Shasta River Tailwater Reduction Plan

Prepared For:

Shasta Valley Resource Conservation District

Funded By:

State Water Resource Control Board

Project Description

Shasta River Tailwater Reduction-
Demonstration and Implementation

Agreement #:

06-271-551-0

Grant Source

2005-06 Consolidated Grants- Proposition 40/50
Agricultural Water Quality Grant Program

Prepared By:

AquaTerra CONSULTING

PO Box 1384
Mt. Shasta, CA
530-859-2782

September 2011

SHASTA VALLEY TAILWATER REDUCTION PLAN

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Section 1- Project Setting

The Shasta River watershed, is located 22 miles south of the California/Oregon border. As shown in *Figure 1*, Shasta River is located in the Klamath River Basin and is considered an important tributary to the Klamath River. The extent of this project within the Shasta River Watershed, includes the irrigated acreage along the mainstem of the Shasta River from the mouth to Dwinnell Reservoir, as well as irrigated acreage along Parks Creek, Big Springs Creek, Little Shasta River, Oregon Slough, and Willow Creek.

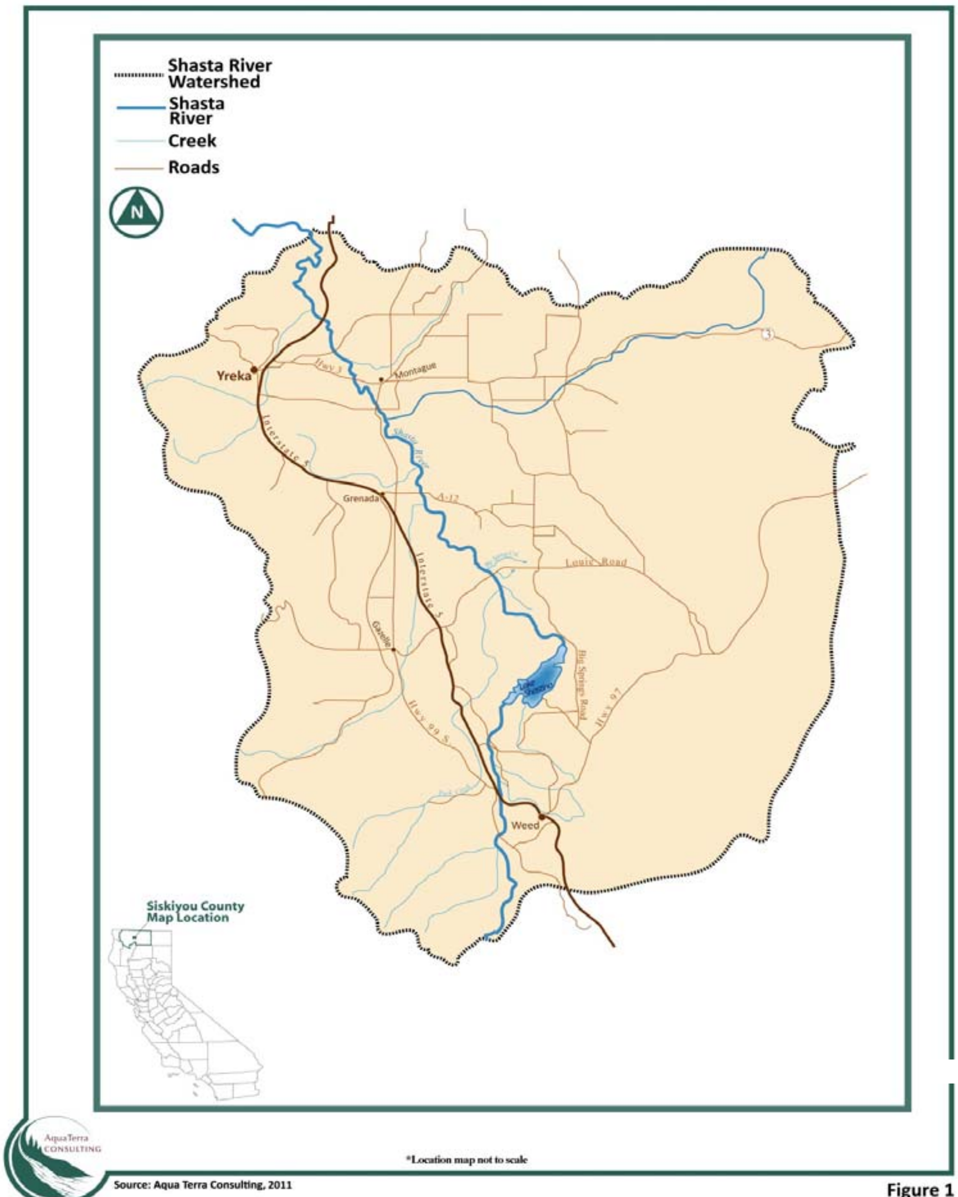


Figure 1
Location Map

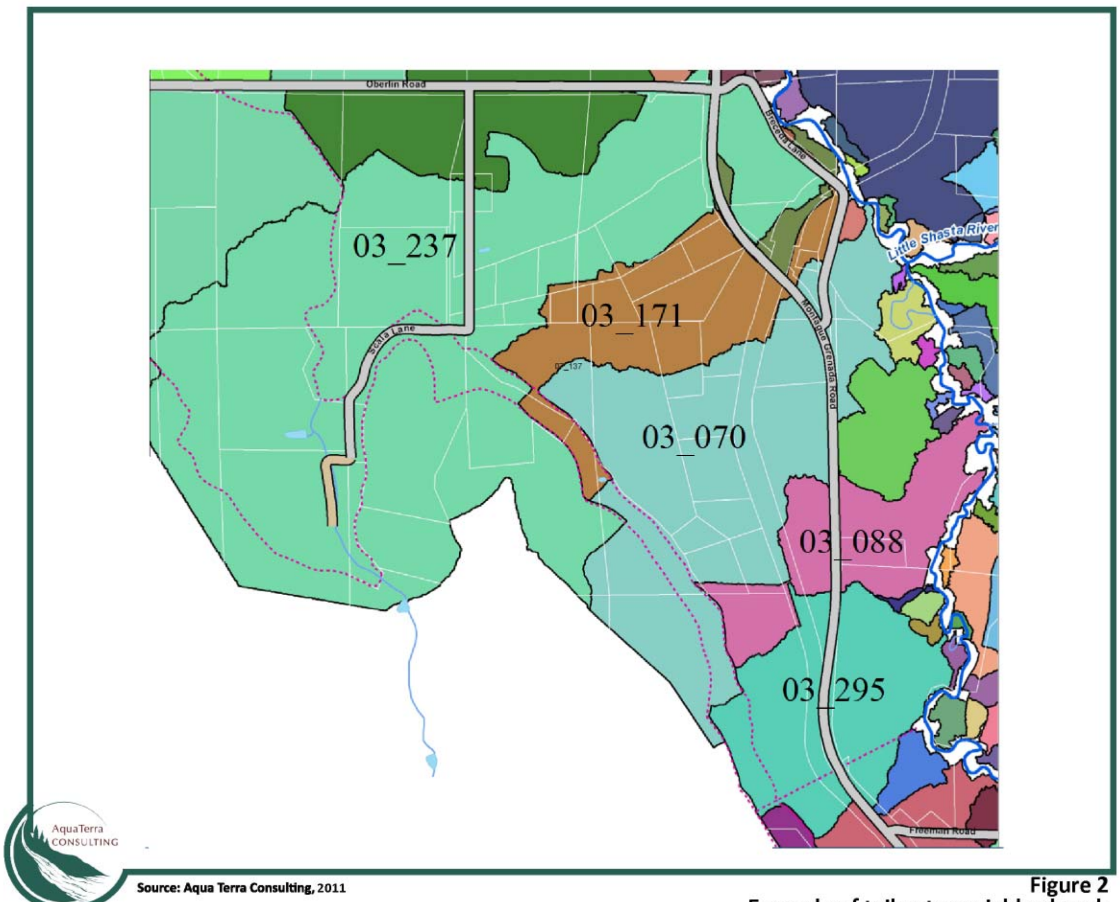
Pursuant to Section 303(d) of the Clean Water Act, the Shasta River was listed by the EPA as impaired for organic enrichment/dissolved oxygen in 1992, and as impaired for temperature in 1994. Low dissolved oxygen concentrations and elevated water temperatures in the Shasta River and its tributaries have negatively affected the river's ability provide adequate spawning, reproduction, and rearing habitat for salmonid species, including ESA listed Coho salmon, along with Steelhead and Chinook. It is believed that elevated temperature and low dissolved oxygen are primary reasons that populations of anadromous salmonoid populations in the Shasta River and throughout the Klamath River watershed have declined dramatically over the last half century.

