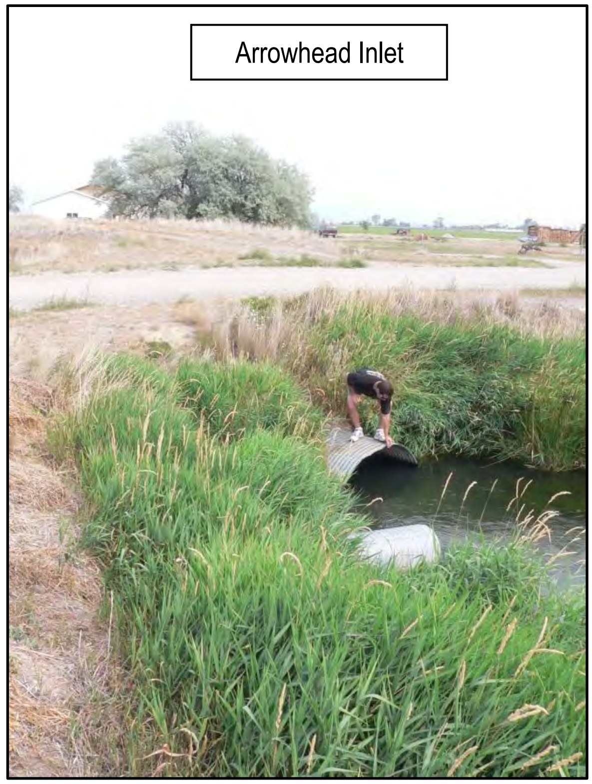
Glass Drive #2 – The second D2 crossing directly south of Glass Drive is a 7' by 7' concrete box culvert installed by the landowner for access to agricultural property. The D2 in this area is approximately 6' to 10' deep with a well-defined channel and grasses lining both banks. There is rip-rap around the upstream and downstream portals to the Glass Drive #2 crossing, providing effective stabilization.

Glass Drive #2 inlet gate

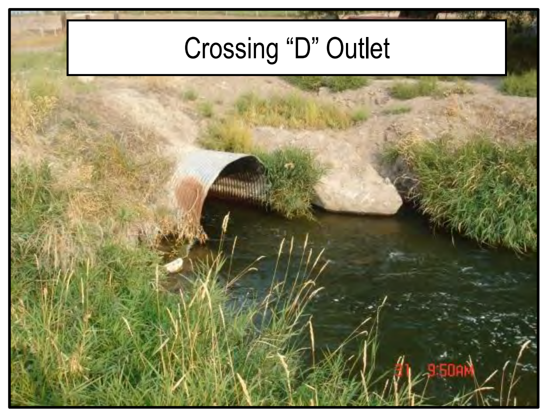
Glass Drive #2 outlet to east

Glass Drive #2 outlet to east

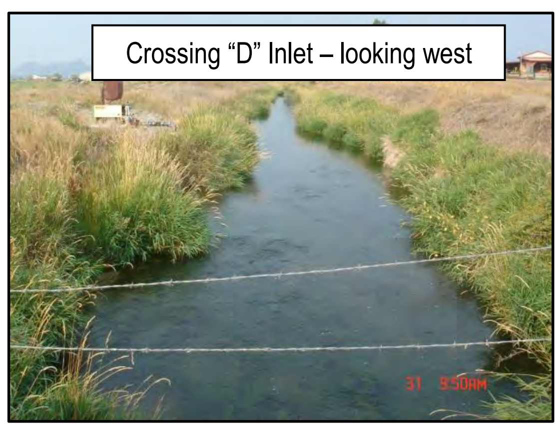
Arrowhead - The Arrowhead Drive crossing is a 60" CMP flowing close to capacity during the site visit. There are some accumulated sediments in this crossing, likely due to the slow velocities (1.3 fps). In this area, the D2 ditch is approximately 9' to 12' deep including a berm on both sides. The ditch is heavily vegetated on both sides with grasses, shrubs and some mature trees – primarily Russian Olives and willows. The top of the culvert is approximately 3' below the level of Arrowhead Drive.


Arrowhead Inlet

Crossing "D" – This crossing is accessed from the Hurni property and consists of a 72" CMP culvert. The D2 in this area is 6' to 9' deep with a well-defined channel and heavy vegetation on both banks. With the relatively rapid flowrate (5.8 fps) through this culvert, there are no accumulated sediments.

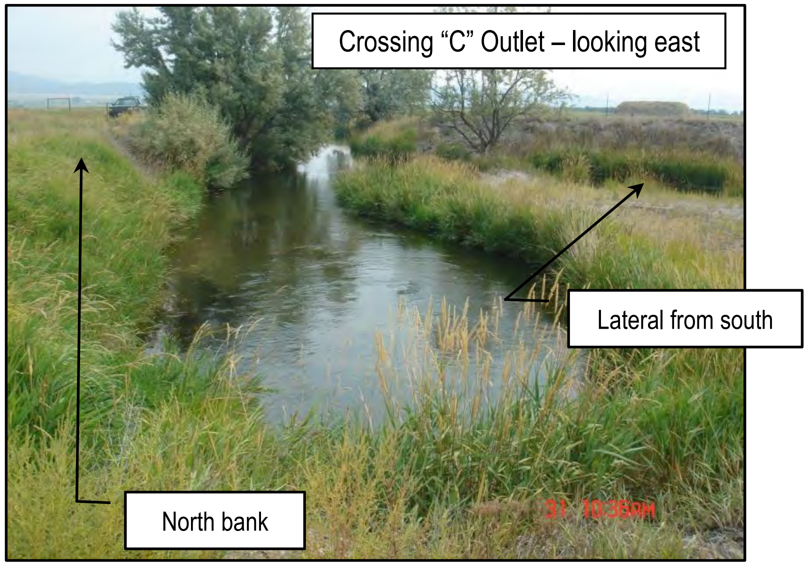

Crossing "D" Outlet


Crossing "D" Outlet – looking east


Crossing "D" Inlet – looking west

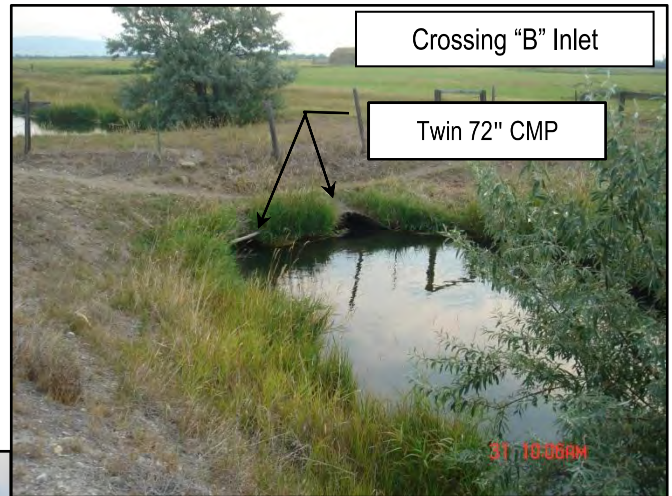
Crossing "C" – Crossing "C" consists of a 72" CMP culvert. Downstream 60' from this crossing a major lateral enters from the south. The D2 in this area is 8' to 10' deep with a well-defined channel upstream, and a heavily-vegetated channel downstream. The north bank is noticeably higher than the south bank downstream of "C" crossing. With the relatively slow velocity in the culvert (1.3 fps), there are some accumulated sediments that are limiting capacity.

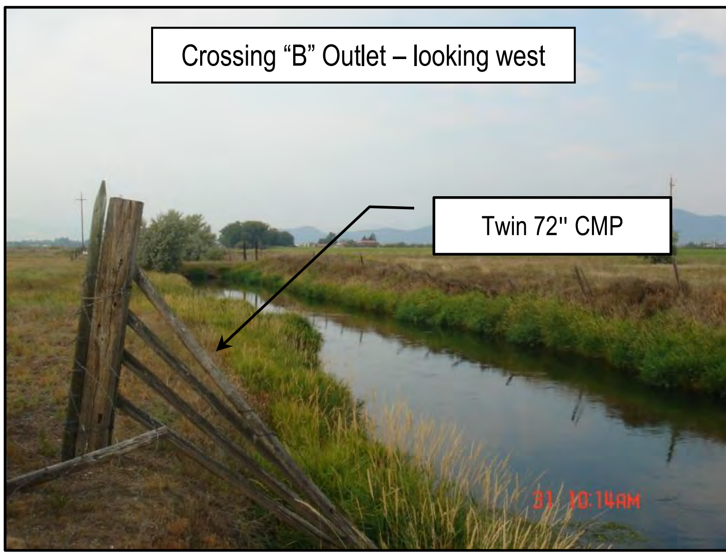

Crossing "C" Inlet – looking west

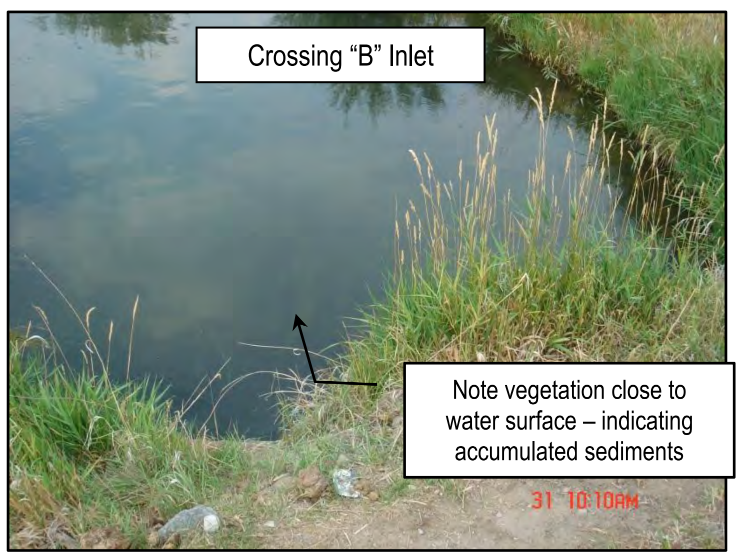


Crossing "C" Outlet – looking east

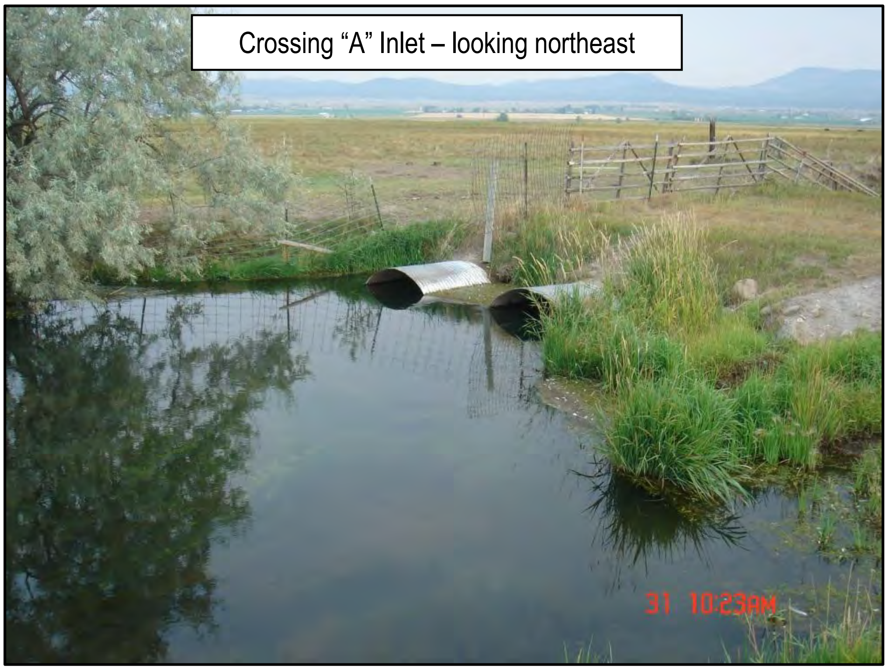
Crossing "B" – This crossing consists of twin 72" CMP culverts. At the time of the site visit, they were 60" full with a velocity of 0.8 fps. Slow velocities have resulted in significant sediment accumulation in both culverts, limiting capacity. The D2 in this area is heavily vegetated upstream with abundant Russian Olives, willows and other riparian plant species. The ditch itself is wide and relatively shallow - 8' to 10' deep including berms on both sides.

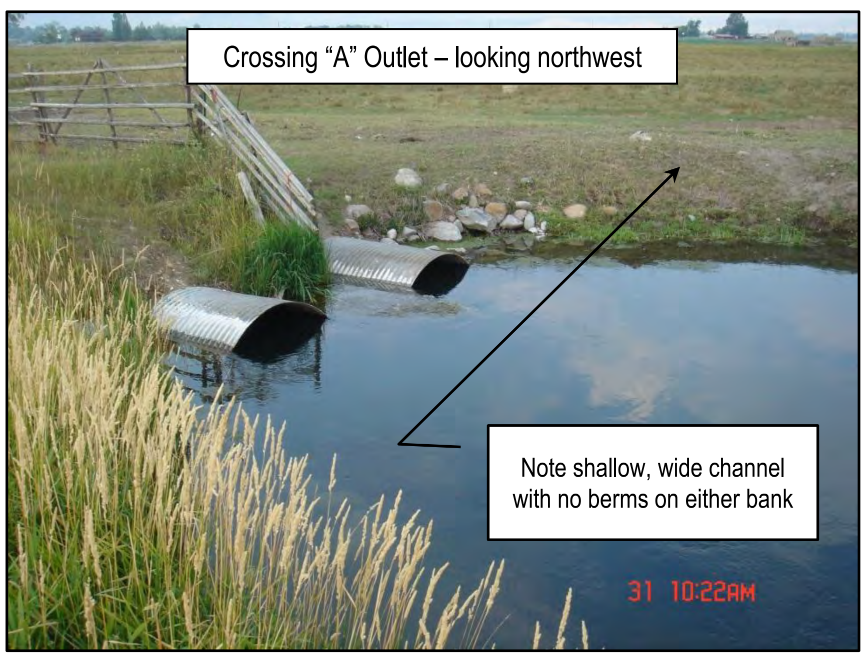






Crossing "A" – Crossing A consists of twin 72" CMP culverts. At the time of the site visit, they were 58" full with a velocity of 0.9 fps. Slow velocities have resulted in significant sediment accumulation in both culverts, limiting capacity. The D2 in this area is heavily vegetated upstream with abundant shrubs, willows and other riparian plant species. The ditch itself is wide and relatively shallow - 5' to 8' deep and virtually no berms on either side.





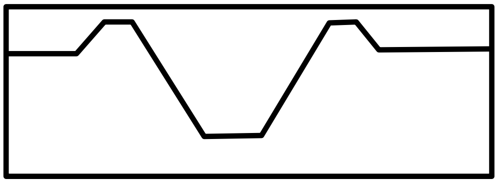
B. D2 Ditch Improvements

Most of the project elements discussed in Chapters 2 and 3 include a direct discharge of up to 600 cfs into the D2 Drain Ditch, during the 25 to 50-year storm event. The D2 Drain is owned by the U.S. Bureau of Reclamation and is operated by the Helena Valley Irrigation District. The D2 currently receives direct stormwater discharge from a ditch on the west side of Interstate 15. This I-15 ditch currently collects virtually all of the runoff from the Tenmile Creek and Sewell Study Areas.

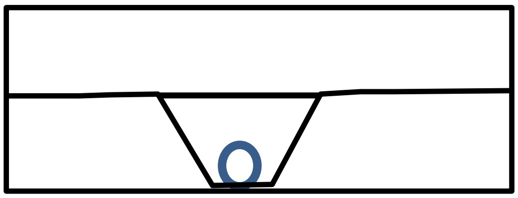
Problem: The recommended Hilger Ditch improvements (Chapter 2 - section D.1) propose to introduce up to 200 cfs. into the D2 at its origination point. The recommended McHugh Ditch improvements (Chapter 2 - sections D.2, D.4 and D.5) propose to introduce up to 200 cfs. into the D2 just west of Rosewood. The recommended Sewell improvements (Chapter 3) propose to introduce up to 200 cfs. into the D2 just east of Interstate 15. Comparing the calculated capacities of all 15 crossings of the D2 between its origin and its mouth at Lake Helena, along with its existing flows and the anticipated flood contributions from the Tenmile and Silver Creek improvements, all 15 crossings of the D2 would require significant upgrades. Furthermore, several lengths of open ditch itself will need to be cleaned, re-graded and in some cases: expanded in order to carry the expected flows. If the proposed Tenmile and Silver Creek project elements were to be implemented as proposed in Chapters 2 and 3, the likely result would be flooding at virtually every existing D2 crossing downstream of Crestwood.

Solution: Generally, the eight crossings west of and including the Interstate 15 Frontage Road could be equipped with larger culverts to provide the needed capacity. The seven east of I-15 would require single-span bridges over the ditch since projected flood flows are too great to be economically handled by culverts. As a general rule, the crossing recommendations represent the improvements that will provide the largest flow capacities and will physically fit within the site-specific confines of each crossing. The reason for this is due to the unknown hydrology of the D2's *existing* flows. Flow measurements taken during field observations in August 2012 estimate that approximately 2 cfs was flowing at the Crestwood crossing and at least 30 cfs was flowing in the D2's lower reaches. **Figure 16** shows recommendations on how the existing D2 crossings could be upgraded to handle the Tenmile and Silver Creek flood mitigation project elements.

It should also be noted that the crossings at: Crestwood; Rosewood; Glass Drive; Arrowhead; "D"; "C"; "B", and; "A" crossings of the D2 have also compromised the capacity of the ditch itself. From the point of the D2's origin, the bottom of the ditch is between 6' to 11' below the surrounding ground surface, with a 2'-3' berm on both sides. At most of the crossings, the berms have been cut down to the natural ground elevation. The following cross section provides a graphic description of the D2 where it has been compromised by the crossings.



D2 Drain typical cross section: bottom of ditch 6' to 11' below ground surface with 2' to 3' berm both sides.



D2 Drain cross section at crossings where: bottom of ditch 6' to 11' below ground surface, with no berm.

Specific Elements of Proposed Solution: See **Figure 16 – Improved Crossings of D2 Drain to Accommodate Tenmile and Silver Creek.**

- Replace the existing 24" CMP culvert crossing under the access with 40' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 24" corrugated plastic culvert crossing under Crestwood with 50' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 30" CMP culvert crossing under Rosewood with 50' of 84" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 24" CMP culvert crossing west of N. Montana Avenue with 25' of 60" equivalent concrete squash pipe with flared-end section on both ends;
- Replace the existing 60" CMP culvert crossing the access road east of N. Montana Avenue with 60' of 84" equivalent squash pipe with flared-end section on both ends;
- Raise the D2 approaches at both Crestwood and Rosewood to re-establish the berm height of the original ditch
- Earthwork and berm to contain flow west of N. Montana Avenue to avoid flooding agricultural field northwest of the D2 crossing under N. Montana Avenue.
- Bore an additional 96" diameter concrete culvert (250' length) adjacent to the existing 96" CMP culvert to add 340 cfs of capacity under I-15 and Frontage;
- Install a 32' long by 32.5' wide precast concrete bridge over each of the two crossings at the extension of Glass Drive
- Install a 32' long by 32.5' wide precast concrete bridge over the crossing at Arrowhead Drive
- Install a 32' long by 32.5' wide precast concrete bridge over each of the four crossings east of Arrowhead Drive (designated Crossings “D”, “C”, “B” and “A”.

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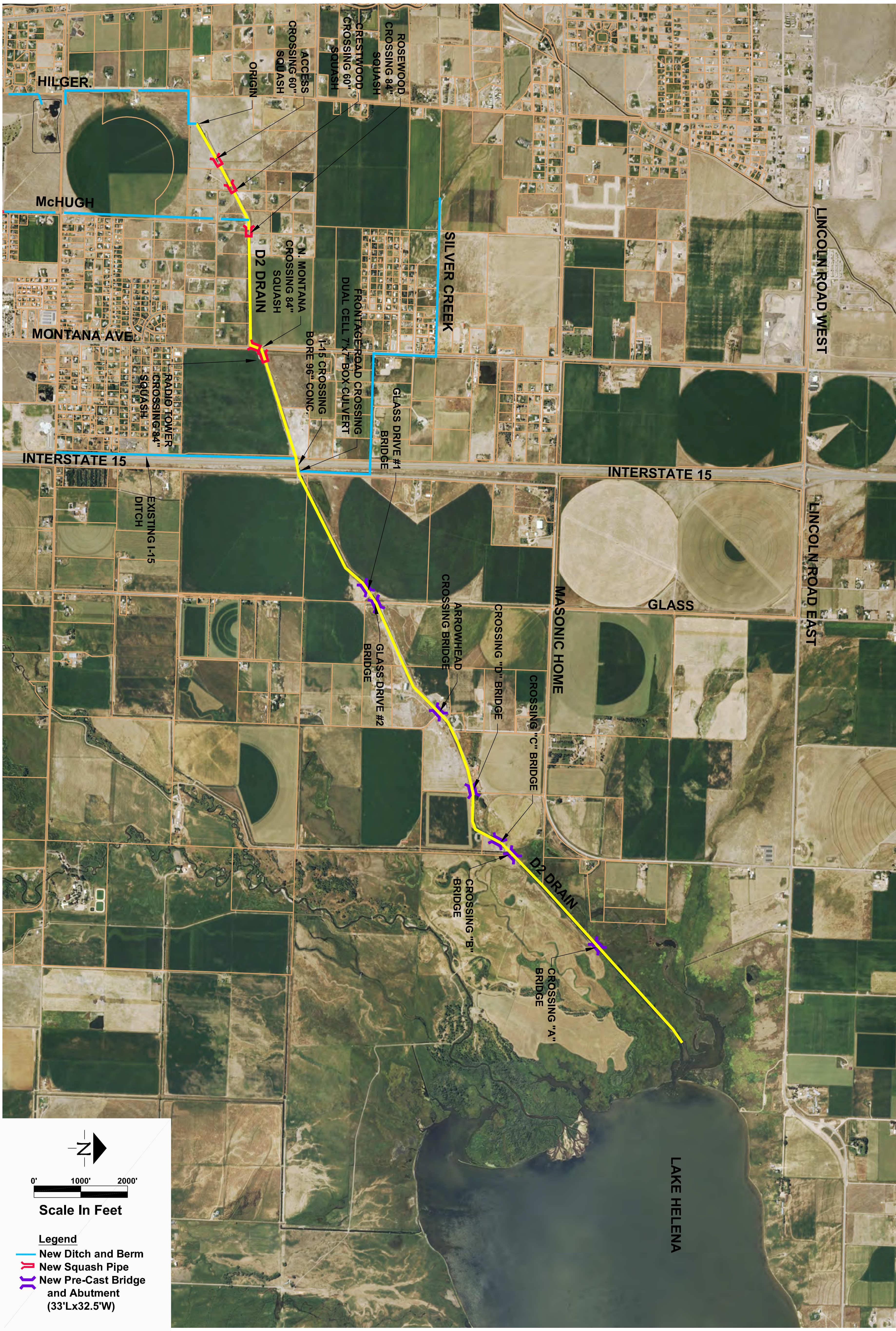


Project:	Figure Title:	Engineer	Figure:
Lewis and Clark County - Helena Valley Flood Mitigation Master Plan	D2 Drain to Lake Helena Proposed Improvements to Accomodate Tenmile and Silver Creek Flooding	Anderson~Montgomery Consulting Engineers 1064 N. Warren Helena, Mt 59601 Phone (406) 449-3303 Fax (406) 449-3304	16

Engineer's Estimate of Cost: See Project Cost Estimate: D2 Drain Improvements in Appendix C. The estimated cost for this project element is $2,477,000. This estimate includes a 10% contingency and engineering services, as well as flared-end transition sections for both ends of all culverts, guardrail on both sides of all precast concrete bridges, abutments, ditch thalweg and gravel road reconstruction.

Implementation Strategy: The following activities, in chronological order, should be undertaken to implement the project to implement the D2 Drain Improvements:

a. Approach the Helena Valley Irrigation District to determine whether higher storm flows can be introduced into the D2 Drain through currently-utilized conveyance channels. This will require coordination with the Bureau of Reclamation and downstream landowners. These discussions should also include maintenance or improvement of the D2 drain infrastructure in order to mitigate the effects of higher flows.
b. Approach the Montana Department of Transportation to ascertain jurisdictional issues with installing new culverts in N. Montana and Interstate 15 rights-of-way. Determine specific requirements that must be observed.
c. Explore methodologies for funding improvements
d. Approach the utility companies with the proposed plan, determine the effect upon existing utilities, and move the utilities if necessary.
e. Final Design
f. Bidding and Construction

C. D2 Existing Easement

The entire drainage network installed by the Bureau of Reclamation in the late 1960's is on a series of donated easements throughout the Helena Valley. The specific easement language for the drains (versus the laterals) provides for the following stipulations:

- The Grantor of the easement (landowner) will allow the perpetual right to enter, use and occupy the land for the purposes of "a drainage ditch and the incidental uses pertaining to or in connection therewith".
- The grant of the easement(s) shall include "all other rights necessary to contribute to and effectuate the successful and efficient drainage of the above-described and other lands in the near vicinity thereof", provided the landowner reserves the right to continue cultivating and occupying the property adjacent to the ditch itself.
- "GRANTOR hereby forever releases and discharges the USA, its officers, employees and agents, from any and all claims, demands and causes of action whatsoever kind or nature, caused by the drainage, direct or indirect, of any of the Grantor's lands whether on or off said right-of-way, due to or caused by said drainage program".

Initial discussions with the Helena Valley Irrigation District (HVID - which manages the supply and drain ditch network on behalf of the Bureau of Reclamation) indicated that the direct introduction of flood waters into the D2 Drain would require approval by the Bureau as well as a review of the easement language in order to determine whether the activity would jeopardize validity of the easement(s). At the time of the drafting of this Master Plan, the Manager of the HVID had written a letter to the BoR inquiring as to the possibility of using D2 for flood flows and an interpretation of the easement consequences. This letter along with sample easement language for the drains and laterals are included in Appendix F.

Given the importance of D2 in the overall flood mitigation strategy proposed in this Master Plan, it would be prudent for the County to continue discussions with HVID and BoR to determine whether a direct discharge of flood waters to the D2 is a viable solution. As the discussion with BoR and HVID moves forward, this Master Plan must be re-visited and adjusted to reflect the regulatory setting.

