

Technical Memorandum



To:	John Woods
From:	John Knutson, PE URS Corporation 3810 Kern Rd., Suite A Yakima, WA 98902 (509) 469-0163
Copies:	File
Date:	July 29, 2014
Subject:	Review and Comments on Flood Study for Black Horse
Project:	33764776—Bender Road Flood Review

Background

URS has been retained by John Woods to review and comment on a flood study developed for the proposed Black Horse development project. The proposed Black Horse development is located on the north side of Bender Road near Ellensburg, WA. Eastern and southern portions of the development site are frequently flooded by Whiskey Creek, which inundates the area as the flood water flows in a generally southern and southwestern direction. The area is relatively flat with a generally shallow stream channel. The creek is bisected by roads and irrigation canals, which tend to disrupt the flood flow pattern that would occur under the natural topography. In addition, the location of Whiskey Creek has likely been altered over time to facilitate agricultural land uses in the area. However the creek has been in its current crossing location on Bender Road for many years, where it passes under the road through a culvert. The surface of the road is raised approximately 4-5 ft above the creek channel. WDFW identifies the culvert “as a bottomless arch with a span of 60-inches and a rise of nominally 30-inches (i.e. half of a 60-inch round culvert) placed on timber footings. (The culvert was exposed during excavation for the sewer main, and this is how it appeared in the trench.)”. However, Anchor QEA, who performed the flood study for Black Horse identifies the culvert as a “48 corrugated metal pipe”, presumably round. The maximum capacity of the culvert under Bender Road was estimated at approximately 125 cfs (Ellensburg Water Company, 1985), assuming a 5 ft wide by 4 ft tall section of circular culvert – which is close to WDFW’s observed size. The existing capacity is likely less than 125 cfs due to accumulation of sediment in the channel near the entrance to the culvert.

After crossing under Bender Road, Whiskey Creek continues in a southwesterly direction across the John Woods property where it encounters the Town Ditch, which is operated by the Ellensburg Water Company. Whiskey Creek passes under the Town Ditch via an undershot with an estimated maximum capacity of approximately 320 cfs under inlet control (Ellensburg Water Company, 1985).

Kittitas County Code

Some of the sections of Kittitas County Code and Ordinance 2007-06 that may be relevant to the effects of the proposed Black Horse development on the John Woods property are:

- *14.08.050 Compliance. No structure or land shall hereafter be constructed, located, extended, converted, or altered without full compliance with the terms of this chapter and other applicable regulations. (Ord. 2001-03; Ord. 93-18 § 3.3, 1993).*

John Woods

July 29, 2014

- *14.08.150 Interpretation of FIRM boundaries. Make interpretations, where needed, as to exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions). The person contesting the location of the boundary shall be given a reasonable opportunity to appeal the interpretation as provided in KCC 14.08.160. (Ord. 2001-03; Ord. 93-18 § 4.7, 1993).*
- *14.08.220 Subdivision proposals. 1. All subdivision proposals shall be consistent with the need to minimize flood damage. ...4. Where base flood elevation data has not been provided or is not available from another authoritative source, it shall be generated for subdivision proposals and other proposed developments and shall be noted on the final mylar...5. All subdivisions shall show on the face of both the preliminary and final plat, for either short or long plats, the boundary of the 100year floodplain and floodway.*
- *14.08.315 Standards for filling, grading in floodplain. Filling, grading or other activity that would reduce the effective storage volume shall be mitigated by creating compensatory storage on-site, or offsite if legal arrangements can be made, to assure that the effective compensatory storage volume will be preserved over time; provided, however, that no increased upstream or downstream flood hazard shall be created by any fill authorized in the floodplain by this chapter or other applicable chapters.*
- *ORD 2007-06 F. Site grading and development shall be designed as to minimize loss of existing flood storage or flood conveyance capacity, and shall have adequate drainage provided to reduce exposure to flood damage.*

Black Horse Proposed Floodplain and Conveyance Changes

URS understands that the Black Horse project proposes to make the following changes to Whiskey Creek, its floodplain, and the existing distribution of its floodwaters:

- Filling in portions of the floodplain upstream of Bender Road.
- Filling in areas along the ditch-line west of Whiskey Creek upstream of Bender Road.
- Constructing a berm to eliminate the westerly flow of Whiskey Creek floodwaters in and along the ditch-line on the upstream side of Bender Road.
- Eliminating the overtopping of Bender Road by Whiskey Creek floodwaters west of the Whiskey Creek culvert.
- Eliminating the overtopping of the Town Canal by Whiskey Creek floodwaters near the intersection of Reecer Creek Road and Bender Road.
- Upsizing the Bender Road culvert to pass 378 cfs (the estimated 1996 Rain on Snow Flood Discharge) versus the existing condition estimate of 94.5 cfs (Anchor, Sept. 28, 2012).

Flood Study Comments

URS comments are based only on the information provided by Mr. Woods and should be considered preliminary in nature. Comments are based mainly on the March 14, 2012 and September 28, 2012 Floodplain Analyses Memos, prepared by Anchor QEA for ESM Engineers, along with related Anchor documents prepared for WDFW (dated 12/14/12). URS did not have access to, or review: (a) the detailed HEC-RAS model showing the placement and function of lateral weirs and culverts; (b) the surveyed channel/floodplain cross-sections; (c) the GIS based inundation mapping routine used to delineate floodplain boundaries; (d) surveyed elevation data for structures on the Woods property; (e) the raw LiDAR data or LiDAR based topography for the area.

Existing Conditions

There appears to be a partially inaccurate understanding of the existing flooding conditions on the downstream side of Bender Road. Some portions of Anchor's analysis appear correct, however some do not. For instance:

- A. Anchor's model accurately shows that under existing conditions a substantial amount of flood water cannot pass through the existing Bender Road culvert, and instead is diverted to the west along the upstream side of Bender Road where a portion of it overtops Bender Road and a portion overtops the Town Canal banks near intersection of Bender Road and Reecer Creek Road (**Figures 1 and 2**).