The North Coast Regional Water Quality Control Board has identified tailwater return flows as one of the five primary factors affecting elevated stream temperatures in the Shasta River watershed. Accordingly, in order to improve habitat conditions in the Shasta Valley watershed, tailwater reduction planning efforts are imperative.

Section 2- Project Description

Tailwater and Tailwater Neighborhoods

Tailwater can be defined as run-off from agricultural irrigation practices, usually related to flood irrigation. If tailwater returns to the river, it can contribute to poor river water quality, potentially increasing temperatures and nutrient loading. Tailwater can also run onto a neighboring property, from where it may eventually return to the river. In terms of management, a discrete area contributing to a single tailwater stream has been given the name "Tailwater Neighborhood", which can be defined as a geographic area, mini-basin or watershed that produces tailwater; where several landowners contribute to a single tailwater return to the river. Approaching tailwater reduction efforts from a "neighborhood" perspective shares the responsibility of reducing tailwater impacts and can assist in developing the most efficient reduction effort of significant tailwater returns. The following figure is the general concept of a tailwater neighborhood, the colors illustrate the mini-basin ("tailwater neighborhood"), which contributes tailwater to a single return point and the white lines represent property boundaries.



Source: Aqua Terra Consulting, 2011

Figure 2
Example of tailwater neighborhoods

Project Funding and Intent

The Shasta Valley Tailwater Reduction: Demonstration and Implementation Project began on December 29, 2006. The agreement was initiated with the State Water Resources Control Board with funds from 2005-2006 Consolidated Grants- Proposition 40/50 Agricultural Water Quality Grant Program. The grant completion date is December 31, 2011. The Shasta Valley Resource Conservation District (RCD) also has received funding for a second phase of tailwater reduction planning and implementation through the State Water Resources Control Board, which will extend tailwater reduction efforts in the Shasta Valley to December 31, 2013.

The goals of the Tailwater Reduction Project are:

1. Development of watershed-wide planned and prioritized approach that guides efforts to reduce tailwater's negative impacts to water quality.

2. Development of a feasibility study that specifically addresses reducing tailwater on a high-priority ranch or irrigation district.

3. Installing two projects that have been identified as high priority, meet the objectives of this plan and that can serve as a demonstration to the community on different ways to reduce tailwater.

5. Capture detailed topographic data via aerial survey (LiDAR) for use in defining tailwater neighborhood drainage areas, planning for earthmoving activities, and may also prove useful in documenting baseline conditions (riparian trees and stream width).

6. Collection of tailwater quantity and quality data to inform watershed-wide and project specific planning. Documentation of concurrent river water quality data, along with continuous dissolved oxygen data from several locations.

7. Tracking stream flow at established gauging stations on the Shasta River.

8. Outreach to individuals in high priority tailwater areas to solicit the planning and development of tailwater reduction projects.

9. Identification and implementation of two to five tailwater reduction projects in identified high-priority areas.

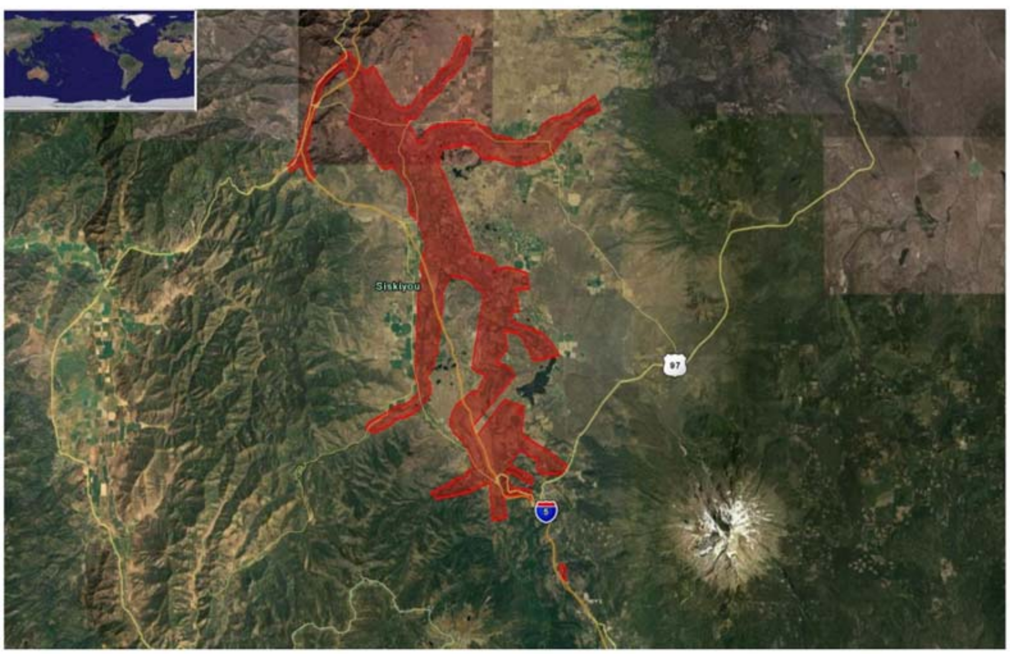
Due to a budget crisis in State of California, the grant was frozen for a period of fourteen months. During this period work on the identified tasks continued, and a tailwater neighborhood flow model was created with funding from The Nature Conservancy and the Department of Fish and Game. This tailwater model assisted in identifying and prioritizing tailwater neighborhoods throughout the basin, this model is explained in the following section.