D. NPDES Permitting Issues

Currently, the D2 Drain discharge into Lake Helena is not subject to a National Pollutant Discharge Elimination System (NPDES) permit or the Montana equivalent of a MPDES permit. Generally, agricultural discharges such as the drainage of groundwater directly into a surface water are not considered under the Clean Water Act provisions as point sources subject to permitting. According to discussions with the Montana DEQ's Stormwater Environmental Specialist, as long as the source of the "runoff" is not from a Municipal Separate Storm Sewer System (MS4) than neither would it be subject to a MS4 MPDES Stormwater Permit under General Permit MTR400000. Runoff is characterized as "precipitation from rain or snowmelt events that flows over land and impervious surfaces and does not percolate into the ground." If the source of the stormwater discharge to surface waters is from precipitation or snowmelt that flows overland and originates within the City limits, then it would be subject to a MS4 stormwater permit. Since neither of these conditions is met for the D2 (source is floodwaters from a stream that is outside Helena's City limits), the D2 discharge into Lake Helena is not subject to a permit.

Any of the project elements anticipated in Chapters 2, 3 or 4 of this Master Plan, similarly should not require stormwater permitting, except for possibly construction disturbance (General Permit MTR100000) or construction de-watering (General Permit MTG070000).

E. Summary of Recommended Improvements for D2 Drain Capacity Improvements

Chapters 2 and 3 provided a series of project elements that would help mitigate flooding in the Helena Valley due to Tenmile and Silver Creeks. The objective of several of these project elements is to convey a portion of the flood flows to the D2 Drain. In order to accommodate these proposed higher flows, the D2 is in need of significant improvements to enhance its hydraulic capacity. Generally, the overall goal of the D2 improvements is:

- to increase the hydraulic capacities of all 15 existing crossings of the D2 in order to convey existing flows plus the anticipated flow additions from TMC and Silver Creek;
- to increase the capacity of the entire 4.38 miles of open D2 Drain in order to convey existing plus expected flows;
- to minimize flooding impacts to residences, commercial properties, transportation corridors, emergency vehicle routes, utilities, etc., in the vicinity of the D2 by conveying flood waters out of the Helena Valley as rapidly as possible;

Figure 16 shows a summary of the project elements discussed in Section B, along with their respective flow capacities.

It is important to note that in order to achieve the goals of minimizing the impacts of flooding from Tenmile and Silver Creeks as proposed in Chapters 2 and 3 respectively, it is necessary to route a portion of the flood flows to the D2 Drain. The D2 represents the lowest channel in the Helena Valley and much of the current storm flows end up in the D2. By improving conveyance infrastructure through the Study Area, it is very likely that flood flowrates will significantly increase, while the duration of the flooding will be reduced. This will be mitigated by improving and using the two retention ponds (Forestvale Cemetery and the Trap Club) as proposed. Higher D2 flows present some challenging problems for the HVID and BOR. Landowner's down gradient from the Study Area on the D2 have expressed concerns that if flood flows increase to the D2, then their property will experience flooding and there could be legal ramifications. Flooding of these properties has apparently occurred in the past, due in part to poor maintenance of much of the D2's infrastructure in this area.

It can be reasonably concluded that proposed improvements to the D2 Drain should be implemented before any flood conveyance projects are undertaken for the Tenmile Creek or Silver Creek project areas. While the improvement of flood water retention in the Forestvale Cemetery Pond and the Trap Club Pond is expected to eliminate most of the flood flows to D2 during moderate events, it is likely that improved introductions of flood water into the D2 from larger events could prove catastrophic for landowners on the drain and the D2 itself.

Appendix A

Tenmile Creek Gauging Station Summary Data

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Flood-frequency data are based on recorded annual peak discharges through 1998. Peak discharges for specified frequencies (exceedance probabilities) were determined by fitting a log-Pearson Type 3 probability distribution to base 10 logarithms of recorded annual peak discharges as described by the Interagency Advisory Committee on Water Data (1982, Guidelines for Determining Flood Flow Frequency--Bulletin 17-B of the Hydrology Subcommittee: U.S. Geological Survey, Office of Water Data Coordination). **Note: Data are provisional and user is responsible for assessment and interpretation of flood-frequency data.**

Most of the basin characteristic data were measured in the 1970s from the best-scale topographic maps available at the time. Some data, such as mean annual precipitation, soil index data, and mean January minimum temperatures, were compiled from maps prepared by other agencies. Channel widths were measured in the field by USGS personnel.

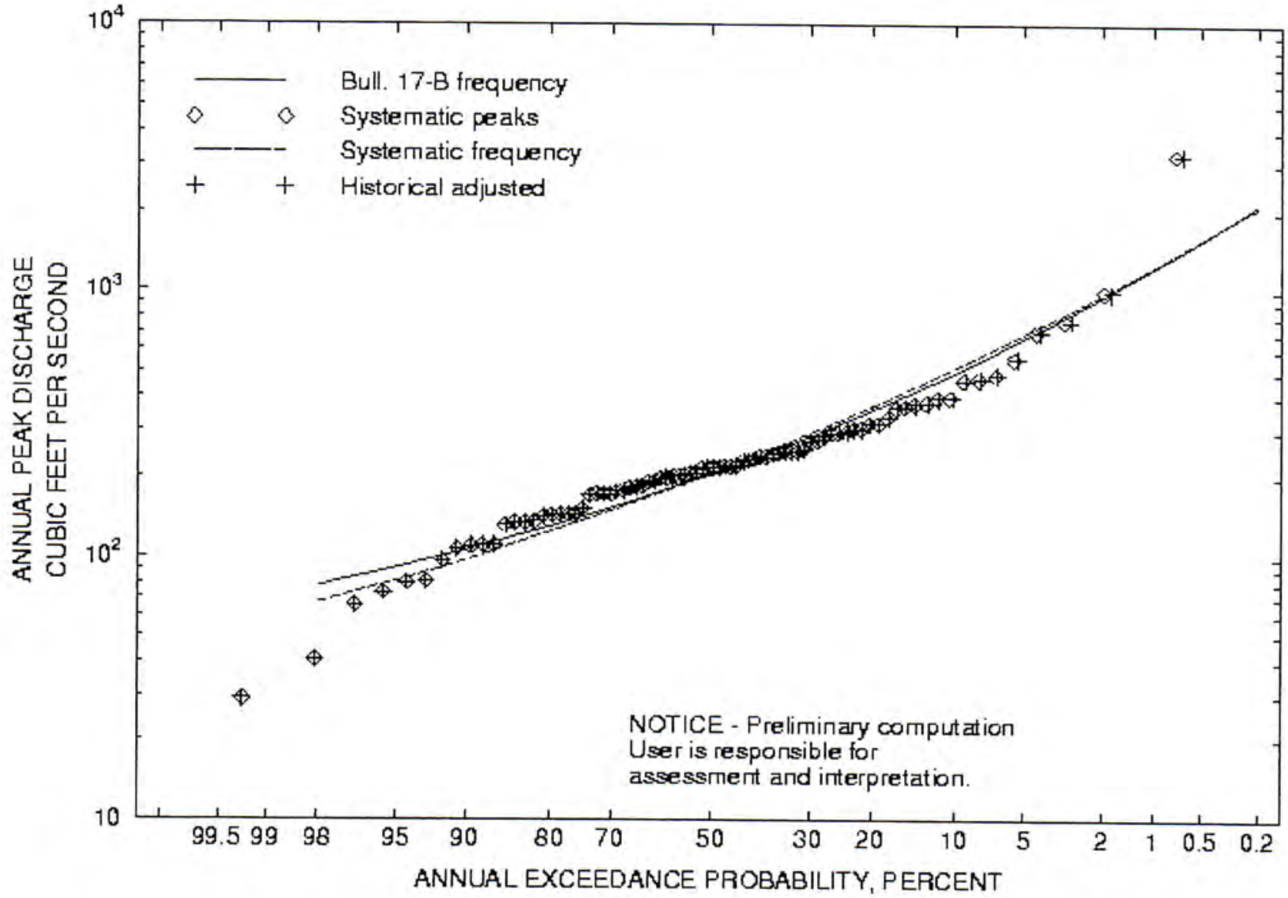
The flood-frequency and basin characteristics data were used in a new flood-frequency report just published by the USGS, entitled "Methods for estimating Flood Frequency in Montana Based on Data through Water Year 1998" (Water-Resources Investigations Report 03-4308). Information about the equations described in that report can be found at the following link.

For more detailed information contact Wayne Berkas:
Phone: 406-457-5903 or by e-mail.

06062500 Tenmile Creek near Rimini, MT

Annual peak discharge, in cubic feet per second (top line), for indicated exceedance probability, in percent (bottom line):

--	--	90	105	129	205	359	501	737	963	1240	1580	2140
99.5	99	95	90	80	50	20	10	4	2	1	0.5	0.2



NOTE: Systematic peaks are those that are recorded within the period of gaged record. The computed systematic flood-frequency curve is based only on the systematic peaks. The computed Bulletin 17-B flood-frequency curve often is different from the systematic flood-frequency curve because of differences between station skew and regional skew, low- or high-outlier adjustments, or the presence of one or more historical peaks outside the systematic record. Historical peaks also result in historical adjusted plotting positions (exceedance probabilities) for all peaks.

Recorded Annual Peak Discharge:

06062500 Tenmile Creek near Rimini, MT

Location.-- Lat 46 31' 27", Long 112 15' 22", Hydrologic Unit 10030101.
Drainage area.-- 30.90 square miles.
Datum of gage.-- 4850.00 ft above sea level.

Table of annual peak discharge data [--, no data]

Water year	Date	Gage height (ft)	Discharge ft3/s	Date of Max. gage height	Maximum gage height (ft)
1915	June 16, 1915	--	471	--	--
1916	June 28, 1916	--	296	--	--
1917	May 27, 1917	--	781	--	--
1918	June 7, 1918	--	172	--	--
1919	May 20, 1919	--	80	--	--

1920	June 7, 1920	--	299	--	--
1921	May 17, 1921	--	373	--	--
1922	May 25, 1922	--	385	--	--
1923	May 24, 1923	--	173	--	--
1924	May 16, 1924	--	367	--	--
1925	May 18, 1925	--	173	--	--
1926	Apr. 19, 1926	--	200	--	--
1927	June 11, 1927	--	703	--	--
1928	May 9, 1928	--	249	--	--
1929	May 23, 1929	--	400	--	--
1930	Apr. 24, 1930	--	179	--	--
1931	May 13, 1931	--	41	--	--
1932	May 13, 1932	--	195	--	--
1933	May 31, 1933	--	258	--	--
1934	June 7, 1934	--	143	--	--
1935	May 23, 1935	2.20	81	--	--
1936	June 8, 1936	1.81	66	--	--
1937	May 20, 1937	2.15	134	--	--
1938	May 26, 1938	3.62	490	--	--
1939	Apr. 29, 1939	2.59	136	--	--
1940	May 10, 1940	2.41	96	--	--
1941	June 5, 1941	2.86	209	--	--
1942	May 25, 1942	2.96	242	--	--
1943	May 27, 1943	2.93	297	--	--
1944	June 27, 1944	2.89	253	--	--
1945	June 10, 1945	2.89	231	--	--
1946	May 28, 1946	2.28	73	--	--
1947	May 8, 1947	3.17	338	--	--
1948	May 21, 1948	3.35	403	--	--
1949	May 13, 1949	2.49	107	--	--
1950	June 18, 1950	3.02	319	--	--
1951	June 11, 1951	2.92	289	--	--
1952	Apr. 27, 1952	2.75	242	--	--
1953	June 2, 1953	3.56	469	--	--
1954	June 10, 1954	2.40	111	--	--
1955	May 21, 1955	2.52	145	--	--
1956	May 20, 1956	2.73	219	--	--
1957	May 26, 1957	2.47	145	--	--
1958	May 11, 1958	2.69	216	--	--
1959	June 6, 1959	2.53	202	--	--
1960	May 12, 1960	2.71	274	--	--
1961	May 25, 1961	2.49	186	--	--
1962	May 26, 1962	2.51	222	--	--
1963	May 25, 1963	2.68	152	--	--
1964	June 9, 1964	3.77	563	--	--
1965	June 17, 1965	2.97	246	--	--
1966	May 6, 1966	2.55	142	--	--
1967	May 23, 1967	3.01	320	--	--
1968	June 9, 1968	2.80	278	--	--
1969	July 7, 1969	2.90	308	--	--
1970	May 26, 1970	2.66	218	--	--
1971	May 31, 1971	2.97	177	--	--
1972	June 1, 1972	3.06	204	--	--
1973	May 17, 1973	2.71	110	--	--
1974	May 27, 1974	3.10	220	--	--
1975	June 19, 1975	4.89	995	--	--
1976	May 14, 1976	3.52	379	--	--
1977	Apr. 26, 1977	2.19	29	--	--
1978	May 22, 1978	3.23	237	--	--
1979	May 26, 1979	3.18	234	--	--
1980	May 31, 1980	3.08	208	--	--
1981	May 22, 1981	6.20	3290	--	--
1982	June 13, 1982	2.93	252	--	--

1983	May 26, 1983	3.52	253	--	--
1984	May 15, 1984	3.36	224	--	--
1985	May 3, 1985	2.83	111	--	--
1986	May 28, 1986	3.23	202	--	--
1987	May 27, 1987	2.96	145	--	--
1988	May 16, 1988	2.89	132	--	--
1989	May 10, 1989	3.15	184	--	--
1990	May 30, 1990	2.89	135	--	--
1991	May 21, 1991	3.04	171	--	--
1992	June 16, 1992	3.04	182	--	--
1993	June 16, 1993	3.20	198	--	--
1994	Apr. 22, 1994	3.06	193	--	--
1997	June 11, 1997	3.50	306	--	--
1998	June 20, 1998	3.27	222	--	--

Basin Characteristics:

Value	Abbrev	Explanation
260.0	SLOPE	Main channel slope, in ft per mile
8.8	LENGTH	Total stream length, miles
6580.0	ELEV	Mean basin elevation, ft above msl
86.2	EL6000	Percent of basin above 6,000 ft, msl
0.67	STORAGE	Percent of basin in lakes, ponds, and swamps
97.3	FOREST	Percent of basin in forest
--	SOIL_INF	Soil index, in inches
46.52416667	LAT_GAGE	Latitude of gage, in decimal degrees
112.25611111	LNG_GAGE	Longitude of gage, in decimal degrees
24.0	PRECIP	Mean annual precipitation, in inches
1.3	I24_2	Precipitation intensity for a 24-hour storm having a 2-year recurrence interval, in inches per hour
9.0	JANMIN	Mean minimum January temperature, in degrees F
16.0	WAC	Width of active channel, in feet
0.8	W2	Mean depth for active channel, in feet
25.0	WBF	Width of bankfull channel, in feet
2.5	W4	Mean depth of bankfull channel, in feet

Montana Flood-Frequency and Basin-Characteristic Data
etrieved on: 2012.07.24 19:36:36

MORRISON-MAIERLE CONSULTING ENGINEERS

HYDRAULICS OF BRIDGE WATERWAYS

STAGE DISCHARGE RESULTS

TENMILE CREEK BRIDGES -- MCHUGH DRIVE LEWIS AND CLARK COUNTY FLOOD STUDY APRIL 1982

X-SECTION NUMBER 1

SLOPE OF CHANNEL = .0085 FT/FT

DESIGN FLOW = 395 CFS

STAGE ELEVATION = 96.4 FT

STAGE-DISCHARGE CURVE DATA

STAGE (FT)	E GRADE (FT)	FLOW (CFS)	AREA (SQ FT)	AVE VEL (FPS)
92.50	92.53	4.45	3.20	1.39
93.00	93.06	16.26	8.45	1.92
93.50	93.60	40.26	15.89	2.53
94.00	94.15	75.54	24.27	3.11
94.50	94.70	120.37	33.45	3.60
95.00	95.25	174.76	43.43	4.02
95.50	95.80	238.88	54.21	4.41
96.00	96.36	317.05	65.65	4.83
96.50	96.93	405.35	77.15	5.25
97.00	97.49	499.57	88.65	5.64
97.50	98.06	598.98	100.15	5.98
98.00	98.62	702.93	111.65	6.30
98.50	99.17	810.92	123.15	6.58
99.00	99.73	922.51	134.65	6.85
99.50	100.28	1,037.32	146.15	7.10
100.00	100.83	1,155.03	157.65	7.33

Low Chord 98.0
Less than 5-year flood capacity

CROSS-SECTION PROPERTIES

TENMILE CREEK BRIDGES -- MCHUGH DRIVE LEWIS AND CLARK COUNTY FLOOD STUDY APRIL 1982

X-SECTION NUMBER 1

..E PROPERTIES OF THE X-SECTION PRIOR TO ANY CONSTRICTION ARE LISTED BELOW

PUT DATA

DESIGN Q (CFS) = 395
NORMAL STAGE = 96.4
SLOPE = .0085

SKEW (ANGLE) = 10
NUMBER OF CROSSINGS = 1

UB-SECTION PROPERTIES WHERE X = DISTANCE FROM BASELINE

BEGIN	X END	N VALUE	AREA	WET PER	HYD RADIUS	CONVEYANCE	DISCHARGE	VELOCITY
100.0	123.0	0.050	75.9	28.9	2.6	4,288.5	395.0	5.2

MPUTED QUANTITIES

TOTAL AREA (SQFT) = 75.9
TOTAL CONVEYANCE = 4,288.5
TOTAL DISCHARGE (CFS) = 395.0

WIDTH AT WATER SURFACE (FT) = 23.0
KINETIC ENERGY COEFF = 1.00
AVERAGE CHANNEL VELOCITY = 5.2

INPUT DATA

ELEVATION	STATION	N VALUE
100.0	100.0	0.050
95.7	100.0	0.050
93.2	108.0	0.050
92.7	113.0	0.050
91.7	123.0	0.050
100.0	123.0	0.050

To estimate the contribution from the Sevenmile Creek drainage to the peak discharge on Tenmile Creek a drainage area transfer method described in the USGS Open File Report 81-917 was used. Results of transferring the flood frequency analysis near Helena at Williams Street to below the confluence with Sevenmile Creek are shown on Table 5.

TABLE 5 - FLOOD MAGNITUDES TENMILE CREEK

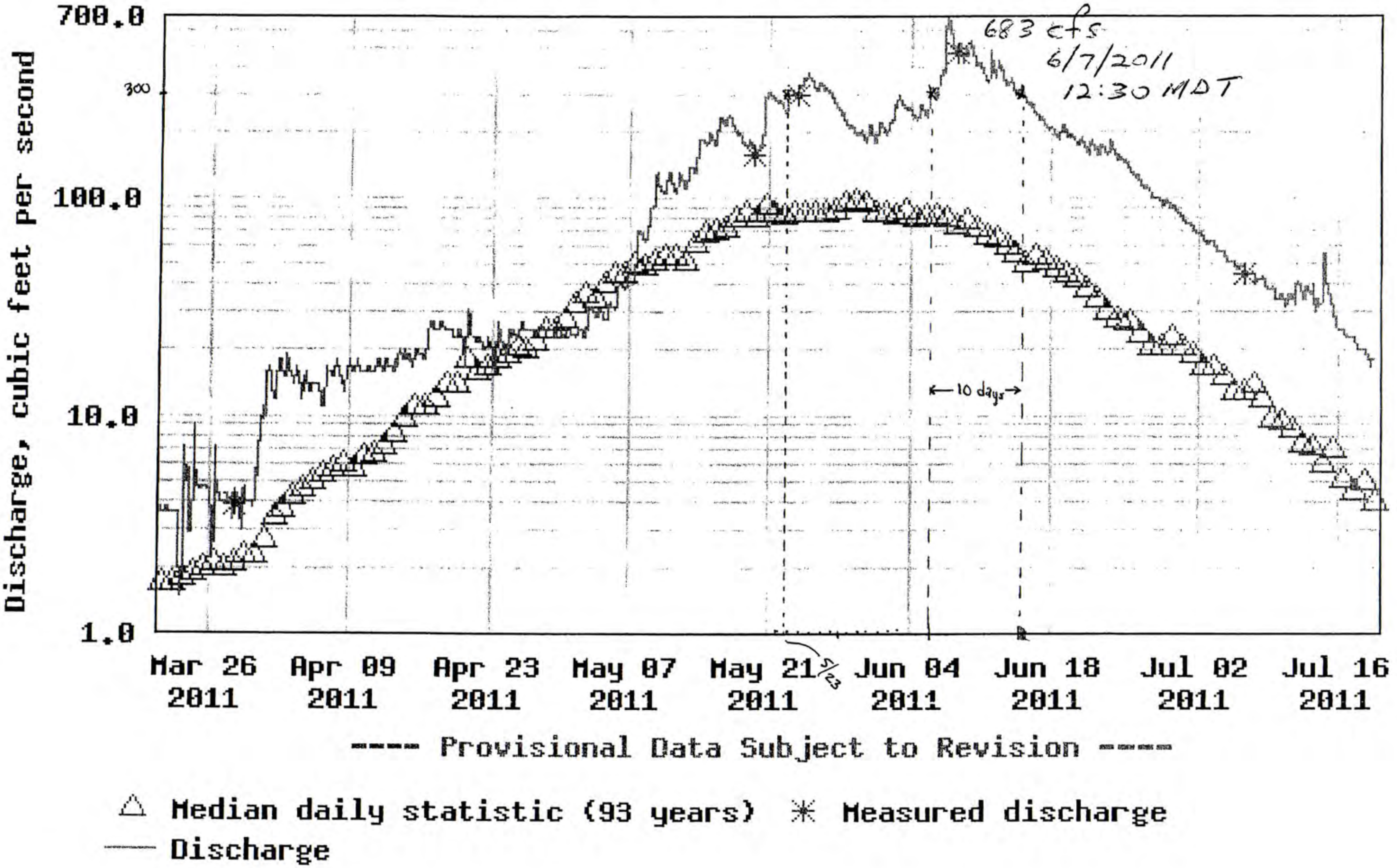
FLOOD FREQUENCY	USGS STATION #060625 Near Rimini 1/ DRAINAGE AREA = 32 sq mi	USGS STATION #060630 Near Helena 2/ DRAINAGE AREA = 103 sq mi	Below confluence w/Sevenmile Cr. 3/ DRAINAGE AREA = 161 sq mi
2-year	215 cfs	260 cfs	395 cfs
5-year	435	560	820
10-year	660	860	1,260
25-year	1080	1410	2,000
50-year	1515	1970	2,760
100-year	2090	2670	3,710

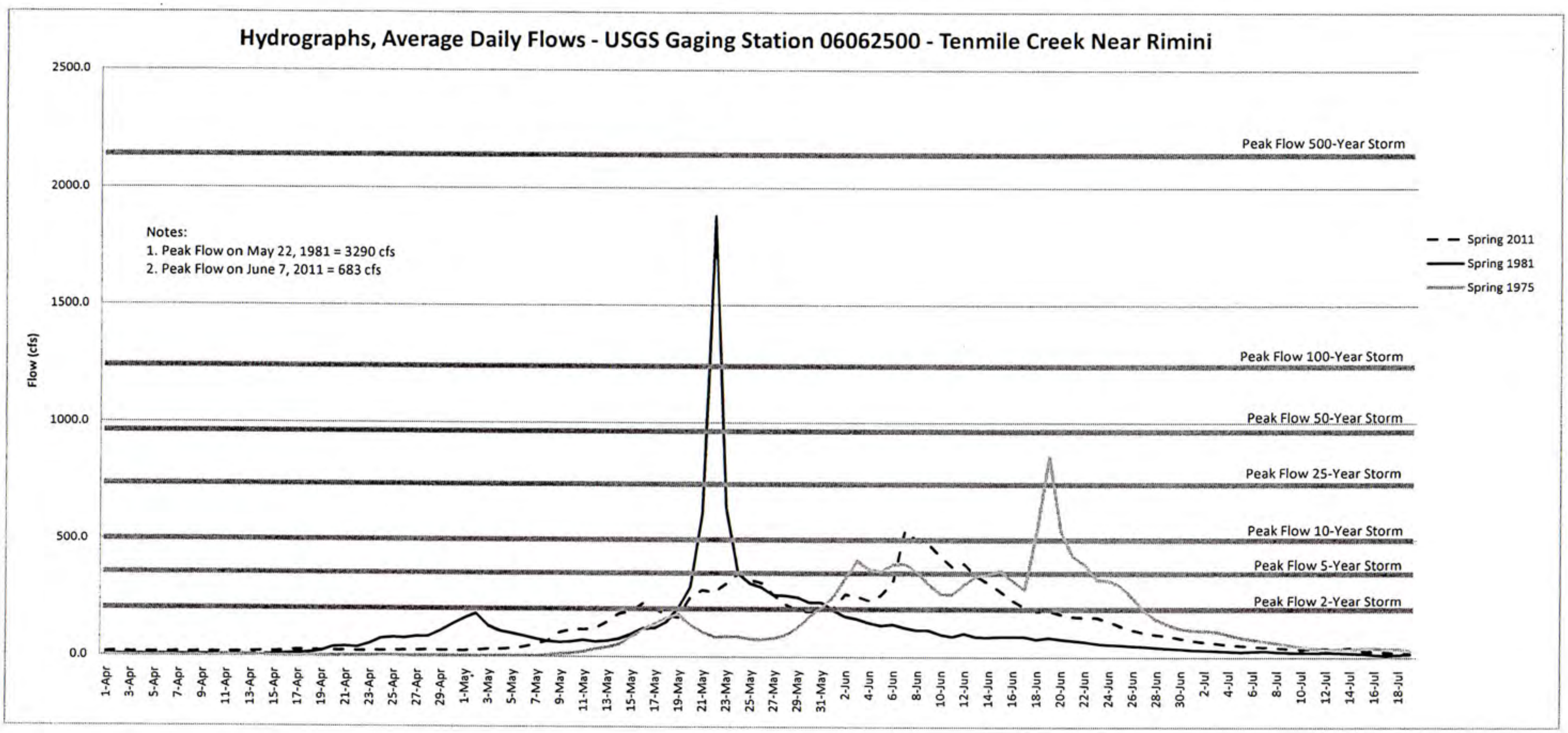
1/ log Pearson type III analysis using 67 years of systematic record (1915 - 1979) including: 1981 = 3290 cfs, 1908 = 3000 cfs estimated, and 1975 = 995 cfs.

2/ log Pearson type III analysis using 48 years of systematic record (1909 - 1954) including: 1981 = 3770 cfs, 1908 = 3600 cfs estimated, and 1975 = 1360 cfs and extending the record historically to 73 years.

