A FARM SEDIMENT TRAP AND POND IN COLUSA COUNTY, CALIFORNIA

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INTRODUCTION

Two brothers wanted to reduce the quantity of sediment leaving their farm, build a farm pond, and reestablish a corner of native habitat. Their project now includes a sediment trap, pond, and plantings of native grasses, trees, and shrubs spread across a four-acre site. These new features were integrated into an intensively managed farmscape without disrupting the existing farming patterns. The transformation of the site was managed by the Colusa County Resource Conservation District as a demonstration project. Funding was provided by the landowners and by the CALFED Bay-Delta Program. The field office of the USDA Natural Recourses Conservation Service designed and managed the construction of the earthworks. The landowners, the Conservation District, and local high school students planted the site.

The immediate transformation of the site was dramatic. Over time, there will be a second transformation as the tree canopy arches over the plantings. Energy flow and structural diversity will be greatly altered. The flora and fauna of the site will continue to shift as the canopy matures. The results of sediment trapping have also been dramatic. The immediate effects have been an over-filled sediment trap and a consequent reduction in the quantity of sediment leaving the farm, one of the original goals of the project. Over time, sediment trapping may provide feedback that helps growers reduce the volume of sediment generated in the field.

This paper describes the design and implementation of the project and reports some initial observations and measurements made at the site. The functioning of the sediment trap is emphasized.

SITE DESIGN

The site is on the former flood plain of Sycamore Slough about one-half mile north of the old channel. Sycamore Slough was cut off from its source, overflow from the Sacramento River, early in the last century as the surrounding land was developed for farming. Parts of the channel remain as narrow strands of mature riparian vegetation. Other sections have been completely filled, their locations unmarked in uniform, laser-leveled fields.

The project was located at this site because it is the low point in the constructed topography of 230 acres of cropland and because it has had a history of poor germination and low yields. A shallow surface drainage ditch ran the length of the west edge of the site and emptied into a farm drainage system. Farm drainage flows into the Colusa Basin Drain, and eventually into the Sacramento River. The site is favorably located for capturing water and sediment. Three sides of the site were bounded by existing farm roads. The new boundary between habitat and cropland was established as a straight line orthogonal to the farming direction. This simple geometry facilitates the use of large equipment in the crop field.

Within the site, the constructed features are curvilinear. The general nature of the earthwork is shown in Figure 1. We chose these shapes to introduce contrasting elements into the landscape and to suggest natural physiographic forms, but they also have a functional basis. The sediment trap has two long arms that bow out from the road at their centers. Constructing these as relatively narrow, linear channels helps to distribute flow through the full volume of the trap and