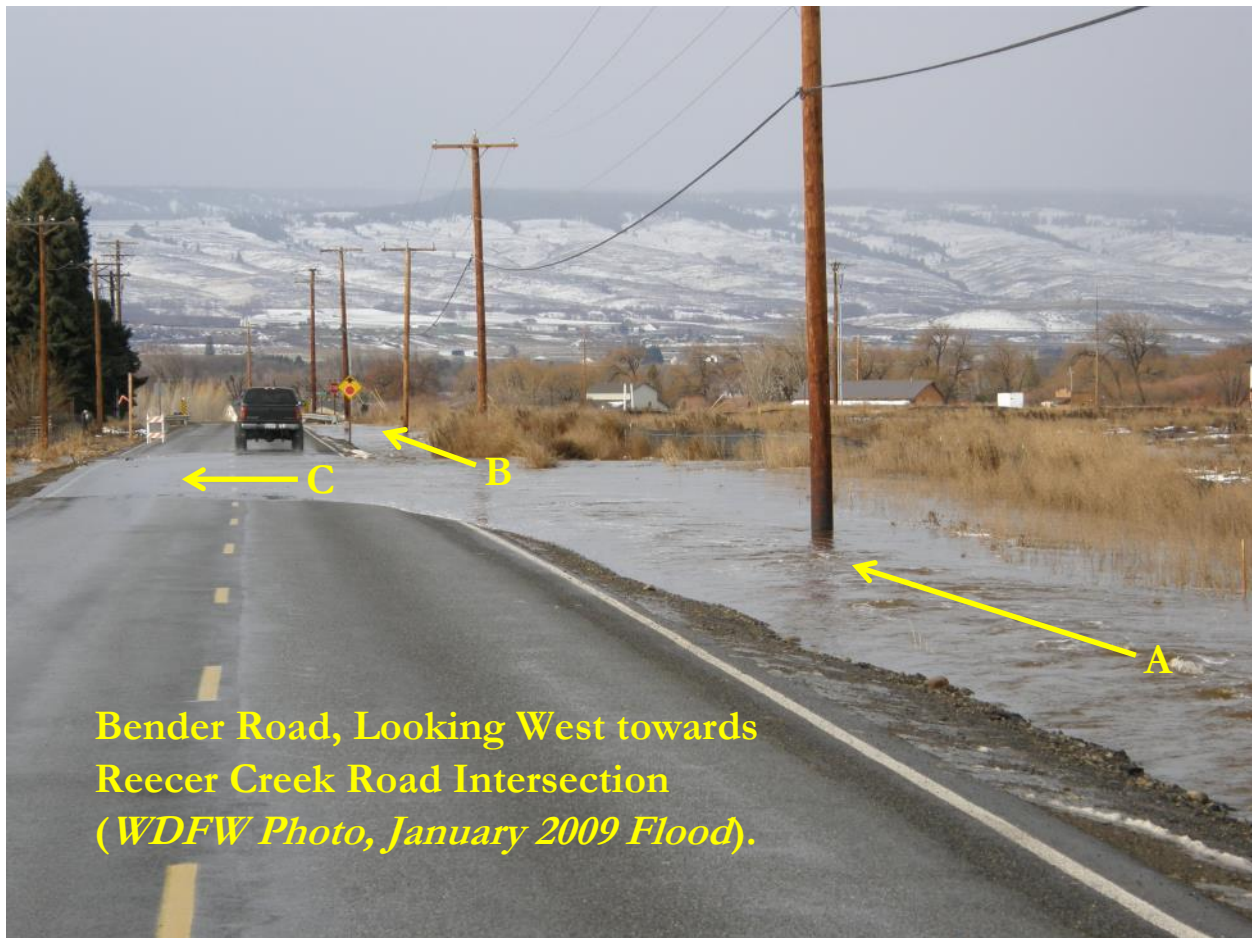


Figure 1. Whiskey Creek floodwaters flowing west away from the creek along Bender Road. **A.** Based on Anchor's model using the estimated 1996 flood flow, the diverted flow would be approximately 283 cfs for a Whiskey Creek flood flow of 378 cfs (*likely greater than the 2009 flood flow shown here*). **B.** The majority of diverted flow overtops the Town Canal banks and leaves the area. **C.** A smaller portion of the diverted flow overtops Bender Road (shallow enough to still see road stripes in 2009) and enters the roadside ditch where it flows into the Town Canal on the south side of the road. In 1996 the flow overtopping Bender Road was great enough to overwhelm the capacity of the south side ditch and enter Woods field.