3/ drainage area transfer analysis of USGS Station #060630 Tenmile Creek near Helena (Williams Street) to below the confluence with Sevenmile mill @ around 300 cfs

USGS 06062500 Tenmile Creek near Rimini MT





Hydrographs, Average Daily Flows - USGS Gaging Station 06062500 - Tenmile Creek Near Rimini
Flow (cfs)
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Notes:
1. Peak Flow on May 22, 1981 = 3290 cfs
2. Peak Flow on June 7, 2011 = 683 cfs
Peak Flow 500-Year Storm
Peak Flow 100-Year Storm
Peak Flow 50-Year Storm
Peak Flow 25-Year Storm
Peak Flow 10-Year Storm
Peak Flow 5-Year Storm
Peak Flow 2-Year Storm
Spring 2011
Spring 1981
Spring 1975
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
2-Jun
4-Jun
6-Jun
8-Jun
10-Jun
12-Jun
14-Jun
16-Jun
18-Jun
20-Jun
22-Jun
24-Jun
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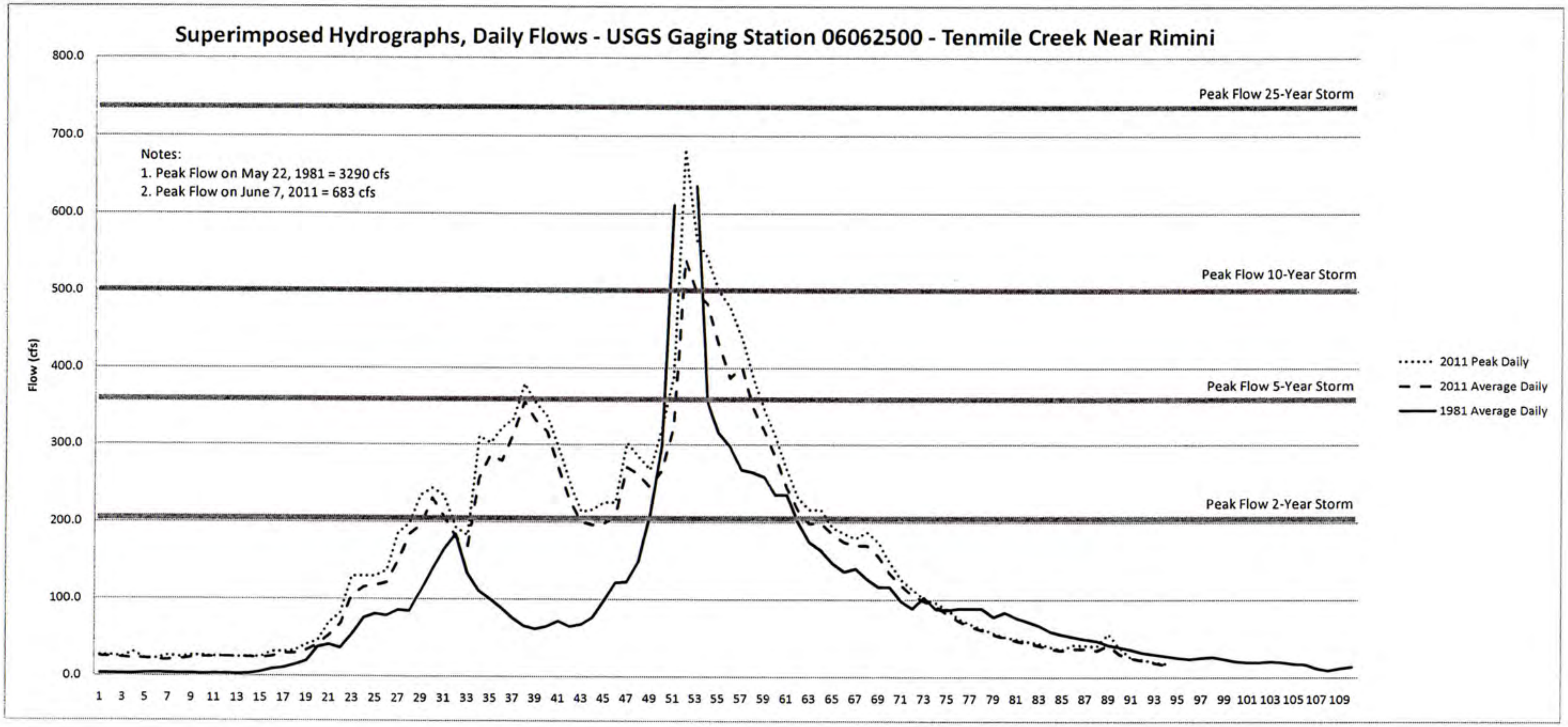
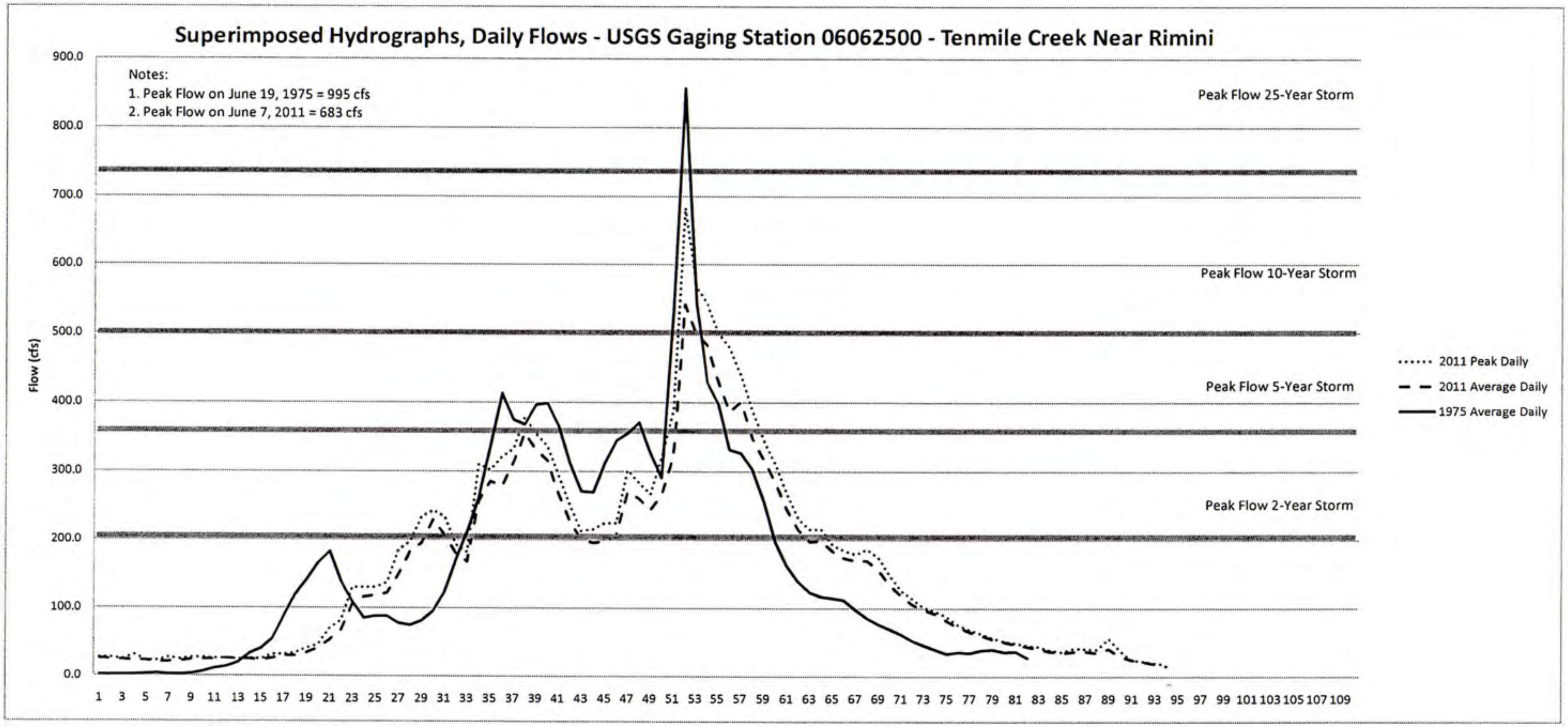
14-Jul
16-Jul
18-Jul



Superimposed Hydrographs, Daily Flows - USGS Gaging Station 06062500 - Tenmile Creek Near Rimini
Flow (cfs)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
Notes:
1. Peak Flow on May 22, 1981 = 3290 cfs
2. Peak Flow on June 7, 2011 = 683 cfs
Peak Flow 25-Year Storm
Peak Flow 10-Year Storm
Peak Flow 5-Year Storm
Peak Flow 2-Year Storm
2011 Peak Daily
2011 Average Daily
1981 Average Daily
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 101 103 105 107 109



Superimposed Hydrographs, Daily Flows - USGS Gaging Station 06062500 - Tenmile Creek Near Rimini
Notes:
1. Peak Flow on June 19, 1975 = 995 cfs
2. Peak Flow on June 7, 2011 = 683 cfs
Peak Flow 25-Year Storm
Peak Flow 10-Year Storm
Peak Flow 5-Year Storm
Peak Flow 2-Year Storm
Flow (cfs)
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 101 103 105 107 109
2011 Peak Daily
2011 Average Daily
1975 Average Daily

Appendix B

Tenmile Creek Flow Calculations & Excerpts from 1982 M&M Study

LEWIS and CLARK COUNTY

FLOOD DRAINAGE STUDY

FOR

TENMILE CREEK

APRIL 1982

MORRISON-MAIERLE, INC.
CONSULTING ENGINEERS

MORRISON-MAIERLE CONSULTING ENGINEERS

HYDRAULICS OF BRIDGE WATERWAYS

STAGE DISCHARGE RESULTS

TENMILE CREEK BRIDGES -- MCHUGH DRIVE ◄ LEWIS AND CLARK COUNTY FLOOD STUDY APRIL 1982

X-SECTION NUMBER 1

SLOPE OF CHANNEL = .0085 FT/FT

DESIGN FLOW = 395 CFS

STAGE ELEVATION = 96.4 FT

STAGE-DISCHARGE CURVE DATA

STAGE (FT)	E GRADE (FT)	FLOW (CFS)	AREA (SQ FT)	AVE VEL (FPS)
92.50	92.53	4.45	3.20	1.39
93.00	93.06	16.26	8.45	1.92
93.50	93.60	40.26	15.89	2.53
94.00	94.15	75.54	24.27	3.11
94.50	94.70	120.37	33.45	3.60
95.00	95.25	174.76	43.43	4.02
95.50	95.80	238.88	54.21	4.41
96.00	96.36	317.05	65.65	4.83
96.50	96.93	405.35	77.15	5.25
97.00	97.49	499.57	88.65	5.64
97.50	98.06	598.98	100.15	5.98
98.00	98.62	702.93	111.65	6.30
98.50	99.17	810.92	123.15	6.58
99.00	99.73	922.51	134.65	6.85
99.50	100.28	1,037.32	146.15	7.10
100.00	100.83	1,155.03	157.65	7.33

Low Chord 98.0
Less than 5-year flood capacity

CROSS-SECTION PROPERTIES

TENMILE CREEK BRIDGES -- MCHUGH DRIVE LEWIS AND CLARK COUNTY FLOOD STUDY APRIL 1982

X-SECTION NUMBER 1

..E PROPERTIES OF THE X-SECTION PRIOR TO ANY CONSTRICTION ARE LISTED BELOW

PUT DATA

DESIGN Q (CFS) = 395
NORMAL STAGE = 96.4
SLOPE = .0085

SKEW (ANGLE) = 10
NUMBER OF CROSSINGS = 1

UB-SECTION PROPERTIES WHERE X = DISTANCE FROM BASELINE

BEGIN	X END	N VALUE	AREA	WET PER	HYD RADIUS	CONVEYANCE	DISCHARGE	VELOCITY
100.0	123.0	0.050	75.9	28.9	2.6	4,288.5	395.0	5.2

('PUTED QUANTITIES

TOTAL AREA (SQFT) = 75.9
TOTAL CONVEYANCE = 4,288.5
TOTAL DISCHARGE (CFS) = 395.0

WIDTH AT WATER SURFACE (FT) = 23.0
KINETIC ENERGY COEFF = 1.00
AVERAGE CHANNEL VELOCITY = 5.2

INPUT DATA

ELEVATION	STATION	N VALUE
100.0	100.0	0.050
95.7	100.0	0.050
93.2	108.0	0.050
92.7	113.0	0.050
91.7	123.0	0.050
100.0	123.0	0.050

To estimate the contribution from the Sevenmile Creek drainage to the peak discharge on Tenmile Creek a drainage area transfer method described in the USGS Open File Report 81-917 was used. Results of transferring the flood frequency analysis near Helena at Williams Street to below the confluence with Sevenmile Creek are shown on Table 5.

Difference between These columns represents Sevenmile Creek contribution.

TABLE 5 - FLOOD MAGNITUDES TENMILE CREEK

FLOOD FREQUENCY	2011 USGS #'s	USGS STATION #060625 Near Rimini 1/ DRAINAGE AREA = 32 sq mi	2011 USGS / 1981 USGS %	USGS STATION #060630 Near Helena 2/ DRAINAGE AREA = 103 sq mi (−)	Below confluence w/Sevenmile Cr. 3/ DRAINAGE AREA = 161 sq mi (=)	Q SEVENMILE CREEK (DRAINAGE: AREA = 58 mi²) (DIFFERENCE)
2-year	205	215 cfs	95%	260 cfs	395 cfs	135 cfs
5-year	359	435	83%	560	820	260 cfs
10-year	501	660	76%	860	1,260	400 cfs
* 25-year	737	1080	68%	1410	2,000	590 cfs
50-year	963	1515	64%	1970	2,760	790 cfs
100-year	1240	2090	59%	2670	3,710	1,040 cfs

1/ log Pearson type III analysis using 67 years of systematic record (1915 - 1979) including: 1981 = 3290 cfs, 1908 = 3000 cfs estimated, and 1975 = 995 cfs.

2/ log Pearson type III analysis using 48 years of systematic record (1909 - 1954) including: 1981 = 3770 cfs, 1908 = 3600 cfs estimated, and 1975 = 1360 cfs and extending the record historically to 73 years.

3/ drainage area transfer analysis of USGS Station #060630 Tenmile Creek near Helena (Williams Street) to below the confluence with Sevenmile Creek.

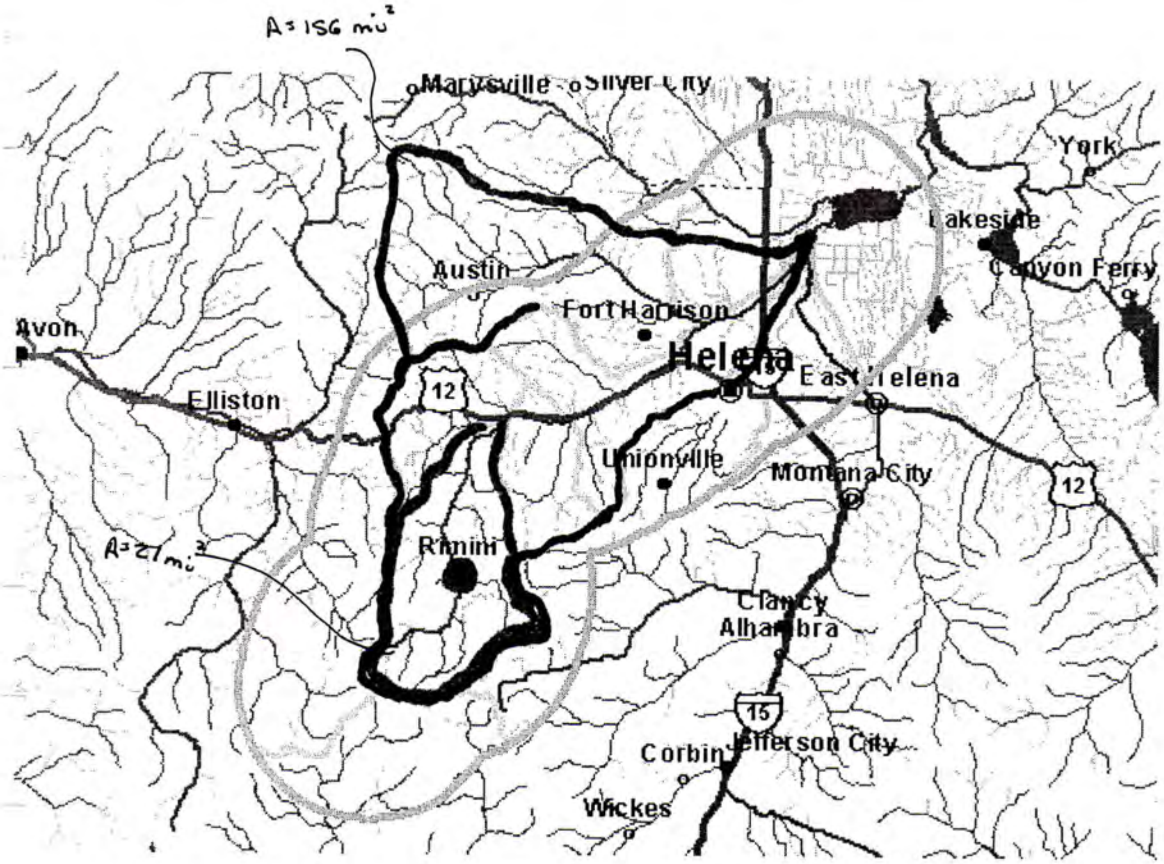
From

2011 FLOOD EVENT:
ESTIMATE FLOOD FLOWS FOR SEVENMILE CREEK:

FOR THE 25-YR STORM, 2011 USGS Q = 68% OF 1981 USGS Q

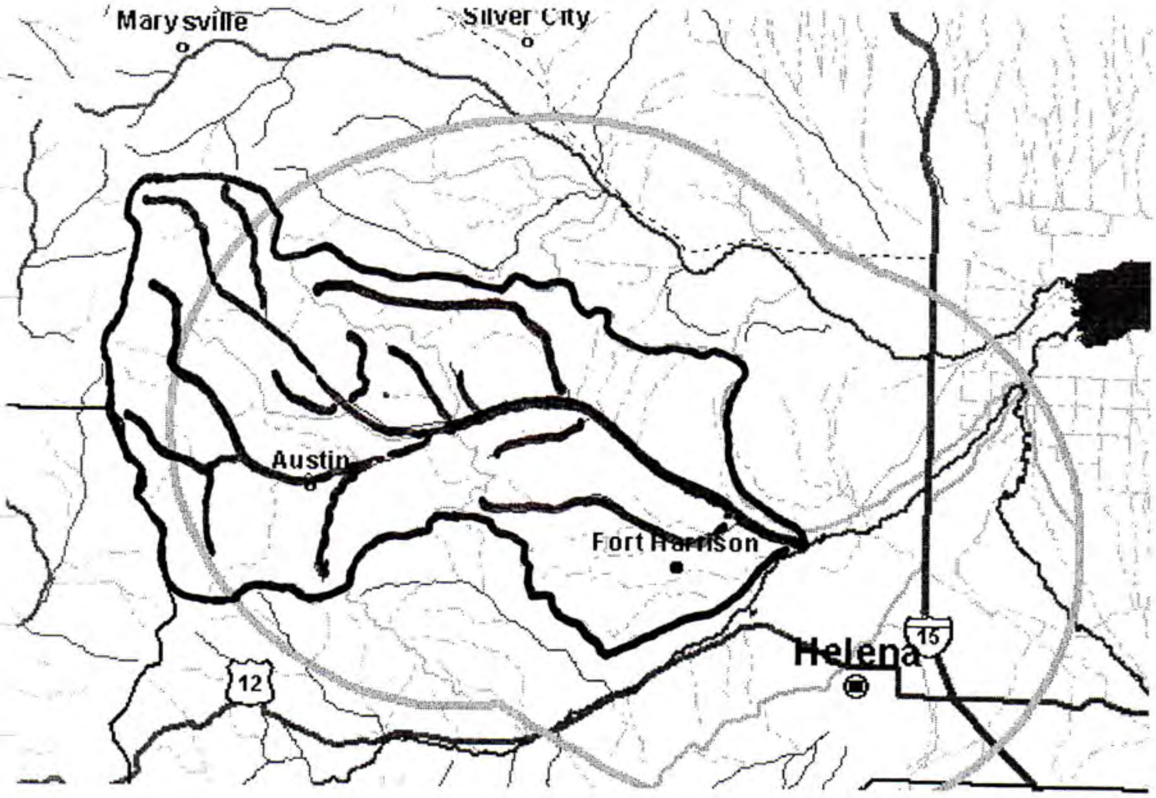
∴ APPLY 68% TO SEVENMILE CREEK 1981 USGS Q: 590(0.68) ≅ 400 cfs — 25 YR INTERVAL FLOOD Q FOR SEVENMILE CREEK.

∴ Assume ≅ 400 cfs contribution from Sevenmile Creek during 2011 Event



43.6 miles

1" = 7.4 miles



AVG W = 4.8 mi
AVG L = 10.6 mi
∴ A = 51.2 mi^2

20.6 MILES
1" = 3.43 miles

SEVENMILE CREEK - DISCHARGES TO TENMILE CREEK BETWEEN RIMINI USGS GAUGING STATION & HELENA VALLEY STUDY AREA.

SEVENMILE CREEK
BASIN SIZE: 51.2 mi^2

- TENMILE CREEK
  BASIN SIZE (ABOVE RIMINI): 32 mi^2

TENMILE CREEK
- BASIN SIZE (BELOW CONF. w/ 7MILE): 161 mi^2

MORRISON-MAIERLE, INC.
HELENA, MONTANA

PROJECT: LEWIS & CLARK CO. FLOOD DRAINAGE STUDY		
BY:	DATE APRIL 82	PROJ. NO. 225-022-01 (33)
CHK:	DATE	PAGE: OF

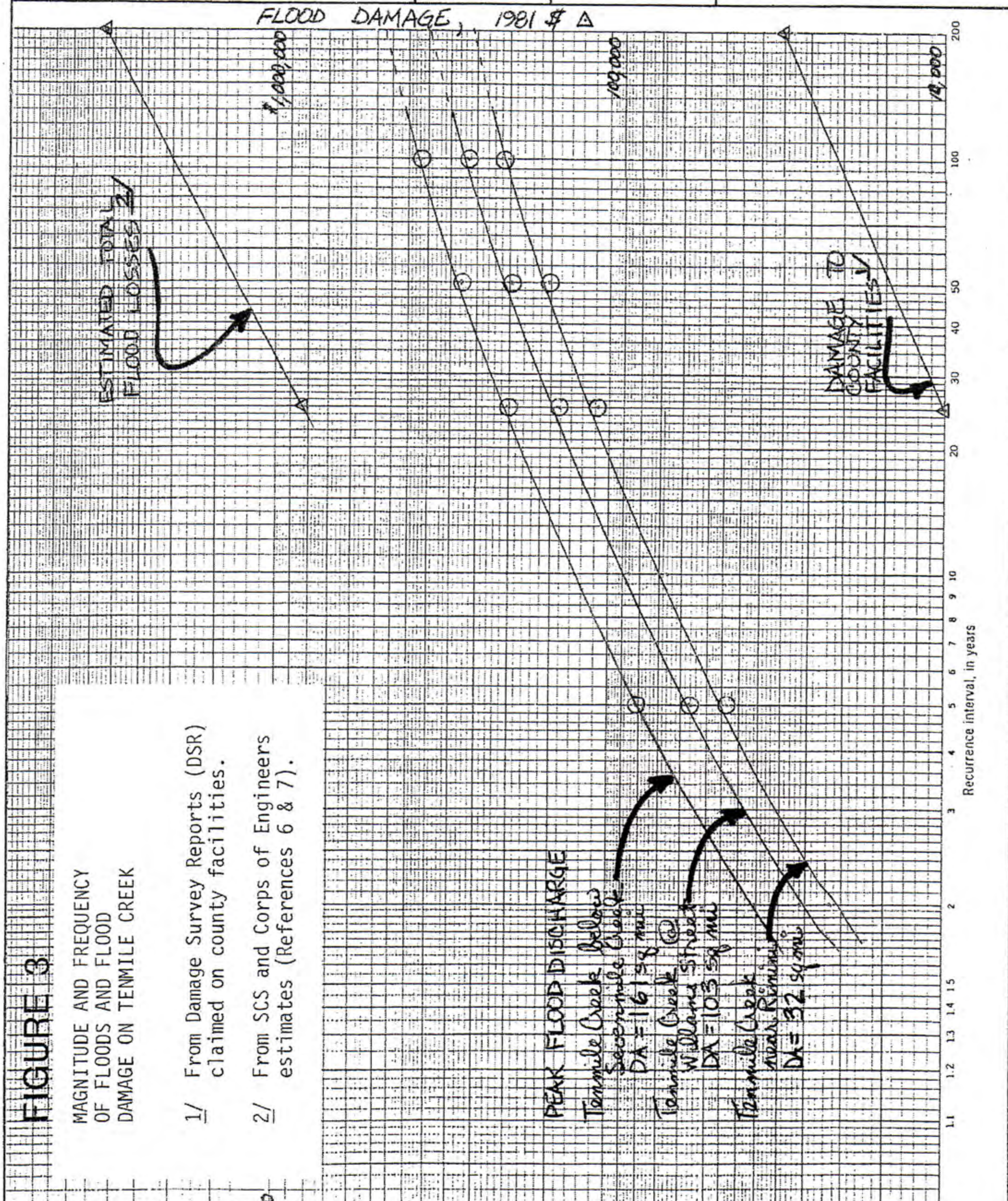


FIGURE 3

MAGNITUDE AND FREQUENCY OF FLOODS AND FLOOD DAMAGE ON TENMILE CREEK

1/ From Damage Survey Reports (DSR) claimed on county facilities.

2/ From SCS and Corps of Engineers estimates (References 6 & 7).

