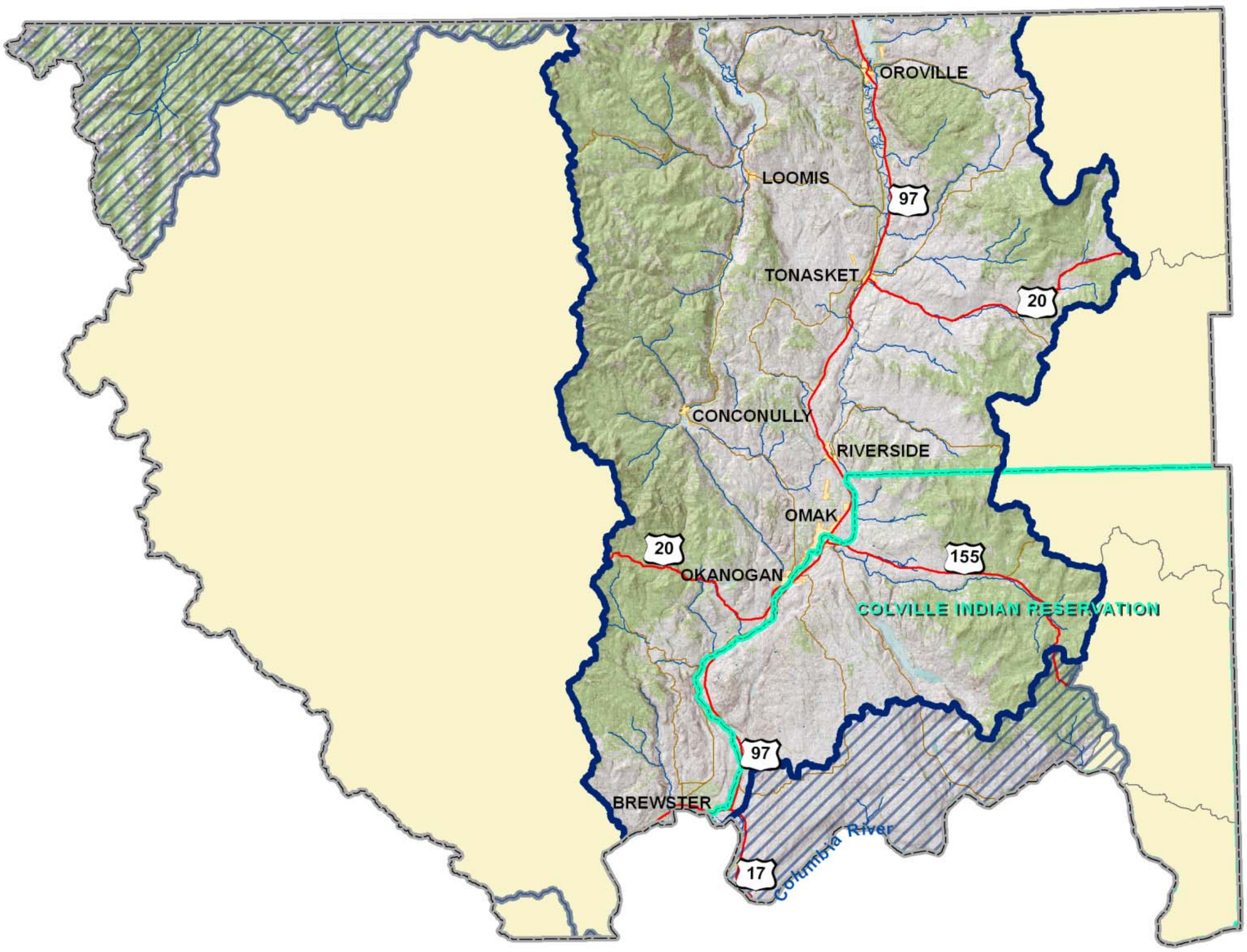
OKANOGAN WATERSHED PLAN

Okanogan River Erosion Survey



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Okanogan River Erosion Survey
September 30 – October 1
2008

For: Okanogan Conservation District

Submitted By: Pacific Hydraulic Engineers & Scientists

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Introduction & Purpose

The Okanogan Conservation District (OCD) has conducted erosion damage and soil entrainment surveys of the Okanogan River channel through the reach from Oroville to Tonasket over the past two decades. This reach of the river is characterized by low gradient channel slope, meandering planform, fine silt and sand alluvium, limited riparian buffer width, and high beaver population concentrations. The downstream end of the study reach near Tonasket is characterized by old glacial erratic boulder and bedrock grade controls, gravel alluvium, and slightly higher gradient channel slope. Significant volumes of silt and sand are eroded from the banks of the river in the old gradient reach each year, causing high maintenance costs and undue wear on pumps drawing river water to the Oroville-Tonasket Irrigation District's (OTID) system. The OTID operates several large pump stations to deliver irrigation flows to the District's orchard operators and farmers. In addition, the continued erosion of bank materials contributes fine sediments to salmon spawning grounds located downstream of the study reach, leading to decreased egg survival and poor juvenile salmon production. Riparian vegetation is lost as bank erosion occurs as well, leading to an overall degradation of aquatic and riparian habitat value.