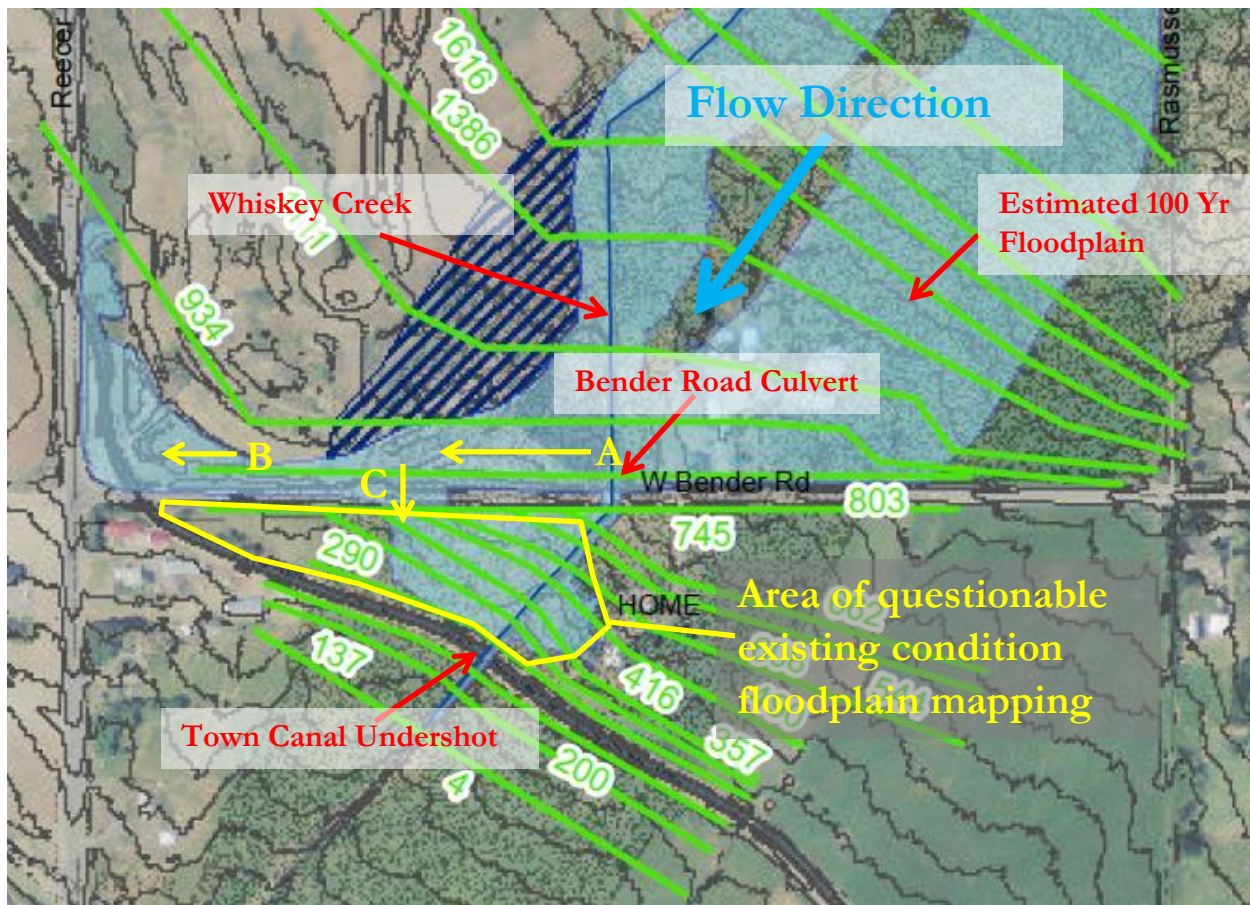


Figure 2 (Edited from Anchor Floodplain Analysis, Sept. 28, 2012). Anchor model shows Whiskey Creek floodwaters flowing west away from the creek along Bender Road. **A.** Based on Anchor’s model, the diverted flow would be approximately 283 cfs for a Whiskey Creek flood flow of 378 cfs. **B.** The model shows the Town Canal being over-topped. **C.** A portion of the diverted flow is shown crossing Bender Road and entering John Woods field.

- B. While the diversion of flow along Bender Road and the overtopping of the road and the Town Canal appear correct, the floodplain mapping on the south side of Bender Road does not appear to be correct (**Figure 2**). Nor does it match Mr. Woods’ observations over the last 30 years, during which several floods have occurred with the largest occurring in 1996. The floodplain mapping does not match the Anchor HEC-RAS model output either. There are several inconsistencies:
- i. Once the diverted floodwater overtops Bender Road, based on the 2 ft contours the Anchor mapping essentially has it flowing up-hill, across a low topographic rise, and back down to Whiskey Creek. While it may be slight, the topographic rise can be observed in the field and is also shown in the 2 ft contours. The 2 ft contours (presumably derived from LiDAR data) show that, once overtopping Bender Road, the floodwater should: (a) flow down the south side ditch and into the canal on the south side of Bender Road; and (b) when over topping flows are great enough (such as in 1996), flow downhill (perpendicular to the contour lines) in the field and pool in the low spot in the vicinity of the “290” location (**Figure 3**). There appears to be no reason to map as floodplain the entire area between the road overtopping location and the creek/canal undershot.

Once pooled near the “290” location, there is no topographic reason the floodwater will not overtop the Town Canal bank and enter the canal rather than return to Whiskey Creek (which is what Mr. Woods has observed). In fact, prior to 1996 Mr. Woods and the Ellensburg Water Company installed a “cut-out” on the side of the canal at the low spot in the field to drain excess irrigation water from the Woods field – this is how floodwaters from the field entered the canal in 1996. This flooding pattern is also validated by a video of the 1996 flood provided by Mr. Woods. The video (1:12:46) shows the road being overtopped (deeper than 2009), yet the field between the overtopping location and the creek channel is still covered with snow (1:12:34) - not inundated with floodwater as shown by the Anchor floodplain map (see **Figure 4**). The video shows Bender Road being overtopped in the same location as in 2009, and shows floodwater entering the Town Canal near the intersection of Bender Road and Reecer Creek Road (1:13:27).