Appendix C

Cost Estimate Spreadsheets – Tenmile Creek & D2 Drain

Project Cost Estimate

Improved Hilger Ditch - Mill crossing to F-Vale Cemetery Pond

4030 lineal feet of new ditch

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Total Price	
1.	Mobilization, Bonds, Ins.	LS	12%	$1,460,890.00	$175,307	
2.	Unclassified Excavation	CY	10,000	$4.50	$45,000	5,200' Hilger ditch from Mill to Forestvale cemetery pond
3.	Embankment	LF	2,200	$6.95	$15,290	Berm both edges of ditch
4.	54" Concrete squash pipe	LF	150	$140.00	$21,000	crossing under Mill (2 parallel 54" - capacity = 280 cfs)
5.	Install squash culvert	LF	150	$100.00	$15,000	crossing under Mill
6.	pavement replacement	SY	220	$18.00	$3,960	crossing under Mill
7.	36" concrete squash pipe	LF	225	$80.00	$18,000	crossing under Forestvale (3 parallel 36" - capacity 260 cfs)
8.	Install squash culvert	LF	225	$95.00	$21,375	crossing under Forestvale
9.	pavement replacement	SY	270	$18.00	$4,860	crossing under Forestvale
10.	land acquisition	ac	3	$8,600.00	$25,800	legal, survey, easements, landowner negotiations (11 landowners)
11.	Unclassified Excavation	CY	300,000	$3.00	$900,000	increase Forestvale Cemetery Pond to 13M cubic feet capacity
12.	Embankment	CY	66,000	$3.50	$231,000	berm around Forestvale Cemetery Pond
13.	Outlet structure	ea	1	$8,400.00	$8,400	outlet for pond to D2
14.	Unclassified Excavation	CY	6,620	$4.50	$29,790	ditch from pond to D2
15.	rip rap at culverts & turns	CY	170	$90.00	$15,300	outlet ditch
16.	Flared-end sections	ea	7	$1,600.00	$11,200	crossings under Mill, Forestvale, Sierra
17.	Gravel bedding/subgrade	CY	110	$35.00	$3,850	
18.	seeding/fertilizing	SY	28,500	$1.25	$35,625	disturbed area
19.	traffic control	LS	1	$6,300.00	$6,300	Mill, Forestvale, Sierra
20.	42" concrete squash pipe	LF	240	$90.00	$21,600	Sierra Rd Crossing (3 parallel 42" - capacity = 275 cfs)
21.	Install squash culvert	LF	240	$90.00	$21,600	Sierra Rd Crossing
22.	pavement replacement	SY	330	$18.00	$5,940	Sierra Rd Crossing
						$1,460,890
	Construction Subtotal				$1,636,197	$505,197
	Contingency		10%		$163,620	$50,519.68
	Engineering		22%		$359,963	$111,143.30
			Estimated Price		$2,159,780	**$666,860**

without increasing FVale pond capacity to 13 M cuft.

Project Cost Estimate 2A - Part 1

Improved Hilger Ditch - Mill crossing to F-Vale Cemetery Pond - HVID Culverts #1, #2, #3, #4 all to Hilger

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Total Price	4030 lineal feet of new ditch
1.	Mobilization, Bonds, Ins.	LS	12%	$1,514,810.00	$181,777	
2.	Unclassified Excavation	CY	13,500	$4.50	$60,750	5,200' Hilger ditch from Mill to Forestvale cemetery pond
3.	Embankment	LF	3,200	$6.95	$22,240	Berm both edges of ditch
4.	54" Concrete squash pipe	LF	150	$140.00	$21,000	HVID #1 crossing under Mill (2 parallel 54" - capacity = 280 cfs)
5.	Install squash culvert	LF	150	$110.00	$16,500	HVID #1 crossing under Mill
6.	pavement replacement	SY	220	$18.00	$3,960	HVID #1 crossing under Mill
7.	42" concrete squash pipe	LF	255	$100.00	$25,500	crossing under Forestvale (5 parallel 42" - capacity 500 cfs)
8.	Install squash culvert	LF	225	$100.00	$22,500	crossing under Forestvale
9.	pavement replacement	SY	440	$18.00	$7,920	crossing under Forestvale
10.	land acquisition	ac	3	$8,600.00	$25,800	legal, survey, easements, landowner negotiations (11 landowners)
11.	Unclassified Excavation	CY	300,000	$3.00	$900,000	increase Forestvale Cemetery Pond to 13M cubic feet capacity
12.	Embankment	CY	66,000	$3.50	$231,000	berm around Forestvale Cemetery Pond
13.	Outlet structure	ea	1	$8,400.00	$8,400	outlet for pond to D2
14.	Unclassified Excavation	CY	7,800	$4.50	$35,100	ditch from pond to D2
15.	rip rap at culverts & turns	CY	200	$90.00	$18,000	outlet ditch
16.	Flared-end sections	ea	7	$1,600.00	$11,200	crossings under Mill, Forestvale, Sierra
17.	Gravel bedding/subgrade	CY	170	$35.00	$5,950	
18.	seeding/fertilizing	SY	31,000	$1.25	$38,750	disturbed area
19.	traffic control	LS	1	$6,300.00	$6,300	Mill, Forestvale, Sierra
20.	42" concrete squash pipe	LF	240	$100.00	$24,000	Sierra Rd Crossing (3 parallel 42" - capacity = 275 cfs)
21.	Install squash culvert	LF	240	$100.00	$24,000	Sierra Rd Crossing
22.	pavement replacement	SY	330	$18.00	$5,940	Sierra Rd Crossing
						$1,514,810
	Construction Subtotal				$1,696,587	$565,587
	Contingency		10%		$169,659	$56,558.72
	Engineering		22%		$373,249	$124,429.18
	Estimated Price				$2,239,495	**$746,575**

without increasing FVale pond capacity to 13 M cuft.

This cost estimate includes improvements to all of Hilger Ditch to accept flow from HVID #1 thru #4. It does NOT include any improvememts to get HVID #2 thru #4 to Hilger.

Project Cost Estimate 2A - Part 2

HVID Culverts #1, #2, #3, #4 Directly north, flow to Hilger 160' north of Mill, #5 to Mill/McHugh

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Total Price	2,850 (McHugh) & 1,760 (Mill)
1.	Mobilization, Bonds, Ins.	LS	12%	$198,433	$23,812	
2.	Unclassified Excavation	CY	3,000	$4.50	$13,500	2,130' ditch south side of Mill to Mill/Hedges
3.	Embankment	LF	850	$6.95	$5,908	Berm north edge of ditch along Mill
4.	36" concrete squash pipe	LF	135	$80.00	$10,800	3 - parallel 36" squash under Mill west of Hedges
5.	Install 36" concrete squash pipe	LF	135	$95.00	$12,825	3 - parallel 36" squash under Mill west of Hedges
8.	Unclassified Excavation	CY	850	$4.50	$3,825	New ditch Mill/Hedges to Hilger - 530' long
9.	Embankment	CY	450	$6.95	$3,128	New ditch Mill/Hedges to Hilger - 530' long
10.	Unclassified Excavation	CY	1,350	$4.50	$6,075	New ditch HVID culvert #5 to Mill/McHugh
11.	Embankment	SF	2,200	$6.95	$15,290	New ditch HVID culvert #5 to Mill/McHugh - gulley already there
12.	Gravel bedding/subgrade	CY	310	$35.00	$10,850	bedding for culverts, bridges and road subgrade
13.	seeding/fertilizing	SY	9,100	$1.25	$11,375	entire disturbed area
14.	Ditch re-grading	SY	5,090	$1.75	$8,908	south side of Mill to direct flow to McHugh
17.	utility crossing conflicts	ea	21	$530.00	$11,130	UG phone, fiber, gas, electrical at Mill & McHugh
18.	utility parallel conflicts	LF	2,200	$2.50	$5,500	UG phone, fiber, gas, electrical in Mill & McHugh ditches
19.	30" concrete squash pipe	LF	360	$75.00	$27,000	8 ditch crossings on Mill (3) and McHugh (5) to NW quadrant of
20.	Install 30" concrete squash pipe	LF	360	$90.00	$32,400	Mill/McHugh
21.	Unclassified Excavation	CY	450	$4.50	$2,025	2,850' ditch HVID #5 west side of McHugh to Mill
22.	Embankment	CY	310	$2.50	$775	New ditch Mill/Hedges to Hilger - 530' long
23.	Pavement restoration	SY	720	$18.00	$12,960	Address low spot just west of McHugh on Mill
24.	36" concrete squash pipe	LF	52	$80.00	$4,160	Crossing under Mill @ McHugh
25.	Install 36" concrete squash pipe	LF	52	$95.00	$4,940	Crossing under Mill @ McHugh
26.	Flared-end sections	ea	9	$1,600.00	$14,400	Crossing under Mill @ McHugh
	Construction Subtotal				$241,584	$198,433
	Contingency		10%		$24,158	
	Engineering		22%		$53,149	
						Includes Mill crossing, 3 approach crossings - all with Tri-Deck,
						concrete end panels, abutments, guardrail.
			Estimated Price		$318,891	

This cost estimate includes improvements to get HVID #2 thru #4 to Hilger AND to get HVID #5 NW quad of Mill/McHugh

Project Cost Estimate 2A - Part 3

HVID #5 - to Trap Club Pond

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	
						2150 LF of new ditch - contain overland flow west of Kerr
1.	Mobilization, Bonds, Ins.	LS	12%	$371,425.00	$44,571	
2.	Unclassified Excavation	CY	1,920	$4.50	$8,640	2150' ditch - 12' top width, 4' bottom width, 3' deep
3.	Embankment	LF	600	$6.95	$4,170	Berm both sides of ditch to 1'
4.	land acquisition	LS	0.5	$44,000	$22,000	legal, survey, easements, landowner negotiations (11 landowners)
5.	seeding/fertilizing	SY	5,200	$1.25	$6,500	entire disturbed area
6.	utility crossing conflicts	ea	12	$530.00	$6,360	Forestvale and McHugh
7.	utility parallel conflicts	LF	250	$2.50	$625	UG phone, fiber, gas, electrical in Kerr & McHugh ditches
8.	Ditch re-grading	SY	500	$1.75	$875	Forestvale south 150' on Kerr
9.	rip rap	CY	300	$90.00	$27,000	armor outside bank on each turn for 100'
10.	36" equivalent squash pipe	LF	125	$80.00	$10,000	
11.	install 36" squash pipe	LF	125	$95.00	$11,875	Culverts at Stadler & Edgerton
12.	pavement replacement	SY	110	$18.00	$1,980	
13.	barbed wire fencing	LF	4,300	$2.40	$10,320	both sides of ditch
14.	42" equivalent squash pipe	LF	70	$100.00	$7,000	
15.	install 42" squash pipe	LF	70	$100.00	$7,000	Replace crossing under McHugh
16.	pavement replacement	SY	100	$18.00	$1,800	
17.	36" equivalent squash pipe	LF	1,300	$80.00	$104,000	north side of Forestvale - Georgia to N. Montana
18.	install 36" squash pipe	LF	1,300	$95.00	$123,500	north side of Forestvale - Georgia to N. Montana
19.	pavement replacement	SY	110	$18.00	$1,980	Under N. Montana, north of Forestvale
20.	traffic control	LS	1	$11,000.00	$11,000	
21.	Flared End Sections	ea.	3	$1,600.00	$4,800	
	Construction Subtotal				$415,996	$371,425
	Contingency		10%		$41,600	
	Engineering		22%		$91,519	
			Estimated Price		$549,115	

This project includes conveyance for HVID Culvert #5 from the NW quadrant of Mill/McHugh, north 820' to a new crossing under McHugh (crossing under Stadler & Edgerton), overland to the corner of Kerr/Forestvale, cross under Forestvale and piped to the east ditch of North Montana Avenue.

Project Cost Estimate

Ditches to intersection Mill & McHugh

2,850 (McHugh) & 1,760 (Mill)

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	
1.	Mobilization, Bonds, Ins.	LS	12%	$502,215.00	$60,266	
2.	Unclassified Excavation	CY	3,000	$4.50	$13,500	1,760' ditch south side of Mill to Mill/McHugh
3.	Embankment	LF	850	$6.95	$5,908	Berm north edge of ditch along Mill
4.	TriDeck precast Bridge	SF	1,080	$46.00	$49,680	two approaches on south side of Mill - cannot fit squash
5.	Install precast bridge	SF	1,080	$32.00	$34,560	two approaches on south side of Mill (32.5' wide bridges each)
6.	TriDeck precast Bridge	SF	540	$46.00	$24,840	crossing approach north of Motsiff (32.5' wide bridge)
7.	Install precast bridge	SF	540	$32.00	$17,280	crossing approach north of Motsiff
8.	Unclassified Excavation	CY	5,700	$4.50	$25,650	New ditch HVID canal to Mill
9.	Embankment	SF	1,100	$6.95	$7,645	New ditch HVID canal to Mill - berm north side
10.	Unclassified Excavation	CY	4,630	$4.50	$20,835	New ditch HVID canal to McHugh
11.	Embankment	SF	900	$6.95	$6,255	New ditch HVID canal to McHugh - berm east side
12.	Gravel bedding/subgrade	CY	240	$35.00	$8,400	bedding for culverts, bridges and road subgrade
13.	seeding/fertilizing	SY	14,000	$1.25	$17,500	entire disturbed area
14.	Ditch re-grading	SY	5,090	$1.75	$8,908	to direct flow to McHugh - avoid flooding 3 homes
15.	TriDeck precast Bridge	SF	800	$46.00	$36,800	Mill crossing ditch at McHugh 25' span, 32.5' wide
16.	Install precast bridge	SF	800	$32.00	$25,600	Mill crossing ditch at McHugh
17.	utility crossing conflicts	ea	21	$530.00	$11,130	UG phone, fiber, gas, electrical at Mill & McHugh
18.	utility parallel conflicts	LF	13,000	$2.50	$32,500	UG phone, fiber, gas, electrical in Mill & McHugh ditches
19.	guardrail	LF	200	$21.00	$4,200	four bridges, 25' each side
20.	Bridge abutments & end panels	ea	8	$11,500.00	$92,000	four bridges, 40' each abutment
21.	Unclassified Excavation	CY	3,550	$4.50	$15,975	2,850' ditch west side of McHugh to Mill
22.	Pavement restoration	SY	350	$18.00	$6,300	2,850' ditch west side of McHugh to Mill
23.	36" concrete squash pipe	LF	210	$175.00	$36,750	four approaches to McHugh - south of Motsiff
24.	Install 36" concrete squash pipe	LF	210	$175.00	$36,750	four approaches to McHugh - south of Motsiff
	Construction Subtotal				$599,231	$502,215
	Contingency		10%		$59,923	
	Engineering		22%		$131,831	
						Includes Mill crossing, 3 approach crossings - all with Tri-Deck,
						concrete end panels, abutments, guardrail.
			Estimated Price		$790,985	

Project Cost Estimate

HVID Culverts #6 & #7 - Improved Ditch - McHugh, Nona to TMC

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	1500 lineal feet of new ditch
1.	Mobilization, Bonds, Ins.	LS	12%	$78,885	$9,466	
2.	Unclassified Excavation	CY	820	$4.50	$3,690	400' ditch - McHugh to Nona/Carol
3.	Embankment	LF	500	$6.95	$3,475	berm both sides of ditch
4.	Unclassified Excavation	CY	4,100	$4.50	$18,450	2,100' ditch/berm - Nona/Carol to Tenmile Creek @ Montana
5.	Embankment	LF	2,300	$6.95	$15,985	berm north side of ditch
6.	seeding/fertilizing	SY	8,500	$1.25	$10,625	entire disturbed area
7.	rip rap	CY	115	$90.00	$10,350	riprap both banks for 100' @ each turn & @ TMC
8.	utility crossing conflicts	ea	16	$530.00	$8,480	McHugh - Nona - TMC
9.	utility parallel conflicts	LF	2,100	$2.50	$5,250	Nona
10.	Land Acquisition	ac	0.3	$8,600.00	$2,580	McHugh to Nona/Carol
	Construction Subtotal				$88,351	$78,885
	Contingency		10%		$8,835	
	Engineering		22%		$19,437	
			Estimated Price		$116,624	

Project Cost Estimate

Improved Ditch - McHugh from Mill to 36" Cemetery Diversion

3830 lineal feet of new ditch - capacity 210 cfs.

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	
1.	Mobilization, Bonds, Ins.	LS	12%	$369,950.00	$44,394	
2.	Unclassified Excavation	CY	7,300	$4.50	$32,850	3830' ditch west side of McHugh from Mill to Maynard
3.	Embankment	LF	1,200	$6.95	$8,340	Berm both edges of ditch
4.	42" Concrete squash pipe	LF	180	$90.00	$16,200	crossing under Stadler. (material cost) 3 parallel 42" = 210 cfs.
5.	Install squash culvert	LF	180	$90.00	$16,200	crossing under Stadler (labor/equipment)
6.	42" Concrete squash pipe	LF	180	$90.00	$16,200	crossing under Edgerton (material cost) 3 parallel 42" - 210 cfs.
7.	Install squash culvert	LF	180	$90.00	$16,200	crossing under Edgerton (labor/equipment)
8.	42" Concrete squash pipe	LF	124	$90.00	$11,160	crossing under Ronda (material cost) 3 parallel 42" - 210 cfs.
9.	Install squash culvert	LF	124	$90.00	$11,160	crossing under Ronda (labor/equip))
10.	42" Concrete squash pipe	LF	124	$90.00	$11,160	crossing under Sewell (material cost) 3 parallel 42" - 210 cfs.
11.	Install squash culvert	LF	124	$90.00	$11,160	crossing under Sewell (labor/equip)
12.	42" Concrete squash pipe	LF	150	$90.00	$13,500	crossing under driveway (material cost) 3 parallel 42" - 210 cfs.
13.	Install squash culvert	LF	150	$90.00	$13,500	crossing under driveway (labor/equip)
14.	Flared-end sections	ea	15	$1,600.00	$24,000	upstream end of culverts only
15.	Gravel bedding/subgrade	CY	200	$35.00	$7,000	bed pipe
16.	seeding/fertilizing	SY	13,000	$1.25	$16,250	entire disburbed area
17.	pavement replacement	SY	720	$18.00	$12,960	
18.	rip rap at culverts & turns	CY	50	$90.00	$4,500	Sierra @ McHugh to north
19.	42" Concrete squash pipe	LF	240	$90.00	$21,600	crossing under Forestvale (material cost) 3 parallel 42" - 210 cfs.
20.	Install squash culvert	LF	240	$90.00	$21,600	crossing under Forestvale (labor/equip)
21.	42" Concrete squash pipe	LF	240	$35.00	$8,400	crossing under approach south of diversion (material cost)
22.	Install squash culvert	LF	240	$90.00	$21,600	crossing under approach south of diversion (labor/equip)
23.	traffic control	LS	1	$5,500.00	$5,500	
24.	utility crossing conflicts	ea	47	$530.00	$24,910	
25.	utility parallel conflicts	LF	9,600	$2.50	$24,000	
	Construction Subtotal				$414,344	$369,950
	Contingency		10%		$41,434	
	Engineering		22%		$91,156	Does not include Mill crossing. Presumes 42" concrete squash pipe at each crossing - 3 in parallel.
			Estimated Price		$546,934	

Project Cost Estimate

Improved Ditch - McHugh/36" Cemetery Diversion (south of Maynard) to Sierra

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	1500 lineal feet of new ditch
1.	Mobilization, Bonds, Ins.	LS	12%	$0.00	$0	
2.	Unclassified Excavation	CY	2,600	$4.50	$11,700	1,500 ' ditch from Cemetery diversion to Sierra - no crossing
3.	Embankment	LF	450	$6.95	$3,128	berm both sides of ditch
4.	seeding/fertilizing	SY	13,000	$1.25	$16,250	entire disburbed area
5.	rip rap	CY	35	$90.00	$3,150	at culverts and turns
6.	42" Concrete squash pipe	LF	144	$90.00	$12,960	northerly cemetery entrance off McHugh - 3 parallel 42"
7.	Install squash culvert	LF	144	$90.00	$12,960	northerly cemetery entrance off McHugh
8.	pavement replacement	SY	75	$18.00	$1,350	northerly cemetery entrance off McHugh
9.	curb & gutter replacement	LF	30	$50.00	$1,500	northerly cemetery entrance off McHugh
10.	42" Concrete squash pipe	LF	190	$90.00	$17,100	crossing under McHugh south of Maynard - 3 parallel 42"
11.	Install squash culvert	LF	190	$90.00	$17,100	crossing under McHugh south of Maynard
12.	pavement replacement	SY	160	$18.00	$2,880	crossing under McHugh south of Maynard
13.	traffic control	LS	1	$5,500.00	$5,500	
14.	utility crossing conflicts	ea	22	$530.00	$11,660	
15.	utility parallel conflicts	LF	3,000	$2.50	$7,500	
	Construction Subtotal				$124,738	
	Contingency		10%		$12,474	
	Engineering		22%		$27,442	
			Estimated Price		$164,654	

Project Cost Estimate

New Ditch - McHugh/Sierra to D2 Drain

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	4030 lineal feet of new ditch
1.	Mobilization, Bonds, Ins.	LS	12%	$207,860.00	$24,943	
2.	Unclassified Excavation	CY	9,500	$4.50	$42,750	4,030' ditch McHugh/Sierra north to D2 drain
3.	Embankment	LF	1,200	$6.95	$8,340	Berm both edges of ditch
4.	54" Concrete squash pipe	LF	72	$140.00	$10,080	crossing under Sierra Rd. (material cost)
5.	Install squash culvert	LF	72	$165.00	$11,880	crossing under Sierra Rd. (labor/equipment)
6.	54" Concrete squash pipe	LF	72	$140.00	$10,080	crossing under Crestwood (material cost)
7.	Install squash culvert	LF	72	$165.00	$11,880	crossing under Crestwood (labor/equipment)
8.	54" Concrete squash pipe	LF	56	$140.00	$7,840	approach crossing west of Silverwood Loop (material cost)
9.	Install squash culvert	LF	56	$165.00	$9,240	approach crossing west of Silverwood Loop (labor/equip))
10.	54" Concrete squash pipe	LF	40	$140.00	$5,600	access to ag field west of Silverwood Lane
11.	Install squash culvert	LF	40	$165.00	$6,600	access to ag field west of Silverwood Lane
12.	Flared-end sections	ea	4	$1,800.00	$7,200	on upstream ends of each squash culvert (installed)
13.	Gravel bedding/subgrade	CY	200	$35.00	$7,000	bedding for culverts and road subgrade
14.	seeding/fertilizing	SY	13,000	$1.25	$16,250	entire disturbed area
15.	Ditch re-grading	SY	1,600	$1.55	$2,480	along silverwood
16.	Land acquisition	ac	3	$8,200.00	$24,600	Easements, R.O.W., Landowner negotiations
17.	barbed wire fencing	LF	8,200	$2.40	$19,680	both sides of ditch from Sierra to D2
18.	utility conflicts	ea	12	$530.00	$6,360	Sierra @ McHugh to north
	Construction Subtotal				$232,803	$207,860
	Contingency		10%		$23,280	
	Engineering		22%		$51,217	
			Estimated Price		$307,300	

Project Cost Estimate

Ditch Mill/McHugh/Edgerton to Kerr/Forestvale, Pipe to N. Montana Ditch

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Engineers Estimate Total Price	2150 LF of new ditch - contain overland flow west of Kerr
1.	Mobilization, Bonds, Ins.	LS	12%	$604,570.00	$72,548	
2.	Unclassified Excavation	CY	1,920	$4.50	$8,640	2150' ditch - 12' top width, 4' bottom width, 3' deep
3.	Embankment	LF	600	$6.95	$4,170	Berm both sides of ditch to 1'
4.	land acquisition	LS	1	$44,000.00	$48,400	legal, survey, easements, landowner negotiations (11 landowners)
5.	seeding/fertilizing	SY	5,200	$1.25	$6,500	entire disturbed area
6.	utility crossing conflicts	ea	12	$530.00	$6,360	Forestvale and McHugh
7.	utility parallel conflicts	LF	250	$2.50	$625	UG phone, fiber, gas, electrical in Kerr & McHugh ditches
8.	Ditch re-grading	SY	500	$1.75	$875	Forestvale south 150' on Kerr
9.	rip rap	CY	300	$90.00	$27,000	armor outside bank on each turn for 100'
10.	barbed wire fencing	LF	4,300	$2.40	$10,320	both sides of ditch
11.	42" equivalent squash pipe	LF	48	$140.00	$6,720	(concrete) replace crossing under McHugh
12.	install 42" squash pipe	LF	48	$165.00	$7,920	
13.	pavement replacement	SY	70	$18.00	$1,260	(concrete) replace crossing under McHugh
14.	36" equivalent squash pipe	LF	1,300	$175.00	$227,500	north side of Forestvale - Georgia to N. Montana
15.	install 36" squash pipe	LF	1,300	$175.00	$227,500	north side of Forestvale - Georgia to N. Montana
16.	pavement replacement	SY	110	$18.00	$1,980	Under N. Montana, north of Forestvale
17.	traffic control	LS	1	$14,000.00	$14,000	
18.	Flared End Sections	ea.	3	$1,600.00	$4,800	
	Construction Subtotal				$677,118	$604,570
	Contingency		10%		$67,712	
	Engineering		22%		$148,966	
			Estimated Price		$893,796	

Project Cost Estimate

D2 Drain Improvements

5070 lineal feet of re-graded ditch and 4 crossings

Item No.	Item	Unit	Quant.	Engineers Estimate: Unit Price	Engineers Estimate: Total Price	
1.	Mobilization, Bonds, Ins.	LS	12%	$215,272.50	$25,833	
4.	60" Concrete squash pipe	LF	90	$175.00	$15,750	D2 crossing under Access and Crestwood
5.	Install squash culvert	LF	90	$175.00	$15,750	crossings (labor/equipment)
6.	84" Concrete squash pipe	LF	110	$210.00	$23,100	crossing under Rosewood and @ N. Montana (material cost)
7.	Install squash culvert	LF	110	$210.00	$23,100	crossings (labor/equipment)
8.	84" Concrete squash pipe	LF	60	$210.00	$12,600	crossing under access east of Montana (material cost)
9.	Install squash culvert	LF	60	$210.00	$12,600	crossing under access east of Montana (labor/equipment)
10.	Flared-end sections	ea	4	$2,200.00	$8,800	on upstream ends of each squash culvert (installed)
11.	Gravel bedding/subgrade	CY	200	$35.00	$7,000	bedding for culverts and road subgrade
12.	seeding/fertilizing	SY	13,000	$1.25	$16,250	entire disturbed area
13.	Ditch re-grading	SY	30,000	$1.55	$46,500	along silverwood
14.	FETS trash guards	Ea	4	$2,200.00	$8,800	Easements, R.O.W., Landowner negotiations
15.	Gravel road repair	SY	100	$12.00	$1,200	crossings at Crestwood and Rosewood
16.	utility conflicts	ea	12	$530.00	$6,360	Crestwood, Rosewood
17.	traffic control	LS	1	$4,200.00	$4,200	Crestwood, Rosewood
18.	Berm	CY	35	$7.50	$263	at N. Montana to contain flow toward 96" CMP under Montana
19.	Coordination with BoR/HVID	LS	1	$13,000.00	$13,000	Eng.effort to coordinate project, easement compliance, pub. Ed.
	Construction Subtotal				$241,105	$215,273
	Contingency		10%		$24,111	
	Engineering		22%		$53,043	
	Estimated Price				$318,259	

