United States Department of Agriculture

NRCS

Natural Resources Conservation Service
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Flood Hazard Assessment Report
Falls Gulch, Larimer County, Colorado

January 16, 2013

Prepared by: Al Albin, Dave Droullard, and Dave Wolff.

Purpose: The purpose of this report is to summarize the findings of our (NRCS) site evaluation of the Falls Gulch Area in relation to potential flooding that could be expected from the Falls Gulch Watershed after the High Park fire.

Background: Wildfire burned 259 homes and approximately 87,000 acres of forest land west of Fort Collins, Colorado in June 2012. Larimer County asked NRCS for assistance in evaluating the risk to structures in the Falls Gulch area and make recommendations for mitigation of potential losses.

NRCS Evaluation Team: Al Albin, Dave Droullard, and Dave Wolff.

Assets and Resources at Risk: The principal concerns for the community in Falls Gulch related to post fire flooding are: 1) the risk of damage to residences due to flooding and associated risk to personal safety. 2) The risk of flood damage to the roadway serving the community. 3) The cost of repairs, debris cleanup, and road maintenance following a flood event. 4) Flood waters crossing highway 14 with the associated deposition of debris and potential damage to the highway resulting in hazards to travelers. 5) Sediment, debris, and contaminants transported to the Poudre River by flood flows that negatively impact the resource including municipal and irrigation water supplies. The relative importance of each of these will vary depending on individual perspectives and circumstances.

Assessment of the Conditions: The stream channel passing through the community is not capable of containing flows in excess of 0.5 inches of rain in many locations. Flow in excess of the channels capacity is forced onto the roadway at a number of locations. This is especially true where culverts have been installed. Out of channel flows increase the potential for damage to residences, other property, and the road itself. Aggregate eroded from the roadway is then deposited on properties farther downstream including highway 14 as occurred during the flood event in July, 2012. Flood water crossing the highway is a hazard to travelers, can damage the highway, and deposit sediment and debris resulting in costly cleanup and repairs as well as hampering access to and from the residences.

A series of profiles were measured using surveying levels survey methods. Profiles were developed at residences in the community in order to determine the estimated water level from various selected precipitation events relative to those residences (see Site Plan). Water levels at each profile were determined from a hydrologic analysis of post fire conditions in the watershed from a 2 inch precipitation event occurring in one hour.

Constructing a channel of sufficient capacity to protect the entire community from flooding is not economically feasible.

Recommendations: At the upper end of the community, the main branch of Falls Gulch enters the valley from the west. Flows in excess of the culvert's capacity will be forced onto the adjacent ground and across the road in the area of station 17+50. The recently constructed water bars on the road down slope of the culvert are an appropriate approach. The crest of the water bar should be at least 1.5 feet above the average level of the road between the existing water bar and the culvert to effectively divert the flow. This can be accomplished by lowering the level of the road through excavation, building up the water bar or a combination of each. Obstacles to flow along the road between the culvert and the water bar should be removed. Maintenance of the water bar will be necessary from time to time to ensure its continued effectiveness.

The drainage at cross section 18+04, near home site number 284, drains a much smaller area than the main branch of Falls Gulch. A berm has been constructed to channelize flow across the site. The berm should be maintained at a height of 1.5 feet and leaving a channel width of at least 20 feet to protect the building site from flooding. This site may also be subject to high flows from the main branch of Falls Gulch. A berm or other barrier 2 feet high placed from the mountain side to the edge of the road would divert flows away from the building site. Plans for construction that might occur in the next several years, before the forest recovers, should include consideration for adequate protection from flood flows.

The channel is restricted between station 10+50 and 14+00, where houses, or lots, numbered 164, 176 and 200 are located. Flood water in excess of the channel's capacity will be forced onto the roadway and properties near or below the road level. This is especially true at culverts where capacity is further reduced. Measures such as grading the road slightly toward the channel and constructing water bars would serve to redirect the flow back into the channel thus limiting damage to the roadway. The shed recently placed on lot number 200 is quite vulnerable to flood flows. If dislodged, it would likely become an obstruction to flow at some point downstream and contribute directly or indirectly to additional flood damage. Sandbags should be UV resistant.

At house number 164, station 10+50, a concrete block barrier placed near the edge of the channel from the large boulders to the driveway or even part way across the driveway would help to direct flow downstream. Another potential alignment for a concrete block wall is along the stone wall in front of the house from the concrete pad at the southwest corner of the house to the entrance near the garage to protect the foundation. A sandbag wall placed along the existing stone wall is another option since variability in the slope of the ground and the curvature of the stone wall make the placement of concrete blocks difficult and prone to gaps. The sandbags would conform to the slope and the shape of the stone wall and the wall would support the sandbags.

A path should be left open downstream of the driveway for flood flows to reenter the channel. The storage shed upstream of the house should be protected from high flows. Sandbags may be a better option for protecting the shed because of limited accessibility to this area. Sandbags should be placed against the upstream side and the side facing the

channel to a height of 2 feet. It would be best to continue the sandbag wall to the large boulders downstream of the shed. Sandbags should be UV resistant.

The culvert adjacent to house number 100, near station 7+75, is not large enough to pass even a moderate flow event. Water backed up behind the culvert will flow around the culvert and likely over the bank and down the slope into the low area between the channel and the house. The history of culverts in this location indicates the culvert is likely to be plugged by sediment resulting in increased flow around the culvert and over the bank. The culvert could be washed out.

The constructed bank upstream of the culvert is made up of gravelly and sandy material that is prone to erosion. The bank is at a bend in the channel and subject to the force of the current during high flows. This could lead to failure of the bank.

The most cost effective solution at this location is a low water crossing, a broad, open section of the channel, preferably armored with large stones. A structure such as this might also be overtopped at some point but would have a great deal more capacity than the existing culvert.

If the culvert is kept at this location, flood protection could be provided by constructing a concrete block wall. A conceptual drawing of a wall at this location shows an alignment from the mountainside to 5 feet past the culvert opening, 45 feet. Extending the wall another 25 feet along the culvert to the road might be considered to provide additional protection for the home and property. The drawing shows the base of the concrete block wall at or below the level of the stream bed. The wall shown is three blocks high and buttressed on the front side by a wedge of coarse stone with large boulders along the base to direct the current around the curve in the channel and resist erosion. The wall must be supported on the back side by a wedge of earthen material no steeper than a 2:1 slope. If concrete blocks are placed <u>on</u> the existing bank, it is essential to protect the bank from erosion with coarse stone and large boulders grouted in place to prevent the block wall from being undermined and collapsing. The design option selected by the community for a structure at this location should be reviewed by a qualified engineer. If the culvert fills or is washed out, water will still flow toward the house but would be farther downstream than if the bank upstream of the culvert were to fail. See the note on concrete block placement below.