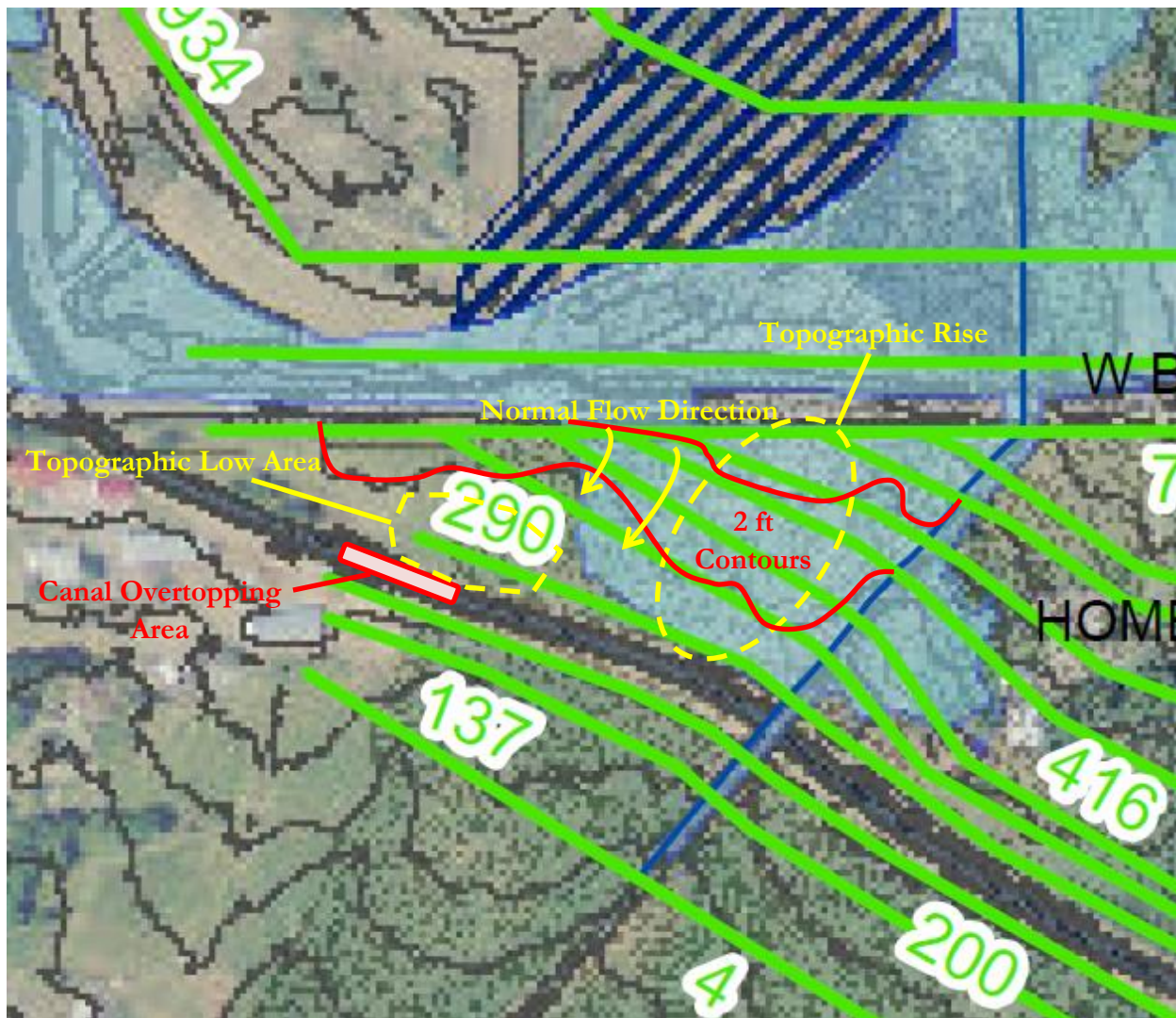


Figure 3 (Edited from Anchor Floodplain Analysis, Sept. 28, 2012). Shows 2 ft contours, low topographic rise, the direction that floodwaters that overtop Bender Road should flow, the low area along the canal, and the zone where overtopping and flow into the canal occurs.



Figure 4. Screen shot (1:12:34) of 1996 flood video (Video by the Lebo Family) showing the Woods field still covered in snow (not being flooded) during the 1996 flood. The video also shows Bender Road being overtopped shortly after this (1:12:46).

- ii. Based on the anomalies noted above, a clearer picture of the existing condition floodplain south of Bender Road becomes apparent, one that is more consistent with Mr. Woods observations and video evidence. The only floodwater that flows down the Whiskey Creek channel between Bender Road and the canal undershot, and the only floodwater that can inundate the floodplain along the reach of Whiskey Creek near Mr. Woods home, is what is able to pass through the existing culvert under Bender Road (estimated at 94.5 cfs for an upstream flood discharge of 378 cfs). The flood water that overtops Bender Road does not return to the Whiskey Creek Channel on the Woods property. Therefore the extent of the floodplain on both sides of the creek in the vicinity of Mr. Woods home and outbuildings represented on the Anchor existing condition floodplain map is overstated.

URS understands that hydraulic models are a useful tool but they are only as good as the data used. In addition, it can be difficult to use a 1-dimensional HEC –RAS model to accurately represent a complex two dimensional flow situation such as occurs here:

- *Some flood flow passes through a culvert under Bender Road into the downstream reach of the creek;*

- *Some flow cannot pass through the culvert and instead leaves the creek channel and flows westerly in a ditch along the upstream side of the road;*
- *Some of the flow in the ditch along the upstream side of the road enters a canal and is lost;*
- *Some of the flow in the ditch along the upstream side of the road overtops the road and enters a ditch on the downstream side of the road;*
- *Some of the flow that overtops the road continues down the ditch on the downstream side of the road, enters a canal, and is lost;*
- *During the largest flood, some of the flow that overtops the road overwhelms the ditch capacity and enters a field adjacent to the ditch;*
- *Flow that enters the field moves downhill, pools in a low spot, enters a canal, and is lost.*

A two dimensional model with high resolution topography would be more appropriate for situations such as this, but are much more intensive/expensive to use.

