GEOMORPHIC CHANGES IN LOWER CACHE CREEK 2012

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Technical Memorandum

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EXECUTIVE SUMMARY

Based the Annual Inspection Field Trip of May 9-11, 2012, the following observations were made, which are related to the goals set out in the Cache Creek Improvement Plan (CCIP).

Annual inspection goals
The TAC geomorphologist recommends that we update the annual inspection goals so that: Number 4 (*Degree of channel armoring and bed material imbrication*) be deleted. Numbers 1, 2, 3, and 11 should reflect that they depend on pre-walk analyses in order to be meaningful as field inspections.

1. Evidence of changes in channel dimensions or bank erosion;
2. Evidence of bed degradation or aggradation;
3. Significant changes in the locations or sizes of bars and other channel features;
11. Areas where the existing capacity of the channel can no longer contain a 100-year flood event, or is nearing the loss of such capacity.

Reevaluation of the CCRMP Boundary
Map analyses done prior to the creek walk, and field verification, showed areas where the CCRMP boundary, established in a former time, no longer corresponds with areas that should define the boundary. We verified in the field where these were located, and considered the implications for the CCIP and CCRMP. Most locations were small, and not significant in terms of program goals. A more definitive analysis, in order to consider a revision of the CCRMP boundary, is proposed when the HEC-RAS model is available for use.

"Test 3" Line
In the course of the creek walk, there were a number of places where we observed potential options for management actions. In some of these locations, it was not clear whether they fall within the "test 3" line or not. The producers have suggested that we put the "test 3" line on the maps that we use for planning and evaluation purposes.

Evidence of changes in channel dimensions or bank erosion (bank retreat)
Evidence of significant changes in bank dimensions was observed at a number of sites. The 2010-2011 channel cut and fill analyses were used to consider where past (2010-2011) changes might suggest continued bank retreat. These sites were then checked in the field. Note that some bank retreat is beneficial, allowing natural channel processes to occur. This bank retreat (erosion) can provide regeneration of riparian habitat, and can provide a diversity of in-channel habitat that might not exist otherwise. Some of the sites identified here were observed to have no significant negative consequences. The following locations were verified for active bank erosion:

- RM 26.9 (Site of PGE& E pipe crossing)
- RM 26.4 (Near Capay Bridge)
- RM 25.4 -25.5 (In the vicinity of the Jensen property)
- RM 22.0 (Near the Old Madison Bridge)
- RM 21.6 (Near the Old Madison Bridge)
- RM18.2-18.0 (Upstream from the Moore Siphon)
- RM 15.4 and RM 15.0

Evidence of bed degradation or aggradation
and
Significant changes in the locations or sizes of bars and other channel features;
"Bar skimming" has been recommended as a possible management action where there is significant aggradation taking place. Removing material that has deposited and created large mid-channel bars can reduce erosive effects and maintain flood capacity. The basic idea is that some areas deposit more material than is necessary for equilibrium channel maintenance.

One of the challenges of selective bar skimming is implementation. Bar skimming requires permits, which are not currently in place. In addition, the cost of bar skimming may be prohibitive. An ideal situation would be to have a producer willing to mine for channel maintenance in return for the material acquired by such mining.

Bar skimming was called for in the 1996 planning, and, to my knowledge, has not been implemented.

Possible sites, as determined on the creek walk, are:

- Near RM 25 (in the vicinity of Granite Construction North Bank Stabilization Project)
- Near RM 21.6 (near the old Madison Bridge and Scheuring Property)
- RM 20.3-20.5 mid-channel bar in the vicinity of the most upstream of the CEMEX repair sites (called site F)

Conditions at bridges along levees and other major infrastructure

The following areas were observed to be areas of potential problems:

- At the Capay Dam Area (RM 28.3), the grade control structure has a possibility of “end-cutting”.
- At the PG&E Pipe Crossing (RM 26.9), the cement “pillows” are exacerbating bank ersoion on the south bank.
- At the PG&E Palisades (RM 26.9), deposition between nets seems to be beneficial; and yet, we understand that there are plans to remove this deposition.
- At the Capay Open Space (RM 26.3), the walking access ramp appears to be in the 100-year flood zone.
- At the Capay Bridge (RM 26.35) there is some erosion of the bank upstream of the bridge, with no observable negative consequences to the bridge.
- At the Esparto Bridge (RM 24.35), there appears to be a tendency for erosion on the north side, and the northern-most pier is slightly undercut. This seems to have stayed roughly the same since last year.
- At the I-505 Bridge (RM 21.0), there appears to be 2-10 feet of sediment build up (aggradation) around the two southern bridge bays, with vegetation growing on the deposited material.
- Near RM 19.5(?) Runoff from the top of the bank has been causing a gully along the levee and bank face, which is a concern for bank stability.
- At the Road 94B Bridge (RM 16.55), there seems to be little erosion or deposition; this appears to be the most stable channel condition at any bridge. This may be because there is a small degree of channel narrowing as the channel passes under the bridge.
- At the Rodgers Demonstration Water Recharge and Habitat Project (RM 14-13.8), the berm/cement barrier between the two sub-basins, which originally served a purpose, but no longer serves a purpose, could be removed. The main benefit would be aesthetic.