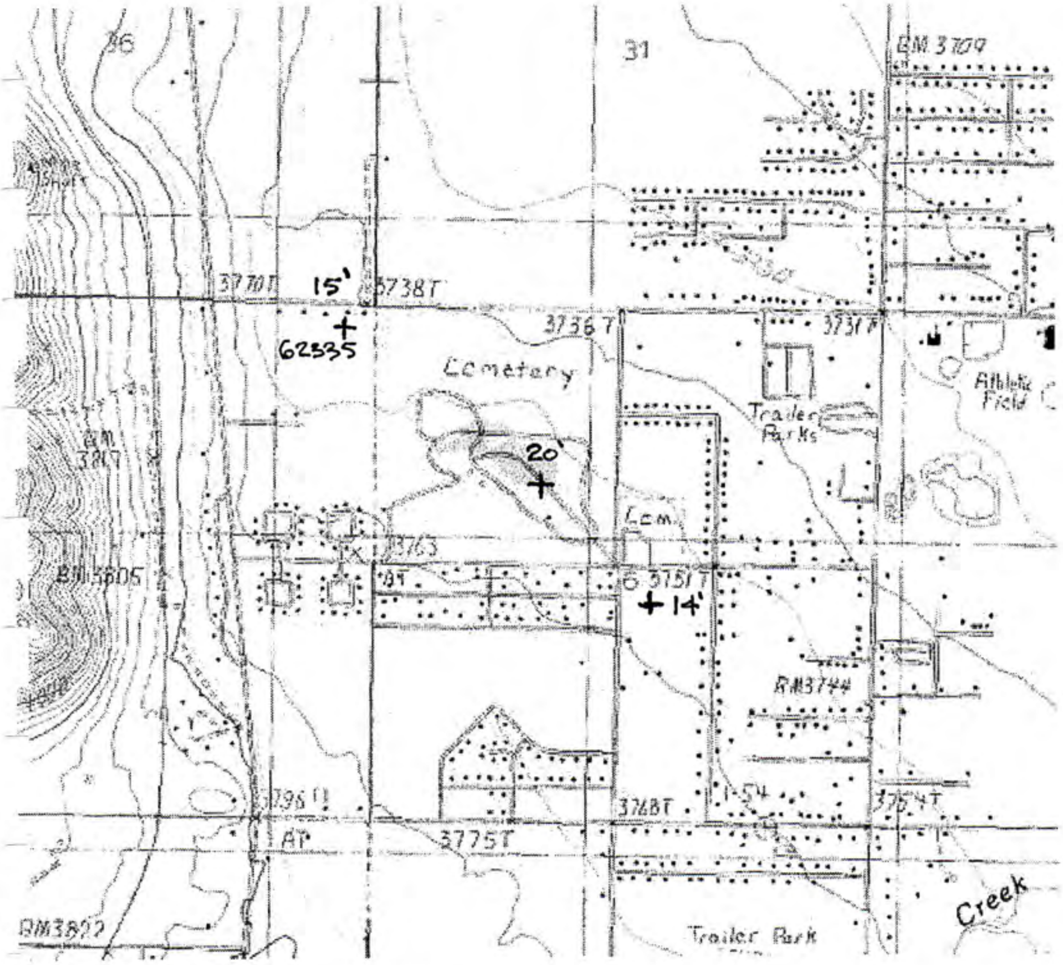
Project Cost Estimate

D2 Drain Improvements - OVERALL

Item No.	Item	Unit	Quant.	Engineers Estimate Unit Price	Total Price	5070 lineal feet of re-graded ditch and 4 crossings
1.	Mobilization, Bonds, Ins.	LS	12%	$1,675,057.50	$201,007	
4.	60" Concrete squash pipe	LF	90	$175.00	$15,750	D2 crossing under Access and Crestwood
5.	Install squash culvert	LF	90	$175.00	$15,750	crossings (labor/equipment)
6.	84" Concrete squash pipe	LF	110	$210.00	$23,100	crossing under Rosewood and @ N. Montana (material cost)
7.	Install squash culvert	LF	110	$210.00	$23,100	crossings (labor/equipment)
8.	84" Concrete squash pipe	LF	60	$210.00	$12,600	crossing under access east of Montana (material cost)
9.	Install squash culvert	LF	60	$210.00	$12,600	crossing under access east of Montana (labor/equipment)
10.	Flared-end sections	ea	4	$2,200.00	$8,800	on upstream ends of each squash culvert (installed)
11.	Gravel bedding/subgrade	CY	200	$35.00	$7,000	bedding for culverts and road subgrade
12.	seeding/fertilizing	SY	13,000	$1.25	$16,250	entire disturbed area
13.	Ditch re-grading	SY	54,000	$1.55	$83,700	along Rosewood
14.	FETS trash guards	Ea	4	$2,200.00	$8,800	Easements, R.O.W., Landowner negotiations
15.	Gravel road repair	SY	100	$12.00	$1,200	crossings at Crestwood and Rosewood
16.	utility conflicts	ea	12	$530.00	$6,360	Crestwood, Rosewood
17.	traffic control	LS	1	$2,200.00	$2,200	Crestwood, Rosewood
18.	Berm	CY	35	$7.50	$263	at N. Montana to contain flow toward 96" CMP under Montana
19.	Coordination with BoR/HVID	LS	1	$13,000.00	$13,000	Eng.effort to coordinate project, easement compliance, pub. Ed.
20.	TriDeck precast Bridge	SF	7,280	$46.00	$334,880	Seven bridges east of I-15 over existing crossing points:
21.	Install precast bridge	SF	7,280	$32.00	$232,960	Arrowhead; accesses, etc.
22.	Pre-cast bridge abutments	ea	14	$11,500.00	$161,000	Seven bridges east of I-15.
23.	Guardrail on bridges	LF	450	$21.00	$9,450	both sides of all seven bridges.
24.	Regrade, clean D2 ditch	SY	100,700	$2.85	$286,995	East of I-15 to Lake Helena - higher unit cost due to mucking
25.	Bore 96" parallel conc. Culvert	LF	250	$1,100.00	$275,000	Under I-15. Added capacity 340 cfs.
26.	7'x7' double cell box culvert	LF	120	$880.00	$105,600	Under Frontage Rd. east of I-15
27.	Type 1 sloped end sections	ea	2	$6,900.00	$13,800	ends of double cell box culverts under Frontage Rd.
28.	Traffic control	LS	1	$4,900.00	$4,900	for Frontage Road.
	Construction Subtotal				$1,876,064	$1,675,058
	Contingency		10%		$187,606	
	Engineering		22%		$412,734	
			Estimated Price		$2,476,405	

Appendix D

Well Logs Near Forestvale Cemetery



Groundwater Depth (bgs)

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Plot this site on a topographic map
View scanned well log (11/7/2006 3:28:08 PM)

Site Name: GILREATH JACK & K
GWIC Id: 62335

Section 1: Well Owner

Owner Name
N/A

Section 2: Location

Township	Range	Section	Quarter Sections
10N	04W	1	NE¼ NE¼ NE¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.659709	112.043951	TRS-SEC	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

DOMESTIC (1)

Section 4: Type of Work

Drilling Method: AIR ROTARY

Section 5: Well Completion Date

Date well completed: Tuesday, June 16, 1987

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	100	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	40	6				STEEL
22	100	4				PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
60	100	6		1/4X4	SLOTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	20	BENTONITE	

Section 7: Well Test Data

Total Depth: 100
Static Water Level: 15
Water Temperature:

Air Test *

15 gpm with drill stem set at _ feet for 2 hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level 90 feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	2	TOPSOIL
2	25	GRAVEL, SAND
25	39	CLAY
39	100	GRANITE BEDROCK

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name:
Company: LINDSAY DRILLING CO INC
License No: WWC-253
Date Completed: 6/16/1987

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Plot this site on a topographic map
View scanned well log (10/18/2006 1:16:07 PM)

Site Name: INGEBRITSON WILLIAM
GWIC Id: 163200

Section 1: Well Owner

Owner Name
INGEBRITSON WILLIAM

Mailing Address
5465 MCHUGH

City	State	Zip Code
HELENA	MT	59602

Section 2: Location

Township	Range	Section	Quarter Sections
10N	03W	6	SE¼ NW¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.655194	112.035326	TRS-SEC	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water
DOMESTIC (1)

Section 4: Type of Work
Drilling Method: AIR ROTARY

Section 5: Well Completion Date
Date well completed: Thursday, August 28, 1997

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	81	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	80	6				STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
80	80	6			OPEN BOTTOM

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	20	BENTONITE	

Section 7: Well Test Data

Total Depth: 81
Static Water Level: 20
Water Temperature:

Air Test *

30 gpm with drill stem set at _ feet for 1 hours.
Time of recovery 1 hours.
Recovery water level 20 feet.
Pumping water level 75 feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	2	TOP SOIL
2	18	GRAVEL
18	58	HARDPAN
58	70	GRAVEL/SAND
70	78	CLAY/GRAVEL
78	81	GRAVEL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: TERRY LINDSAY
Company: LINDSAY DRILLING CO INC
License No: WWC-253
Date Completed: 8/28/1997

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Plot this site on a topographic map
View scanned well log (10/18/2006 1:16:13 PM)

Site Name: CALMETTES VIOLET
GWIC Id: 61205

Section 1: Well Owner

Owner Name
CALMETTES VIOLET
Mailing Address

City	State	Zip Code
HELENA	MT	59601

Section 2: Location

Township	Range	Section	Quarter Sections
10N	03W	6	SE¼ NW¼

County	Geocode
LEWIS AND CLARK	

Latitude	Longitude	Geomethod	Datum
46.655194	112.035326	TRS-SEC	NAD83

Ground Surface Altitude	Method	Datum	Date
3745			

Addition	Block	Lot

Section 3: Proposed Use of Water
DOMESTIC (1)

Section 4: Type of Work
Drilling Method: CHURN DRILL

Section 5: Well Completion Date
Date well completed: Monday, August 05, 1957

Section 6: Well Construction Details
Borehole dimensions

From	To	Diameter
0	44	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	44	6				STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
44	44	6			OPEN BOTTOM

Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth: 44
Static Water Level: 14
Water Temperature:

Bailer Test *

20 gpm with _ feet of drawdown after 2 hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level 28 feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log
Geologic Source
111ALVM - ALLUVIUM (HOLOCENE)

From	To	Description
0	5	TOP SOIL AND GRAVEL
5	19	GRAVEL
19	29	HARD PAN
29	33	CLAY
33	43	CLAY AND GRAVEL
43	44	CLEAN GRAVEL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: WESLEY LINDSAY
Company: LINDSAY DRILLING CO INC
License No: WWC-38
Date Completed: 8/5/1957

Appendix E

Cost Estimate Spreadsheets
Silver Creek and Sewell

PROJECT COST ESTIMATE

LEWIS AND CLARK COUNTY FLOODPLAIN IMPROVEMENTS

Sewell Subdivision - Improve Existing Infrastructure

				Engineers Estimate	
Item No.	Item	Unit	Quant.	Unit Price	Total Price
1.	Mobilization	LS	1	$30,000.00	$30,000.00
2.	Install New Culverts 3 -36" CMP	LF	150	$75.00	$11,250.00
3.	Clean Silver Creek Channel	CY	180	$45.00	$8,100.00
4.	Renovate Mt Avenue Culvert	LS	1	$4,500.00	$4,500.00
5.	Regrade Creek Channel	LF	3100	$8.00	$24,800.00
6.	Misc. Earthwork	CY	1000	$8.00	$8,000.00
7.	Driveway restoration	EA	30	$1,500.00	$45,000.00
8.	Clean and Grade Channel to I-15	LF	2650	$8.00	$21,200.00
9.	New Culvert under Interstate	LF	200	$1,000.00	$200,000.00
10.	Road Restoration	LS	3	$3,500.00	$10,500.00
11.	Seeding/fertilizing	SY	4000	$2.50	$10,000.00
12.	Permitting	LS	1	$4,000.00	$4,000.00
13.	Traffic Control	LS	1	$2,500.00	$2,500.00
14.	Utility Conflicts	EA	20	$530.00	$10,600.00
	Construction Subtotal				$390,450.00
15.	Contingency		10%		$39,045.00
16.	Engineering		22%		$85,899.00
			Estimated Price		**$515,394**

PROJECT COST ESTIMATE

LEWIS AND CLARK COUNTY FLOODPLAIN IMPROVEMENTS

Sewell Subdivision - Bypass Channel

				Engineers Estimate	
Item No.	**Item**	**Unit**	**Quant.**	**Unit Price**	**Total Price**
1.	Mobilization	LS	1	$125,000.00	$125,000.00
2.	Install New Culverts 3 -30" CMP	LF	90	$60.00	$5,400.00
3.	Clean Silver Creek Channel	CY	180	$45.00	$8,100.00
4.	Renovate MT Ave Culvert	LS	1	$4,500.00	$4,500.00
5.	Second MT Ave Culvert	LF	50	$150.00	$7,500.00
6.	Excavation	CY	131200	$4.50	$590,400.00
7.	Embankment	CY	86,192	$6.95	$599,034.40
8.	Road Restoration	LS	3	$3,500.00	$10,500.00
9.	Seeding/fertilizing	SY	45000	$1.25	$56,250.00
10.	New Pipe Crossing Under I-15	LF	200	$1,200.00	$240,000.00
11.	Utility Conflicts	EA	20	$530.00	$10,600.00
12.	Permitting	LS	1	$8,000.00	$8,000.00
13.	Traffic Control	LS	1	$5,000.00	$5,000.00
14	Easement Acquisition	LS	1	$30,000.00	$30,000.00
	Construction Subtotal				$1,700,284.40
15.	Contingency		10%		$170,028.44
16.	Engineering		22%		$374,062.57
			Estimated Price		**$2,244,375**

Appendix F

U.S. Bureau of Reclamation Sample Ditch Easement & HVID Letter to Bureau of Reclamation

Contract No. 14-06-600-9841

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Parcel No. DD-29

Helena Valley Unit

Drains D-9 (North Side
D-9-0.5R Drains)

CONTRACT AND DONATION EASEMENT

1. THIS CONTRACT, made this 12 day of April, 19 68 pursuant to the Acts of Congress approved June 17, 1902 (32 Stat. 388), October 14, 1940 (54 Stat. 1119), and December 22, 1944 (58 Stat. 887), and acts amendatory thereof or supplementary thereto, between THE UNITED STATES OF AMERICA, hereinafter styled the United States, represented by the Officer executing this contract, and the O'Connell Ranch Company, a Montana Corporation,

hereinafter collectively referred to as the Grantor.

WITNESSETH, THAT:

2. In consideration of the mutual and dependent stipulations and agreements herein made, the parties hereto agree as follows:

3. The Grantor is the owner of the following described premises, situated in the County of Lewis and Clark, State of Montana, to wit:

$E\frac{1}{2}NW\frac{1}{4}$ and $N\frac{1}{2}SW\frac{1}{4}$ of Sec. 25, and the $E\frac{1}{2}SE\frac{1}{4}$ of Sec. 26, T. 11 N., R. 3 W., Principal Meridian

4. The Grantor by these presents does hereby grant to the United States, its successors and assigns, by donation, the perpetual right, privilege and easement to enter, use and occupy, in a prudent and careful manner, for a drainage ditch and the incidental uses pertaining to or in connection therewith, a strip of land, through, over, and across the above-described premises, together with the necessary ingress and egress thereover, for the purpose of investigating, constructing, operating and maintaining open and closed, one or both, drain ditches and laterals, one or both, through, over, across, on or under the surface of a strip of land ~~---------feet in width, being----------feet left of and--------feet right of a centerline across the lands more particularly described as follows:~~ 25 feet in width lying along the North-South midsection line in the $E\frac{1}{2}NW\frac{1}{4}$ of Sec. 25, T. 11 N., R. 3 W., Principal Meridian, beginning at a point being 4,574.9 feet North and 2,646.7 feet West of the Southeast Corner of said Section 25 and ending at a point which is 2,720.1 feet North and 2,667.2 feet West of the Southeast Corner of said Section 25; thence a strip of land 90 feet in width, being 45 feet left of and 45 feet right of a centerline beginning at the above-described point which

Checked for Engineering Data 5-20-68
Engineer [illegible]

is 2,720.1 feet North and 2,667.2 feet West of the Southeast Corner of said Section 25; thence S. 60°-55'-20" W., 3,159.20 feet to a point in the E½SE¼ of Section 26, T. 11 N., R. 3 W., Principal Meridian, being 1,246.8 feet North and 94.5 feet West of the Southeast Corner of Section 26 and containing 7.59 acres more or less.

5. The grant of easement herein contained shall include all other rights necessary to contribute to and effectuate the successful and efficient drainage of the above-described and other lands in the near vicinity thereof. It being understood and agreed by and between the parties hereto that the Grantor, his heirs and assigns, reserve the right to cultivate, use and occupy the above-described right-of-way for any purpose consistent with the rights and privileges above granted and which will not in anywise interfere with or endanger any facilities of the United States or the use thereof used thereon or in connection therewith. In case of permanent abandonment of said right-of-way, the title and interest therein herein granted shall end, cease and determine. The United States, its successors and assigns, shall use due care in its use and occupancy of said right-of-way to the end that the Grantor's reserved right in said right-of-way may be fully recognized and protected.

6. The grant of easement herein contained is subject to existing right-of-way for highways, roads, railroads, canals, laterals, ditches, electrical transmission or distribution lines and telegraph and telephone lines covering any part of the above-described premises.

7. The Grantor represents to the United States that he is the owner or entitled to the possession and use of the aforesaid right-of-way land and said Grantor, his executors, administrators and assigns, agree to and with the United States, its successors and assigns, to warrant and defend, in the Grantor or his executors, administrators or assigns, the title, use and possession of the above-described lands and premises against all and every person and persons whomsoever lawfully claiming or to claim the same; AND SAID GRANTOR HEREBY FOREVER RELEASES AND DISCHARGES the United States of America, its officers, employees and agents, from any and all claims, demands and causes of action whatsoever kind or nature, because of any damage to said right-of-way land, and in particular to any and all crops on said right-of-way, due to the excavation, construction, operation and maintenance of said drainage ditch on said right-of-way land; AND FURTHER, SAID GRANTOR HEREBY FOREVER RELEASES AND DISCHARGES, the United States of America, its officers, employees and agents, from any and all claims, demands and causes of action whatsoever kind or nature, caused by the drainage, direct or indirect, of any of the Grantor's lands whether on or off said right-of-way, due to or caused by said drainage program.

E23A

East Side Lateral

BOOK 207 PAGE 186

R645-60
(5-57)

OFFICE COPY LAND ACQUISITION BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
HELENA VALLEY UNIT
Missouri River Basin Project

Contract No. 14-06-600-3517

CONTRACT AND GRANT OF EASEMENT

Parcel No. E-23A & D-14

EASEMENT Long.

THIS INDENTURE, Made this 21 day of January, 1959, pursuant to the Act of Congress of June 17, 1902 (32 Stat. 388), and all acts amendatory thereof or supplementary thereto, particularly the Act of Congress of August 4, 1939 (53 Stat. 1187), and the Act of December 22, 1944 (58 Stat. 887), between the United States of America hereinafter referred to as United States, and ________

____

hereinafter collectively referred to as Vendor.

WITNESSETH:

The following grant and the following mutual covenants by and between the parties:

1. For the consideration hereinafter expressed the Vendor does hereby grant unto the United States and to its successors and assigns forever a right of way and easement, together with all the rights and privileges incident to the use and enjoyment thereof, including but not limited by this recital to the right of ingress and egress, to construct, maintain and operate an irrigation canal, ditch, or lateral, with appurtenant structures over and across the following described premises in the County of Lewis and Clark, State of Montana to-wit:

A strip of land over and across the North Half of the Northeast Quarter ($N\frac{1}{2}NE\frac{1}{4}$), and the Southwest Quarter of the Northeast Quarter ($SW\frac{1}{4}NE\frac{1}{4}$), of Section Thirty-four (34), Township Eleven (11) North, Range Three (3) West, Principal Meridian, more particularly described as follows: A strip of land 45 feet wide, being 20 feet wide on the left side and 25 feet wide on the right side of the following described center line.: Beginning at a point on the West line of the $NE\frac{1}{4}$, of Sec. 34, T. 11 N., R. 3 W., P.M., 2727.3 feet North and 2694.0 feet East from the Southwest Corner of said Sec. 34; thence N.89°28'E., 178.5 feet to a point 2729.0 feet North and 2872.5 feet East from the Southwest Corner of said Sec. 34, containing 0.18 acres, more or less. Also a strip of land 115 feet wide, being 60 feet wide on the right side and 55 feet wide on the left side of the following described center line: Beginning at a point on the East line of Sec. 34, T. 11 N., R. 3 W., P.M., 60 feet southerly from the Northeast Corner of said Sec. 34; thence S.89°56'W., 2671.7 feet to a point on the West line of the $NE\frac{1}{4}$, of said Sec. 34, 60 feet southerly from the North Quarter Corner of said Sec. 34, and containing 7.05 acres, more or less. The sum of the areas above described is 7.23 acres, more or less.

$13.50
528.75
$542.25

0.18 Acre
7.05 "
7.23 Acres

E23A
D14

Checked for Engineering Data 1-6-59 **Engineer** W.H.F.

0.18 Acre $13.50

Helena Valley Irrigation District

3840 North Montana Avenue Helena, MT 59602
(406) 442-3292 jimfoster@bresnan.net

August 23, 2012

Bureau of Reclamation, MT Area Office
Mr. Dan Jewell, Area Manager
P.O. Box 30137
Billings, MT 59107-0137

Dear Mr. Jewell,

The Helena valley is geographically shaped somewhat like a bowl. During flooding events, water from almost all directions flows towards and into Lake Helena. During the 1960's, Reclamation built a series of open and buried drains intended to lower the ground water levels for successful farming and raising crops. Although there are approximately twelve individual drainage systems throughout the District, there are three major ones, all which drain water into Lake Helena.

Since the 500 year 1981 flood, engineers and planners for Lewis and Clark County have investigated ways to channel and divert flood waters from Ten Mile and Silver Creeks away from residential homes and subdivisions and find or create a path to Lake Helena. Historically, flood waters from both of these creeks end up in Drain D-2. Following last year's flooding, county commissioners hired an engineering firm to look once again at plans for flood mitigation, and again the result of their investigation is that the only available and feasible channel is through D-2.

The preliminary plan developed by Anderson-Montgomery Consulting Engineers, Inc. involves extensive work up-gradient of D-2 to channel a couple thousand CFS away from development and to the drain and to Lake Helena. This type of plan would involve substantial upgrading of the drain including larger culverts, bank protection and reshaping. I can imagine a plethora of issues that could surface with a plan such as this and probably many I am not aware of. Some of my thoughts include:

1. D-2 is privately owned land with a federal easement that allows for the construction and maintenance of a drainage ditch. Considering the drainage language of the easement, could the structure be used for another purpose such as flood control, and wouldn't landowners have to agree?

2. Can the original "Congressional Purpose" for financing and constructing the drain be changed or amended from "drainage" to "drainage and flood control?"

3. Would allowing flood waters from other basins purposefully directed into the drainage system threaten or jeopardize any Federal Clean Water Act exemptions currently granted the District?

4. Liability?

Before the County Commissioners continue down the road of designing towards D-2 as its solution, we need to know if it is even possible. Thank you and I look forward to hearing back from you.

Sincerely,

JAMES A. FOSTER, MANAGER
HELENA VALLEY IRRIGATION DISTRICT

Attachment

Appendix G

Written Public Comment

Lewis & Clark County Floodplain Meeting
West Valley Fire Station
8/30/11

Scott's Notes:

- 65-70 attended
- Put map on website
- Eric G – priority – school access, wintertime needs
- Discussed on going Lewis & Clark needs and flood repairs
  - FEMA – pre-disaster condition's
  - Photos around county
- Projects
  - Forestvale – McHugh
  - McHugh bridge debris
  - Location – 10 Mile at Montana Ave
  - Pipe at Alfalfa Drive - ??
- Darek
  - Don't do things twice
  - Address priorities
  - Stalled with FEMA situation
  - Permitting process – get this going
  - Bypass Silver Creek
  - Dan on Prickly Pear Creek – on list?
  - Get with Gun Club
  - ? Use of drainage canals
- Eric
  - McHugh Forestvale/Island Road; high spot
  - Sewell – work with MDT on box culvert
  - Sierra – East of Rossiter school
  - Bank stabilization – East of Green Meadow on 10 Mile Creek
  - ? Belair Subdivisions – need culverts cleaned out
  - * Design criteria for bridges
  - Gridwater (?) highs in 2011 than 81' flood
  - ? Silver Creek still running – from mine ???
    - Mine claims all water is recycled
    - Old timer – more flow in 80 years
  - ? Homeowners responsibility to clean ditches, culverts in front of houses
  - Eric – private approaches should be cleaned by homeowner
  - MDT – Green Meadow ? their responsibility
  - ? Lack of money, could volunteers help?

- Marliss – help from resident committee
- ? List additions/deletions
- Better describe log jams
- Can we reduce wl in 10 Mile Creek to reduce ground water levels?
- 10 Mile flow/ground water, elevation linked
- Inventory ditches
- Forestvale & Robin Road – could use a culvert, high spot hits cars
- Lake on Stadler ? Drive
- Headgates on 10 Mile cause problems
- Create flood district
- FEMA pays 75%
- 2 Mile emergency levy
- Drainage pond on Stadler ? to Mill Road
- Clean sediment in borrow ditches
- Move surface water thru area
- How long to address big projects
- Mike Murrey – meet late Sept, mid Oct to discuss progress
- Newsletter? Website? – dedicated page
- FEMA 404, Notice of Intent, Sept 30th
- Put public documents in Library
- Add to list access to 10 Mile
- Andy Hart? – meeting on quarterly basis

Recommendations

to the draft

Helena Valley Flood Mitigation Master Plan

Jan. 28, 2013

The finalization of the Flood Mitigation Master Plan is scheduled to occur in the near future so any recommendations or alternatives must be submitted now. Hopefully anyone with suggestions will step forward. The best possible plan will emerge through a critical analysis of planning to date, an openness to sound yet novel ideas and solutions, and an emphasis on cost containment.

The recommendations that follow are intended to assist with this development of the best flood mitigation plan for the Helena valley. The recommendations are twofold:

1. **Construct a retention pond on the south side of the Helena Valley Irrigation Canal to capture and manage the water that flows into canal culverts #2 - #5.**
2. **Route all of the water that passes through culverts #2 - #5 into one ditch immediately after it passes under the canal, and then through the Hilger Ditch to the Cemetery retention pond.**

The 34-acre parcel of land that contains canal culverts #2 - #5 is reportedly for sale at the cost of $3,000 per acre. Because this land contains a stretch of the canal and is not accessible, i.e. it is enclosed on all sides by private property, it could possibly be purchased for even less. If L&C County bought the land it could then build a retention pond to better manage the flow of flood water through culverts #2 - #5 under the canal. (See the map on page 5.)

It is estimated this retention pond could potentially hold approximately 5 million cubic feet of water. The pond could be created by allowing/promoting the excavation and use of the material as a borrow source. (A second retention pond could also be constructed north of the canal.)

It is unclear, however, what affect a pond of this size and in this location would have on the groundwater problems in the valley.