One data concern that URS has is related to the extent of the floodplain shown on the east side of the creek near the Woods home and outbuildings. It has not been possible for URS to ascertain how the existing condition floodplain on the Woods property was mapped by Anchor, but Mr. Woods has never seen any inundation like that shown on the Anchor existing condition map. Instead, he has observed that the flow that comes through the culvert under Bender Road, including the 1996 flood, has always been able to stay within the banks of the creek across his property, with flow widths on the order of 20 ft maximum. Most of Anchor's HEC-RAS model width-of-flow output is consistent with the Woods observations, although a couple x-sections (608, 490) have flows wider than observed. X-section 745 has a width-of-flow of about 900 ft, mostly on the west side of the culvert outlet, but this x-section is aligned along the ditch line where linear inundation within the ditch is expected.

One possible reason some width-of-flow estimates are wider than observed may be the x-section data. It appears that portions of x-sections 490-357 are aligned in a downhill direction on the east side of the creek, which would increase the estimated extent of inundation (**Figure 5**). For instance, if not aligned downhill, x-section 490 (flow width of 95 ft) would intersect with a 2 ft contour line about 150 ft from the creek. With its somewhat downhill orientation, it does not intersect the 2 ft contour even after 400 ft. X-section 416 appears to be aligned in an even more downhill direction but its width-of-flow is estimated at 12 ft.

In any case, the floodplain area shown on the existing condition map (Figure 3 of Anchor's Sept. 28, 2012 Memo) does not match Table 1 of the same memo. For instance the predicted width of flow at x-section 490 is about 95 ft, which would inundate about 47.5 ft on each side of the creek, assuming the creek is in middle of the inundation area. Anchor's map shows x-section 490 being inundated by about 150 ft on the east side of the creek alone. The discrepancy is greater for x-section 416 with an 11.8 ft predicted width of flow in Table 1, but a mapped width of flow of about 180 ft on the east side of Whiskey Creek alone.

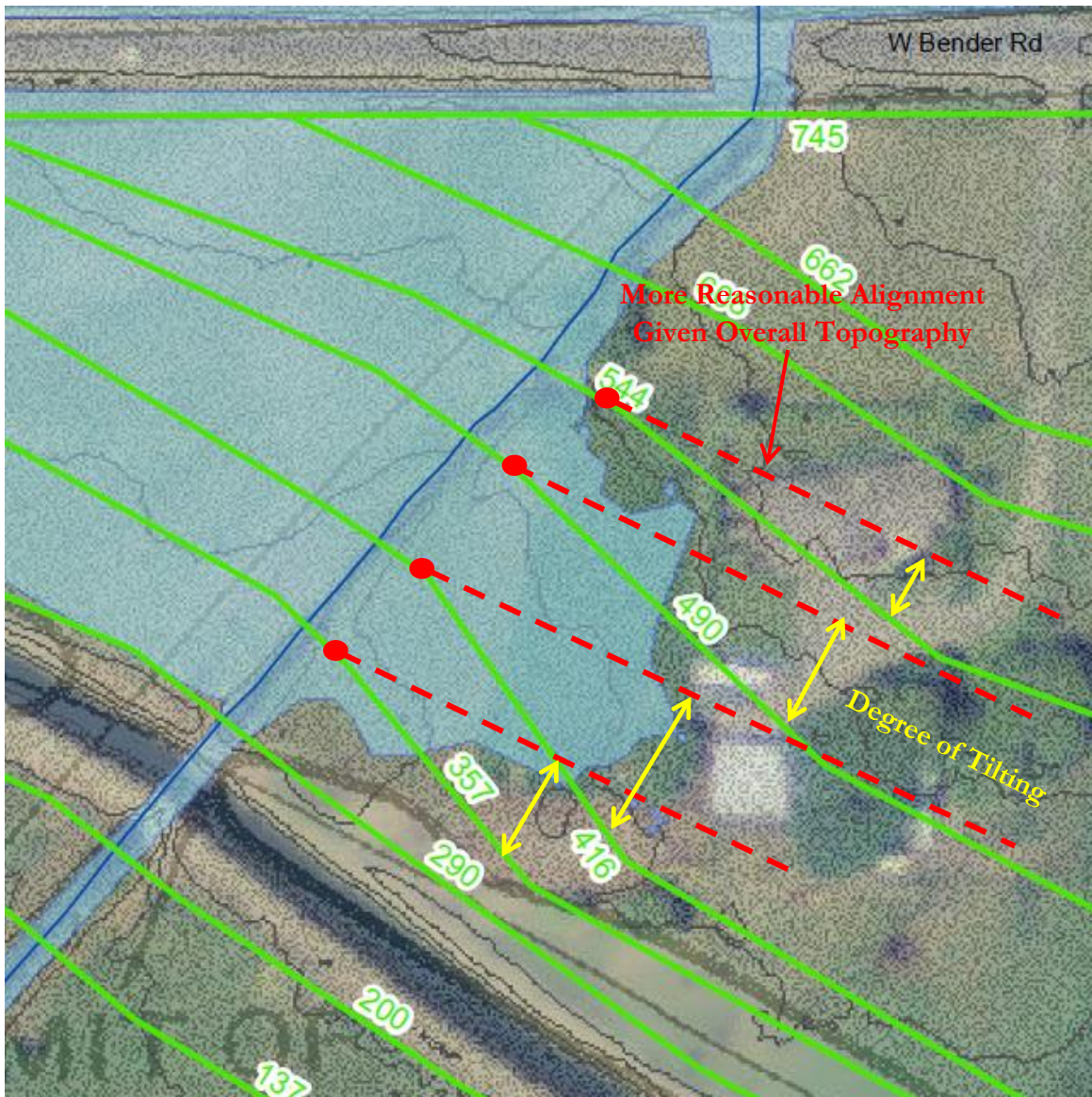


Figure 5. Tilting of the HEC-RAS model x-sections in what appears to be a downhill direction, which can lead to overestimation of floodplain limits.