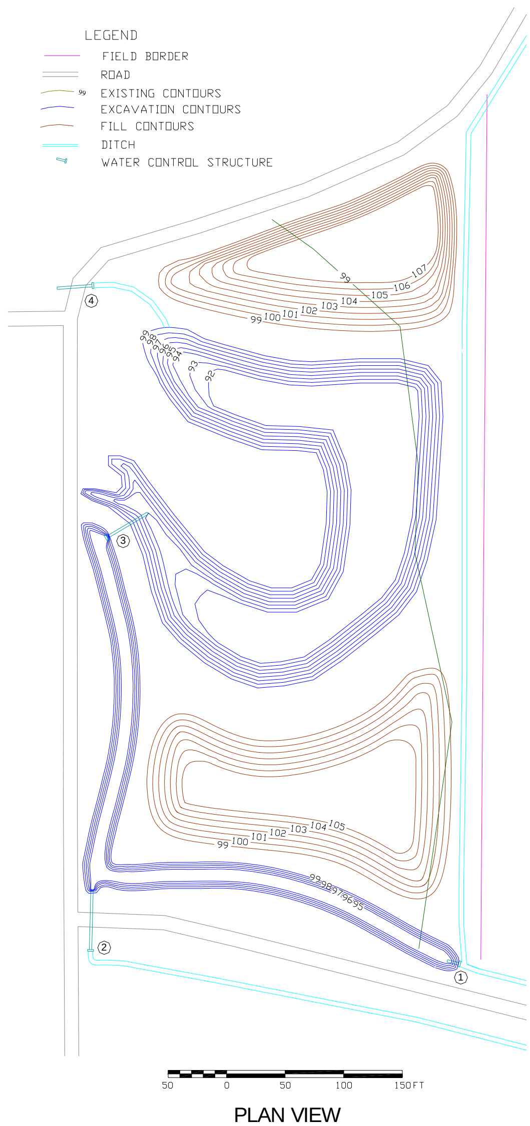

Figure 1 Plan of earthwork.

allows them to be cleaned from one side by a small excavator. The arc of land between the road and the bowed channel provides space for the sediment to be piled for drying. The two arms of the sediment trap each start at the road where they connect to the existing field ditches. The sediment trap has two curved segments, each 300 feet long with a ten-foot bottom width and four-foot depth. The total excavated volume is 1320 cubic yards and the useable storage volume is 890 cubic yards with a surface area of 9600 square feet.

The primary function of the pond is to provide wildlife habitat, but it also traps sediment, and it too is designed to reduce short-circuit flows between the inlet and outlet without the use of baffles. The shape is from a 1905 topographic map of the area. It is a mirrored and scaled transformation of an oxbow lake along the Sacramento River. The pond was designed with a bottom depth that is seven feet below field level. This depth was chosen to assure a large area of open water. The pond is filled by runoff from winter rains and summer irrigations. Even at low water levels, the depth of water is three to four feet, sufficient to prevent the establishment of emergent vegetation. Emergent vegetation is expected to establish around the perimeter of the pond and especially at the two ends where there are bands with a relatively shallow and fluctuating water depth.

The pond has a flow length of 600 feet. The width varies from less than 30 feet to more than 100 feet. The total excavated volume is 8,700 cubic yards. Filled to a depth one foot below field level, the pond covers one acre and holds 4.8 acre-feet of water.

Four water control structures regulate the water depths in the pond, sediment trap, and field ditches. The structures are flashboard weirs with high-density polyethylene corrugated pipe conduits. The conduits allow for field road crossings. The weirs were installed so that the invert of the flow lines could be maintained at the levels that existed before installation of the project or the inverts could be raised independently to near field level. Sediment trapping is maximized when the flashboards are maintained at the highest level. Rapid field drainage is maintained with the boards at the lowest level. With an active strategy, the pond could be drawn down before an irrigation to provide more capacity for short-term tailwater storage.

Excavation spoils were used on site to build contoured mounds. The slopes are gentle; we designed them to allow planting and mowing with normal farm equipment. The two mounds were placed on the north and south sides of the pond to provide shelter from the prevailing strongest winds.

CONSTRUCTION AND PLANTING

The pond and sediment trap were built by a contractor. Excavation was started in the fall of 2002, but rains delayed completion until the following spring. The contractor used a long-reach excavator and off-road dump truck to move the soil. The mounds were built without compaction. The landowners finished the grading of the mounds with a dozer.

The landowners seeded the flats and mounds with native grasses in the fall of 2003. Native trees and shrubs were planted as container stock the following winter. The featured trees are California sycamore (*Platanus racemosa*) and valley oak (*Quercus lobata*), the two dominants of the riparian strand along Sycamore Slough. The landowners, the Resource Conservation District, and an environmental science class from Colusa High School worked together on the plantings.

OBSERVATIONS AND MEASUREMENTS

Near the end of the second growing season after the pond was installed, the landowner reported that there was a danger that the sediment trap would overflow. The trap did not overflow, but by the end of the season the tailwater was running in rivulets over the top of an accumulated mass of sediment. Figure 2 is a photo of the trap at the end of the growing season. The bulk of the sediment came from a tomato field that drained into the downstream arm of the trap. Erosion was evident in the tailwater ditch at the end of this field and in the ends of the furrows where head cutting had occurred. Winter wheat had been grown in this field the previous year, and there had been no evidence of erosion in the field or of sediment accumulation in the trap.