Section 3- Watershed-wide Planning

<u>LiDAR and Tailwater Data Model</u>

<u>LiDAR</u>

As part of this project, a LiDAR (Light Detection And Ranging) flight was completed in January 2008. The main intention of the LiDAR was to obtain high resolution topography in order to identify tailwater neighborhoods and to assist the project planning process. LIDAR is defined as an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser pulses. The range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal. For this application, a contract was signed with Terrapoint to perform an ALSM (*Airborne Laser Swath Mapping*) over an area of approximately 59,832 acres within the Shasta Valley. This acreage consisted of irrigated lands adjacent to the Shasta River and it's tributaries. The raw data from the flight was then processed to produce a 6-inch contour map of the area. The following figure illustrates the extents of the LiDAR mapping.



Source: Aqua Terra Consulting, 2011

Figure 3
LiDAR Coverage

Flow Accumulation Model

Based on the LiDAR coverage, a flow accumulation model was created to identify tailwater neighborhoods or the mini basins in which irrigation water is likely to flow overland back to the river. The flow accumulation model identified potential tailwater returns (pour points) from the topography. These pour points are low lying areas along the river corridor that likely collect water from upslope and channel it back to the river. Secondly, the model traced all upslope areas that could contribute flow to each pour point. The areas that encompassed the individual flow paths were identified as the discrete tailwater neighborhoods and the pour points were identified as points of tailwater returns on the waterways.

Limitations

It must be noted that there are real world limitations to this model. Most notably that the model does not consider where water is artificially delivered from, and only identifies where water is traveling, working backwards from a low spot along the river to the highest point in each neighborhood. If the modeled flow path encountered a ditch that in reality transports water from one mini-basin into another, the model would show the water accumulating in the ditch, traveling down the ditch, but as the flow accumulates, it would eventually flow out of the ditch and down gradient to some other pour point. This scenario may not necessarily represent how water flows across the landscape in reality. Irrigation ditches are extensively utilized throughout the valley and management practices for each ditch vary, so there are limitations to the first iteration of this neighborhood identification process. Often irrigators create ditch outlets by installing temporary blockages in their ditches to cause the water to go out of the ditch where they need it. Those blockages are frequently moved, and were not in place in January when the LiDAR flight was done. In order to overcome this limitation in the model, extensive ground truthing would need to occur on a yearly basis, as land management can vary if ownership or management changes.

Tailwater Data Model

The neighborhoods identified in the flow accumulation model were then overlaid with the best available data in order to calculate estimated potential tailwater run-off (acre-feet/season) returning to the Shasta River or it's tributaries. These calculations were based on NRCS estimations of water applied for given land cover (based on crop need) and estimated efficiency values based on irrigation methods. The water-applied estimations were adjusted in areas where water rights for particular land tracts were known. Weighted run-off coefficients for each field unit were obtained using Hydraulic Conductivity (Ksat) and slope, which was calibrated against monitoring data obtained during the 2008 irrigation season. It would be beneficial if these coefficients could be updated yearly as more monitoring data is obtained.

Once the estimation of tailwater returning to the system was obtained, a temperature impact model was created. Based on tailwater monitoring data in several locations, an estimation of average daily maximum tailwater temperature of 23 degrees Celsius was used. An estimate of the rivers average daily temperature was determined by using known monitoring data from various locations throughout the watershed and backing out solar gain to determine the river temperature upstream of each identified return. The general mixing equation was used to estimate downstream temperature after tailwater was returned at each neighborhood's tailwater pour point.

Monitoring Data

In order to calibrate the tailwater data model, monitoring data from 15 sites was collected at various pour points in the Shasta Valley during the 2008 irrigation season. Tailwater flow and temperature was logged hourly at each site, in order to obtain mean daily maximums. Upstream of each tailwater pour point, river temperatures were also logged hourly, to obtain mean daily temperatures. Various river gaging stations were monitored for discharge to obtain the mean daily discharge for the irrigation season. The monitoring data was essential in fine tuning the weighted run-off coefficients, which were based on slope and soils.

Limitations

When trying to estimate run-off and impacts due to tailwater for a large area, with irrigation systems as complex as they are in Shasta River Valley, there are always some gross estimations that have to be made and the risk of a large degree of error exists. It should be noted the run-off calculations may be off considerably due to the discrepancy between the "water applied" number that was used in the calculations and actual water used on the ground. The calculations are based on "water needed" for crop productivity not "legal right to water applied" or "actual water applied". Other unknowns that are not apparent in the calculations are as follows:

- existing tailwater re-use systems (thus reducing the amount of water actually returning, with increase retention, ET or deep percolation),
- how irrigation water is managed on the ground (water being ditched/pumped into different neighborhoods),
- how much of the water is returning as subsurface to waterways.

In the estimation of tailwater temperature effect, there were many unknowns for the Shasta River tributaries. Despite the many potential causes of error, in neighborhoods where adequate monitoring data was collected, model results and real world results compared very favorable. Since the entire watershed was modeled, calculations were made with best estimations available and impact estimates should be updated/reviewed when specific monitoring data becomes available.

For both temperature and flow models, data from an entire irrigation season was used to determine impacts. This is a considerable limitation, considering data for both river temperature and flow and tailwater temperature and flow vary from spring to summer to fall. From observing the data, there is a general trend of increased tailwater temperatures and flows in the late spring, while the ground is still saturated and any field shading from crops is not yet established, this of course is dependent on the spring weather. This is also the time when direct solar gain to the river is potentially greatest, as emergent vegetation has not been able to grow enough to provide sufficient shade to minimize direct heat gain. So, despite the fact that the air temperatures may be hottest in July or August, and river flows the lowest at that time of year, the river may be most vulnerable in May.

Section 4- Prioritization Criteria

Tailwater Neighborhood Prioritization Criteria

Each tailwater neighborhood identified using the flow accumulation model as explained above, has an associated “Neighborhood Impact Score”. This Impact Score was obtained using the criteria developed by AquaTerra Consulting, the Shasta Valley Resource Conservation District (SVRCD), and a Tailwater Advisory Committee. These criteria are for planning purposes only and will need to be adjusted periodically as more information about the watershed becomes available. The neighborhood scores will help assist the SVRCD and others focus outreach, project planning, and the allocation of public funds to reduce tailwater impacts in the highest priority areas. As projects are implemented and tailwater from the most critical areas reduced, the criteria will need to be adjusted to meet new conditions. The criteria are generally explained below, as well as how to use the criteria to evaluate a potential project within the neighborhoods. The neighbohood impact scoring sheet shown below was used when evaluating specific neighborhoods for project implementation.