While there are still some inconsistencies between the model output and the Woods observations, Anchor's HEC-RAS model output (Table 1 from Anchor Sept. 28, 2013 Memo) can be used to develop a better estimate of the existing condition floodplain along Whiskey Creek through the Woods property. URS has prepared a mock-up of the existing condition floodplain map using Anchor's width-of-flow information for the reach of Whiskey Creek crossing the Woods property (**Figure 6**).

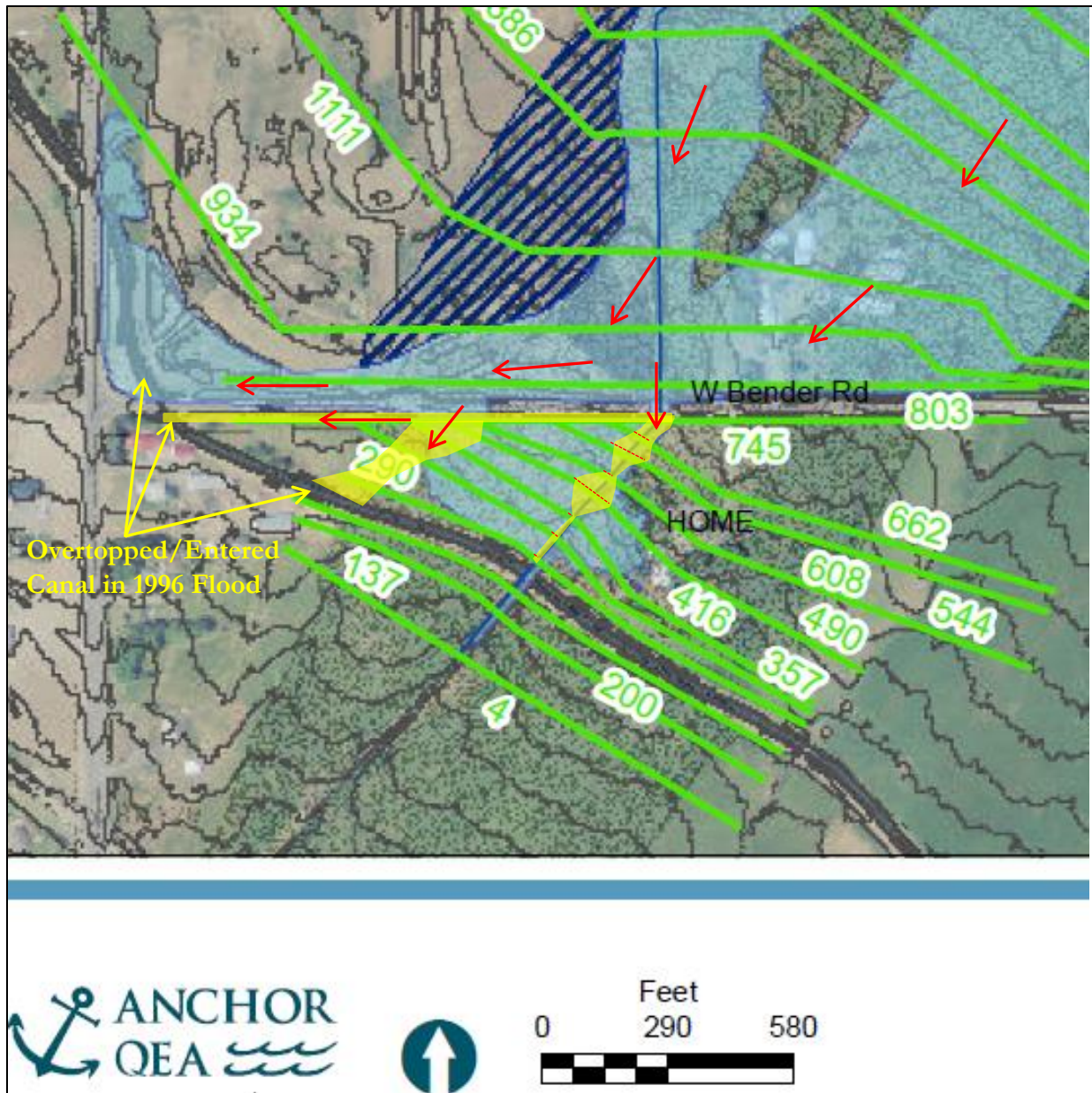


Figure 6. URS mock-up of more correct floodplain on John Woods property (yellow shading) based on Anchor’s Table 1 (X-Section/Width-of Flow): 745/899.62 ft, 662/38.62 ft, 608/89.66 ft, 544/22.21 ft, 490/94.71 ft, 416/11.83 ft, 357/19.66 ft, 290/12.77 ft.

Proposed Conditions

Under current conditions, the Woods have: (a) little to no flooding from the Whiskey Creek channel through their property; and, (b) have a small amount of shallow flooding in the western end of their pasture on an infrequent basis (only in 1996). The shallow flooding in the western portion the pasture is of little concern to the Woods because it rarely occurs, flows into the canal, and is well away from the developed area of the property.

As discussed earlier, the proposed condition involves installing a larger culvert under Bender Road and upstream floodplain fills and a berm that will force the full peak flood flow to discharge through the new culvert and into the reach of Whiskey Creek that passes through the Woods property.

John Woods
July 29, 2014

Therefore the reach is estimated to have a 400% increase in flow compared to existing conditions (378 cfs vs. 94.5 cfs). The proposed floodplain on the Woods property is shown in **Figure 7**. In addition to the increase in peak flow rate, there is a corresponding increase in channel velocity, depth, and width-of-flow.