The draft Valley Flood Plan proposes routing canal culvert #1 (284 cfs) through the Hilger Ditch to the Cemetery Pond at the cost of $667,000. This current proposal to route culverts #2 - #5 also through the Hilger Ditch would increase the necessary flow capacity by 204 cfs for a total flow capacity of 489 cfs in the Hilger Ditch. This would require a very large ditch. For example, compare this to the 395 cfs flow capacity of Ten Mile Creek through the Study Area. (Routing the ditches from culverts #2 - #5 in this manner would move them closer to where they used to flow in the 1950's prior to the creation of the canal.)

Prior to implementation of the final Master Flood Plan all necessary easements and/or land purchases would have to be negotiated as needed. This current proposal would require such negotiations with a relatively small number of property owners.

The Baertsch Irrigation Ditch receives its water from culvert #2. It would be essential to maintain the integrity of the Baertsch Ditch.

Routing the Ten Mile Creek flood water that flows through canal culverts #1 - #5 and creating a retention pond south of the canal would have its benefits. It would eliminate and/or greatly minimize the proposed numerous and costly improvements contained in the current draft Flood Plan to ditches and culverts along miles of streets through the central valley area. There would be no reason to pursue a retention pond at the Trap Club. The water from most floods could be managed without having to make significant improvements to the D2 Drain if the retention ponds at the Cemetery and south of the canal were of sufficient size.

If this proposal was adopted the funding requested in the FEMA application submitted in June 2012 relative to improvements to the Trap Club Pond and to the existing Interstate 15 drainage ditch would no longer be needed for those purposes. Immediate action would be necessary in order resubmit this application to fund a different but related project. The current application in the amount of $661,669 is in fact expected to be funded. This amount of money would nearly cover the cost of improvements to Hilger Ditch so that it could route all of the water from culverts #1 - #5 to the Cemetery pond.

There would still be a need for some ditch and culvert improvements to handle the runoff from the land south of Mill Road and west of McHugh Lane. These improvements would be less than originally envisioned since they would not have to carry flood water. The ditches and culverts along the south side of Mill Road would direct the drainage water eastward toward McHugh where it would be directed northward. The improvements along Mill Road would include redirecting the water that currently flows in a culvert under Mill and feeds into Stadler Lake so that this water flows eastward to McHugh.

The improvements along the west side of McHugh would start just south of Skeeter and Maggie Baertsch's house in order to catch the runoff from the field west of there. From there they would run northward past the Big Sky Subdivision. At approximately 130' north of Edgerton the drainage flow would be directed east under McHugh Lane through the existing culvert toward the drainage improvements already made starting at Kerr and Forestvale.

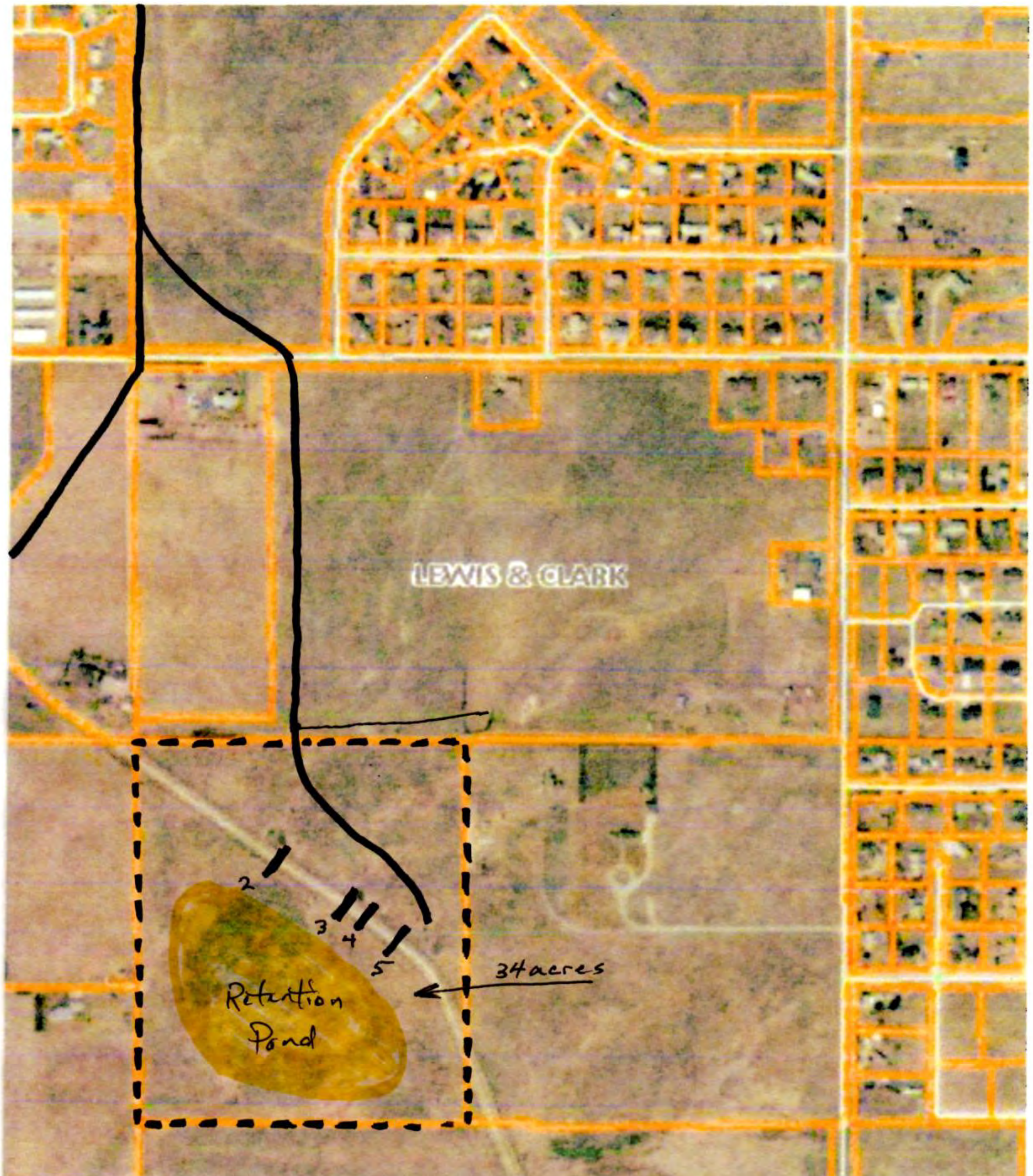
All of these drainage improvements could be made for relatively little cost compared to the current draft Flood Plan. For example the scope of the project would be greatly reduced and the County may already have culverts at its disposal that would be sufficient in many cases.

The ditch along the south side of Rhonda Road would appear to be adequate to handle the rain and snow runoff from the field south of Rhonda. This is because any flood waters flowing toward Rhonda would have been directed through the Hilger Ditch.

The above scenario is dependent upon certain assumptions. The land around the canal culverts #2 - #5 is assumed to be available for purchase at a reasonable price. The hydraulics assumptions implied throughout are assumed to be manageable but require further analysis.

If we can work together to come up with a flood plan that we all support and which we can afford, then we have met our objective. Hopefully this paper will encourage further critical analysis and helpful suggestions into this process.

Roger La Voie


LEWIS & CLARK
2
3
4
5
34acres
Retention Pond

Anderson~Montgomery

Montgomery, Paul< paul@a-mce.com>

Retention Pond southwest of HVID Canal

2 messages

Paul Montgomery< paul@a-mce.com> Thu, Jan 31, 2013 at 10:58 AM
To: Eric Griffin <EGriffin@lccountymt.gov>, Eric Bryson <EBryson@co.lewis-clark.mt.us>, Eric Bryson <EBryson@lccountymt.gov>

Eric, Eric,

As a follow up to a comment at the meeting last Thursday as well as George's discussion at the Commission Work Session - I have analyzed construction of a large retention pond on the upstream side of the HVID supply canal. Here are my findings:

- average slope between TMC and the HVID canal is 0.003 ft/ft. Distance from TMC to the canal culverts #2 - #5 is approximately 1,400 feet. This equates to a possible water depth against the upstream side of the canal embankment of approximately 4.2'. Geometry dicatates that the average depth allowable for a retention pond near the HVID dike would be around 3'.
- groundwater depths in this field (according to Montana GWIC) range from 12' to 7', most depth recordings occurred in August - dry part of the year. Since it does not make sense to excavate the retention pond bottom below the groundwater elevation, we are left with a maximum possible excavation depth of around 5'-6'.
- Allowable TOTAL depth (including excavation and that allowed by the slope between TMC and the retention pond) would be a *maximum* of 9' - presuming *everything* works out in favor of feasibilty.
- The largest pond footprint that could be practically fit in the area is about 850'x1200' - for a total surface area of 1,020,000 square feet (23.4 acres)
- So - the largest volume retention pond that could be fit onsite would be 9,000,000 cubic feet. Note this would require the excavation of approximately 230,000 cubic yards of material.
- At the calculated flowrate for the 2011 flood (688 cfs), a 9,000,000 cubic foot retention pond will fill in 3.7 hours. Note, the pond would have long since filled (and rendered ineffective) before the peak flow rate is experienced, since there would be no controls between Tenmile Creek and the pond itself.

A couple other items weighing against this alternative:

- In the springtime - when floods are expected - the groundwater elevation increases and would likely "pre-fill" a substantail portion of the available retention pond volume if excavated to 6' of depth. Any loss of effective volume will further reduce the exceedingly-short fill time.
- The HVID would likely never allow a project designed to retain up to 4.2' of water against the upstream side of their supply canal. Intentional saturation of the dike and surrounding subgrade would likely be looked upon with disfavor by the District. Furthermore - failure of HVID's canal during a flood event would lead to a more severe downstream impact than if the TMC flood is metered into the study area.
- With any elevated groundwater resulting from filling the pond, it will likely take a very long time for the pond to drain - we need to give some thought to safety, mosquitos, etc.
- The land is currently cultivated. It would need to undergo MEPA review including the loss of farmland.
-

I don't know if you want me to spend further time evaluating this alternative (or including in the Master Plan), but my thought is that it is not practical.

--

Respectfully,

Paul Montgomery, P.E., VP
Anderson-Montgomery Consulting Engineers, Inc.
1064 N. Warren St.
Helena, MT 59601
406-449-3303
406-449-3304 - FAX
406-459-8463 Cell

March 14, 2013

Paul Montgomery, P.E.
Anderson-Montgomery Consulting Engineers
1064 N. Warren St.
Helena, MT 59601

Dear Mr. Montgomery:

The Valley Flood Committee (VFC) met Thursday, February 28th, to discuss the draft Flood Mitigation Master Plan (Plan) including comments/feedback from concerned valley residents about the Plan. Our concern is the Plan does not adequately address large overland flows northeast of the Helena Valley Irrigation District (HVID) canal that contribute to significant ponding/flooding of homes, specifically in and around the Baertch property including Mill Road.

The VFC and other concerned residents attending the meeting, therefore, wish for an adjustment to the Plan that would channelize and re-divert the majority of flood waters on the Baertch property to an improved Hilger Ditch once they pass under the HVID canal via culverts #2 thru #5 as depicted on the attached map (figure 1). This adjustment would require increasing the capacity of the Hilger Ditch to accommodate the flood flows from HVID culverts #3 and #4. It will also require close coordination with two key landowners, Baertch and Mihelish, to construct important connector ditches that convey flood waters to the Hilger Ditch. This adjustment would convey approximately 2/3rds of the combined flood flows exiting culverts #2 through #5 to the Hilger Ditch; the other 1/3rd of floodwaters would be channelized northeast and then north along an improved Mill Road ditch.

Understandably, this would require some additional fieldwork to determine the feasibility of the proposed routing adjustment (or something similar) as depicted on the enclosed map. Since there were no other proposed adjustments brought forth to this committee, the VFC has no further suggestions for changes to other project elements in the Plan.

If there are any questions, please call me at 495-3923.

Sincerely,

Archie Harper

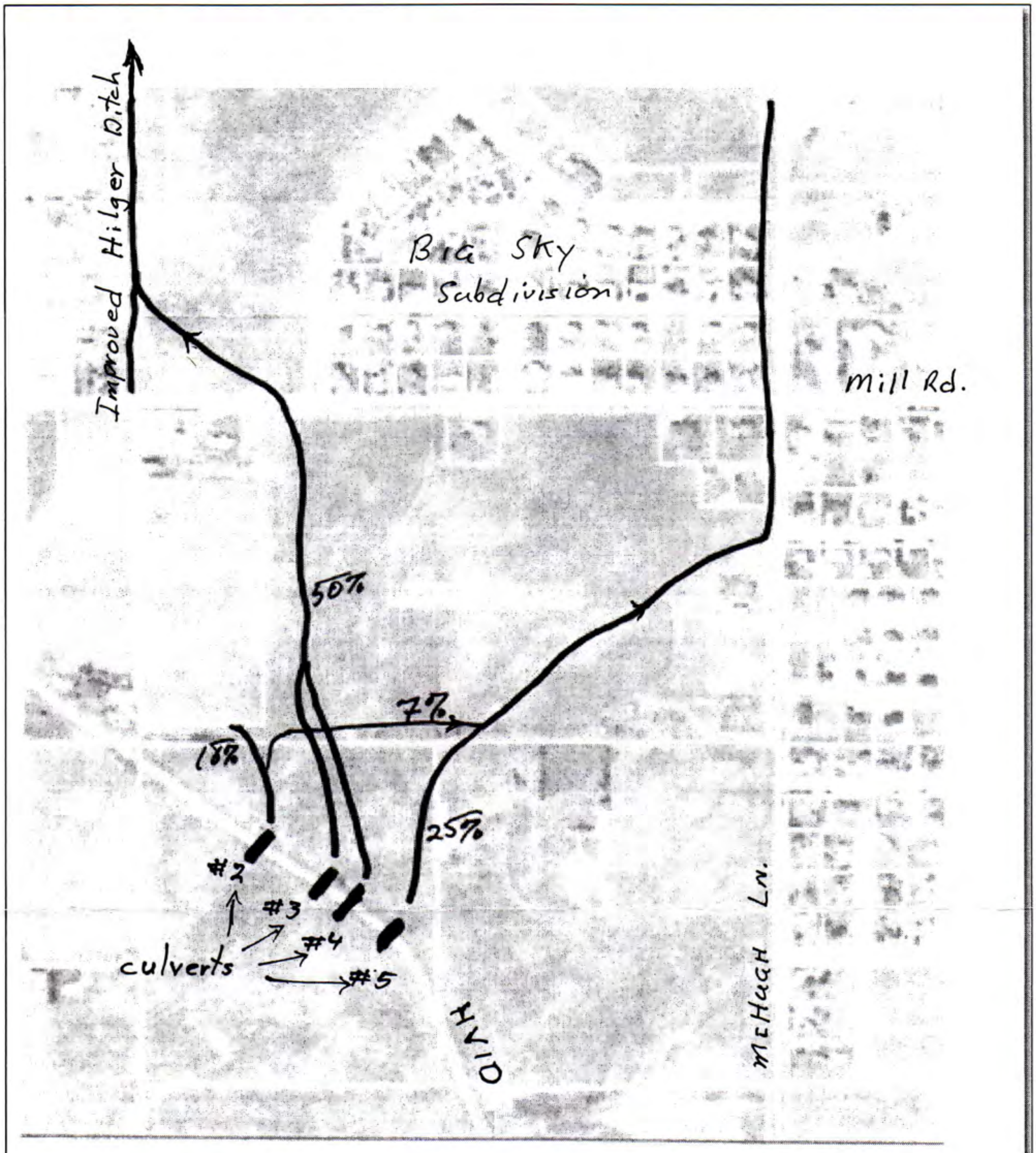
/s/ Archie Harper, Co-Coordinator
Valley Flood Committee

Cc: Eric Bryson
Helena VFC

(Enclosure)

Valley Flood Committee (VFC)

Figure 1. Preferred flood routing proposal to convey flood waters after they pass through HVID culverts #2 thru #5 to Hilger Ditch and improved McHugh roadside ditch.



February 25, 2013

To: Lewis & Clark County Commissioners
316 North Park Ave.
Helena, MT 59623

From: Lyle Lallum
4905 Arrowhead Drive
Helena, MT 59602

(406) 458-4966, lllmboy@yahoo.com

Subject: Helena Valley (10 Mile Creek) "New" flood plan.

I was not able to attend the January 2013 public meeting at the West Valley Fire Station concerning the subject plan but have since reviewed said plan on the Lewis and Clark County website and have the following comments concerning this proposal.

First, I would like to commend the County and the engineering firm of Anderson &Montgomery for including all of the Helena Valley areas that are affected by 10 Mile Creek flood flows including the Bureau of Reclamation's (BOR) D-2 Drain Ditch operated and maintained by the Helena Valley Irrigation District (HVID). As I stated in my previous correspondence dated February 17, 2012, the D-2 Ditch segment is a critical part of the system ultimately carrying the Silver Creek as well as the 10 Mile Creek flood flows to the discharge point at Lake Helena.

As a property owner with a residence and 65 acre hay meadow located immediately adjacent to the D-2 Ditch downstream from the Arrowhead Road crossing, I am particularly concerned with the handling of these floodwaters in this area. The report verifies my suspicions that the 60-inch diameter CMP at this crossing is woefully inadequate to accommodate flood flows with the report stating that this CMP only has a capacity of 45 cfs in addition to the drainage flows that it is designed and intended to carry. The report anticipates an estimated 600 cfs flood flow in the D-2 Ditch from 10 Mile Creek and Silver Creek. It is comforting to see that a bridge is proposed to replace the 60-inch culvert at the Arrowhead Road crossing. I assume that the waterway through this bridge opening will be designed to pass 100 year flows without encroachment of the bridge superstructure.

Under current conditions, any significant flood flows at this location will top the road crossing, flooding adjacent properties and likely washing out the 60-inch CMP as well as the buried telephone and natural gas pipeline located at this crossing. When this situation occurs, the only means of access to six residences will be immediately cut off preventing the people from commuting to and from work as well as the transportation of school children to local schools and emergency access for fire, law enforcement, medical, etc. services.

According to the report, the D-2 Ditch channel in this area only has a capacity of 267 cfs which is less than one-half of the anticipated 600 cfs flood flow. It appears that significant reconstruction of the D-2 Ditch Channel will be required in this area in order to contain these flows preventing damage to private properties in this area.

The 600 cfs anticipated flood flow in this area is also questionable as the report states it is based on a 100 year flood event for Silver Creek, but only a 50 year flood event for 10 Mile Creek. It would seem that this is a double standard and not in concurrence with the FEMA flood insurance requirement based on a

100 year event. As is, should a 100 year event occur in the 10 Mile Creek drainage, it should be anticipated that all of the flood flow over and above a 50 year event will be coming across the valley inundating all of the proposed improvements and causing considerable damage to private properties along the route.

The report indicates that the work on the D-2 Ditch will be priority work to the other proposed Helena Valley flood drainage system improvements which it should be since it is located at the lower end of the planned improvements. In numerous places, the report emphasizes the need for meetings and cooperation between Lewis & Clark County, the BOR, and the HVID in order to accomplish the improvements on the D-2 Ditch. Hopefully, this is proceeding in a timely manner. Also, the affected D-2 Ditch affected property owners will hopefully be kept informed of progress in this area.

One other item that appears blatantly missing in this plan is the absence of any work on the 10 Mile Creek channel itself. Since the flood overflows addressed occur in the area between the Green Meadow and Interstate 15 road crossings of 10 Mile Creek, it would seem that 10 Mile Creek channel improvements and ongoing maintenance of this channel area should be a critical part of any long term plan addressing Helena Valley flooding.

Without doing any work in this area, it should be anticipated that ongoing clogging of the channel in this area due to vegetation (trees, brush, deadfall, etc) will occur as well as continued sedimentation deposits within the streambed itself. The net effect of these items will be increased backwater elevations in the valley areas where flood flows are exiting the channel. This will result in increased Helena Valley flood flows over those currently estimated in the report and, in fact, will likely result in decreased future flood flows in the natural 10 Mile downstream channel.

It would seem reasonable that the 10 Mile Creek channel through this area should be reconstructed including the installation of levies through this area in order that the channel could handle the 50 year flood flows that are now being addressed in the report. Control structures could be designed into the levee system to allow discharges of those flows in excess of the 50 year events to be handled by the facilities proposed in the existing plan to transport these flows to Lake Helena.

According to the Independent Record, the report is intended to be the final report addressing flood flows in the Helena Valley. As stated herein, there are some significant issues remaining with this report, (10 Mile Creek flood flow frequency – 50 year vs. 100 year, and the inclusion of the above segment of the 10 Mile Creek channel). These issues need to be addressed to make the Helena Valley Flood Plan complete.

Thank you for your consideration of these items.

Sincerely,

Lyle K. Lallum

MT PE license 2722E (Emeritus)

Encs.

Copies to: Mr. Paul Spangler, L & C Cty. Flood Plain Adm.; Anderson & Montgomery Consulting Engineers; Mr. Jim Foster, Manager, Helena Valley Irrigation District; Mr. Brent Esplin, Area Manager, Montana Area Office, Bureau of Reclamation

February 17, 2012

To: Lewis & Clark County Commissioners

316 North Park Ave.

Helena, MT 59623

ATTN: Mr. Derek Brown

From: Lyle Lallum

4905 Arrowhead Drive

Helena, MT 59602

(406) 458-4966, lllmboy@yahoo.com

Subject: Helena Valley (10 Mile Creek) flood flow management.

I am writing this as a follow-up to the January 12, 2012 meeting at the West Valley Fire Station concerning the subject activity.

Enclosed, please find three photo exhibits depicting February 16, 2012 flow conditions at the 72-inch diameter CMP crossing of the Bureau of Reclamation's D-2 Drain Ditch under Arrowhead Drive. I reside immediately downstream and adjacent to this crossing.

Exhibit A depicts the Arrowhead Drive crossing of the D-2 Ditch, looking upstream. Exhibit B illustrates a closer view of flow conditions at the 72" diameter CMP outlet. Exhibit C illustrates flow conditions at the inlet of this CMP.

Measured flow conditions at the CMP outlet on the date of these photos include:

Vertical height from the top of the CMP to the water surface: 18 inches.

Vertical height from the top of the CMP to the gravel/silt deposits in the CMP: 46 inches.

Calculated and measured water depth: 28 inches.

Calculated gravel/silt thickness in the CMP outlet: 26 inches.

Visual estimation of the flow velocity at the outlet: 1 ft./sec.

Past and present visual observations of winter time flow conditions (water surface levels) indicate flows remain very similar to the above criteria from about November thru March. In the Spring (Generally April), the flow increases and the water surface level at the outlet rises to within about 6 inches of the top of the CMP, usually within about 5 days after the Helena Valley Irrigation District (HVID) waters up the Main Helena Valley Canal. It will rise slightly during prolonged periods of significant rainfall in the Helena Valley area. These combined flows have caused full flow conditions at the CMP outlet but I have not seen them submerge the inlet.

It should be obvious from these Exhibits and data that the D-2 Ditch and this crossing are neither designed for or capable of handling flood waters from Ten Mile Creek. At the January meeting, Mr. Jim

Watson, manager of the HVID stated that the D-2 Ditch was not designed for nor intended to carry flood waters.

The 2011 Ten Mile flood waters diverted into Reclamations open drain near the Rossitter School on Sierra Road, and entering the D-2 Ditch just upstream from it's I-15 crossing, almost immediately submerged the inlet of the subject 72" CMP to an estimated depth of two feet. This situation would have been worse had not the HVID shut off all irrigation flows in the Main Helena Valley Canal for the duration of the 10 Mile Creek flooding.

These silt-laden flood waters also deposited large amounts of silt in the pool immediately below this CMP outlet, most of which still remains today. This ponding area used to harbor a significant visible trout population on a regular basis. Since this siltation has occurred, it is a very rare occasion to observe any trout at this location.

In any event, should flood flows top the Arrowhead Drive crossing, considerable damage to my hay field as well as damage to my buildings, farm machinery and, or vehicles would likely occur. Since 10 Mile Creek flows are not natural to this drainage, I feel that the County would be responsible for any and all damages that occur from these flows. Flooding of this roadway would also cut off the only access to at least six residences located along Arrowhead Drove which terminates about one-half mile beyond this crossing.

Solutions??? Likely, the best solution to relieve the possibility of Ten Mile Creek flooding at this location and throughout the applicable Helena Valley areas would be to design and construct a levee system from its I-15 crossing upstream to Green Meadow Drive or to where the Ten Mile flood flows begin their cross country journey.

A second alternative would be to channel these flows through the I-15/Sierra Road Grade Separation structure adjacent to the Rossitter School. These flows would then continue down the Sierra Road borrow ditches and return to the 10 Mile Creek channel.

Lastly, if the 10 Mile Creek flood flows continue to be routed to the D-2 Drain, the subject 72" diameter CMP needs to be replaced with a single span, two lane bridge designed and constructed to Lewis & Clark County road standards. I believe that hydraulic calculations will reveal that opening up the D-2 channel with a bridge at this crossing would accommodate these flood flows in addition to the drainage flows the ditch is currently designed for.

Thank you for your considerations and I look forward to attending future presentations concerning this issue.

Sincerely,

Lyle K. Lallum

Lyle K. Lallum

MT PE license 2722E

Encs.

Copies to: Mr. Paul Stangler, L & C Cty. Flood Pain Adm.; Anderson & Montgomery Consulting Engineers; Mr. Jim Watson, Manager, Helena Valley Irrigation District; Mr. Dan Jewell, Area Manager, Montana Area Office, Bureau of Reclamation


xhibit M
/16/2012


Exhibit B
2/16/2012

:xhibit C
2/16/2012

To: Paul Montgomery February 6, 2013
Anderson~Montgomery Consulting Engineers

cc; Eric Griffin
Lewis & Clark County

I am writing this in response to the flood mitigation plan, by Anderson Montgomery consulting engineer's inc. for Lewis & Clark County.

First I would like to thank Lewis & Clark County for starting a process to find a workable solution to an extremely difficult problem. I would also like to thank Paul Montgomery, with Anderson~ Montgomery Consulting Engineers, for his research to find the best cost effective solution to this dilemma.

Most of the proposed does not affect me directly, but there are some indirect problems:

Number one being the culvert that crosses Mill Road at the northwest corner of my property at 419 Mill Road, the culvert is undersized for the maximum capacity of canal culvert #1 (which is 280cfs) that feeds it. In the flood mitigation master plan, the recommendation is to change this culvert to a 54" squash pipe. This would be an easy fix as it is on County right of way. When the water backs up on the south side of Mill Road, because the culvert is undersized, it then floods my property as well as Zimmerman's property, and then it flows across Mill Rd, some into the Hilger ditch and some across the Mihelish property to the north. Installation of 54" squash pipe would eliminate the water flow across Mill road which ends up being a traffic hazard. I would hope this could be accomplished soon.