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BACKGROUND AND OVERVIEW

The annual creek walk is called for in the Cache Creek Improvement Plan (CCIP), which was developed to implement the Cache Creek Resource Management Plan (CCRMP). In the 1996 CCIP, the goals for the annual inspection were listed to guide the TAC in what would be useful for implementing the CCRMP. The goals, as listed in the Plan, are summarized as eleven specific items (listed below) to document the channel conditions.

1. Evidence of changes in channel dimensions or bank erosion;

2. Evidence of bed degradation or aggradation;

3. Significant changes in the locations or sizes of bars and other channel features;

4. Degree of channel armoring and bed material imbrication;

5. Vegetation located within the center portion of the channel (within 100 feet of the low flow channel), including type, density, and size;

6. Conditions at bridges along levees and other major infrastructure;

7. Potentially hazardous conditions involving public safety or property damage;

8. General hydraulic condition of the channel based on qualitative comparison with previous years (e.g., restrictions due to vegetative growth, changes in bed form, etc);

9. General evaluation of channel and bank stability on a reach-by-reach basis;

10. Identification of areas where vegetation may be getting so thick as to adversely alter flow direction or reduce channel capacity; and

11. Areas where the existing capacity of the channel can no longer contain a 100-year flood event, or is nearing the loss of such capacity.

Related to a number of items in the CCRMP and the CCIP, the creek conditions, our understanding of the creek, and the technology related to studying the creek has changed over the past 16 years since these guidelines were prepared. It was always expected that the creek walk was not the only way that we, as a TAC, would evaluate the eleven items listed above. Map analyses, hydraulic models, and other tools were also specified as being important in evaluating these items. Although the eleven items still point out what is important for us to consider, some of the items can be difficult to determine in the field without supplemental information. For example, #11 - *Areas where the existing capacity of the channel can no longer contain a 100-year flood event, or is nearing the loss of such capacity* – is difficult (or impossible) to identify in the field without having first examined the issue with a hydraulic model such as HEC-RAS. In addition, determining areas of bank erosion can be highly subjective if one tries to do it only on a field visit. In order to support the need to examine these eleven key issues, and others that are related, we have developed a protocol to bring maps, charts, and previous observations into the field with us on the creek walk, in order to supplement and guide our field observations. In addition, we have developed a clear agenda of sites of importance to us so that we focus our intention on the areas that are important.

The format of the creek walk, and our analyses related to it, are works in progress. We have returned to the original mandate of the program; we are trying to make it both effective and relevant to our needs today. On the creek walk, we evaluated the current relevance of the items on the list.

PROGRAMATIC CONSIDERATIONS

Review of Annual Inspection Goals

On the creek walk this year, we reviewed the utility and appropriateness of the annual inspection goals. In general, all of the goals can be informed by pre-walk analyses that will identify areas of interest, which call for a more detailed examination in the field.

The TAC geomorphologist and hydraulic engineer agreed that we should drop from the list:

4. Degree of channel armoring and bed material imbrication;

In the rapidly changing and spatially heterogeneous bed of Cache Creek, determining the degree of armoring and imbrication would require extensive work. The geomorphologist and the engineer also agreed that the effort to do this in a statistically meaningful way was not worth the information that would be gained. Note that as far as we know, these data have not been collected since 1996.

In addition there are a four items that depend significantly on pre-walk office analyses to be meaningful. These include the first three:

1. Evidence of changes in channel dimensions or bank erosion;

2. Evidence of bed degradation or aggradation;

3. Significant changes in the locations or sizes of bars and other channel features;

These are best determined with maps, aerial photos, and Digital Terrain Models (when available). With maps available in the field, field checking is useful.

In addition, number 11 - *Areas where the existing capacity of the channel can no longer contain a 100-year flood event, or is nearing the loss of such capacity* – totally depends on hydraulic analyses, but could be verified in the field once the analyses identified the appropriate areas.

> ***Action:*** The TAC geomorphologist recommends that we update the annual inspection goals accordingly. Number 4 should be deleted. Numbers 1,2,3, and 11 should reflect that they depend on pre-walk analyses in order to be meaningful as field inspections.

Reevaluation of the CCRMP Boundary

In both map analyses and in the field, we noticed that the area of the 100-year flood (which is largely the definition of the CCRMP boundary) was extended beyond the mapped CCRMP boundary in a number of areas.

For example, near the Capay Bridge, because the CCRMP boundary is based on the 100-year flood level, the pre-bridge 100-year flood line was back farther than the existing 100-year flood line. If the CCRMP boundary were to be redone now, it would be in a different place because the new bridge would cause a different 100-yr floodplain pattern.

There are a number of other areas like this that can be estimated by looking at the 2010-2011 cut and fill maps. Ultimately, a new CCRMP boundary could be established by detailed HEC-RAS modeling.

"Test 3" Line

There are a number of places where there are options for considering management actions where it is not clear whether they fall within the "test 3" line or not. The producers have suggested that we put the "test 3" line on the maps that we use for planning and evaluation purposes.

One area that is in this category is near the Jensen property (near RM 25.5). This has been a dynamic area for many years. At one point in time, Questa Engineering installed jetties to control the dynamics. The area continues to have erosion pressure and should be continued to be observed and evaluated, particularly with respect to the "test 3" line. We plan to do an analysis of historical erosion in order to be aware of past patterns. This will help inform the current dynamics and provide information about possible future dynamics.