Neighborhood Criteria Guidelines

Even though the scoring for all the neighborhoods in the project area has been done as part of this plan, there may need to be some adjustments to the scores. It is recommended that any tailwater reduction project being evaluated for funding should be scored individually based on best available information. An instance when this would be particularly necessary, is if a tailwater reduction implementation project spans several neighborhoods, the following guidelines will assist in re-scoring for an accumulated impact score for such a project. In all cases, when using estimated/modeled values, the source of those estimates need to be documented in the notes column of the score sheet, in order to legitimize the score and the process.

Neighborhood Criteria #1 - *Location of tailwater return in relation to identified summer-long salmon rearing areas.* Areas that were identified for the 2008/2009 Neighborhood Prioritization Criteria were due to known cold water resources and salmon rearing that have been documented by the Department of Fish and Game and/or other entities. This criteria has been identified as a priority for TMDL and ITP requirements, thus the weighting is 30.

Highest Priority Areas (10 points):

- Big Springs Creek (BSC)
- Upper Shasta River (1 mile below BSC confluence to Dwinnell Dam)
- Park Creek (confluence to I-5)
- Hole in the Ground Creek?
- Little Springs Creek?

Moderate Priority Areas (8 points):

- Shasta River (Mainstem from A-12 to 1 mile below BSC)
- Parks Creek (above I-5 to the last TW return)

Lower Priority Area (4 points):

Shasta River (Little Shasta River Confluence to A-12)

Other Areas (1 point):

Since all areas in the watershed are potentially important at some point during the year, all other areas are given 1 point.

Neighborhood Criteria #2- *Quantity of total average tailwater re-entering the waterway in acre-feet per season (weight 20).* This neighborhood estimate is calculated using the method explained above. Each neighborhood's estimated or actual average tailwater (acre-feet/season) return can be obtained from the GIS neighborhood database or from the excel spreadsheet (if the neighborhood identification number is known).
If a project includes more than one neighborhood, then the neighborhood impact score needs to be re-evaluated based on the total tailwater returning from all of the neighborhoods involved in the project. It is advised that when one is evaluating a project where this is the case, they pull the quantity calculations for each of the neighborhoods from the GIS or spreadsheet and add them together to obtain a new tailwater quantity and re-assign the score for this criteria. It would be a good idea to fill out a new "Neighborhood/Area Impact Scoring Sheet" to assist in tracking the results from this procedure. Other factors, such percentage of tailwater reduced, management considerations, cost benefit, etc is addressed on the "Project Screening and Prioritization Sheets", which is explained in this section.

Neighborhood Criteria #3- *Temperature Effect (Degree that tailwater affects river temperatures).*

<u>*Part A*</u>*. Individual tailwater neighborhoods potential temperature effect on river temperatures (weight 8).* Using recorded or estimated Average Daily water Temperatures and Average Daily Flow for the Shasta River and it's tributaries, averaged over the entire irrigation season, were used in a standard mixing equation with Average Daily Maximum Temperatures and Average Daily Maximum Flows for each tailwater return. Tailwater maximums were either monitored or calculated, calculated maximums for flow were found using peaking factors that presented themselves as trends in the monitoring data. Average Maximum Daily tailwater temperatures were consistently 23 degree C in the monitoring data and were used throughout the watershed for this calculation. Using the mixing equation, a river temperature change due to the contribution of that particular tailwater return was obtained. This potential temperature change is what is being scored for each contributing return. If more than one neighborhood is being evaluated for a tailwater reduction project, than each neighborhood's temperature effect should be obtained from the neighborhood GIS and summed together and re-scored. As in Criteria #2, it would be a good idea to fill out a new "Neighborhood/Area Impact Scoring Sheet" to assist in tracking the results from this procedure.

<u>*Part B.*</u> *Susceptibility to temperature effect on reaches due to tailwater (weight 10).* When looking at trends within certain reaches it became obvious that tailwater returning to certain parts of the river had a greater cumulative temperature effect. It is not to say that all tailwater within an area will return to the river at one time, however some reaches are more susceptible to tailwater's effect on river temperature. The SVRCD felt that it would be important to evaluate both individual neighborhood impacts, as well as the

potential accumulated temperature affect tailwater from a given neighborhood might have on a given area/reach of the river. Since the method used to calculate temperature effect is highly dependent upon the ratio of river flow to tailwater flow and the ratio of river temperature to tailwater temperature, it is obvious that areas where the river has a colder, lower flow and there is a potential for a large volume of hot tailwater returning, will be an area where accumulated impacts could be greater to the river temperature. Conversely, areas where there is more river flow and the temperature is already elevated, even greater returns of tailwater will not have the same temperature affect on the river temperature. Based on this, the areas scoring most susceptible to accumulated tailwater impacts are the upper reaches of the Shasta mainstem, Parks Creek, mid-Shasta mainstem and then lower Shasta mainstem. Since flow and temperature of many of the tributaries is unknown at the writing of this plan, the full temperature impacts to these areas due to tailwater are also unknown and will have to score in this manner until further data is collected. As shown on the neighborhood scoring sheet, unknown accumulated impacts is assigned the score of 1.

It should be noted that the calculations for this criteria are based on averages, so the actual temperature impact of individual neighborhoods or accumulated impacts to reaches could be greater or less than calculated. Much of the actual impacts are related to what time of day tailwater returns to the waterway (if larger quantities return in the a.m. when tailwater temperatures are lower or just the opposite), and it changes daily depending upon actual river flow and temperature at the time the tailwater returns. Subsurface returns or spring accretion that affect river temperature in a specific reach were not considered in the model, as this is not fully known at this time. These areas could be affected more drastically by tailwater inflow. As the data presents itself, this criteria should be re-evaluated.

Neighborhood Criteria #4- *Monitoring Data Available (weight 4).* As stated above there are many unknowns and estimations to our calculations, so actual monitoring data is invaluable. To make the appropriate evaluation of tailwater returns, the return itself must be monitored for flow and temperature. The river must be monitored for temperature upstream of the return, and flow above the return must be obtainable. Also, monitoring data is important to calibrate the model and to make calculations for the rest of the study area. If a project is being evaluated for a project it would be wise to request the landowner to monitor for a season prior to implementation to ensure that the project is valid and worth the expenditure.

Neighborhood Criteria #5- *Are existing tailwater reduction strategies implemented within this neighborhood?* If there are already efficiency techniques strategies implemented within a neighborhood (ponds, land-leveling, border checking, gated pipe and/or re-circulation systems) being evaluated, the calculations in the neighborhood can be thrown off due to management practices, additional storage within that neighborhood and increased ET. If there are any known strategies in place within a neighborhood, the neighborhood will be flagged within the GIS, signaling the evaluation committee to insist on monitoring data or re-evaluating the impact score. When evaluating a potential project it would be wise to ask NRCS staff to assist in evaluating if tailwater systems may be in place within the questioned neighborhood and if they know how they are operated or managed.