The purpose of this particular erosion survey was to document changes in bank erosion that have occurred since the previous survey was conducted in 1994. PHES was contracted to provide hydraulic engineering and geomorphology inspection and review during the survey. Biologists and other technical disciplines were represented on the survey team by OCD, OTID, and USFS staff.

Summary

On September 30, 2008, the survey team launched from the base of the Highway 97 bridge over the Okanogan River at Oroville, Washington in an inflatable raft. The group included the following individuals; Tom Scott – OTID manager, Craig Nelson – OCD Manager, Bob Clark – OCD technical specialist, Ed Zapel – PHES, and Nancy Wells - US Forest Service Tonasket Ranger District biologist. Propulsion and progress downstream was accomplished with a small electric motor and manual rowing with the river current. The survey route included a short reach of the Okanogan River between the bridge and a cross channel connecting the Okanogan River channel with the Similkameen River, thence through the cross channel and down the Similkameen. The rest of the survey continued down the Similkameen to the confluence with the smaller Okanogan River channel a few miles downstream of Oroville, thence down the combined stream of the Okanogan River to Tonasket. The end of the first day of travel downriver brought the group to the Ellisforde pumping plant boat launch, roughly 8.5 air miles downstream of the launch point. The second day carried the group from the Ellisforde pumping plant downstream about another 8 air miles to the Bonaparte pumping plant, located a little more than one mile downstream of Tonasket.

Notes

Aerial photographs of the entire reach of interest were provided for use in the field by OCD staff prior to the survey. Field notes included hand markups of the aerial photos/maps and digital photographs of specific areas throughout the survey trip. Digital photos generally documented current condition of the banks and channel, and were used to visually describe the notations marked up on the aerial photos/maps.

In general, the survey documented several types of typical bank and channel conditions:

1. Stable bank – generally stable with no evidence of active bank erosion and loss of fine sediments
2. Relatively stable – areas where recent bank erosion was not generally noted, but where erosion may have damaged the bank in the past, or areas where there may have been some instability of loss of vegetation on the bank.
3. Light erosion – areas where some erosion has occurred recently, but the height and breadth of the bank line was not entirely affected.
4. Erosion – areas where erosion was clearly evident and little or no vegetation remained on the bank.
5. Heavy erosion – areas where actively caving banks were contributing fine sediments into the channel.
6. Cattle damage – areas where cattle have trampled the vegetation and worn the bank vegetation down to bare soil. Some of these areas were also actively eroding, as noted on the aerial photos/maps and in photographs.
7. Beaver damage – these areas showed damage due to beaver activity, where large trees and smaller shrubs had been actively cut and killed. Some of these areas had apparently begun to suffer from erosion damage as a direct result of beaver activity wherever former vegetated banks of fine silts were left exposed due to loss of vegetation.
8. Riprap – areas where riprap bank protection was noted. Most of these areas appeared to be stable and bank erosion was not a problem. However, some areas appeared to have spotty riprap protection. In one particular area, the riprap appeared to have been flanked at the upstream end and a new high flow channel through highly erodable fine silts had formed on the east side of the river channel.
9. Rock and log barbs – these areas had apparently been modified through installation of barbs comprised of riprap and logs/rootwads partially buried into the banks. Though there were only a few areas where this treatment had been used, generally it appeared to be effective at reducing active erosion and allowing vegetation such as grass and shrubs to begin growing along the bank.
10. Detroit riprap – these areas seemed to be limited to just a few reaches where abandoned automobile bodies had been pushed over the bank. Although very unattractive and not recommended, the treatment appeared to be moderately effective. Recent evidence of this bank erosion treatment was not noted, with most all car bodies of pre-1950’s origin, and all apparently placed many years ago.