The channel between house numbers 100 and 50, station 4+35 and 7+75, has limited capacity. The roadway provides the only feasible channel for flood water forced out of the channel in this area. Residents in this area should take appropriate measures to protect their property from flood water and debris. See the attached Site Plan for specific recommendations for flood protection at each residence.

The channel crosses from the west side of the gulch to the east side between house numbers 50 and 57. Improving the channel at the road crossing, near cross section 4+35, provides the best opportunity to direct out of channel flows back into the channel. Currently, flows are conducted under the road through a 3.3 foot diameter 43 foot long culvert. The headwall on the upstream side is made up of boulders. There is a wooden headwall on the downstream side of the culvert. The space between the headwalls is filled to provide a rather wide crossing. The culvert has a capacity of 70 cubic feet per second (cfs). This is not enough capacity to conduct the flow from even a moderate post

fire precipitation event. Flows beyond the culvert's capacity will be forced onto the roadway. The 43 foot wide crossing provides a bridge, in effect, to carry water over the channel and continue down the road, past or into the homes and properties down slope of this crossing and onto highway 14.

Removing the culvert, replacing it with a bridge and making a few alterations to improve the capacity of the existing channel and direct flood water back into the channel would be a significant improvement. The threat of flooding and property damage down slope of this crossing would be greatly reduced along with the associated damage to the road. The risk of flood waters reaching the highway and resultant sediment deposition would also be greatly reduced. If this crossing is substantially improved, the flood protection measures recommended on the Site Plan for properties down slope of this crossing should be reassessed. The estimated cost savings resulting from decreased flood protection requirements would be about $1,700.

Crossing Reconstruction Concepts: The current crossing near cross section 4+35 consists of approximately 55 cubic yards of earth fill material including some large boulders, a culvert 3.3feet in diameter and 43 feet long, and a wooden head wall. The capacity of the channel would be increased greatly by the removal of these materials and restoration of the channel to a configuration similar to that of the channel downstream of the crossing. The channel below this crossing has much more capacity than other reaches of the channel passing through the community. The channel from the existing crossing to about 20 feet upstream should also be improved to allow out of channel flows to return to the channel. Any boulders, trees, or other obstructions that might hamper overland flow from entering the channel should be removed. Material excavated from the existing crossing can be used to build up the level of the road approaching the reconstructed crossing. The road upstream of the crossing should be built up such that the extent of flood flow on the road is reduced by displacing flood flows to the west, away from the houses and directing water toward the improved channel. Concrete abutments for the new bridge may be poured in place or constructed from precast concrete blocks. The abutments should be placed on secure foundations and high enough that the structural members of the new bridge will not extend below the level of the existing road. This is to preserve the maximum capacity of the channel and allow for additional channel bank height on the north side of the channel. The approaches to the bridge should be built up to meet the bridge deck. Concrete blocks or other durable material may be placed along the north side of the channel on either side of the bridge to provide for additional channel bank height and channel capacity in this area. A one-lane bridge with suggested H-20 loading should be sufficient. The span of the bridge, as measured between abutments, should be about 15 feet, depending on the extent of excavation and channel improvement done during removal of the existing crossing. The bridge should be designed or approved by a qualified engineer.

Alternatively, the crossing may be improved and the potential of returning flows to the channel can be increased with less effort and expense. An improved path for water to reenter the channel could be developed by removing the wooden head wall at the downstream end of the culvert to the top of the culvert and sloping the ground from the existing road to the culvert. Constructing a large water bar at least 2 feet high on the north side of the channel between the existing concrete wall along the road and the foot

bridge, a distance of 29 feet, would provide a barrier to water flowing down the road and encourage water to enter the existing channel. The water bar could be built with a core of concrete blocks, if available, and covered over with compacted earth to allow for vehicular traffic. If this approach is selected, the stone wall in the channel between the culvert and the footbridge should be improved and capped with concrete to protect the wall and the channel bank from erosion. This option will not be nearly as effective in providing flood protection to the properties down slope of this crossing as would the option of opening the channel and constructing a bridge.

Suggested placement of concrete block for flood protection at various locations in the community is addressed on the site plan.

Note on Concrete Block Placement: Prior to the placement of concrete blocks, a foundation should be prepared about 6 inches below grade and on a uniform slope. The foundation should be well compacted to prevent settlement and resulting miss alignment of the blocks. Blocks stacked two high that may be exposed to the direct impact of flood flows will require support. Support could be provided by pneumatically driven anchors with cables running to the blocks. The space behind blocks may be filled in some instances to provide support. A ½ inch cable should be used to tie the top course of blocks together. The cable can be passed through the lifting loop on each block. Both ends of the cable should be secured to an anchor that will prevent the blocks from being transported in the current should they become dislodged or undermined. The anchor point can be drilled and secured into bedrock, a driven anchor, or a large tree.

Debris Control: The debris consisting of woody and rock, boulders, gravel and sand transported by high flows could impede the passage of water through the community exacerbating the effects of flooding and resulting in additional property damage and increasing cleanup costs.

There is a significant potential for the drainages upstream of the community to produce debris during a flood event. A survey of these drainages has yet to be done to define the extent of that potential.

Debris structures could be constructed to prevent primarily large woody debris and boulders from being carried by flood water into and through the community and onto highway 14. Debris structures would reduce the potential for blockage of culverts and reduce the amount of post flood cleanup required. Debris structures would have to be cleared of debris following a flood event in order to remain effective. Someone or some group would have to accept the responsibility of clearing the trash racks.

Debris structures could be constructed in each of the two drainages near the uppermost home site in the community at stations 18+04 and 18+52 (see Site Plan). Alternatively, if these locations are not acceptable, a trash rack could be constructed just below the confluence of the two branches, approximate station 16+00. This location would not be as readily accessible for cleaning.

A design approved by NRCS is included with this report. There are other design approaches that could be utilized depending on the needs and resources of the community. Another design should be approved by a qualified engineer.

Debris structures could be constructed of logs or structural steel members embedded in concrete. The advantage of a log structure is the abundance of available material nearby. Also these log structures will gradually decay as the years pass and the forest recovers lessening the need for such structures. The advantage of the structural steel trash rack is that they are relatively easy to construct. They are very durable and effective but may have to be physically removed after the threat of debris flows has past.