Once the neighborhood score is obtained from the GIS, the spreadsheet or re-calculation, due to multiple neighborhoods involved in a specific project, then the project specific evaluation can be performed as explain in the next section.

Neighborhood/Area Impact Scoring Sheet

Neighborhood/Area Name: ______________________ TW Neighborhood Codes: ______________________

Impact Criteria of Neighborhood		Score	Wt	Totals	Notes:
1. Location in relation to identified salmon rearing areas:			**30**		
	Big Spring Creek	10			
	Upper Shasta River (RM 33 to 45)	10			
	Parks Creek (RM 0 to 9)	10			
	Shasta River (RM 24 to 33)	8			
	Parks Creek above I-5 (RM 9 to 17)	8			
	Shasta River (RM 16 to RM 24)	4			
	Other	1			
2. Quantity of total tailwater re-entering waterway in acre-feet per season: *(May be calucated from neighborhood acreage and NRCS efficiency estimates)*			**20**		
	>400	10			
	350 to 400	8			
	300 to 350	7			
	250 to 300	6			
	200 to 250	5			
	150 to 200	4			
	100 to 150	3			
	50 to 100	2			
	less than 50	1			
3. Temperature Effect (Degree TW affects River Temp)					
A. Individual tailwater neighborhoods potential temperature effect on river temperature.	**degree C**		**8**		
$\frac{(Temp_{TW} \times Q_{TW}) + (Temp_R \times Q_{R(w/o\ TW)})}{Q_{R(w/TW)}} = Temp_{R(w/\ TW)} - Temp_{R\ (w/o\ TW)}$ = Temp change	>1.0	15			
Q-----cfs Temp----C	1.0 to 0.6	10			
**Use Average Daily Maximum Tailwater Temperture = 23 degrees (based on monitoring data)	0.6 to 0.5	6			
	0.4 to .05	5			
**Use Average Daily Maximum Tailwater Flow generated in TW accumulation model or monitoring data	0.3 to 0.4	4			
	0.2 to 0.3	3			
**Use Average Daily River Temperature and Flow (Best estimates used where monitoring data was unobtainable)	0.1 to 0.2	2			
	.001 to 0.1	1			
	0/unknown	0			
B. Accumulated temperature effect of reach due to tailwater			**10**		
Upper Shasta (RM34 to 45)	>10 degrees	10			
Parks Creeks	8>10 degrees	8			
Mid Shasta (RM 16 to 34) and Big Springs Creek	4>8 degrees	6			
Lower Shasta (RM 7 to RM 16)	<4	2			
	Unknown	1			
4. Monitoring Data Available			**4**		
	YES	10			
	NO	0			
5. Are exising tailwater reduction strategies implemented within this neighborhood? (needed if monitoring data not available)					
Exisitng ponds and other TW projects can effect the accuracy of the model calculations.	YES	**			
	MAYBE	**			
	NO				
Total Impact Score for Neighborhood:					

Table 1- Neighborhood Impact Score Sheet

Tailwater Reduction Project Prioritization Criteria

When scoring a specific Tailwater Reduction Project, that may either be identified by SVRCD staff, NRCS staff or requested by a landowner, it would be wise to know as many details about the project as possible. Many times during the planning stage of a project many specifics will be unknown, in that case make educated assumptions and/or use NRCS staff to assist or re-evaluate when more information is known. It would be wise to know all the assessor's parcel numbers (APN's) for the location of the project to be implemented, have access to the GIS neighborhood layers and database, meet with all landowners involved and determine how involved they will be in the planning, implementation and operation of the project. A site visit would be helpful to evaluate the potential issues that may ensue with implementation or management. The goal of a tailwater reduction project is to reduce tailwater impacts, thus improving river water quality. Proper pre-project investigations and planning will be needed to avoid projects that could create a bigger water quality issue down the road if present or future owners are not able to properly maintain or operate the system. Also identify what, if any, legal implications might be involved with water rights, permitting, easements, access, as well as if there would be an impact to groundwater or river base flow.

Since considerable project planning and design may be needed to fully evaluate project effectiveness or priority, the project prioritization criteria, has been split in order to evaluate if a project concept is in line with the tailwater reduction project goals and is shown below as P*roject Screening Criteria*. Once the project has been evaluated for project goals and prioritized upon the screening criteria, then planning and design of the project can begin to fully evaluate the project. The following section includes the screening and project prioritization criteria score sheets, as well as direction and guidelines on how to evaluate projects based on the set criteria.

Project Screening Criteria Guidelines

Before a project can be considered for funding, it should be screened to evaluate if the project meets the goals of the SVRCD's Tailwater Reduction Project. Using the Project Screening Sheet shown below, an evaluator should write a brief concept of the project and attach other documents that exist to assist in screening the project for prioritization. All landowners involved and all APNs associated with the project should be included on the sheet. Using the neighborhood GIS, identify all the tailwater neighborhood codes. If there is more than one neighborhood, then a re-evaluation of the neighborhood impact score may need to be done by following the procedure detailed above for neighborhood criteria #2 and #3.

Project Criteria #1 - *Is there direct Tailwater re-entry to river within the Shasta watershed? (weight 10)* This project is to improve river water quality, so if "YES" the tailwater goes into a waterway (either directly or eventually) then the project may be valid and gets 10 points. If "NO" than project is **eliminated from funding consideration**. Multiply the score of 10 times the weight of 10 and place 100 in the "Totals" column.

Project Criteria #2- *Impact score of neighborhood(s) that project is within.* This will be found on the GIS, on the Excel spreadsheet, or from **re-calculating, if more that one**

neighborhood is involved in the project. Place the impact score into the far right box, for this criteria in "Totals" column.

Project Criteria #3- *Is landowner(s) willing to participate in project?* If more than one landowner is involved, use the majority consensus or if it is split use "maybe". Write the score in the middle box for this criteria and then multiply by the weight and insert in the "totals" column for this criteria. If any landowners involved in project are not willing, then the project may have to be put on hold until further outreach can be done to have full participation. Finish evaluating the project to determine it's effectiveness, but mark the project for "outreach".

Project Criteria #4- *Will project keep cold water in the river? Or Will project return cold water to the river?* Priority will be given to projects, where the participating landowner has direct control over the diversion to ensure this criteria can be met since this is the essential goal of the tailwater project. A short list of potential projects that could qualify as a "yes" to this criteria, include:

-A capture and re-use project must result in a diversion reduction to off-set the water availability gain resulting from the project so that the excess will remain in the river (i.e. the project will not increase net water use).

-Efficiency projects designed to deliver the amount of water needed to keep ground productive, reducing the amount of water diverted and keeping cold water in the river.

-Water exchanges can be made where tailwater can be delivered and re-distributed to another user in-lieu of pumping river water.