11. Gravel – areas where the bank materials appeared to be comprised of gravel. These were most often noted wherever the river channel came hard against the valley wall or the toe of talus slopes along the valley wall. Not surprisingly, most of these also occurred where glacial erratics (boulders and bedrock) appeared in the channel bed. These zones clearly served as natural channel grade controls, effectively ponding water to very low gradients upstream, with a short riffle section and the following low gradient reach downstream. In addition, most of these types of grade controls were noted downstream of the Ellisforde pumping plant, where the river gradient overall steepens and the meandering planform was not as evident. Not surprisingly, these areas were also noted as having little bank erosion of fine sediments.
12. Fine silts – areas where the banks were almost entirely comprised of very fine silt and sand. These areas were almost universally unstable and suffered from erosion wherever they fell along the outside of channel bends.

Overall, it appeared that, where vegetation was allowed to prosper along the banks where fine silts were encountered, bank slopes of less than 3 to 5H on 1V seemed to remain stable. Where gravel bank materials were encountered, stable banks appeared to occur wherever bank slopes were flatter than about 3H on 1V. In nearly all areas where beaver damage had reduced the trees and shrub cover on banks of any slope, active erosion was occurring regardless of bank slope. It seems that the beaver contribution to erosion of banks may be significant throughout the survey reach. In addition, livestock trampling and grazing of the banks appeared to be associated with active erosion in nearly all locations where poor grazing practices persisted. Only one location was noted where a riprap protection blanket had been flanked, and the resulting high flow channel had eroded behind the main channel and caused significant loss of fine sediments. All other areas where riprap had been installed appeared to be stable, with slopes as steep as 2H on 1V. Also, where rock and log barbs had been installed along reaches with a very gradual channel curvature, the banks appeared to be reaching a stable condition over time as vegetation has become established. However, several areas of this treatment where the structures had not been installed at the proper spacing exhibited some ongoing erosion. This treatment overall seemed effective, but with the one condition that the structure design and placement must be carefully accomplished by qualified river engineers.

Recommendations

Specific treatment recommendations for actively eroding banks through the survey reach are provided below for each type of bank/planform category and bank erosion damage type.

1. **Cattle Damage** – Fence cattle away from bank, including a buffer width of at least enough to provide a 5H:1V eventual future bank slope from the present toe, plus at least five feet additional top of bank width. Given the present bank height of 10 to 15 feet, this would entail installation of fencing at a distance of approximately 55 to 80 feet landward of the present toe of bank at low water

line. Fencing could be nearer to the toe of bank in some areas where bank heights are lower. Livestock watering should be provided either with watering tanks filled using irrigation water or spring water available on the property. Alternately, but not highly desirable, cattle watering access could be provided on the riverbank by constructing riprap and quarry spall pathways down the bank at a slope of flatter than 5H on 1V, and constrained on both sides by fencing to keep cattle from trampling the banks on either side. These types of watering access ramps will suffer from debris loading and possible failure of fencing during high water and spring flood events, and will require vigilance on the part of the property owner to maintain the fences upstream and downstream. See example figure 1.

2. **Beaver Damage** – an aggressive trapping program can be initiated to control beaver populations. In addition, all future planting programs should consider using only species that are not attractive to beavers, as specified by local foresters or botanists experienced in local beaver behavior.

3. **Fine silts on sharp river bend banks** (bend radius less than 500 feet) – These areas could be treated by backsloping the bank to a stable 5H:1V and planting erosion-resistant grasses and shrubs, combined with toe erosion protection and upper bank erosion protection. Toe erosion protection could consist of riprap (Class III) carried up the bank at a slope not to exceed 2H:1V and a height of about 3 feet above low water line and down to the maximum depth of scour (about 10 to 12 feet below low water line), with launching toe. Upper bank protection could consist of dense plantings of grasses and low growing shrubs, or cobble blanket, both on slopes not to exceed 5H:1V. In addition, it may be desirable to install barb or groin structures extending from the top of the riprap blanket out into the channel at least 20 percent of the channel width to move the thalweg out away from the toe. Spacing and configuration of these structures should be designed by a qualified hydraulic engineer or geomorphologist, but generally will range from 3 to 5 times the extended length from low water line of each structure. See example figure 2.

4. **Fine silts on moderate river bend banks** (bend radius between 500 and 1500 feet) – These areas could be treated similarly as in (3) above, using riprap toe protection, upper bank sloping, and dense plantings. Barb or groin structures can be used to enhance the ability of the treatment to move the thalweg out away from the toe. Spacing and configuration of these structures should again be designed by a qualified hydraulic engineer or geomorphologist, and generally will range from 4 to 7 times the extended length from low water line. See example figure 3.

5. **Fine silts on gradual river bend banks** (greater than 1500 feet) – These areas can be treated using log and rock barb structures, upper bank resloping and plantings, and discontinuous riprap toe protection. Upper banks in all areas above the low water line should be resloped to no steeper than 3H:1V, and densely planted with grasses and low growing shrubs. If combined with barb or groin structures, toe protection can consist of Class II riprap, installed as described in (3) above, and extending from the downstream root of each barb structure 50% of the distance to the next downstream barb structure. If no

barb structures are used, then the toe protection should be continuous. See example figure 4.