Well Heads: There are a number of well heads in the community that may potentially be impacted by flooding or debris. The locations of such well heads should be marked with a durable post. Sandbags may be piled around and over a well head for protection. Where a well head may be directly exposed to flood flows, precast concrete barriers or blocks may be used to shield the well head. A section of concrete pipe, large enough to access the well head, may be placed over the well head and partially buried leaving about two feet above ground. A concrete lid would provide protection and allow access. These measures allow the well head to be more easily found and debris to be removed without damage to the well head.

The well cap may leak if submerged. If a well head becomes submerged, it would be prudent to disinfect the well or purify the water before use.

Propane Tanks: All propane tanks that may be impacted by flood flows need to be secured or moved. The tanks can be secured by running a chain or cable through one of the feet, preferably on the upstream side and attaching it to a secure anchor point such as a large tree, a concrete footing, or a large boulder. The valve on the propane tank should be shut off when flooding is imminent.

Cost Estimates: A summary of recommended flood protection measures and cost estimates is attached. These figures are based on prevailing contract costs.

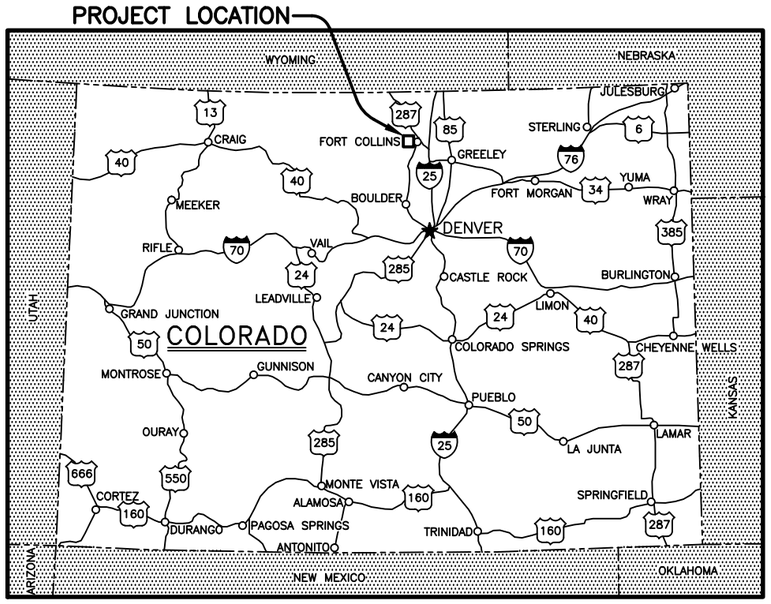
_____

John Andrews
State Conservation Engineer

Summary of Recommended Flood Protection Measures			
Location	Recommendations		Estimated Cost *
As indicated on the Site Plan	Concrete blocks, 2.4'X2.4'X5', 3,800 lb	Trucking 180 (max.) concrete blocks to the site. Placement of concrete blocks Foundation preparation Anchoring blocks Total	72 hours @ $100/hr., $7200, $40 / block $20/each = $3600 $30/each (lower course only) = $2700 $800 $14,300
Station 4+50	Construct bridge	Remove existing crossing and improve channel Bridge, delivered Concrete block abutments Excavation and foundation preparation Total	$5,000 $25,000 $7,500 $5,000 $42,500
Station 4+50	Crossing Improvement (Alternate)	Excavation Water bar construction Total	$2,500 $2,000 $4,500
Station 8+25	Construct concrete block wall	Excavation and foundation preparation Placingand anchoring concrete blocks construction fill and rip rap Total	Equipment and operator, 12 hrs. @ $100/ hr., $1,200 $1,800 $4,000 $7,000
Station 10+50 to 14+00	Grade road and construct water bars		Equipment and operator, 4 hrs. @ $100/ hr., $400
Station 17+50	Improve water passage over road, construct water bar.		Equipment and operator , 2 hr. @ $100/ hr., $200
Station 18+04	Debris structure	Design included with this report	$30,000
Station 18+52	Debris structure	Design included with this report	$30,000

* Costs are estimated based on prevailing contract costs.

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
FALLS GULCH FLOOD PROTECTION RECOMMENDATIONS



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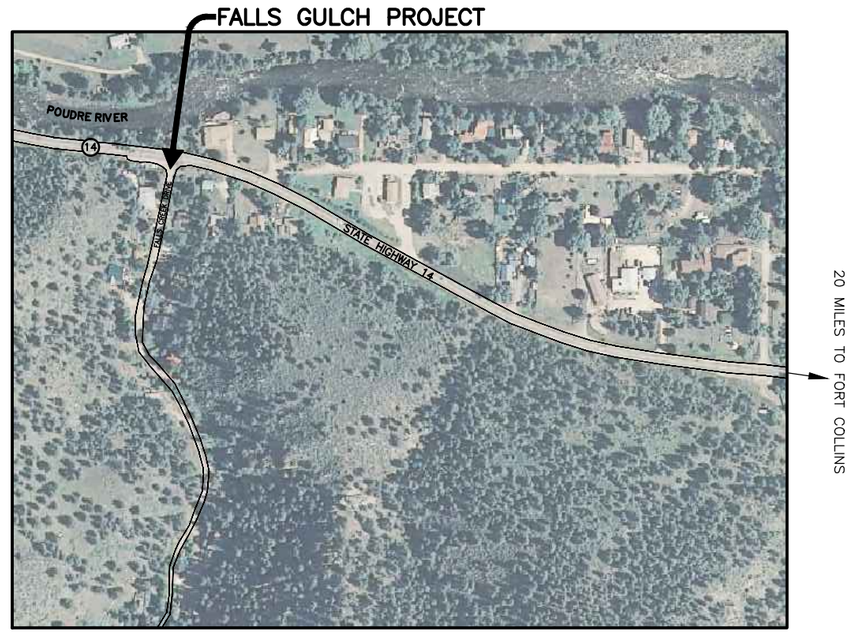
COLORADO STATE MAP
NOT TO SCALE



PROJECT VICINITY MAP
NOT TO SCALE

INDEX OF DRAWINGS	
TITLE	SHEET NO.
COVER SHEET	1
SITE PLAN	2
CROSS SECTIONS	3
CROSS SECTIONS	4
CHANNEL DEBRIS BARRIER	5

GENERAL NOTES

CONSTRUCTION SPECIFICATIONS

NO.	TITLE

CONSTRUCTION QUANTITIES

COOPERATOR AGREEMENT

THIS PLAN HAS BEEN DISCUSSED WITH ME BY THE NRCS AND I AM IN AGREEMENT WITH THE CALCULATIONS AND DESIGN. I WILL PROVIDE NRCS WITH THE UTILITY NOTIFICATION CENTER OF COLORADO (UNCC) TICKET NUMBER MY CONTRACTOR HAS ACQUIRED PRIOR TO START OF CONSTRUCTION.