NOTES FROM CREEK WALK FIELD INSPECTION

These notes are organized on a reach-by-reach basis, except for the conditions at the bridges, which are summarized in a separate section at the end.

CAPAY REACH

Capay Dam to the Capay Bridge (River Miles 28.3-26.3)

Capay Dam Area (RM 28.3)

At the dam site itself, we observed the grade control structure that was installed as part of the recent repair project. We could only see the end abutments of the grade control structure (Figure 1), as the rest of the structure was underwater. An important consideration for the TAC is to determine the form of this grade control structure, and how it functions with respect to high flow patterns. We should consider the possible implications for the channel dynamics at high flows, and the possibility of "end-cutting".

Action: It would be beneficial to have pictures and drawings of the entire grade control structure including the portions under water and buried in the banks. In addition, the TAC should monitor the channel dynamics related to the grade control structure. In particular, it is important to examine any tendency for "end-cutting", where the water could go around the abutment and erode the bank.

Figure 1 Grade control structure downstream of Capay Dam

We did not walk the reach between the Capay Dam and the PG&E site.

PG&E Pipe Crossing and Palisades (RM 26.9)

A description of the goals for which the palisades were built would be useful in order to assess the success or failure of the palisades in meeting their goals. If we are to learn from past actions, it is important to evaluate the success or failure in meeting defined goals. One of the actions that we understand PG&E are going to take is that the upstream and downstream palisade netting (Figure 2) would be cleared of debris. If we assume that one of the goals was to collect sediment in order to protect against and prevent retreat of the bank in this vicinity, then this action seems like it is counter to the imagined goals of the palisades.

The design and orientation of the cement pillows in the creek are causing high velocity flows to move to the south side. This is exacerbating the existing bank retreat on the south side (Figure 3). An important question to ask is "what are the consequences of allowing bank migration to continue on the south bank?" We anticipate that the south bank will continue to erode due to the flow pressure on the south bank which is caused by the pillow placement. The consequences of that bank migration may be negative, neutral, or positive. Therefore, it is

important to evaluate the consequences of the continued erosion.

In addition, it will be important to understand how they plan to excavate on the south bank. Excavation could also tend to destabilize the bank.

Action: Continue to evaluate PGE plans for this site.

Figure 2 Palisades with debris north bank

Figure 3 Palisades area - erosion on south bank

HUNGRY HOLLOW REACH

Capay Bridge to downstream of the Esparto Bridge (River Miles 26.3-23.5)

Access Ramp at Capay Open Space (RM 26.3)

The access ramp is built in the existing floodplain of the creek and is susceptible to flooding. Because of the width of the floodway at this point, it is not expected that the influence of the walkway on high flows will be significant in terms of impeding flow volumes, but there may be some bridge damage.

Action: At an appropriate time, it would be good to relocate the access ramp out of the 100-year floodway.

RM 25.4 -25.5 bank retreat

The bank retreat patterns near RM 25.4 -25.5 show that the channel bends in this location are evolving in a typical pattern for stream channel evolution. The 2010-2011 DTM maps show significant erosion in this location (Figure 4). Downstream from this, the bank is pinned in place by cement material that was placed to limit bank retreat. This constraint to the natural movement has probably caused the upstream bend to be curved more than it would be naturally and, in response, to erode more rapidly. One possible management action would be to remove the concrete constraint, and to allow more natural dynamics in this location. The consequences of this to downstream private land would have to be assessed. Removing the concrete might allow too much erosion onto the Jensen property where there is orchard land, and there would be concern about erosion in that direction. This is one area where evaluating the different management options would benefit from defining the location of the “test 3” line.

Another possibility is that the large bend will cut though and make a cut off in the flat area between the two limbs of the meandering course of the low flow channel, and the channel will move away from the bank naturally, with the rock left in place.

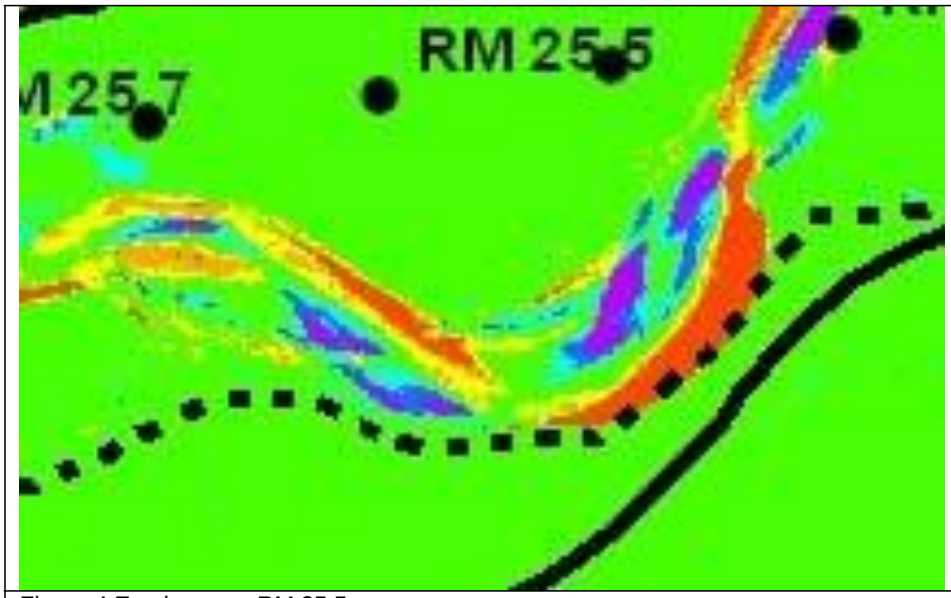

Figure 4 Erosion near RM 25.5
The area in red shows significant erosion between 2010 and 2011.