-Where other projects are not feasible, then consideration will need to be given to how tailwater may be treated or cooled before returning it to the river or how to keep tailwater out of springs or coldwater returns.

Project Criteria #5- *Degree improvement is easily constructed.* Since many of the funds for project implementation are from grants and have a relatively short time frame for completion, projects that are hard to implement, require extensive permitting, etc could contribute to making a project infeasible and less cost effective. The ease in which a project can be implemented may not be fully realized until well underway, however having a discussion with the scoring committee can surface potential issues with the project that can be avoided during full project planning and design. After scoring, multiply by weight and place score in "Totals" column for this criteria.

Project Criteria #6- *Has increased water management already been implemented in the neighborhood to reduce tailwater return flows?* The simplest and most affordable tailwater reduction strategy on the market today is increased awareness and water management efforts. If the landowner or neighborhood has illustrated increased management as a way to reduce tailwater returns and the project will assist in this effort or the project will improve an existing tailwater reduction strategy then the score is yes, place the score in the "Totals" column for this criteria.

Project Criteria #7- *Would project further compromise water quality?* This may occur from a tailwater pond that may not be appropriately managed or not used and could overflow continuously, a condition likely to cause greater water quality (and other) impacts. A project mixing tailwater with spring flow or a coldwater return could impact water quality. If a project could compromise water quality further, then deduct 40 points from the project score and if not, then the score should be increased by 40 points.

Project Criteria #8- *Would project create or potentially create a net increase in consumptive use of water?* The project goals do not include putting additional ground into production or storing water off channel for later use for the benefit of a landowner, both of which increase water consumption. Obviously a project could result in different ground being irrigated due to project design, it just can not increase the acreage that is already being irrigated. Also some water storage may be necessary to effectively utilize water, however consideration must be made if these are necessary to reduce tailwater or if project adjustments can be made to eliminate this need. If this is possible than deduct 40 points from the project score and if not than add 40 points to the project score.

Project Criteria #9- *Would project negatively impact a third party?* Many times on-farm projects can benefit the landowner that is participating but impact another user, either by reducing the amount of tailwater that they normally receive or reduce the amount of water in the river that could be used by a more junior user. This is a signal for the scoring committee to look at how neighbors within a tailwater neighborhood could work together to resolve potential problems before they exist and/or ensure that the water that is being gained from the tailwater reduction project is being traded for reduced diversion from the river to avoid the impacts of junior users. These are just few examples of how third parties could be affected, the committee should discuss other possibilities. If it would impact others, the score should be adjusted as reflected on the scoring sheet.

Project Criteria #10- *Does Project only benefit one landowner?* The goal of the project is to improve water quality and to make a project successful cooperation between landowners may be necessary. If that is the case and cooperation will be involved, than more than one landowner will benefit from project and the answer is "no" then add 20 points to the project score.

Project Criteria #11- *Would realized water savings from project be dedicated to river flow?* The landowner would have to be willing to go through the process of dedication and the water could not be used by junior water-users and would stay in the river for other beneficial uses. If this is possible, than add 50 points to project score.

Initial Project Screening Sheet

Basic Project Concept: ______________________

Landowners Involved: ______________________

TW Neighborhood Codes: ______________________

	Project Specific Tailwater Criteria		Score	Wt	Totals	Notes:
1.	**Is there direct tailwater re-entry to river within the Shasta watershed?**			10		
		YES	10			
		NO	Project eliminated from funding consideration			
2.	**Impact Score for "Neighborhood(s)" that project is within:**					
3.	**Is landowner(s) willing to participate in project:**			10		
		YES	10			
		NO	0			
		MAYBE	5			
4.	**Will project keep cold water in the river?**			10		
	-OR-	YES	10			
	Will project return cold water to the river?	NO	0			
		MAYBE	5			
5.	**Degree improvement is easily constructed:**			6		
	(based on access, permitting issues, proximity to	Easy	10			
	import materials, existing soil conditions, grade	Moderate	5			
	conditions, risk of failure)	Difficult	0			
6.	**Is the project intent to assist landowners in increasing water management? Or has increased water management already been implemented in the neighborhood to reduce tailwater return flow?**					
	(score yes if project is intended to improve existing tailwater	YES	40			
	reduction strategy)	NO	-40			
7.	**Would project further compromise water quality?**					
		YES	-40			
		NO	40			
8.	**Would project create a net increase in consumptive use of water?**					
	(ie. new ground in production, increase off channel storage, etc)	YES	-40			
		NO	40			
9.	**Would project negatively impact third parties?**					
	(reduce stream flow, change natural drainage patterns, etc)	YES	-40			
		NO	40			
10.	**Does project only benefit one landowner?**					
		YES	0			
		NO	20			
11.	**Would realized water savings (if any) from project be dedicated river flow?**					
		YES	50			
		NO	0			
	Total Screening Score for Tailwater Project:					

Table 2- Project Screening Score Sheet

<u>Project Scoring Criteria Guidelines</u>

After the projects have been screened and prioritized based on the above decribed criteria, then further project planning can be initiated. Tailwater monitoring should be implemented to have imperical data to substantiated the modeled impacts created by the tailwater return, baseline assessments of the ranch to evaluate if further management can be implemented prior to on the ground improvements, and final project designs/cost estimates must be completed to determine how cost effective the project will be and if it will be a good use of available funding opportunities. Using the Project Scoring Sheet, included in this section, write a project description and attach other documents that exist and/or a more detailed description, schematic, maps, photos, etc. List all landowners involved and all APNs associated with the project. Transfer all impacts scores and screening scores to the project scoring sheet.

Project Criteria #12- *The degree a completed project is easily managed and cost effective to operate for a landowner will determine the benefit that can be fully realized from a project.* If a project is implemented, but too difficult or too expensive to maintain for the landowner then any benefit to water quality will be greatly reduced. Score both Parts A and B to evaluate the management and operations for the project and multiply both by weight and place scores in the “Totals” column for this criteria.

Project Criteria #13- *Degree which landowner will share in the project implementation cost?* This is not required in order to obtain funding, however if a landowner does participate in some way either with work or cost share they will be more vested in the success of the project. Score as one point per percent the landowner will participate and multiply by weight and place score in “Totals” column for this criteria.

Project Criteria #14- *Has landowner implemented tailwater reduction in past?* If a landowner has a track record of implementing projects that have reduced tailwater returns to the river and/or improved water quality in river due to actions, this should be considered as a sign that the project will be managed and used appropriately.

Project Criteria #15- *Percent of neighborhoods tailwater that would be reduced due to project.* In order to score this criteria, project must also meet Project Criteria #4. To find this number, obtain the total seasonal average tailwater produced for the neighborhood from the GIS database and estimate the amount of tailwater reduced due to the project and calculate the percent of neighborhood tailwater reduced due proposed project. Place the percentage reduced in the “Totals” column for this criteria.