_____ DATE: _____
COOPERATOR

UTILITY NOTIFICATION

NOTICE TO THE COOPERATOR AND CONTRACTOR

NO REPRESENTATION IS MADE BY THE NATURAL RESOURCES CONSERVATION SERVICE AS TO THE EXISTENCE OR NONEXISTENCE OF UNDERGROUND UTILITIES. **CALL 2 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.** CALL UTILITY NOTIFICATION CENTER OF COLORADO AT 1-800-922-1987 OR 811. IN THE METRO DENVER AREA CALL 303-232-0491 OR 811.

UNCC TICKET NUMBER: _____

CONSTRUCTION DATA & AS-BUILT DRAWINGS

LAYOUT BY:

_____ DATE: _____

CONTRACTOR NAME AND ADDRESS:

_____

_____

_____

CONSTRUCTION COMPLETED _____ DATE: _____

PRACTICE (DOES) (DOES NOT) MEET STANDARDS AND SPECIFICATIONS.

_____ DATE: _____

_____
TITLE:

AS-BUILT DRAWINGS REVIEWED AND APPROVED BY:

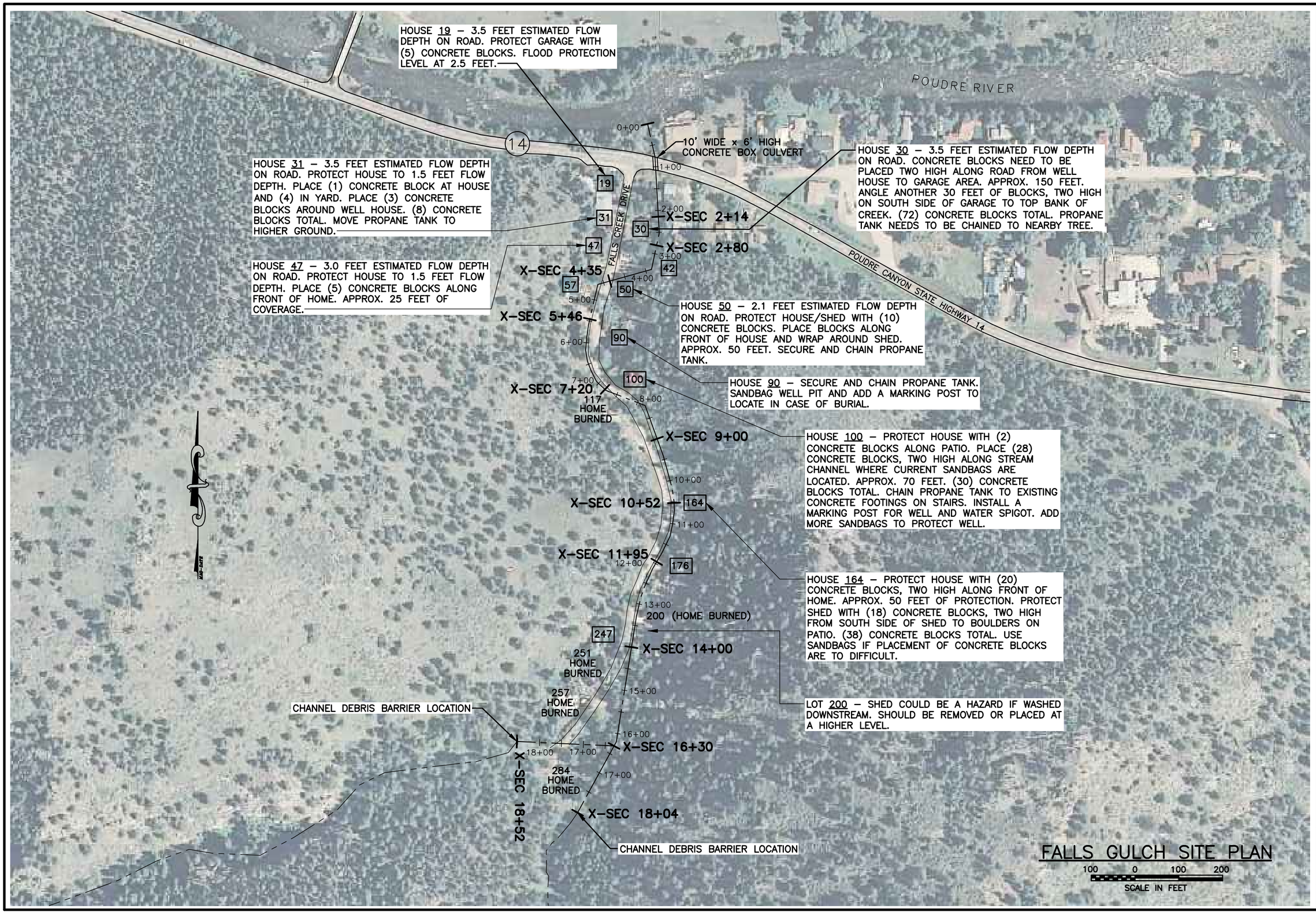
_____ DATE: _____
TITLE:

DESIGNED D. WOLFF DATE 10/9/12
DRAWN D.D. DROULLARD 10/9/12
CHECKED A. ALBIN
APPROVED

COVER SHEET
FALLS GULCH FLOOD PROTECTION RECOMENDATIONS
HIGH PARK BURN AREA
LARIMER COUNTY COLORADO
JOB CLASS

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

FILE NO.
DRAWING NO.
SHEET 1 OF 5



		Date
Designed	D. WOLFF	10/22/12
Drawn	D.D. DROULLARD	10/22/12
Checked	A. ALBIN	10/22/12
Approved		

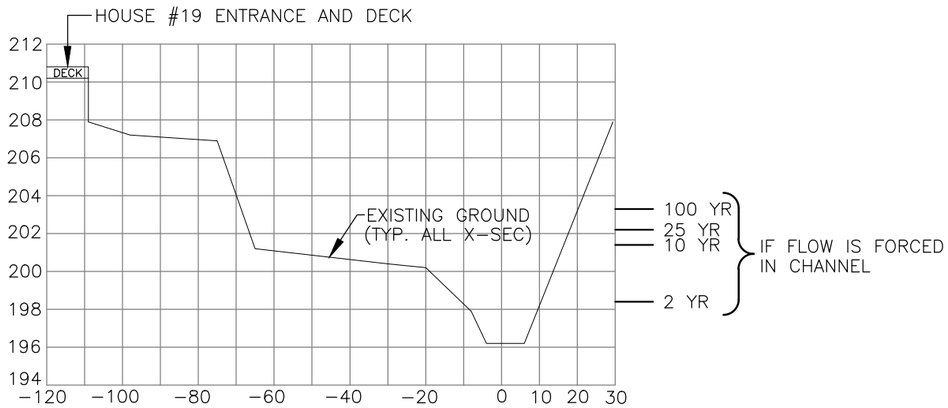
SITE PLAN
FALLS GULCH FLOOD PROTECTION RECOMMENDATIONS
HIGH PARK BURN AREA
LARIMER COUNTY COLORADO

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

File No.