Action: Determine the location of the “test-3” line in this location.

Notes: The TAC geomorphologist plans to assess 2011-2012 erosion patterns. In addition, the TAC geomorphologist plans to consider the historical migration by analyzing maps and aerial photos.

Granite Construction North Bank Stabilization (Near RM 25)

Removal of mid-channel gravel bars could alleviate pressure on the north bank in this vicinity.

Action: Consider bar-skimming in this location.

MADISON REACH

Downstream of the Esparto Bridge to the I-505 Bridge (River Miles 23.5-21.1)

RM 22.0 bank retreat

At RM 22.0 there is bank retreat as shown in the cut and fill maps (Figure 5). A former hypothesis was that the meander migration and bank retreat would leave in its wake a created floodplain on which natural regeneration of riparian vegetation could occur. When observing this area in the field, we observed that this is possible only in a long time period, because the adjacent cut bank is almost 20 feet high and, as the locus of erosion tends to move downstream, it will be a relatively long time before the area could develop a floodplain. This is probably not a site that could be relied on for short-term natural regeneration. We should continue to observe the channel processes as they occur at this site. Another important aspect of this site is that it is an area where the bank retreat has taken the current bank of the stream outside the CCRMP boundary. No management action is currently recommended.

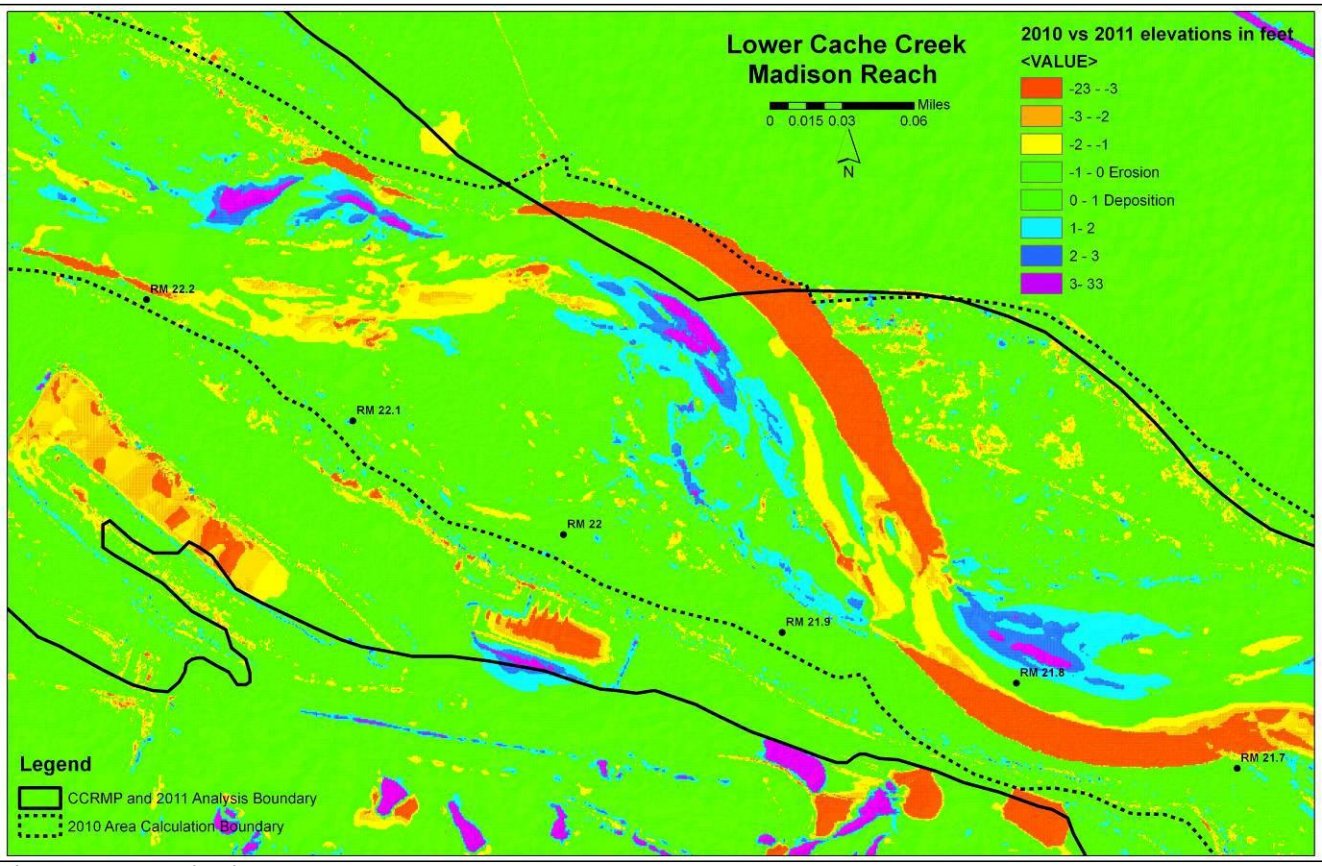

Figure 5 RM 22.0 bank retreat

Figure 6 RM 22.0 bank retreat

Active bank retreat near RM 21.6

(Near the old Madison Bridge and Scheuring property)

The retreat on the north bank, which was occurring in previous years, has stopped because the channel is no longer on the north side. There is significant natural re-vegetation that is occurring here.