Project Critieria #16- *Estimated water quality benefit expected from project activities.* To use grant funds, a “Project Assessment and Evaluation Plan” (PAEP) must be prepared, to estimate the benefits expected from a project. In order to fully evaluate whether project funds should be expended on an implementation project, projections of water quality improvements must be prepared. When evaluating the project, circling the related water quality constituent score if the project can reduce river temperature, increase river flow, increase dissolved oxygen levels in the river and/or reduce nutrient then add that score to the total project score.

Project Criteria #17- *Cost effectiveness.* Calculated by taking the impact score of the neighborhood the project is within and multiply by the score you obtained from Project Criteria #9, then divide by the cost of the project and multiply by the life span of the project (found off the attached NRCS life span chart). Multiply this number by the weight and place score in the "Totals" column.

Project Criteria #18- *Would project impact groundwater due to recharge loss or affect base flow returning to the river?* Currently this is not fully realized, but as more projects are implemented groundwater resources could be impacted due to loss of recharge, or cold river accretion could decrease. If it is certain the groundwater could be impacted, than deduct 10 points from project score.

Project Scoring Sheet

Specific Project Description:______________________________

Neighborhoods/Area Name:______________________________

**(Project design is needed to effectively evaluate project, including pre-project tailwater monitoring data, cost estimates and baseline assessments)

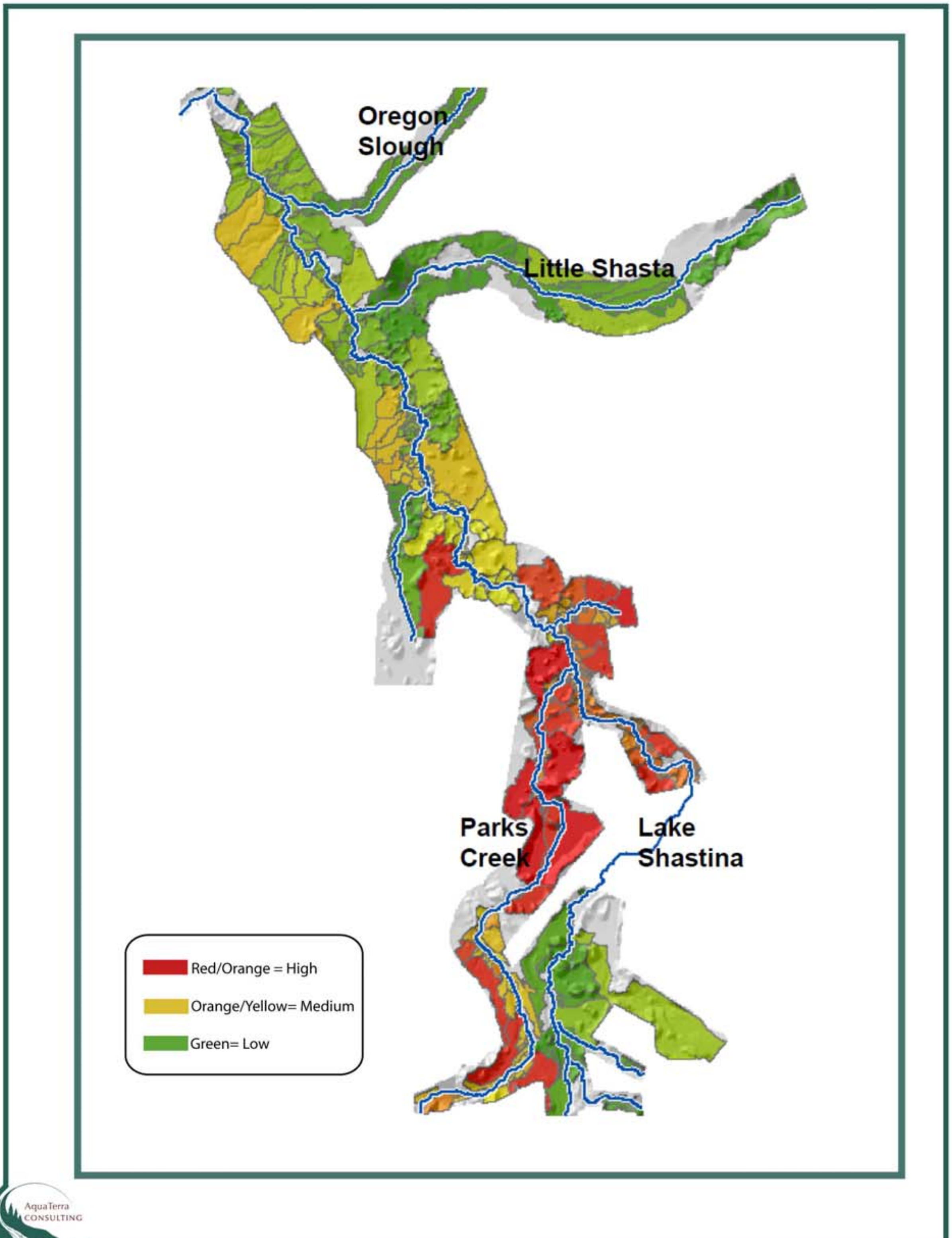
Project Specific Tailwater Criteria		Score		Totals	Notes:
Total Impact Score for Neighborhood:					
Total Screening Score for Tailwater Project:					
12. A. Amount of management required by landowner to realize project benefits.			**4**		
	Low	10			
	Moderate	5			
	High	0			
B. Potential operations cost ($/acre-ft/yr) required by landowner to realize project benefits.					
	Low	10			
	Moderate	5			
	High	0			
13. Degree which landowner will share in the project implementation cost? *(in-kind labor at NRCS rates- can use agency as cost share)* *Scored as 1 point per percent*			**2**		
14. Has landowner implemented tailwater reduction in past? *(which reduced tailwater return and/or improved WQ in river?)*			**2**		
	YES	10			
	NO	0			
15. % of neighborhoods TW that would be reduced due to project *(Must also meet criteria #4 in order to be scored)* Neighborhood TW Q= Project's TW reduction= *Assess percent TW reduced due to existing system and adjust impact score)*		=			
16. Estimated water quality benefit expected from project activities *(note:temperature, flow, dissolved oxygen and/or nutrient loading improvements to assist in project evaluation)*		*River Temp reduced*		10	*Note: Circle score if project will likely accomplish water quality improvement.*
		Flow increased		10	
		DO increased		10	
		Nutrient load reduced		10	
17. Cost Effectiveness: *(Impact Score*#9 score)/ Cost of Project* life span of project (NRCS chart) =*			**8**		
18. Would project impact groundwater due to recharge loss?					
	YES	-10			
	NO/UNKNOWN	0			
Total Score for Tailwater Project:					

Table 3- Project Scoring Sheet

Section 5- Neighborhood Scoring Results

All neighborhoods in the study area were scored for tailwater impacts utilizing the criteria explained in Section 4. The map shown below is a visual representation of the neighborhood scoring process. To generally define the results, areas shown in red and orange are higher priority for tailwater reduction efforts and yellow and green being the lower priority. The areas shown in red and orange that produce tailwater have *the potential* to have a greater impact on river water quality, based on the criteria developed. As tailwater reduction efforts are implemented and water quality improves throughout the system, it is recommended that the criteria and scoring be re-evaluated.