Drawing No.

Sheet of



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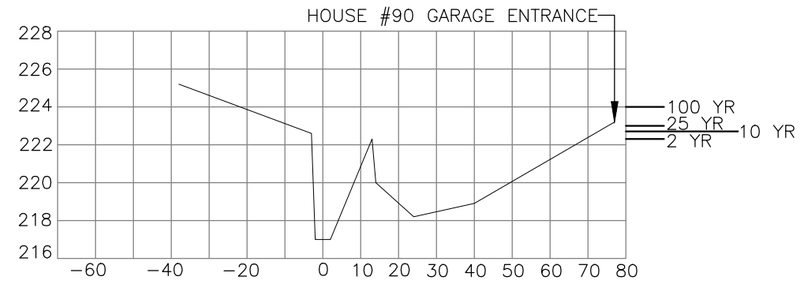

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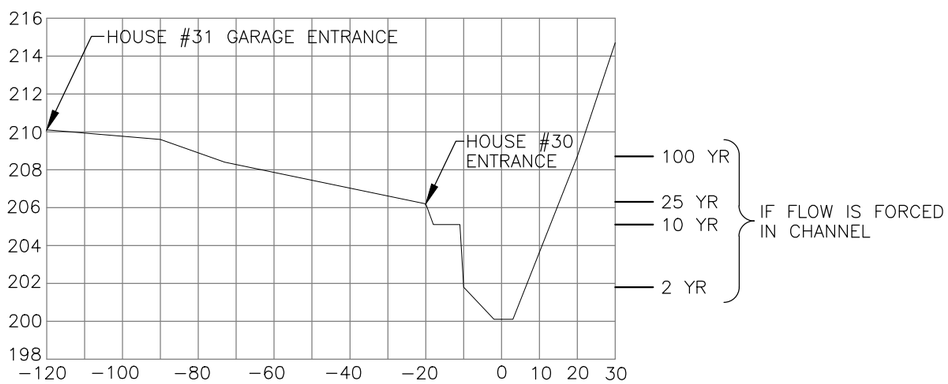

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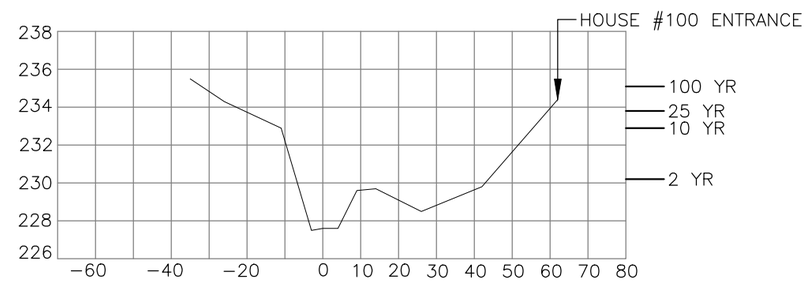

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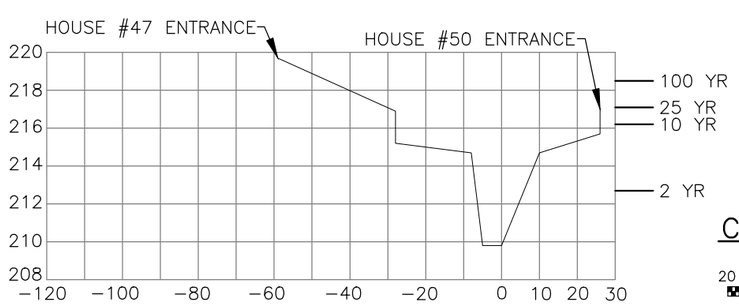

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CROSS SECTIONS
(LOOKING DOWNSTREAM)

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HORIZONTAL SCALE IN FEET

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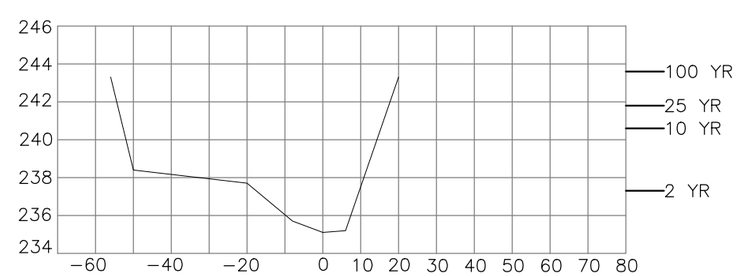
VERTICAL SCALE IN FEET



X-SEC 9+00
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RAINFALL TABLE

RETURN INTERVAL (YEARS)	DURATION (HOURS)	RAINFALL DEPTH (INCHES)
2	1	0.8
10	1	1.5
25	1	1.8
100	1	2.4

Designed D. WOLFF Date 10/22/12
Drawn D.D. DROULLARD 10/22/12
Checked A. ALBIN 10/22/12
Approved

CROSS SECTIONS
FALLS GULCH FLOOD PROTECTION RECOMMENDATIONS
HIGH PARK BURN AREA
LARIMER COUNTY COLORADO

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

File No.
Drawing No.
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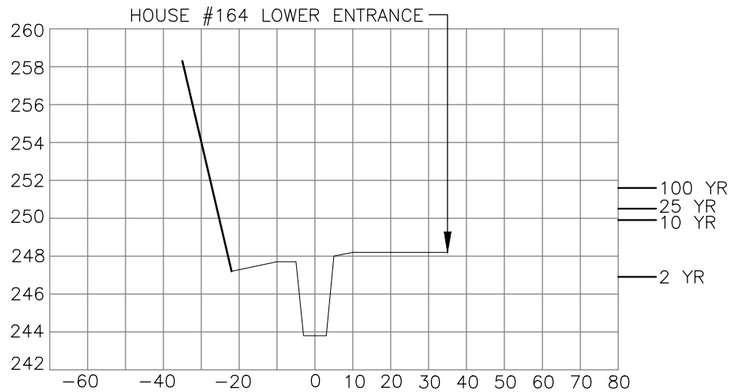