Near the Old Madison Bridge site, we discussed the possibility of cutting a channel across the gravel bar (bar skimming) in order to relieve the pressure on the north bank. If there were high flows, probably a mid-channel cut would do little to alleviate the pressure on the north bank, as the mid- channel would fill rapidly with water and would not significantly alleviate the flow pressure on the northern bank. There is really no concern for relieving the pressure at moderate flows, because moderate flows don't impact the bank. Bar-skimming will not hamper the vegetation establishment on the north side, which is significant. At the same time, bar-skimming will probably not have any negative effect. It would be an experimental management action that may help relieve the pressure of erosion on the north bank.

If a mid-channel excavation were made, members of the TAC speculated that removing the spur dike at the downstream end might help relieve pressure on the north bank. We also speculated that one main drawback would be the cost, as we understand that it might be expensive to remove large cement from the creek. Another issue is that there may be those who do not agree that removing the restraint would be a good idea. Therefore, there are a couple of issues that might have to be dealt with if we pursued removing the downstream spur dike.

At this time, no management action is recommended.

GUESISOSI REACH

I-505 Bridge to just upstream of the Moore Siphon (River Miles 21.1-18.9)

RM 20.3 20.5 mid-channel bar

In the vicinity of the most upstream of the CEMEX repair sites (called site F) there is evidence of a mid-channel bar that has deposited, which is shown in purple on the figure (Figure 7). If the bar were removed, there would be less erosive pressure on the south bank. This is a possible location for "bar-skimming."

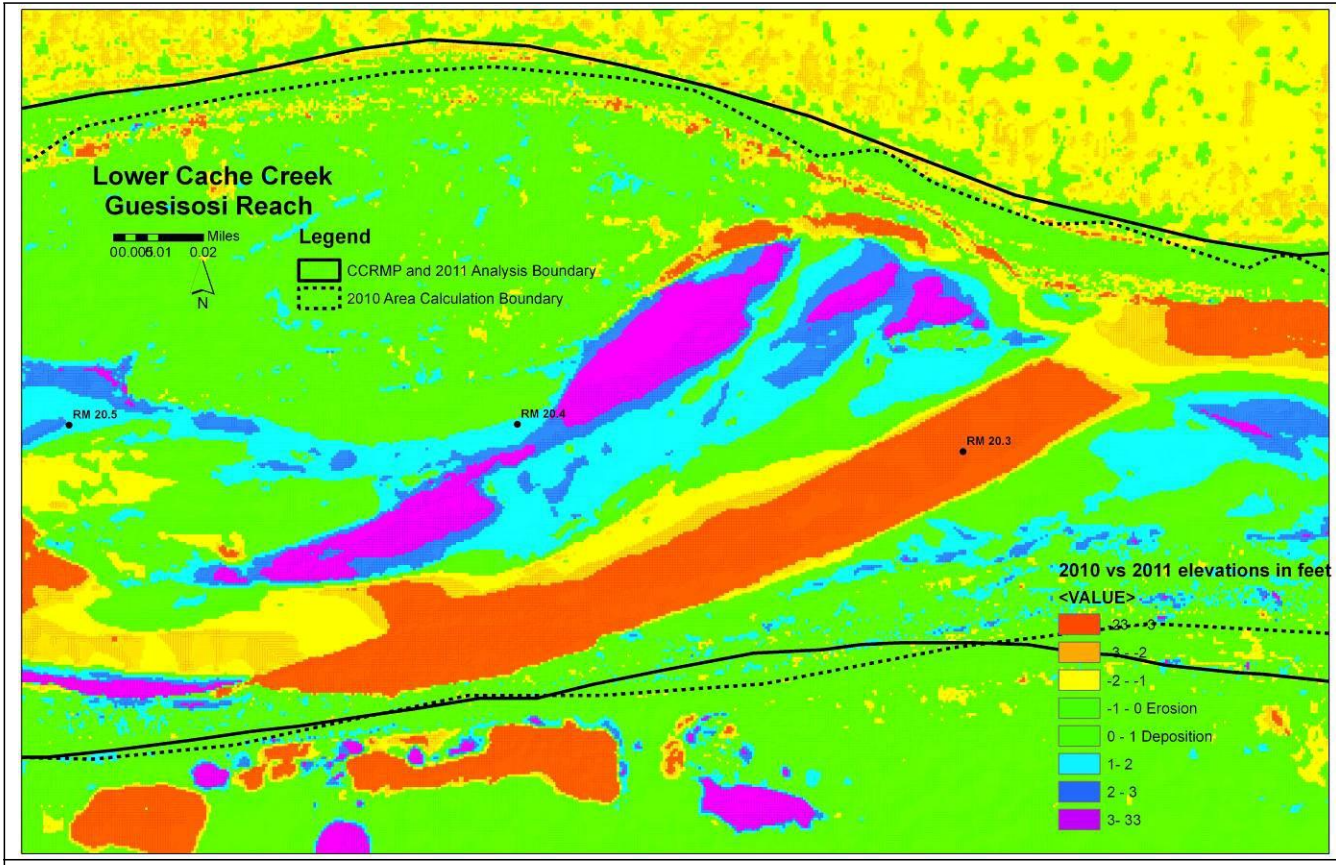

Figure 7 RM 20.3 20.5 mid-channel bar

Action: Discuss this possibility at a future TAC meeting.