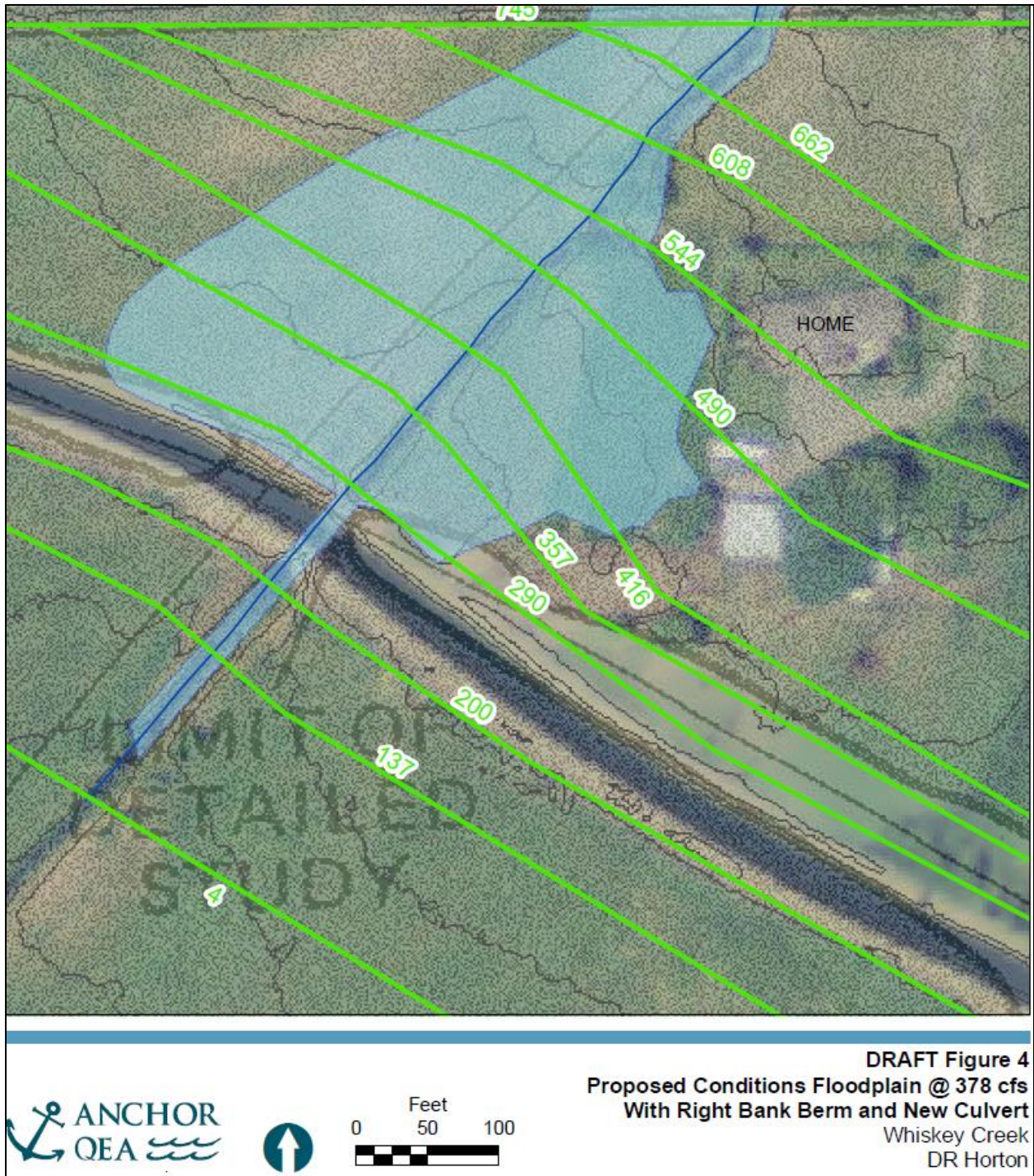


Figure 7. Anchor’s estimated floodplain limits on the Woods property under the proposed conditions (Anchor Sept. 28, 2012 Memo). *The accuracy of the proposed condition mapping should be carefully reviewed for some of the same reasons discussed above.*

The proposed flooding changes in the vicinity of the Woods home, landscaping, out-buildings, barn, and corral are illustrated in Tables 1 and 2 below. URS notes that impacts of the proposed condition could be increased greatly depending on the ability of the Town Canal undershot to pass the flood discharge. The Ellensburg Water Company estimated the maximum capacity of the undershot at 320 cfs, while the estimated 1996 rain-on-snow flood peak discharge is estimated at 378 cfs – a large discrepancy. Flow not able to pass through the undershot will pool on the Woods property and increase the depth of flooding. The undershot appears susceptible to plugging due to debris accumulation (**Figure 8**).

X-Section Station	Existing Condition HEC-RAS Model Output					Proposed Condition HEC-RAS Model Output				
	Bottom of Channel ft	Water Surface ft	Depth of Flow ft	Width of Flow ft	Channel Velocity ft/s	Bottom of Channel ft	Water Surface ft	Depth of Flow ft	Width of Flow ft	Channel Velocity ft/s
745	1605.73	1608.31	2.58	899.62	1.52	1606.7	1609.64	2.94	1000.22	4.99
662	1605.48	1607.8	2.32	38.62	3.73	1605.48	1608.65	3.17	127.08	5.83
608	1604.52	1606.72	2.2	89.66	4	1604.52	1607.62	3.1	222.3	4.32
544	1603.27	1605.39	2.12	22.21	3.77	1603.27	1606.22	2.95	341.49	5.88
490	1601.43	1604.32	2.89	94.71	4.14	1601.43	1605.38	3.95	521.52	4.59
416	1600.07	1602.39	2.32	11.83	5.37	1600.07	1603.89	3.82	438.82	5.81
357	1598.8	1601.51	2.71	19.66	3.29	1598.8	1602.72	3.92	193.62	4.99
290	1597.19	1599.55	2.36	12.77	6.25	1597.19	1601.91	4.72	116.65	5.1