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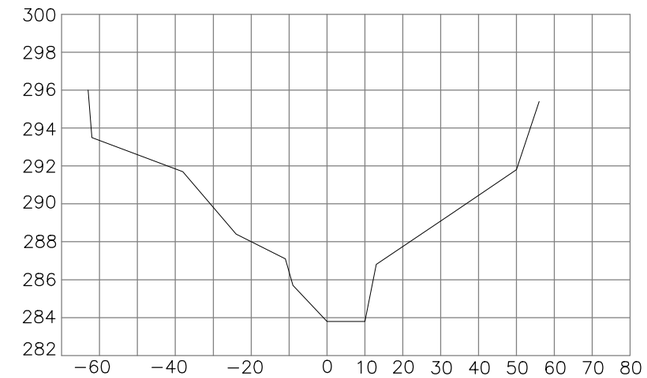

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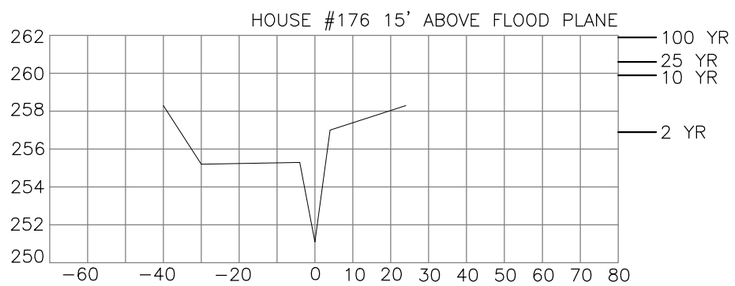

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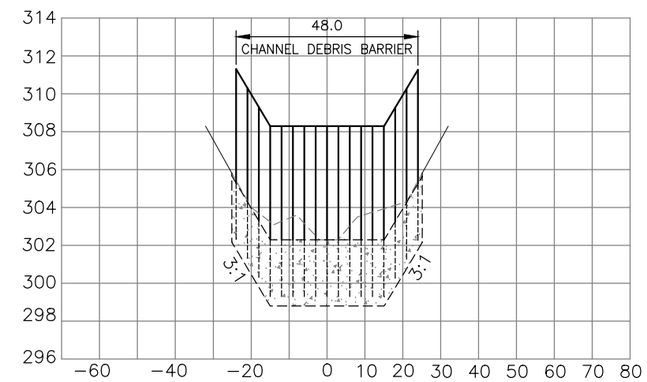

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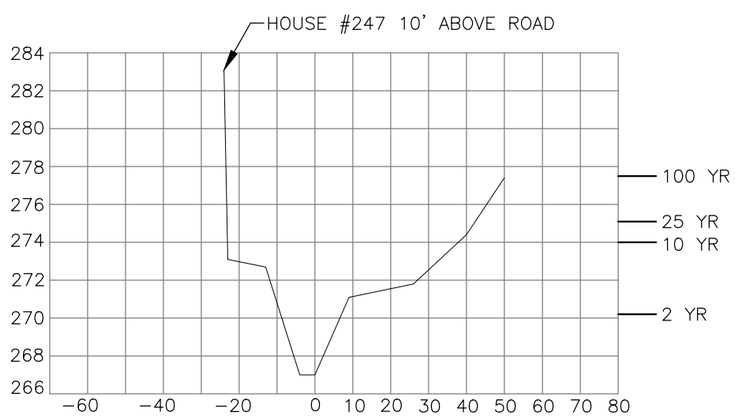

X-SEC 14+00
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CROSS SECTIONS
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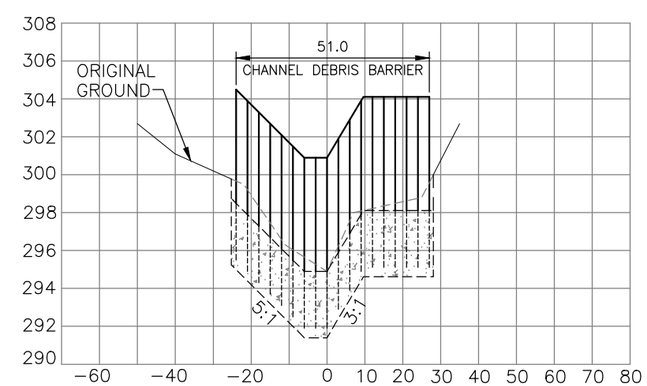
VERTICAL SCALE IN FEET



X-SEC 18+52

RAINFALL TABLE

RETURN INTERVAL (YEARS)	DURATION (HOURS)	RAINFALL DEPTH (INCHES)
2	1	0.8
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25	1	1.8
100	1	2.4

Designed D. WOLFF Date 10/22/12
Drawn D.D. DROULLARD 10/22/12
Checked A. ALBIN 10/22/12
Approved