My other concern is the water from canal culverts #'s 2, 3, 4 & 5, originally the master plan called for a collection ditch along Mill Road, and to improve the ditch along McHugh Lane to move the water that accumulated. Since then there is an alternate plan to install a new ditch from canal culvers 2 & 3, north across the Baertsch property to the corner of Mill and Hedges, then across the Mihelish property and into the Hilger ditch. Alternate plan II was to channel all the water from canal culverts 2, 3, 4 & 5 into this ditch thru the Baertsch property, across the Mihelish property into the Hilger ditch. My concern is that the ditch be sized properly to assure my property is not affected, as my septic system is on the east side of my home. This ditch should be designed so that any overflow would be on the east side of this ditch.

.

Now to address the canal culvert #2: This culvert is used to supply Ten Mile creek water to the Baertsch and Hilger irrigation ditches. The Hilger ditch has been abandoned across my property, so culvert #2 only serves the Baertsch irrigation ditch. There is no way to control the amount of water that flows into the Baertsch irrigation ditch. This ditch has a capacity of whatever a 10 to 12" pipe can handle, anything over that flows into my property. By installing a new ditch across the Baertsch property to move canal water from culverts 2,3,4 or 5, I am proposing a control point at the old Hilger headgate and the Baertsch headgate north of the canal culvert #2. This is the only point where usable water for the Baertsch irrigation ditch can be separated from flood water. By opening the Hilger headgate an allowing it to flow into a designated area and limiting the Baertsch headgate to allow only the water it can handle. This would address the flood water at canal culvert #2 and also keep the integrity of the Baertsch irrigation ditch.

With problems of this magnitude it seems everyone has their pet projects or other solutions. I am sure all proposals help to understand the big pictures, but at some point we all have to have faith in the professionals to make the right decisions, for the best interest of all parties.

Any questions, please feel free to contact me.

Neil Horne
431-0130 or email: mules2ride@msn.com

To: Helena Trap Club Executive Committee
From: D.J. Bakken
Date: 3/7/2013
Re: flood control proposals

I have given some thought to this situation during the last couple days. As we discussed, the ONLY way the Club membership might consider a flood control easement would be if there were clear benefits to the Club from the project. I think there are 4 potential benefits, as described below, though at least three are benefits we would not realize until a future time.

1. Land Value – As the Club now exists, we have a valuable parcel of property in the heart of the Helena Valley. Our property is on the main Highway (Montana Ave.) and is situated at a potential Interstate 15 exit. However, our property is worth way more to us as a Trap Club than the mere monetary value, since it is the easy access to the Valley full of Members which keeps our use and participation high. If we had to drive 20 – 30 miles somewhere else to shoot, many would not so with regularity. Regardless, the property does have an appraisable value, likely discounted to some degree due to the large irregular pit in the center west part of the tract.

   It seems to me that a plan to level up part of the existing pit (i.e. bringing the shot fall zone back up to original grade), using fill excavated from a new long skinny pit along the north property line, would improve the appraised value. I think this because the flat developable land would then all be along Montana and Forestvale. On-the-other-hand, while this might increase the appraised value, the issuing of an easement would decrease the value (since the right of any future owner to do something with that land under the easement would be diminished). All in all, I think there would be a slight net increase in property value.

   This is all speculative though, since it would never be realized unless the Club decided to fold up or move at some future time.

2. Environmental Issues – Valid or not, you can bet over time that there will be increased pressure on shooting ranges regarding lead deposits in the environment. I sent some of you a document I ran across about lead reclamation on shotgun ranges. I will attach that with this document also. The point of that article (and others you might find on the internet) is that there will be concern about the lead, even if you have a reclamation plan, someone will make claims about ground water effects. Personally, I think in our environment the lead at most will develop a thin oxidation layer and would sit without any effect to groundwater almost indefinitely. There have been ranges though, where acid runoff is present, where identified (and high) levels of lead in the groundwater have occurred. Once allegations are made, the Club would be considered guilty until sufficient study (at our expense) either proved us right or wrong (and if wrong, then the costs would really start).

The proposal to elevate the shot drop zone back up to near original grade (after first reclaiming the shot dropped there since our last efforts at this) could be an advantage. The farther the lead is from a groundwater source the better. For darn sure, we do not want water retention over the top of lead. As it worked last time (the flood of 2011), we had just reclaimed the shot in the pit portion of the shot drop zone in 2010, the year before the flood. I would be absolutely opposed to the issuing of a flood water storage easement in the existing pit for this reason. Further such an easement in the middle of the property would be detrimental to the property value.

As with number 1, this is all speculative again, since the benefit of elevating the shot drop zone would only pay off if it prevented some future allegation of the Club affecting ground water in the future.

3. Public Liability – As it stands, I have always been amazed that we operate with no real control of the down range access. The east side has a woven and barb highway R/W fence, good for sheep but not much of deterrent to people (think about how effective it is for hunters along I-15 in the Sieben Flats). The west side has a regular barb wire fence, and the north side (middle and east especially) is a dilapidated barely standing barb wire fence (bordering a ball park and school no less). We have not had issues with people entering the down range area during shooting (so I have been told), but there is nothing really preventing it.

   Please include the establishment of a barrier to prevent entry to the pit whenever water is present.

   They should provide an estimate of how long the pit will take to fill and to completly empty. We know this is based on flow rates so a guess is ok.

   We could, as part of an easement, require some decent fencing (I am thinking 5 – 6 foot chain link at least). If there were a flood water storage pond this would be even more critical but this fence would have value even in the many years when no flood waters were present.

   As with the other items, this is a value which is only realized if it prevents some future down range incident by keeping folks out.

   Pond should be called a Detention pond, meant only to be used for peak flood water protection and should remain dry at all other times. Not as a Retention pond meant to store water or as a wildlife pond or habitat to promote wildlife attraction.

   All engineering, monitoring, testing, permits and legal fees associated with the Detention pond are the counties responsibility.

   County to also fence south side of the pond to keep people out of the flood waters.

Outlet should have a sediment trap in it, but inflow and discharge water quality is the counties responsibility.

Fill compaction to meet Lewis and Clark County or FEMA flood zone foundation building codes, copy of test results to be given to the Trap Club.

4. Cash Money – The only real immediate benefit would be cash money paid for the encumbered easement acreage. Considering the following:
   a. The sweet spot for the shot drop zone is 100 – 200 yards out
   b. For down range safety it is generally recommended a shotgun range have 300 yards
   c. 300 yards ahead of the 16 yard firing line falls just 200 feet short of our north fence line
   d. The land area in a strip 200 feet wide across the full north property line comes to about 11 acres.
   e. The gross value of an easement of this size would be 11 acres * the appraised land value per acre, less any negotiated costs the County would incur on our behalf to level up the shot drop zone (items 1 & 2 above) and fence the area (item 3 above)

   The financial calculations for this are beyond the scope of my comments today.

So for me, I would never consider an easement for the existing pit, but might consider an easement for a reconfigured pit on the north line, which uses the fill to bring the shot drop zone back up to level, especially if after the calculations there was still some cash money today going into our funds. (I do not think there would be any surplus gravel from this plan to sell, as I will explain next.)

On March 7th I made some engineering measurements across four transects of the pit area, to estimate (very roughly) the cut and fill volumes we might be talking about.

Helena Trap Club

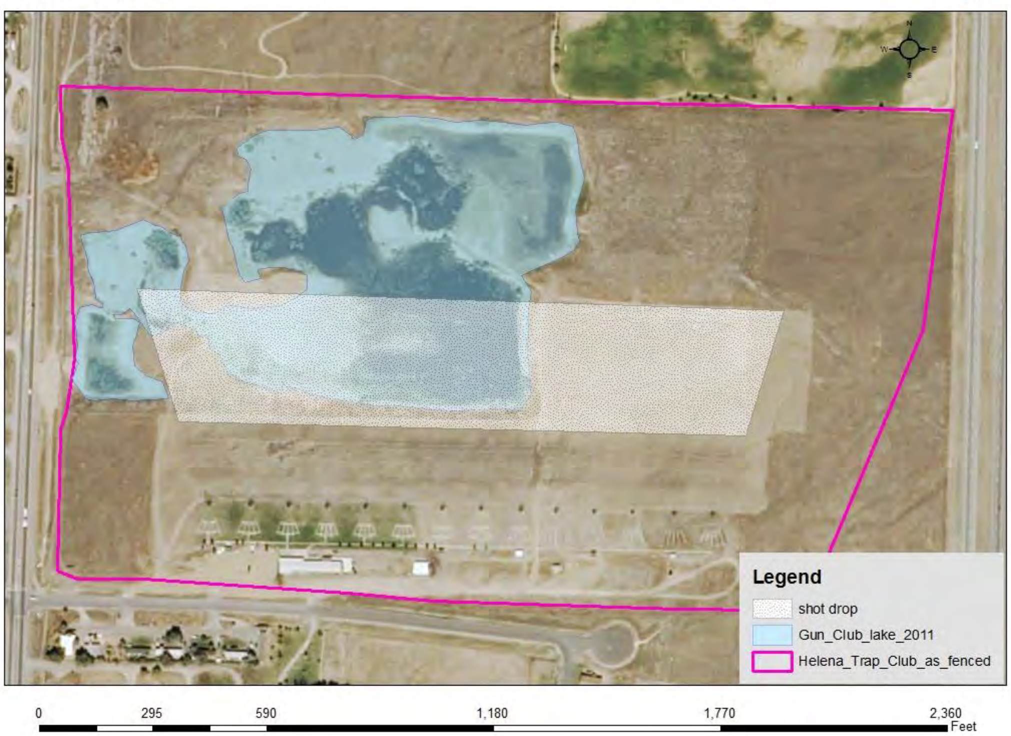
2011 photo

The violet colored line is the property fences (or straight lines connecting the ends of the fences as is the case on the south line). In the pit you can see the ponded water from the flood, still not fully soaked away. This is the lowest pool elevation in the pit. The pit is more or less a uniform depth from the land surface in the shot drop zone, but slopes parallel to the land surface down to the east. The mowed area where we reclaimed shot at the east end in the spring of 2011 is visible.

Helena Trap Club 2011 photo

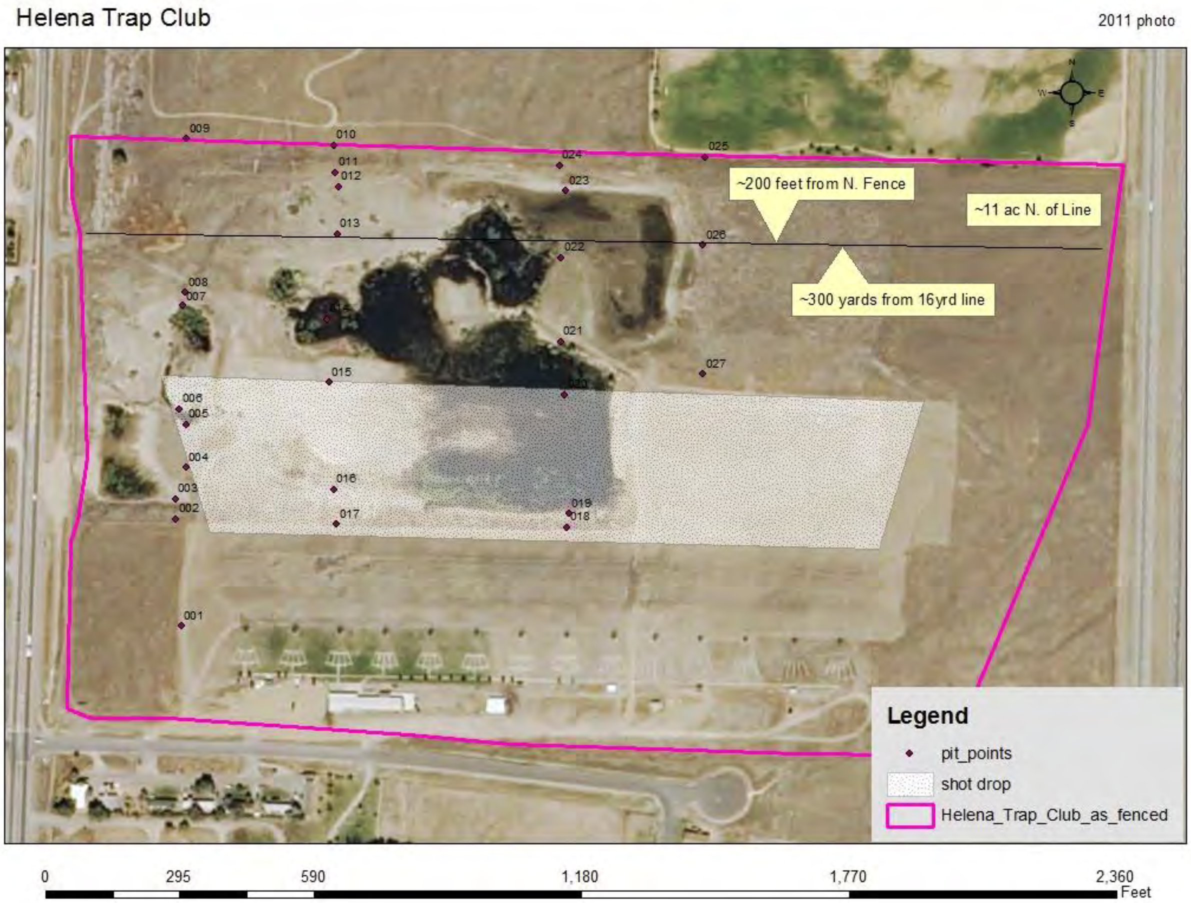
This map shows the full pool at the peak of the 2011 flood. The pond surface was 16.6 acres. As you can see, the existing pit occupies a broad and irregular area in the center and NW part of the property.

Helena Trap Club 2011 photo



In the previous photo you can see the estimated shot drop zone. For this estimation I projected lines 100 yards ahead of the 27 yard line and 200 yards ahead of the 16 yard line, at normal shooting angles. It should be noted that in trap, with standard loads of standard shot at standard elevation targets, the shot will predictably fall within a defined zone. This is mostly true, though not allowing for wind (does it ever blow here?) and not allowing for high targets (for example the high continental targets at P2 and trap 1) and not allowing for any unauthorized heavy loads. The potential for rare shot drop beyond the 200 yard distance is likely why it is recommended that shotgun ranges have 300 yards of down range space. (I did observe shot on the ground north of the 200 yard line at points 014 and 027, see the next map.)

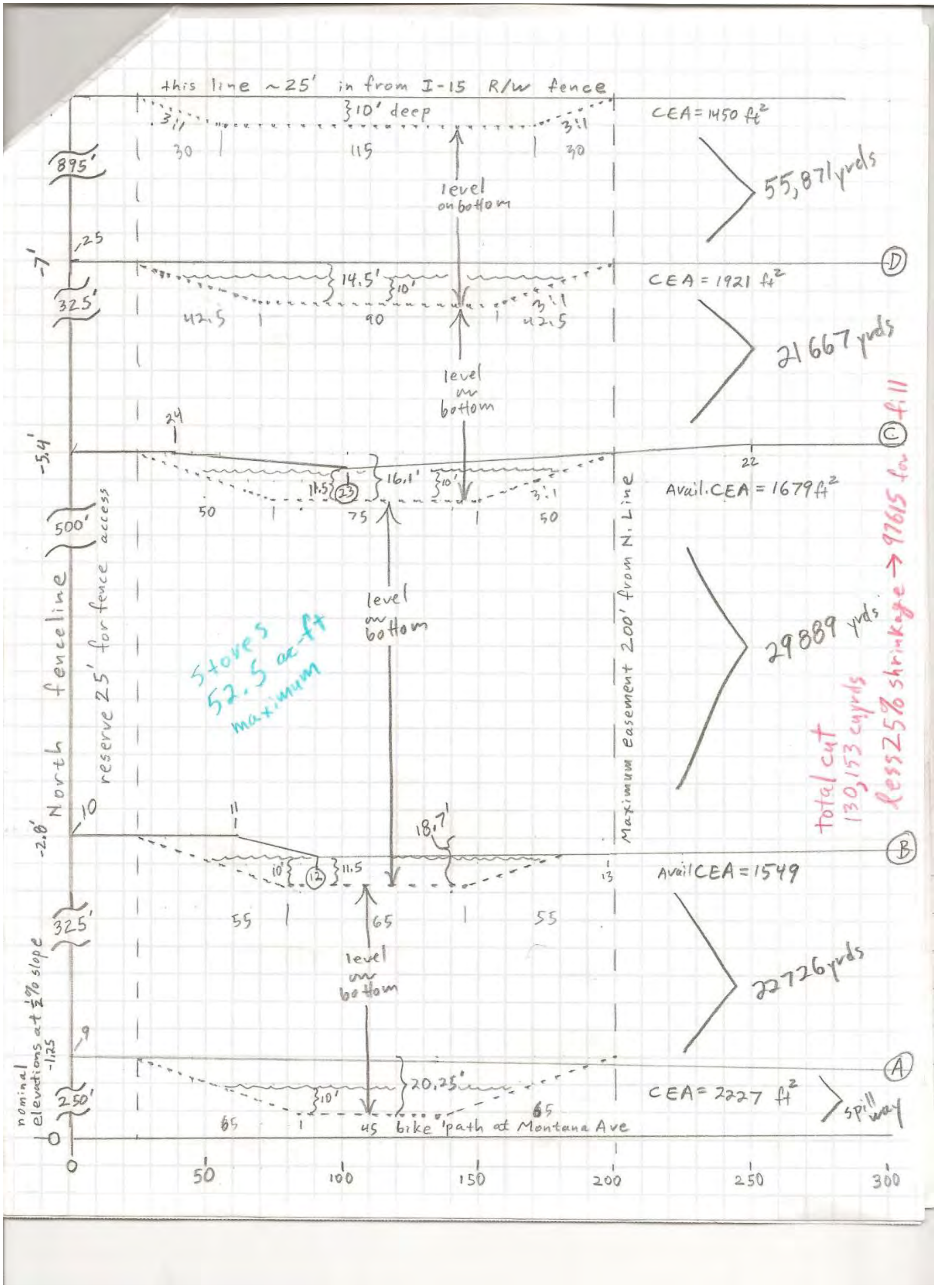
I ran three transects across the pit, line (A) north from a point on driveway to the pit located west of P1, line (B) from the north fence due north of trap 1 running south, line 3 from the edge of the pit in front of trap 6 north, and line (D) from the fence in front of trap 9 running south just east of the pit. I used my GPS to establish the points and measured the distances between the points after downloading to my computer. I recorded the slope between points using a hand held Abney level. I tried to take enough points to allow drafting of pit cross sections on these lines. The pit is extremely irregular so in no way do these measurements capture the exact details, just enough so we have some ballpark numbers to work with.

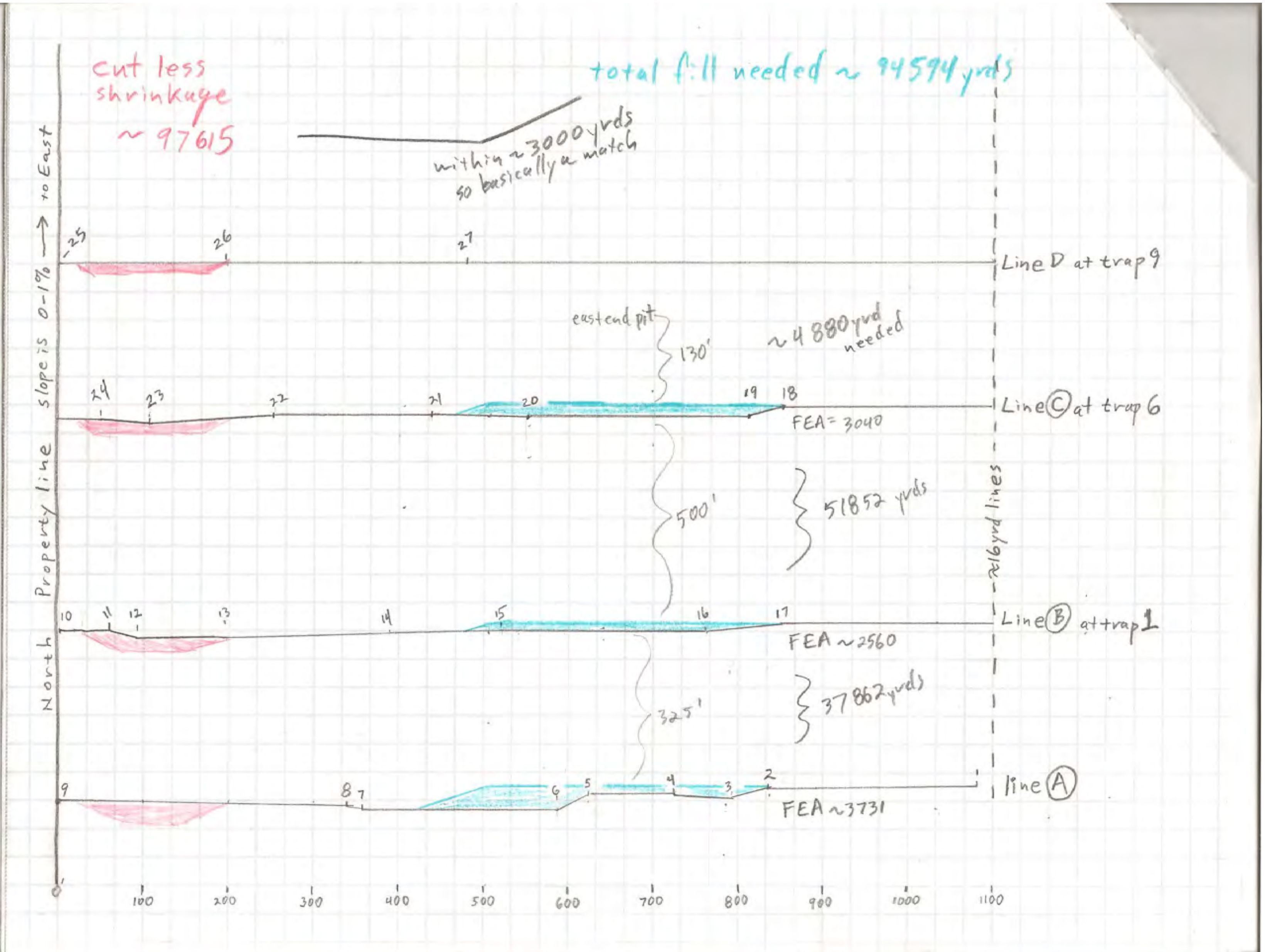


For this engineering exercise, I proposed the following.

- All of the “new” pit for intermittent and temporary flood water storage would be located within the northern most 200 feet of the Club property, thus retaining a clear and un-encumbered 300 yard distance ahead of the 16 yard line.
- A 25 foot pathway on the level would be retained just inside the north fence, for vehicle access along the line either for fence maintenance or for County personnel to reach a discharge gate or pump at the east end.
- The slope from west to east along the north line was about ½ % (I read zero to 1 %, which is as close as I could get with the Abney level) While this is not much slope, it does amount to about 11.5 feet of drop from the west end to the east end. Thus, the pit, to maintain a level bottom, must be deeper on the west end.
- Slopes down into the pit were set at 3:1, which would likely be a minimum. The slope of the pit just ahead of the traps is closer to 4:1, but I wanted to get as much depth as possible.
- I arbitrarily selected a depth of cut at the east end of 10 feet (the existing pit at the SE corner is just over 8 feet deep).
- Fill in the shot drop zone would bring the area back up to original level and extend level out to the 200 yard mark, then slope down to the existing pit floor at the 3:1 angle. It was assumed the

fill would be placed in multiple compacted lifts of not over 1 foot each to limit settling in the future.




cut less shrinkage ~97615
total fill needed ~ 94594 yrds
within ~3000 yrds so basically a match
North Property line slope is 0-1% → to East
Line D at trap 9
Line C at trap 6
Line B at trap 1
line A
east end pit
130'
~4880 yrd needed
FEA = 3040
500'
51852 yrds
FEA ~2560
325'
37862 yrds
FEA ~3731
~16yrd lines
0
100
200
300
400
500
600
700
800
900
1000
1100

Based on these calculations, the excavation of the “new” pit/water storage area would yield a total cut of 130,153 cu. Yrds. However, there is usually some shrinkage when this fill is moved and compacted into a new location. (Some is actually lost as it spills in imperceptible amounts along the way, but mostly it is because the compaction process increases the bulk density of the soil as compared to the original condition. A common rule of thumb I have used is 25% for shrinkage.) The net material to fill in the shot drop zone is therefore 97,615 cu. Yrds.

The fill area, while shorter east to west, is wider south to north. My calculations indicate a fill required of 94,594 cu. Yrds. This is just ~ 3000 yards less than the net available cut, and considering the level of accuracy of these measurements it should be considered to be a wash. It is my opinion that cutting a “new” pit and filling the existing shot drop zone (not the whole existing pit, just the shot drop zone) back up to level would yield no extra gravel for sale. (If some gravel did end up being surplus I would think an in-the-pit price of $1.00 - $1.50 is more the standard rate. The main variable in gravel value being the distance of haul to the point of use. Which, considering future I-15 projects through the valley, and housing development in the valley, gravel in the center of the valley is likely to appreciate over time. Faster than the investment rate we would get? Well I do not know the answer to that.)

The “new” pit, excavated in this manner, would store a maximum of 52.5 ac.-ft. of flood water.

<u>In conclusion</u>

Our assignment was to prepare a list of design factors to present to the County. If they could not meet these the issue would be done and if they could, then it would be up to the Club Membership to debate and decide. My design features are as follows:

1. Maximum Easement would be a 200 foot strip just inside north property line, an area of about 11 acres.
2. Pit excavation within this easement area would retain a 25 foot level driving surface inside all fence lines, for access to maintain fence and to reach the east end of the easement area.
3. The excavated pit would have stable cut slopes (not steeper than 3:1) and a smooth level pit floor. Surface of the pit would be covered with top soil stock piled from the excavation area and would be vegetated with suitable grasses. The County would become 100% liable for the noxious weed control in the easement area.
4. The entire north and west property line fences would be replaced with chain link, not less than 5 foot tall, on cemented in steel pipe posts with no trespassing signs at 200 foot intervals.
5. Spillway from a head gate along Montana Avenue would be concrete or rock armored to prevent erosion.
6. Depending on design to reach the existing drainage ditch, an outflow ditch, perhaps with gated control, would be near the NE corner of the Club property.
7. If/when the need arises to flood this pit, the stored waters shall be drained or pumped out of the pit as soon as possible following the flood.
8. Excavated material would be used to fill a portion of the existing pit in the shot drop zone. Fill would be placed in compacted layers not exceeding 12 inches per lift to restore to original

ground line over the entire area out to a line 200 yards ahead of the 16 yard firing line and then slope downward at no steeper than a 3:1 slope to the existing pit floor.