6. **Gravel banks through deeply scoured reaches** – These areas can be treated using barb or groin structures with limited riprap toe protection on wider bends, combined with upper bank resloping and plantings. Upper banks above the low water line should be resloped to no steeper than 3H:1V and planted with drought-tolerant grasses and low growing shrub species. Barb or groin structures on sharp bends (radius less than or equal to 500 feet) should be placed at a spacing of 3 to 5 times the extended length of the structure below low water line, roughly perpendicular or angled slightly upstream to the bankline. They may be constructed entirely of rock, or in combination with logs and rootwads. Barb or groin structures for wider bend radii may be spaced similarly as those described for (3), (4), and (5) above. See example figure 5.
7. **Gravel and fine silt banks through bed-scour constrained reaches** – These areas are characterized by shallow, exposed bedrock or large cobble/boulder grade controls immediately downstream of the eroded area to be treated. In these areas, provided that depth of scour is limited to less than about 5 to 8 feet, and navigation interests can agree, it may be possible to utilize Large Woody Debris (LWD) groins, barbs, and jams to arrest bank erosion, combined with upper bank resloping and planting. Mechanical anchorage of all LWD structures would be necessary, either by buried deadmen or with high capacity soil anchors driven deep into the toe of the bank. See example figure 6.

Overall, the key to arresting erosion of fine silts and other sediments from the banks of the Okanogan River survey reach is to eliminate toe erosion and reslope upper banks and plant with appropriate, beaver-resistant vegetation. In addition, cattle must be prohibited from trampling the upper bank and grazing bank vegetation except at controlled locations where hardscaping can be constructed wherever cattle must trod on the bank to access watering holes. Elimination of toe erosion alone in reaches comprised of fine silts will not prevent loss of upper bank materials, as these materials may be entrained at any bank slope. Similarly, upper bank resloping and plantings alone will not eliminate continued erosion either, as the toe will continue to suffer erosion, causing the upper bank to lose structural support and cave into the channel. If the bend radius is very sharp, and navigation interests can accommodate a thalweg shift away from the toe, low groin or barb structures can help protect the lower toe from scour and erosion. Such structures can enhance available aquatic habitat as well by creating controlled scour holes and allowing deposition and storage of fine silts and sands in the interim spaces between structures. Overall, it remains unlikely that all suspended sediment can be eliminated from the water column during high spring flows and floods, as the upstream portion of the Similkameen River north of the US Border will continue to contribute significant fine sediment to the river flow. However, some improvement may be achieved by implementation of the recommended measures, in addition to ancillary benefits from improvement of aquatic and riparian habitat quality.

GENERAL GUIDANCE
FOR
RIP RAP GRADATION
(PACIFIC NORTHWEST RIVERS)

Class	I	II	III	IV	V
Rip Rap Blanket Thickness (measured perpendicular to face of finished blanket)	18”	24”	30”	36”	48”
100% Smaller than	150 lbs (14”)	500 lbs (22”)	800 lbs (25”)	1000 lbs (27”)	1800 lbs (33”)
50% Size	50 lbs (10”)	200 lbs (16”)	300 lbs (18”)	400 lbs (20”)	750 lbs (25”)
90% Larger than	25 lbs (8”)	100 lbs (12”)	150 lbs (14”)	200 lbs (16”)	350 lbs (19”)
10%	25 lbs (8”)	25-100 lbs (8”-12”)	25-150 lbs (8”-14”)	25-200 lbs (8”-16”)	22-350 lbs (8”-19”)
Tolerance	+4”	+6”	+8”	+12”	+16”
Selection Velocity	6-10 fps	10-14 fps	14-16 fps	17 fps	18 fps

1. Assuming w = 165 lb/ft^3
2. Assuming 1V:2H slope; for slopes up to 1V:1.5H, use same class with double the thickness.
3. Assume that the Length/Width ratio of the rock is no greater than 3.
4. Riprap gradation for use on the outside bank of a bend should be based on a selection velocity that is twice the average channel velocity.
5. Riprap gradation for use on the banks of a relatively straight reach should be based on a selection velocity that is 1.5 times the average channel velocity.
6. Riprap gradation for channel bottoms should be based on the average channel velocity.

Example Class II

90% of stones shall range between 100 and 500 pounds. The 50% size of the gradation shall be 200 pounds. 10% of the stones may range between 25 and 100 pounds.