CROSS SECTIONS
FALLS GULCH FLOOD PROTECTION RECOMMENDATIONS
HIGH PARK BURN AREA
LARIMER COUNTY COLORADO

NRCS
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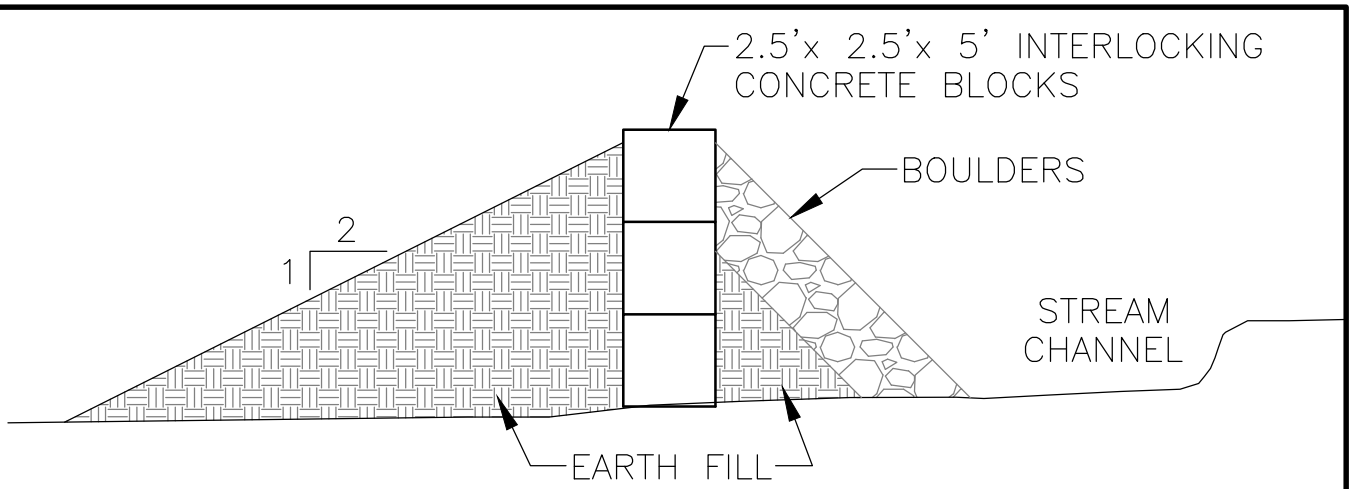
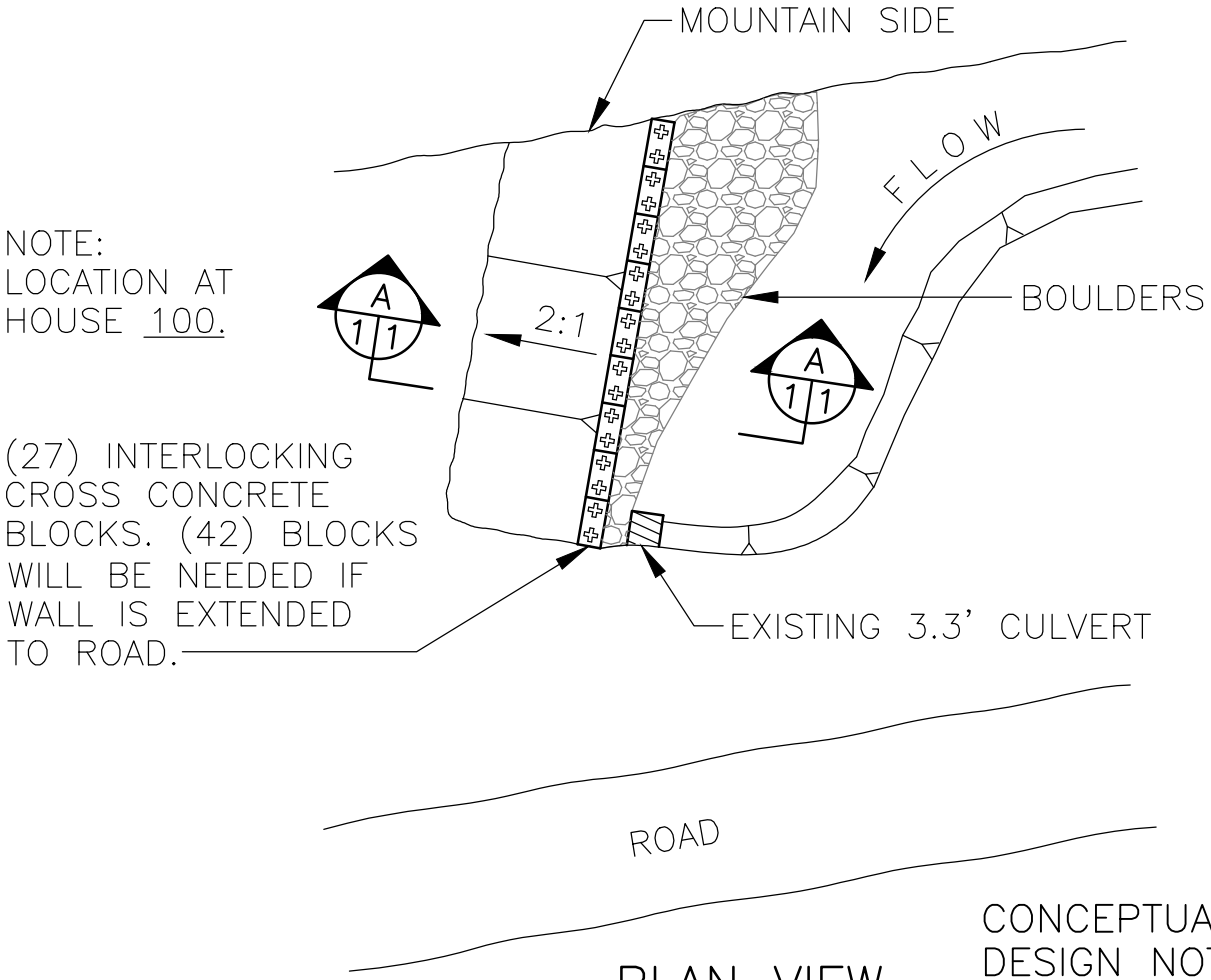
File No.
Drawing No.
Sheet of



SECTION A–A
NO SCALE



NOTE:
LOCATION AT HOUSE 100.

(27) INTERLOCKING CROSS CONCRETE BLOCKS. (42) BLOCKS WILL BE NEEDED IF WALL IS EXTENDED TO ROAD.

PLAN VIEW
NO SCALE

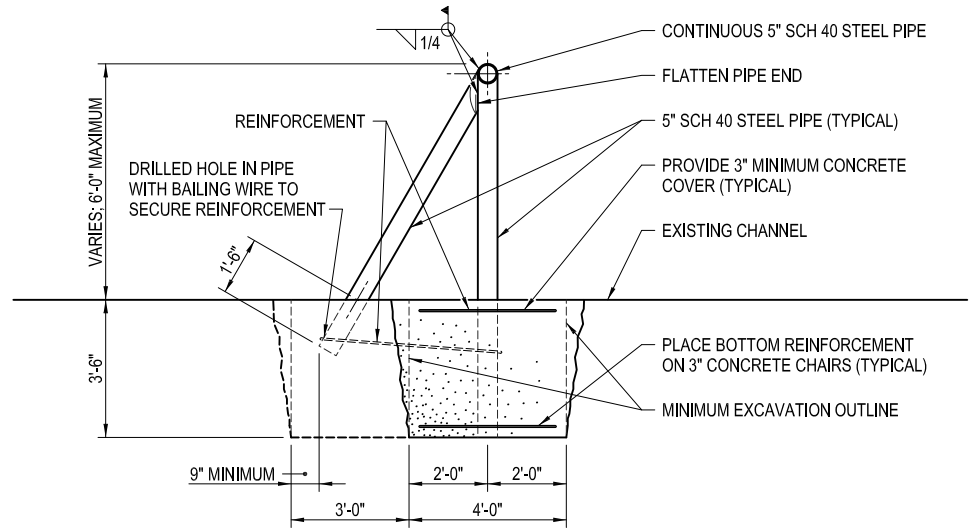
CONCEPTUAL DESIGN NOT TO BE USED FOR CONSTRUCTION

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

DRAWING DETAILS
FALLS GULCH FLOOD PROTECTION RECOMMENDATIONS

LARIMER COUNTY COLORADO

		Date	File Name
Designed	A. ALBIN	11/12	
Drawn	D.D. DROULLARD	11/12	Drawing Name
Checked	D. WOLFF	11/12	
Approved			Sheet of