Near RM 19.5(?) levee and bank erosion

Near RM 19.5(?), [the exact location was not documented] there is runoff coming off the top of the bank which has eroded into the bank, causing a gully from the top of the levee and the bank, which is a concern for bank stability.

Action: Assess for bank stability and consider repair.

DUNNIGAN HILLS REACH

Just upstream of the Moore Siphon to Stephens Bridge (River Miles 18.9-16.1)

RM 18.2-18.0 bank retreat upstream from the Moore Siphon

Immediately upstream from the Moore Siphon, there is bank retreat and a large curved scallop in the bank configuration where the downstream cottonwood forest has restrained the migration. The scallop creates a scour hole in the channel that promotes a diversity of in-channel habitats. There are deep-pool habitats. Large wood is falling into the scour hole (pool), which also contributes to in-channel habitat diversity. WE understand that the local landowner is in favor of allowing this process of bank erosion to occur as a natural process.

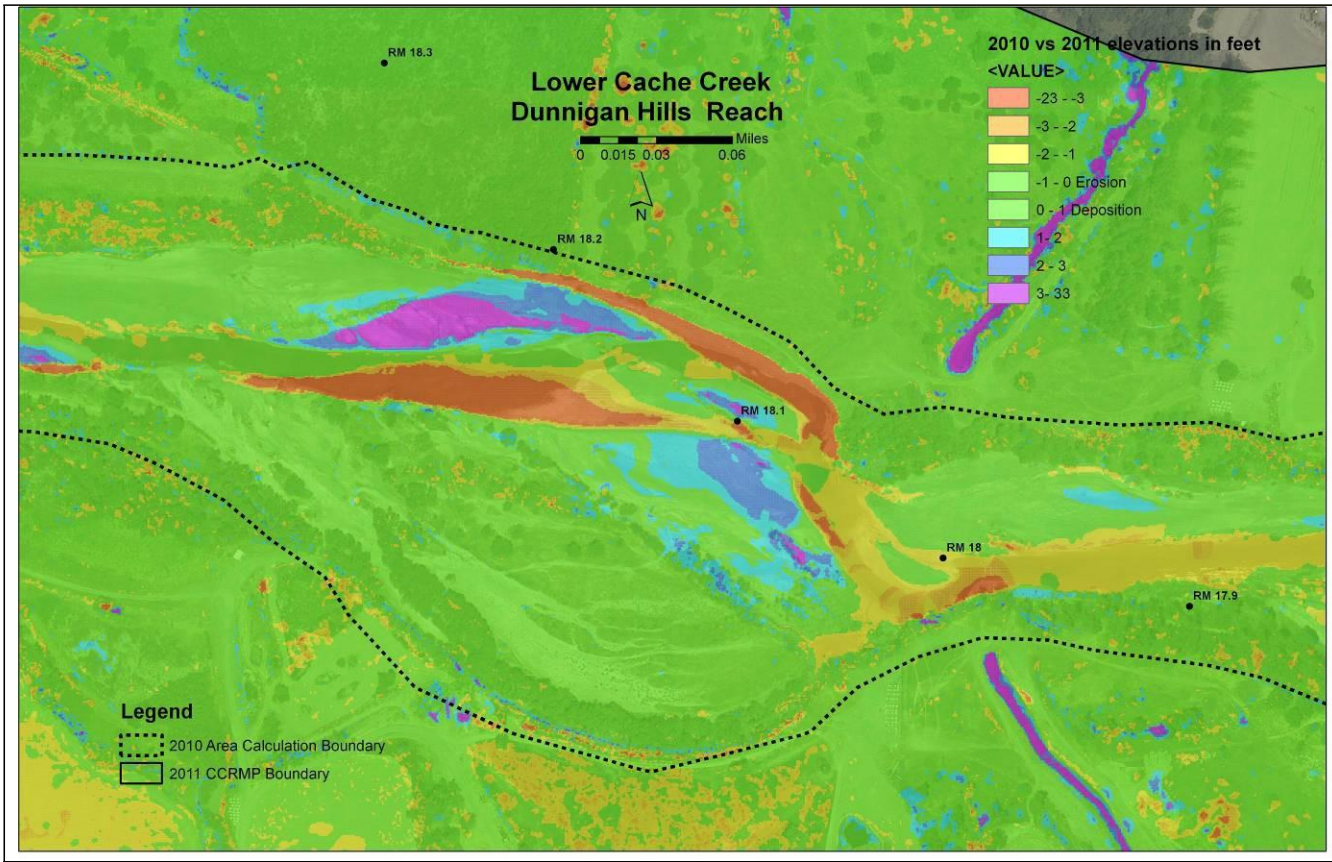

Figure 8 RM 18.2-18.0 upstream from the Moore Siphon

Action: Observe the natural processes as they occur, and document the benefits that we currently see and that we expect to see in the future.