X-Section Station	Proposed Change in Flooding Conditions Near Woods Home					
	Increased Flood Depth		Increased Velocity		Increased Flood Width	
	ft	%	ft/s	%	ft	%
745	0.36	14.0%	3.47	228.3%	100.6	11.2%
662	0.85	36.6%	2.1	56.3%	88.46	229.1%
608	0.9	40.9%	0.32	8.0%	132.64	147.9%
544	0.83	39.2%	2.11	56.0%	319.28	1437.6%
490	1.06	36.7%	0.45	10.9%	426.81	450.6%
416	1.5	64.7%	0.44	8.2%	426.99	3609.4%
357	1.21	44.6%	1.7	51.7%	173.96	884.8%
290	2.36	100.0%	-1.15	-18.4%	103.88	813.5%

Tables 1 & 2. Showing the proposed increase in flood depths, velocities, and width-of-flows in Whiskey Creek adjacent to the Woods home, landscaping, out-buildings, barn, and corral (Derived from Tables 1 and 2 in the September 28, 2012 Anchor Memo).



Figure 8. The entrance to the Town Canal undershot appears susceptible to plugging due to debris or ice however its performance is will be a key factor in controlling the level of flooding on the Woods property. The ability to perform maintenance on the entrance during a large flood is questionable.

The assessment of the impact of the proposed flooding condition in the September 28, 2012 Anchor Memo is inaccurate in several ways:

- The existing condition flooding dynamics and floodplain mapping is not correct on the Woods property (Anchor Figures 2 & 3), so it should not be used for a comparison to the proposed condition.
- The proposed condition floodplain on the west side of Whiskey Creek on the Woods property is stated to be much smaller than the existing condition (Anchor Memo Page 3). This is not correct. The actual existing condition floodplain on the west side of Whiskey Creek is much smaller than proposed conditions.
- The assessment of the increase in floodplain on the east side of Whiskey Creek on the Woods property (Anchor Memo Page 3) is effectively minimized because the existing condition mapping is incorrect. There is far less floodplain on the east side of the creek on the Woods property than depicted on the Anchor existing condition maps.
- It is stated that there is a concern that the existing Woods structures currently flood and that flooding could be increased (no structure elevation data was provided by Anchor). This is not correct. The floodwaters have never gotten close to the Woods structures, even

during the 1996 flood, likely the largest Whiskey Creek flood on record. The Woods' actual concern is that the buildings will become susceptible to flooding post-project due to the large increase in flood flows.

Conclusion and Recommendation

It is good practice to avoid changing flooding dynamics, patterns, depths, velocities, and locations to the benefit of some properties at a detriment to other properties. While the proposed condition may facilitate future fish passage and reduce flooding problems and flood hazards to property owners along the upstream side of Bender Road, it increases flood hazards in the most sensitive area of the Woods property – the vicinity of the home, landscaping, out-buildings, barn, and corral. There appears to be no recognition or adequate discussion of impacts to the Woods within the Anchor memos or the November 19, 2012 ESM response to SEPA comments. Some remaining questions include:

- 1) How was the capacity of the Town Canal undershot assessed/modeled? Was a safety factor used to account for icing or debris? Does the capacity decrease if the undershot outlet is submerged? There is no discussion of it within the Anchor memos.
- 2) The estimated 1996 rain-on-snow peak flood flow is 58 cfs greater than the estimated maximum capacity of the Town Canal undershot by the Ellensburg Water Company (assuming no icing or other inlet restriction due to debris). How much water would really be pooled on the Woods property during a multi-day flood? Up to what depths? For perspective, if the undershot is limited to 320 cfs and a flood discharge of 378 cfs occurred for 4 hours it would result in another 835,200 cubic feet of floodwater storage on the Woods property (19.2 acre-feet).
- 3) Does the Ellensburg Water Company dump water into Whiskey Creek from the canal during a flood? If so, how much and what is the impact on the undershot capacity?
- 4) The topography of Whiskey Creek and its floodplain downstream of the canal undershot looks similar to the upstream side, yet Anchors proposed condition floodplain map shows a much narrower width of floodplain downstream of the canal. Why is this? Is the creek channel much deeper/wider and steeper than above the canal?
- 5) Do the proposed depths, velocities, and widths-of-flow create deep/fast flowing water conditions or otherwise pose a greater hazard to people and animals on the Woods property?
- 6) Will the combination of a larger Bender Road culvert and no more loss of flows into the canal lead to more frequent inundation of the Woods property? If so, what is the effect of this on the Woods?
- 7) Will the increased flood velocities result in channel erosion, instability, and mobility? If so, who will bear the cost to address any future problems?
- 8) Does the much larger floodplain near the Woods home limit additional planned or unplanned improvements they may make? This is the area where improvements would most likely occur.
- 9) Will the Woods incur a greater cost if they choose to make future improvements to their property?

John Woods

July 29, 2014

- 10) HEC-RAS models and hydraulic calculations are not 100% accurate. How much safety factor is left to allow for uncertainties, icing conditions, etc. before the Woods structures are flooded?
- 11) Do the actual proposed changes affect the current or future value of the Woods property?
- 12) Have the Woods been consulted with about the actual proposed changes and have their concerns been heard and addressed?
- 13) Have the Woods agreed to the proposed changes in flooding on their property along with a mitigation plan that addresses the impacts of the proposed condition on both them and their property?

URS recommends that an updated floodplain analysis be developed in consultation with the Woods, and that the impacts to them and their property be more accurately assessed and prevented or mitigated in a manner that is acceptable to them.