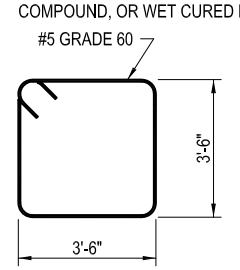


SECTION - A

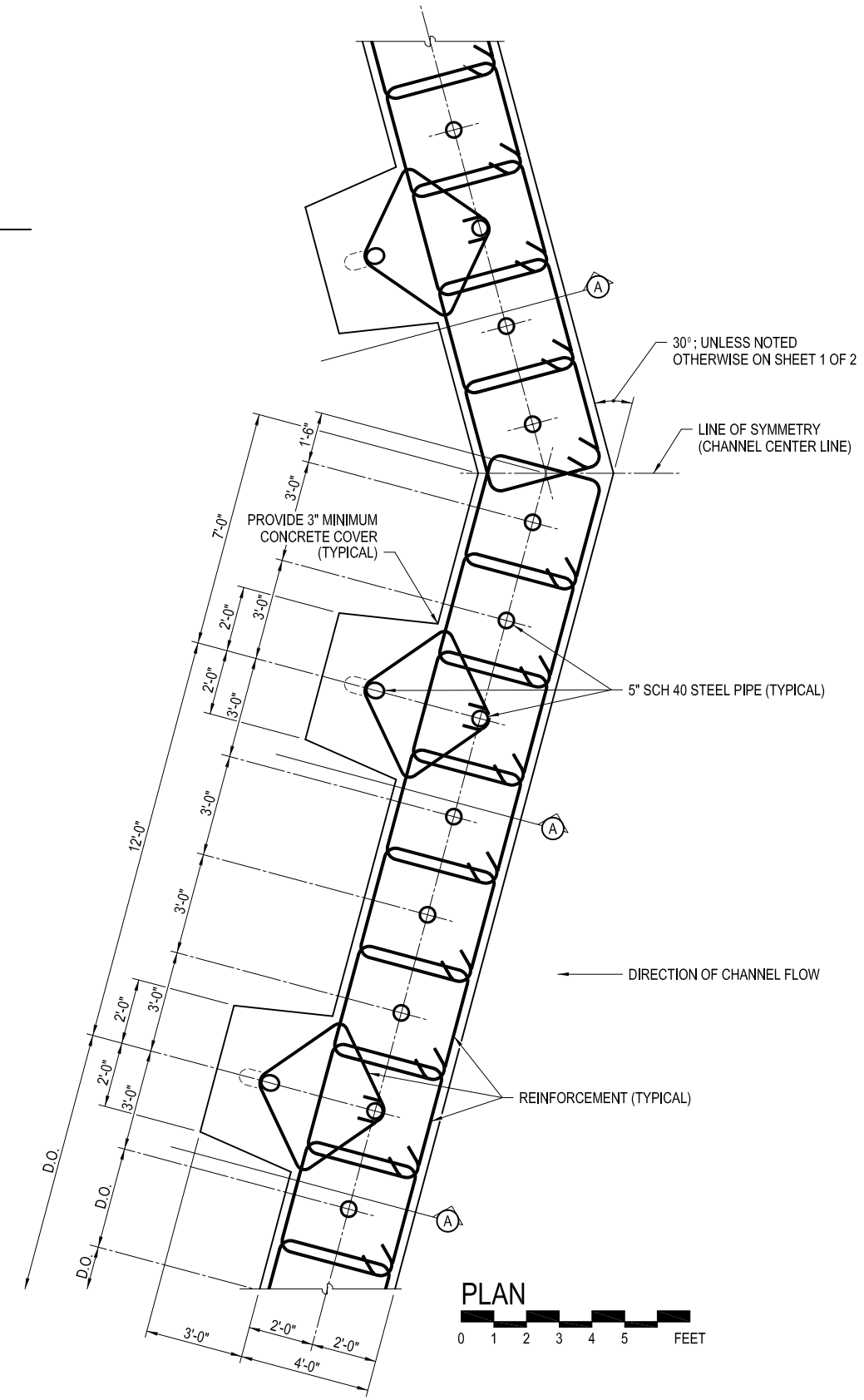
0 1 2 3 4 5 FEET

NOTES

1. LENGTH AND ALIGNMENT OF STRUCTURE TO BE DETERMINED ON A SITE SPECIFIC BASIS. SEE SHEET 1 OF 2 FOR DIMENSIONS AND ELEVATIONS.
2. IN LIEU OF 5" SCH 40 STEEL PIPE; STRUCTURAL STEEL TUBE SHAPES HAVING A SECTION MODULUS OF AT LEAST 4.5 IN^3 MAY BE USED, OR 'W' OR 'I' SHAPES HAVING A SECTION MODULUS OF AT LEAST 4.9 IN^3 MAY BE USED.
3. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 LB/IN^2, AND SHALL HAVE A SLUMP BETWEEN 3 AND 5 INCHES. ALL CONCRETE SHALL BE VIBRATED. EXPOSED CONCRETE SURFACES SHALL BE COATED WITH CURING COMPOUND, OR WET CURED FOR 28 DAYS.



TYPICAL REINFORCEMENT



PLAN

0 1 2 3 4 5 FEET

		Date
Designed	Stambaugh	AUG 2012
Drawn	Stambaugh	AUG 2012
Checked	Marine	AUG 2012
Approved	Andrews	AUG 2012

CHANNEL DEBRIS BARRIER

DETAILS, REINFORCEMENT, AND SECTION
6-FOOT MAXIMUM HEIGHT

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

File Name
XXXXXXXX

Drawing No.
XX - X -XXXX

Sheet 2 of 2