HOPPIN REACH

Stephens Bridge to the narrows of the leveed portion of the channel (River Miles 16.1-12.9)

RM 15.4 and RM 15.0 bank retreat

In the Hoppin Reach, there are two locations of site-specific channel bank retreat. Both areas have no negative impact. It is possible that the continued bank retreat will provide bank swallow habitat. It would good to continue to observe the bank retreat in these areas, and to document if bank swallows use the area.

Figure 9 RM 15.4 bank retreat

Rodgers Demonstration Water Recharge and Habitat Project (RM 14-13.8)

The berm/cement barrier between the two sub-basins, which originally served a purpose, but no longer serves a purpose, could be removed. The main benefit would be aesthetic.

BRIDGE EVALUATIONS

Capay Bridge Road 85 (RM 26.35)

Figure 10 Capay Bridge - view from downstream

2010-2011 DTM maps show significant erosion upstream of the bridge on the south side (Figure 10). This seems like appropriate channel retreat that is widening the constricted area, which provides benefit by lowering the flood levels. We observed this in the field, and confirmed that there are no observable negative consequences of this erosion. No action is recommended at this time. We will continue to observe the bank retreat patterns here.

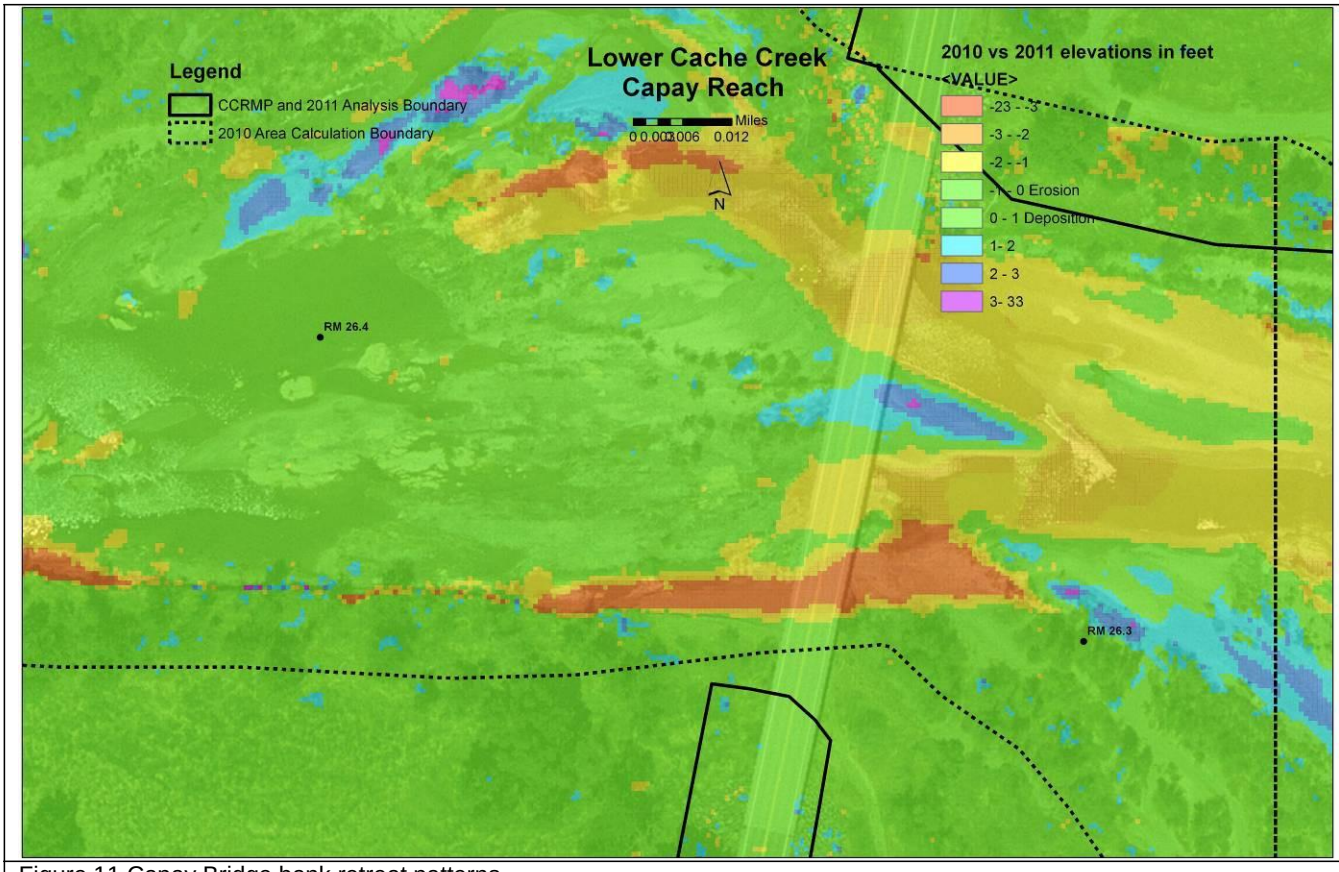

Figure 11 Capay Bridge bank retreat patterns

Esparto Bridge at County Road 87 (RM 24.35)

Figure 12 Esparto Road 87 Bridge

The bridge (Figure 12) appears to be in generally good condition. After the bridge was constructed, there was fill placed on the south side (left hand side in the photo). Syar Industries placed the fill for public works, in order to protect the piers. That fill restricts the cross sectional area available for flow and increases the velocities. It might have been better to leave the area clear of fill.