9. The top 12" layer of this fill would be screened sand, to facilitate lead shot reclamation in the future.
10. Prior to filling the area, the shot currently in the shot drop zone would need to be reclaimed. Depending on when construction would take place there may be sufficient shot for reclamation under normal Club processes. If not, the County would need to scrape and stock pile the material for later reclamation by the Club.
11. An appraisal of the Club property would be paid for by the County. If the fill placement in the shot drop zone and the fencing are less than the land value, the County would need to pay the balance to the Club. If the costs exceeded the land value, the County project would need to absorb the costs.

Questions and comments
Helena Trap Club Board of Directors
Lewis and Clark County Floodplain Management Plan
FEMA Trapclub Detention Pond Application

These questions were submitted in preparation for the County's informational meeting held January 24, 2013. They have not been edited or revised.

Dave Cole's questions –

- Would the proposed alignment of the ditch shown on the aerial photo on page 38 (if that's what it is) interfere with the club's periodic mining of lead shot (an important source of revenue for the club)?

- To reduce the impact of bisecting the club property, could the ditch (which appears to flow toward Rossiter School) be located to flow across the north end of the pit on trap club property instead?

- Would they install a bridge over the ditch to allow vehicle access to the pit for maintenance of the pit area?

- Would they recontour the pit bottom and sides to make it easier to control vegetation growth (such as periodically disking or harrowing the pit bottom) and spray weeds?

- Would they commit to a long-term arrangement to spray for weed control following any flood event when the pit is flooded?

- Who would make the decision regarding when the pit would be flooded and would there be any consultation with the club first?

Gino Pizzini's questions –

1. Re-contouring the pit, anything they do there must allow for the recovery of the discharged lead (our sand lining).

2. Encumbrance of the land, if it becomes an official flood control feature we will be significantly reduced in what we can use that land for.

3. Wetlands, we need to know more about what the wetlands determination means.

4. Weed control, the county needs to be responsible for weed control. There are a lot of issues with this, especially in wetlands.

5. Water quality, we cannot be held accountable for water quality issues; either surface or groundwater.

6. Water quantity, we cannot be held responsible for dewatering (surface or groundwater) or flooding.

7. Fencing, there are a number of issues involved with this as well; i.e. liability, wildlife access (I do like seeing the deer!), and so on.

Jerry Frohreich's questions:

It does say in the Appendix B. Great West Engineering Memo that Landowner permission is required. And I'm sure at this point none of us are going to give permission to this project. Everyone has good comments and concerns. We shoot lead shot into a dry gravel pit right now. If we were to allow this pond to be made with an outflow ditch that drains into Lake Helena and the Missouri River, will we then be the source of lead contamination for the ducks in the lake and the fish in the river? An overflow ditch from the North Montana ditch to the I-15 ditch on our North fence line, maybe we would consider that.

DJ Bakken's comments:

Do not think the alignment of a ditch between the traps and the pit would be in our best interest. If they need more ditch capacity than they can make north on Montana and then east on Sierra, we might consider a ditch just inside our north property line. Perhaps if they did this we could include in such an easement purchase the re-fencing of the entire north side, which is something we would like anyway. If they incorporate a head gate to put water into the Club pit, it should be required that opening the head gate would require case-by-case approval of the Club Executive Committee. We could have operations in the pit or planned which we might not want to flood at some point.

Greg Hahn's comments:

First I would not call it a lease. They will be making permanent changes to the property; they will be affecting some of the property rights the Gun Club has because of its ownership. These changes are normally called damages because they will restrict the use of the property as you know it today. So your ability to reclamation could be impaired. There are presumably other uses the property could be put to, but by making it a retention pond "damages" future development of the property.

I would ask them if they intend to pay for an easement for a detention pond to be placed on the property. If they have or will have a certified general appraiser assess the taking of real property (an easement) and the damages that the Gun Club is entitled to before any government agency can take real and personnel property for a government good (a taking). Before a government agency can take a property to the common good, it must prove necessity (least personnel injury for the greatest common good), will they be assessing that also.

Damages are compensable items that the Club could be entitled to because of the taking. Loss of parking, loss of a reclamation site, future ground water levels or contamination, future flooding, maintenance, upkeep, liability, weeds, trespass etc. I am sure the board has thought of more.

Questions and comments
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I would ask them if the environmental document that was prepared for this taking is sufficient to address the lead shot that has be reclaimed in this pit for many years? If it gets to contentious, the Gun Club could tell them they would like to talk with the Club's attorney before offering any decisions.

March 14, 2013

Paul Montgomery, P.E.
Anderson-Montgomery Consulting Engineers
1064 N. Warren St.
Helena, MT 59601

Dear Mr. Montgomery:

The Valley Flood Committee (VFC) met Thursday, February 28th, to discuss the draft Flood Mitigation Master Plan (Plan) including comments/feedback from concerned valley residents about the Plan. Our concern is the Plan does not adequately address large overland flows northeast of the Helena Valley Irrigation District (HVID) canal that contribute to significant ponding/flooding of homes, specifically in and around the Baertch property including Mill Road.

The VFC and other concerned residents attending the meeting, therefore, wish for an adjustment to the Plan that would channelize and re-divert the majority of flood waters on the Baertch property to an improved Hilger Ditch once they pass under the HVID canal via culverts #2 thru #5 as depicted on the attached map (figure 1). This adjustment would require increasing the capacity of the Hilger Ditch to accommodate the flood flows from HVID culverts #3 and #4. It will also require close coordination with two key landowners, Baertch and Mihelish, to construct important connector ditches that convey flood waters to the Hilger Ditch. This adjustment would convey approximately 2/3rds of the combined flood flows exiting culverts #2 through #5 to the Hilger Ditch; the other 1/3rd of floodwaters would be channelized northeast and then north along an improved Mill Road ditch.

Understandably, this would require some additional fieldwork to determine the feasibility of the proposed routing adjustment (or something similar) as depicted on the enclosed map. Since there were no other proposed adjustments brought forth to this committee, the VFC has no further suggestions for changes to other project elements in the Plan.

If there are any questions, please call me at 495-3923.

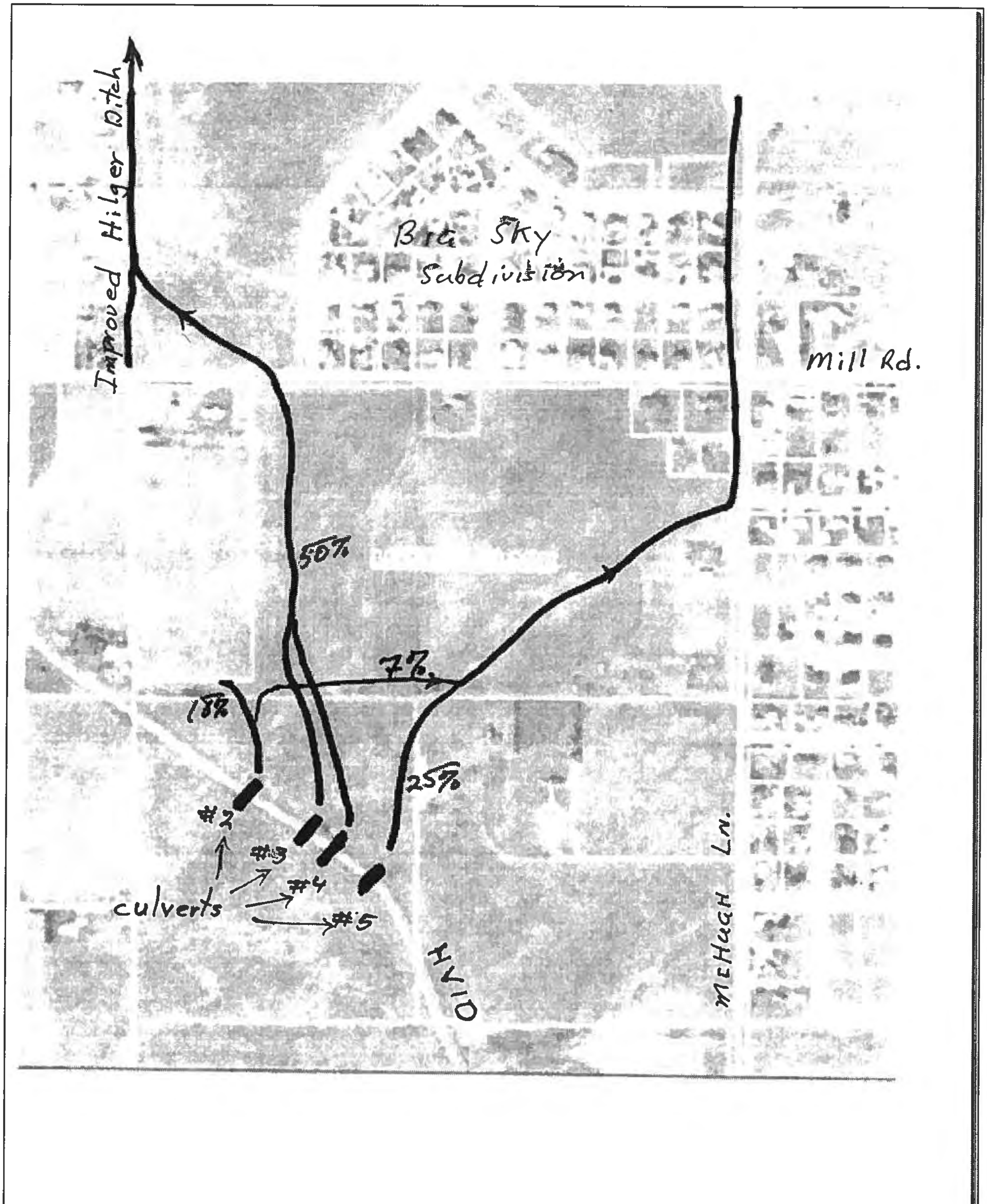
Sincerely,

/s/ Archie Harper, Co-Coordinator
Valley Flood Committee

Cc: Eric Bryson
Helena VFC

(Enclosure)

Figure 1. Preferred flood routing proposal to convey flood waters after they pass through HVID culverts #2 thru #5 to Hilger Ditch and improved McHugh roadside ditch.



Prickly Pear Presentation – Public Comment – 7/7/11

East Helena 7/7/11 public comments:

- Concrete channel is inconsistent in wall height…low at Gail, high at Groschell
- Channel blockages – vegetation encroachment, streambed sedimentation
- Diversion dam between Groschell and Riggs
- Hwy 12 bridge may be restricting flow due to sediment accumulation
- Pacific to Main – particularly important
- Icing Issues – low velocities create icing and ice jams. City has created temporary channel diversions to increase velocities and reduce icing.
- Flood Awareness training for Middle Schoolers was very effective
- Upper PPC generating a significant amount of sediments that historically was mitigated by Lower Lake. Could be the source of sediment accumulation in channel north of Hwy 12 bridge
- East side of Wylie Drive – lack of functional culverts on approaches
- Streambank stabilization of PPC near irrigation ditch head gate downstream of JFK Park
- Project that split PPC caused the creek to cross Wylie Drive in two places vs one historically
- Examine unused irrigation ditches to determine whether the head structures can be removed and the ditches filled
- Dispatch "target notification" prioritization system needs improvement. L&C website has a link for residents to register their cell phone numbers for notification of potential disasters

Scott's Notes:

- DB – should have declared emergency sooner. Pike above dame broke. All main ages to Lake Helena. Integral projects can't have massive project to fix everything.
- Bob Utick: 4 locks thru E Helena. Wall damaged in 1981. Repairs to wall show much different elevations.
- Review wall elevations; PPC needs to be cleared out
- Diversion dam still in stream, (causes hydraulic swell jump) not used. City owns some access points to creek. Creek bed may be filling.
- Scope – permit review for stream modifications
- Channelize stream thru town
- Scope – profile creek and wall thru town
- Breach of dike had big impact on flood flows. Park is low area, used for flood relief
- Amy – review achieves, said Asarco heated water, lot of debris down creek
- E Helena attempted to get a FEMA grant to repair wall
- Smelter site impacts E Helena. Dam traps sand, cold this be cleaned out to prevent trap sand
- Beaver dams, other dams near E Helena WWTP
- Built up creek below WWTP. Ditch protect trailer park. Surge from dike failure at Ash Grove. Debri affected Asarco pond - city had to keep this clean. Creek splits under Wylie Drive, may have created problems – look at this. RR worked on ???? bridge during flood.
- Ag land further down
- Place sandbags systematically; emergency plan to identify sandbag placement
- Access and ownership – review this. Watch line under Main street bridge, must be considered if dreaded. Hwy bridge had less capacity than Main street bridge.

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Infrastructure Projects from Public Comments – 6/30, 7/6 & 7/7 Meetings

Ten Mile Creek

- **Convey floodwaters at Forestvale (west of McHugh) to ditch north of Forestvale. Route to basin north of cemetery. *Culvert at Forestvale/McHugh***
- **Forestvale drainage ditch: poor grade & improperly installed approach culverts. *Re-grade ditch on south side, correct approach culvert problems.***
- **Mill/McHugh - no ditch. *Install drainage ditch E-W on Mill, install approach culverts, direct drainage east to N. Montana ditches.***
- **Irrigation ditch between Ronda and Mill Rd (Hilger Ditch) - poorly maintained and full of debris. This ditch is the continuance of western-most underdrain on canal. *Clean out/dredge ditch and assure hydraulic connection to Forestvale ditch.***
- **Driveway approach culverts missing throughout TMC flood channel network. *Institute mandatory approach culvert policy. Offer incentive program to retro-actively install adequately-sized culverts at existing approaches.***
- **Get the water to and from the Helena Trap Club basin - to the D-2 ditch. *Engineered control structure on east side of N. Montana @ Progress Rd. to direct floodwaters into Gun Club Basin (requires cooperation from landowner)***
- **No culvert at Alfalfa Rd. @ Green Meadow - water stays on west side of Green Meadow. *Direct floodwaters north along west side of Green Meadow (assure approach culverts adequately sized) and east under Green Meadow at Franklin Mine Rd.***
- **Re-evaluate/Implement findings of 1982 M&M study:**
    - **Improved crossings at Green Meadow, McHugh, N. Montana**
    - **Channel clearing, sediment removal**
    - **Improved drainage in McHugh ditches**
    - **TMC bypass channel (not likely)**
    - **Dike 5.6 miles of TMC to PPC confluence (not likely)**
- **Box culvert @ Montana and TMC Estates - not carrying water back to Ten Mile from the west to the east….. North of TMC Estates**
- **Bridge @ McHugh Drive – impedes flow. *Increase hydraulic capacity, elevate and widen span.***
- **645 Stadler Rd. - small obstruction (fallen tree) in TMC causes his property to receive water. Flat grades. *Remove obstructions and stabilize bank.***

- **Pedestrian corridor along the bank of TMC - stream bank stabilization.** ***Acquire easements, design shared-use-path along north bank of TMC from Green Meadow to I-15.***
- **419 Mill Rd.: 60" culvert feeding water to 16" culvert - cannot be increased due to impacts to downstream homeowners**
- **Keep water in TMC between Green Meadow & I-15** ***See above.***
- **East of McHugh - water came over 4' dike.** ***Elevate dike.***
- **South side of Mill between Green Meadow & McHugh: keep the water in drainage on the south side. Homes flooded at points where water crosses Mill to north.**
- **Mill Road off McHugh; reversal of water flow.** ***Remove downstream obstructions, maintain carrying capacity of TMC channel.***
- **Culverts undersized.** ***Inventory existing stormwater infrastructure, model hydraulic response with various intensity runoff events, size culverts appropriately.***
- **Montana Ave 10 Mile Estates; box culvert – no culvert near 10 Mile Estates park; walking path has impeded drainage; box culvert under Montana Ave carries water to North; needs return culvert to creek; walking path near Gun Club pit.**

<u>Silver Creek</u>

- **Silver Creek – huge cottonwood tree – biggest problem.** ***Assess entire length of Silver Creek through Sewell, identify transient obstructions, address as necessary.***
- **Culverts set too high & many ditches too shallow – including Rosemary Rd.** ***Evaluate natural flood drainage channels, survey stormwater infrastructure, install new culverts and re-configure ditches as necessary.***
- **Clean out ditches – sediment accumulation and sloughing in over many years.** ***Identify critical areas where sediment is obstructing free flow, dredge.***
- **Across Montana Ave – 90 degree turns – can these be straightened?** ***Evaluate current configuration, design more linear stream channel and armor banks above/below Montana crossing.***

<u>Prickly Pear Creek</u>

- **Concrete channel is inconsistent in wall height…low at Gail, high at Groschell.** ***Survey PPC containment dike, compare to HEC RAS modeling, identify needs.***
- **Channel blockages – vegetation encroachment, streambed sedimentation. Hwy 12 bridge may be restricting flow due to sediment accumulation** ***Seek***

permitting and authorization to dredge accumulated sediments from critical areas.

- **East side of Wylie Drive – lack of functional culverts on approaches.** ***Identify approaches with inadequate/non-existent culverts, offer incentive program for landowners to install.***
- **Streambank stabilization of PPC near irrigation ditch head gate downstream of JFK Park**
- **Examine unused irrigation ditches to determine whether the head structures can be removed and the ditches filled.**

Silver Creek Meeting – Scott's Notes
7/6/11

Need: Groundwater monitoring and alarm system – let people know early warning

Check Patty Jaques – letter to editor

Silver Creek – huge cottonwood tree – biggest problem

Culverts set too high

Lower barrow pit deeper, trees in borrow pit, backs up tribes, blanchards

Citizens were not allowed to clear culverts

Rosemary Road – undersized culverts, crushed on edges

Clean out ditches - sloughing in over years

Derek Brown – get drainage easements

Silver Creek – usually doesn't flow in Sewell. More flow lately, why? Possibly Mine at Great Divide, irrigation

Ditch has water in it, may be diverted from other areas: ditch has flooded this year

No basements in Sewell

Test wells after last flood

Do restrictions on altering Silver Creek apply? Can it be re-routed?

Larry Michelson – Applegate; doesn't flood now because of new bridges, etc. Bridges on John G and Applegate good – look at these.

Low spot Montana Ave culvert – wrong elevation – dead tree in culvert

What can be done about mosquitos – court, spraying funding resources

Across Montana Ave – 90 degree turns – can these be straightened?

VSC roads for flood flows?

Does Mine have limit on flow via discharge permit?

Silver Creek is dropping slowly

Cell at landfill; Class 4 Material; open account $29/ton vs $73/ton at transfer station

Septic systems – why so big? Has ground water problem

Server the valley ??? happens to septic system

Sand bags – not available for private users until emergency declared

Derek Brown – better advice on locating sand bags

PS – flood plain regulations limit what a private citizen can do requires a permit

Plan – section on individual responsibilities on what a citizen can or cannot do.

Where do people go to get appropriate permits?

Get standards for approach permit

Silver Creek Presentation – Public Comment – 7/7/11

General comments received at the Ten Mile meeting on 6/30/11:

- Objective: "Get the water OUT" – control within ditches/structures
- Mitigate peak Q – utilize short-term storage capacity
- Driveway culverts missing
- Analyze longer duration, lower intensity storm event
- Re-evaluate/implement findings of previous studies
- Accountability to get solutions initiated/implemented
- Availability of sand/bags to residents during emergencies
- Development without planned drainage; county standards for drainage infrastructure – develop/enforce
- Improve communications, PSA's, site visits during flood emergencies (from L&C County)
- Formation of citizen groups to maintain momentum in flood mitigation efforts
- Website to disseminate information on flooding/disasters – assessable, homeowner post-able notifications – reverse 911
- Community access TV – for flood info updates
- Centralized location and policy for volunteers
- Sand bag assistance
- Mailing list – emails, newsletter
- 447-8035 (Audra) – separate solid waste accounts for flood victims – take waste directly to landfill. $23/ton Class IV waste
- County will start to remove sandbags – once all GW has been addressed
- 830 Rinay Road – culverts not deep enough – water does not flow
- Trees growing in borrow pits along Rinay Road
- Too much debris/trash accumulated in drainage ditches – accelerates natural filling in. Need to clean certain drainage ditches
- Volunteers/landowners told not to clean out culverts that they do not own
- Advise landowners regarding what their rights are with respect to tree removal in ditches
- Irrigation take-outs could be utilized to resolve/lessen flood impacts
- Applegate flooded in '81. County installed bridges on John G and Applegate – rip-rapped and flooding was resolved during latest event. Bridge at Montana would resolve flooding in Sewell(?)
- Clean out the current culvert carrying Silver Creek under N. Montana
- Larger upstream culverts feeding smaller downstream culverts – flooding
- Drumlummon Mine a possible source of continuing water in Silver Creek(?) GW they pump out of mine 200-300 gpm – goes into perforated pipe and back into GW through a quasi-drain field. Mine is applying to increase production which will likely trigger an EIS and the ability to comment.
- Mosquito control – county is spraying/fogging
- Process of obtaining permission to build a berm to protect property…timing and what to do afterward. County will remove sandbags if coordinated with landowners.
- Road grading QA/QC
- Replacing a culvert in active stream requires 310 and other permits
- Replacing an approach culvert in ditch or driveway requires a County permit –go to county planning and the permit will be free. County has guidance materials available for approach configuration. Absentee landowner has altered the ditch channel – resulting in flooding.

Ten Mile Presentation – Public Comments – 6/30/11

- **Get the water OUT - control within ditches/structures**
- **mitigate peak Q - utilize short-term storage capacity**
- **Forestvale drainage (955 Forestvale)**
- **Forestvale/McHugh - no ditch**
- **Mill/McHugh - no ditch**
- **Irrigation ditch @ Sewell Rd   Hilger Ditch - poorly maintained**
- **Driveway culverts missing**
- **Get the water to and from the Helena Trap Club basin - to the D-2 ditch**
- **No culvert at Alfalfa Rd. @ Green Meadow - water stays on west side of Green Meadow**
- **Analyze longer duration, lower intensity storm event**
- **I-15 acting as a "dam" - floodplain has expanded west of Hwy.**
- **Re-evaluate/Implement findings of 1982 M&M study**
- **Accountability to get solutions initiated/implemented**
- **Box culvert @ Montana and TMCEstates - not carrying water back to Ten Mile from the west to the east….. North of TMC Estates**
- **Bridge @ McHugh Drive**
- **645 Stadler Rd. - small obstruction (fallen tree) in TMC causes his property to receive water.   Flat grades**
- **Pedestrian corridor along the bank of TMC - stream bank stabilization**
- **Groundwater impacts 675 Edgerton Rd.**
- **Availability of sand/bags to residents during emergencies**
- **Development without planned drainage**
- **McHugh/Hahn - "our bathment is flooded"**
- **County standards for drainage infrastructure - develop/enforce**
- **Improve communication, PSA's, site visits during flood emergencies (from L&C County)**
- **Derek is a sandbagger - in a good way**
- **Groundwater is shallow in valley - introducing water into Gun Club basin caused basements to flood - Ken Hansen -**

- **L&C County WQPD - GW level monitoring**
- **419 Mill Rd.: 60” culvert feeding water to 16” culvert - cannot be increased due to impacts to downstream homeowners**
- **Keep water in TMC between Green Meadow & ???**
- **Formation of citizen groups to maintain momentum in flood mitigation efforts**
- **East of McHugh - water came over 4’ dike**
- **Website to disseminate information on flooding/disasters - accessible, homeowner postable notifications - outreach, reverse 911**
- **Control of up gradient drainages - south of TMC. Impervious surfaces, slopes, etc.**
- **Community access TV -**
- **centralized location and policy for volunteers**
- **Sand bag assistance**
- **Mailing list - e-mails, newsletter(?)**
- **447-8035 (Audra) - separate solid waste accounts for flood victims - take waste directly to landfill. $29/ton**
- **County will start to remove sandbags - once all GW has been addressed Kerr/Forestvale - drainage hoses still being used**
- **Eric Griffin - L&C PWD:**
- **South side of Mill between Green Meadow & McHugh: keep the water in drainage on the south side. Homes flooded at points where water crosses Mill to north.**
- **Assistance with handling/paying for homeowner flood waste**
- **Assistance for homeowners to identify techniques to address home flooding problems on an individual basis.**

Scott’s Notes

Scott’s Notes:

- Problem – sheet flow across field. Why not put water in canel? Underdrains; Capacity ditch 280 cfs – 30 cfs at end
- 10 Mile Creek / Mill Road…10 siphons
- Contain high flows in 10Mile; 100-400 sfs current limit; find better way to deal with extra flow
- Georgia & Forestvale: filling and draining adds to groundwater; high spots in drainage ditches; shallow ditches along Forestvale; undersized culvert at school.

- Law enforcement plus ?? flooding
- Why do drainage ditches go back and forth on Forestdale?
- Pleasant Valley – high groundwater
- 81' Flood – clean out drainage in 10Mile Creek – why did this not happen earlier? Clean out drainage
- Chessman Reservoir – opened up?? DB – full reservoir
- Irrigation ditch Mill Road poorly maintained (Hilgen Ditch, Sewell Road)
- Hedges Drive – professional Geologist; ?? create detention basins
- 81' Flood – perking? Flood; frequency/duration; use 20 year 96 hour event
- Mill Road of McHugh; reversal of water flow
- Funding: where will money come from; FEMA funds, PD Assessment, Paul S
- FEMA Flood Mitigation Grant; difficult competition; sources of funds
- Culverts undersized
- Was 2002 flood mitigation plan put into effect; $600K study to M&M
- Improve drainage along Forestvale; put issue online; Mike some money available
- 10Mile – city/FWP reached agreement to keep 10Mile open; ice jams have become a problem
- Montana Ave 10 Mile Estates; box culvert – no culvert near 10 Mile Estates park; walking path has impeded drainage; box culvert under Montana Ave carries water to North; needs return culvert to creek; walking path near ???? pit
- Eagerton & McHugh; graduate (sp?) 14" ---- 48" ---- 6-7' in basement
- Growth is significant factors in flooding; McHugh/Hahn are standards being applied
- Valley Speed Way – did not have as serious of a problem – check static water levels thru out valley, consider secondary effects, need drainage plan using local products will raise groundwater levels
- WDQ districts – check on monitoring (sp?) wells
- Lead – pH water will be not high ???? to mobilize lead
- East of McHugh – 100' fence (sp?) creek; 4' dike & water went over creek
- 90+% problem is rising graduated (sp?) table – better warning system; reverse 911 – reach people without computers
- City's storm water may be impacting valley
- Put message boards at sandbag site
- Where to put gray water you are pumping out?