Figure 2 Sediment accumulated in trap.

At the end of the second growing season, we resurveyed the sediment trap to determine how much sediment had accumulated. We also took samples for determining the bulk density and particle size distribution of the sediment and the particle size distribution of the field soil. Four hundred and fifty cubic yards of sediment with an average bulk density of 79 pounds per cubic feet, or 480 tons of sediment, accumulated in the two arms of the sediment trap during the two year period. Figure 3 shows the particle size distributions for the sediment and for the field soil, a silt loam. Based on the difference between the sand fraction of the sediment compared to that of the field soil, the estimated trap efficiency was 23 percent, and the estimated sediment delivery from the fields was 2100 tons. The sediment production is 4.6 tons per acre averaged over the two-year period and the full 230 acres draining into the sediment trap. However, approximately two-thirds of the sediment was delivered from a single 85-acre tomato field during one growing season, a production rate of 16 tons per acre.

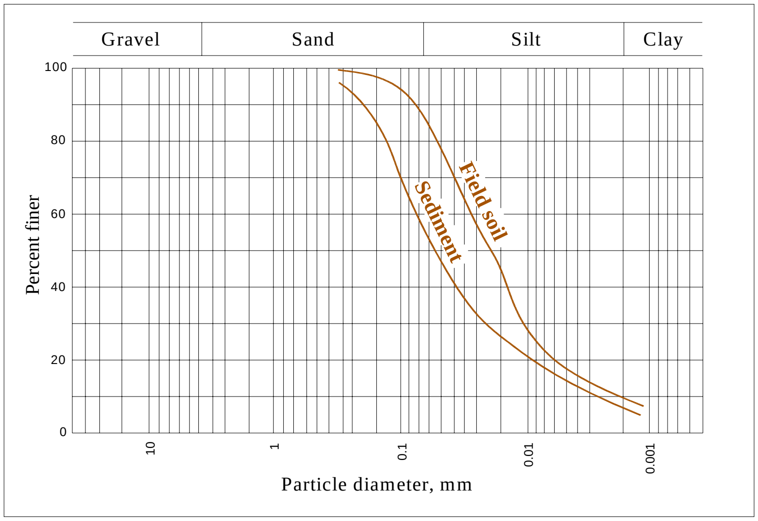

Figure 3 Particle size distributions for field soil and for sediment from the sediment trap.

One reason for the low trap efficiency is that the arm of the trap that captured the most sediment filled. The Yolo County Resource Conservation District (2002) used inlet and outlet water samples to study sediment trap efficiency. They found that efficiency declined during the season as the trap filled. Mid-season efficiencies varied from 33 to 55 percent in their study. There is relatively little guidance available for sizing sediment traps for agricultural operations where sediment is generated by irrigation water rather than stormwater. The California Regional Water Quality Control Board, San Francisco Bay Region (1999) suggests a general method for sizing silting basins and sediment traps based on flow and the particle size to be trapped. For the Colusa site, the maximum anticipated tailwater flow would be three cubic feet per second, and a sediment trap with 15,000 square feet of area would be required to remove fine silt (0.01 millimeter particle size). This is larger than the useable area of the empty sediment trap, but only about one-third the size of the pond downstream of the sediment trap.

Two years after the start of the project 480 tons of sediment that might have entered the Sacramento River was returned to the field. Even over this short monitoring period, the variation in sediment production from different fields and crops has been striking. For the two-year period, approximately two-thirds of the sediment came from one crop on one-third of the land area in one year. The landowners have not had to do calculations to realize this; they saw the sediment clog the trap. Hopefully we will be able to use this knowledge to find the most effective ways to keep the sediment in the field.

REFERENCES

California Regional Water Quality Control Board, San Francisco Bay Region (1999). Erosion & Sediment Control Field Manual, 3rd Edition.

Yolo County Resource Conservation District (2002). Final Report, CALFED Water Use Efficiency Program, Yolo County Resource Conservation District Pilot Program, 2001.