The 2010-2011 DTM analyses (Figure 13) and the cross section plots which were analyzed (not shown here) show some erosion on the north side on the upstream cross sections. This erosion was also observed on the northern-most pier (Figure 14).

It is possible that the erosion on the northern side of the bridge will continue. Observations should be continued, but no action is recommended at this time.

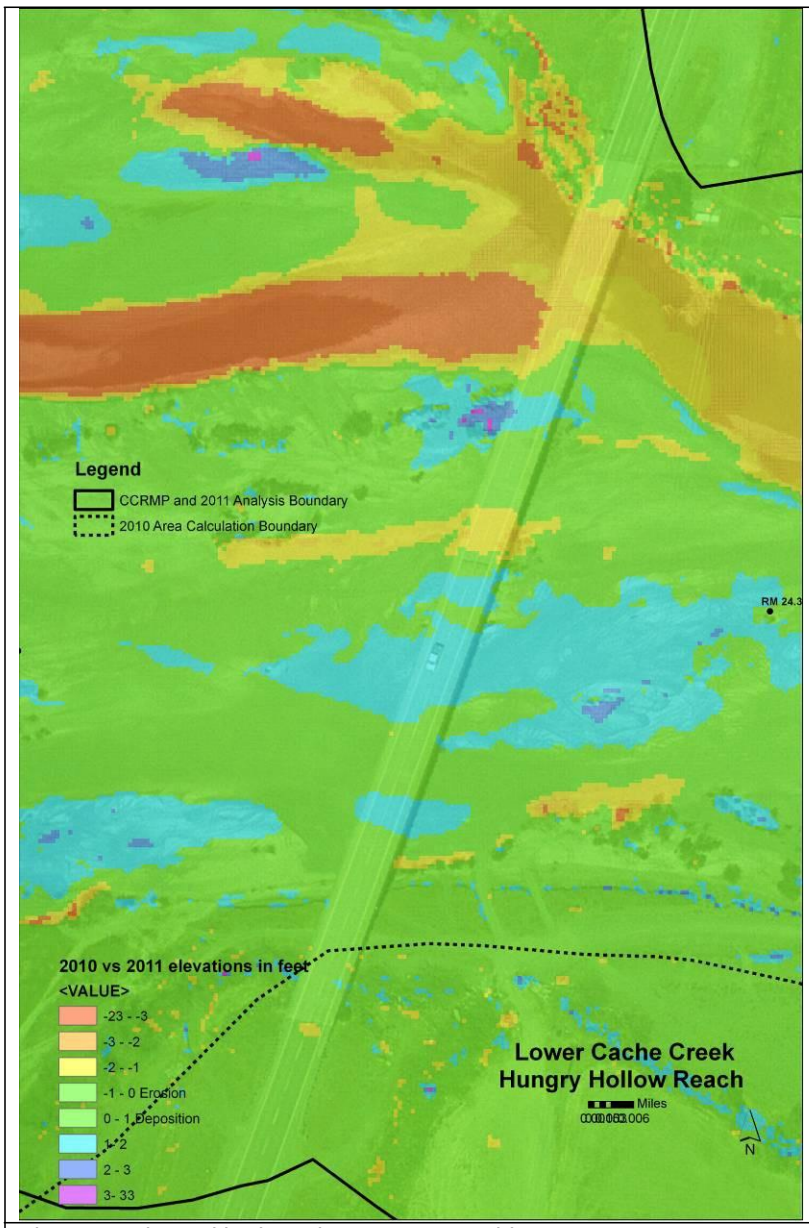

Figure 13 Channel bed erosion at Esparto Bridge

Figure 14 Bridge pier erosion at Esparto Bridge

Highway I-505 Bridge (RM 21.0)

We observed evidence of 2-10 feet of sedimentation around the piers in the two south side bays; they are filed with sediment and vegetation so that they appear to carry little flow at moderate recurrence-interval flows. This sedimentation appears to reduce the capacity of the bridge by 30% or more. Much of the vegetation appears to be Sand Bar Willow and Mule Fat, both of which do not cause much restriction to high flows.

We do not recommend any action at this time, but do recommend continuing to observe the area. One possible management action would be to remove vegetation, which might help in increasing the flow velocities (therefore lowering the flow stage) under the bridge. One effective way to examine this would be to examine the HEC-RAS model of this area, and to see how much the sedimentation actually affects the flow.

The cross sections that we have at this area show no change in bed elevations upstream and downstream from the bridge.

Figure 15 Highway I-505 Bridge from downstream

Figure 16 Highway I-505 Bridge - Evidence of two-stage building
Former degradation as accounted-for in second stage

Road 94B Bridge (RM 15.9)

Between 2010-2011, there was no aggradation shown on the cut and fill analyses. Since 2001, it appears that there has been 2-3 ft of aggradation. There is not a significant amount of narrowing of the channel width at the bridge (Figure 18). The channel width upstream and downstream are similar, and do not differ much from the channel width directly under the bridge. It is possible that there is some effect from vegetation and backwater from Highway I-5 downstream, which would tend to cause bed aggradation , but there is no evidence of that in the recent longitudinal profiles that show the bed elevations over the past few years.

Figure 17 Bridge at Road 94B looking downstream

Figure 18 Bridge at Road 94B showing little constriction