To summarize the results of this evaluation process, tailwater returning to areas of the watershed that typically have lower cooler flow regimes, will have a greater potential impact on water temperature. Thus the area of the Shasta River, below Dwinnell Reservoir to 1-mile downstream of Big Springs confluence, Parks Creek and Big Spring Creek are considered the highest priority for tailwater reduction efforts, due to the naturally occurring spring flows found in these sub-areas contributing to comparatively low cool river flow. The river conditions in the other reaches, at the writing of this plan, had elevated temperatures during the peak summer month (July/August), where individual tailwater returns did not seemingly have as great of an impact on river temperatures. This evaluation does not consider nutrient or sediment loading. As tailwater reduction planning progresses, it is recommended that these other factors be considered. At the time of this writing, the TMDL for the Shasta River was only directed at temperatures and dissolved oxygen, which are generally related, thus stirring this planning and evaluation effort.



Source: Aqua Terra Consulting, 2011

Figure 4
Prioritized Neighborhoods

Section 6- Tailwater Reduction Planning

This section will generally outline possible tailwater reduction projects or management strategies with the intention of reducing the impacts tailwater could have on river water quality. Each geographic area of the valley has its own complexities, in relation to water quality, flow requirements and surface water/groundwater interaction. Due to these complexities, the implementation of certain tailwater reduction projects or strategies could either negatively or positively impact the river. For the purposes of strategic planning for improving water quality, the valley has been split into reaches or areas to generally assess each area's water needs and likely important considerations when evaluating a tailwater reduction projects.

Evaluation Reaches

Above Dwinell Reservoir
Big Springs Complex (Dam to 1 mile downstream of Big Springs Confluence)
Parks Creek (I-5 to confluence with mainstem)
Parks Creek (Above I-5)
Mid-Mainstem Shasta River (Big Springs Complex to Little Shasta Confluence)
Lower Mainstem Shasta River (Little Shasta Confluence to Canyon)
Little Shasta River

Evaluation Areas

Montague Irrigation District
Big Springs Irrigation District
Grenada Irrigation District
Shasta River Water Association

It must be noted that there are a lot of unknowns about how surface application of water affects groundwater and base flows in the Shasta River. In some evaluation reaches or areas, increased efficiency may be a good solution to keeping cold water in the system, however in others, an inefficient irrigation system may actually help contribute cold base flow to the river at times when it is needed the most. At the writing of this plan, the groundwater/surface water interaction was being further evaluated, and recommendations made in this plan may have to be re-visited as more information is made available.

Tailwater Evaluation

This is a watershed-wide planning document, however it must be noted that each ranch/neighborhood's operations are unique and it is recommended that the following evaluation be completed when evaluating tailwater reduction strategies. Tailwater impacts can be reduced or eliminated by implementation of a physical project to increase efficiency (i.e. reduce tailwater creation) or by capturing, treating, or re-using the tailwater. However, the most practical and least expensive strategy to reduce tailwater can be to alter management practices. Prior to the implementation of any tailwater reduction project, management of irrigation should be considered. When evaluating a ranch for tailwater reduction improvements, the following questions can be considered:

1. How many acres are irrigated?
2. How are those acres irrigated?
3. How much water is used to irrigate those acres (what is the water right vs how much is delivered to the point of use)?
4. What is the crop type?
5. What is the consumption rate of that crop?
6. How long are the sets and what is the length of the run?
7. How long is the rotation?
8. Does tailwater from a neighbor contribute to the available irrigation water/system?
9. What efficiency practices are already implemented that assists in water management?
10. Is the ground currently being irrigated with cold spring water?

After evaluating and potentially improving irrigation management, then efficiency of the irrigation system can be evaluated. The following questions can be considered when evaluating efficiency:

1. Will increasing efficiency increase consumptive use of water?
2. Will improving the diversion or delivery system allow for more water to be delivered to the point of use? (what is the water right vs how much is delivered to the point of use)
3. Will increased efficiency reduce the diversion quantity? How will that affect river temperatures?
4. Could increasing efficiency reduce groundwater recharge or the contribution of base flow to the river?

After management and efficiency are addressed, then the tailwater return can be re-evaluated to determine if it has been sufficiently reduced or if the impacts due to tailwater have been minimized. If there is still a significant quantity of tailwater returning from a neighborhood and/or the impact is still relevant to river water quality, then conceptualizing what could be done to reduce the impact of that return would be the next step. When conceptualizing a project, the following questions can be considered.

1. What is the receiving water's current condition? (flow, temperature, dissolved oxygen, nutrients)
2. In this evaluation area, what is the most important threshold that must be met for water quality? (temperature only, flow and temperature, flow only, nutrient loading, dissolved oxygen)
3. Could a project increase consumption?
4. Could a project reduce the diversion quantity?

5. Could a project result in more cold water returned to the river?

This evaluation process may not answer all the questions or reduce the potential impacts that may be actualized from doing a specific project, but it can ensure that all factors of how land is managed is evaluated and encourages some changes to happen in a shorter time frame. The main purpose of this evaluation is to determine if whatever strategy or project is being considered will most efficiently meet the purpose of this plan, which is to improve river water quality.

Potential Reduction Projects

This section lists the potential strategies and projects that could be considered as ways to reduce tailwater or the impacts associated with tailwater returns. See appendix for description/specification of listed strategies, which were developed for this plan or are standard NRCS Practice Sheets.

1. *Management Strategies*
   - Education and Outreach to Neighborhood
     - Meeting to inform neighborhood of responsibilities
     - Brainstorm neighborhood strategies
     - Neighborhood evaluation/monitoring
   - Irrigation Management (NRCS 449)
     - Reducing application time per set
     - Reducing amount of water applied per rotation
     - Irrigating at night or during cooler time of the day
     - Adjust fee schedules in irrigation district to a pay for use
     - Allowing water from springs to return to the river to improve river temperatures (reduce water use or direct spring flow back without co-mingling with tailwater as part of implementation projects)
   - Irrigation monitoring
     - Install moisture sensor in the field to assist landowner in irrigation management
     - River monitoring to inform irrigators of receiving water conditions and thresholds

2. *Efficiency Projects*
   - Land leveling/smoothing (NRCS 466)
   - Border checking/Field Border (NRCS 386)
   - Ditch lining/piping (NRCS 430)
   - Convert flood irrigation to sprinkler (NRCS 442)
   - Installation of gated pipe (NRCS 431)
   - Improving turn-outs
   - Improving diversion points
   - Improving existing tailwater capture systems to reduce water quality impacts.

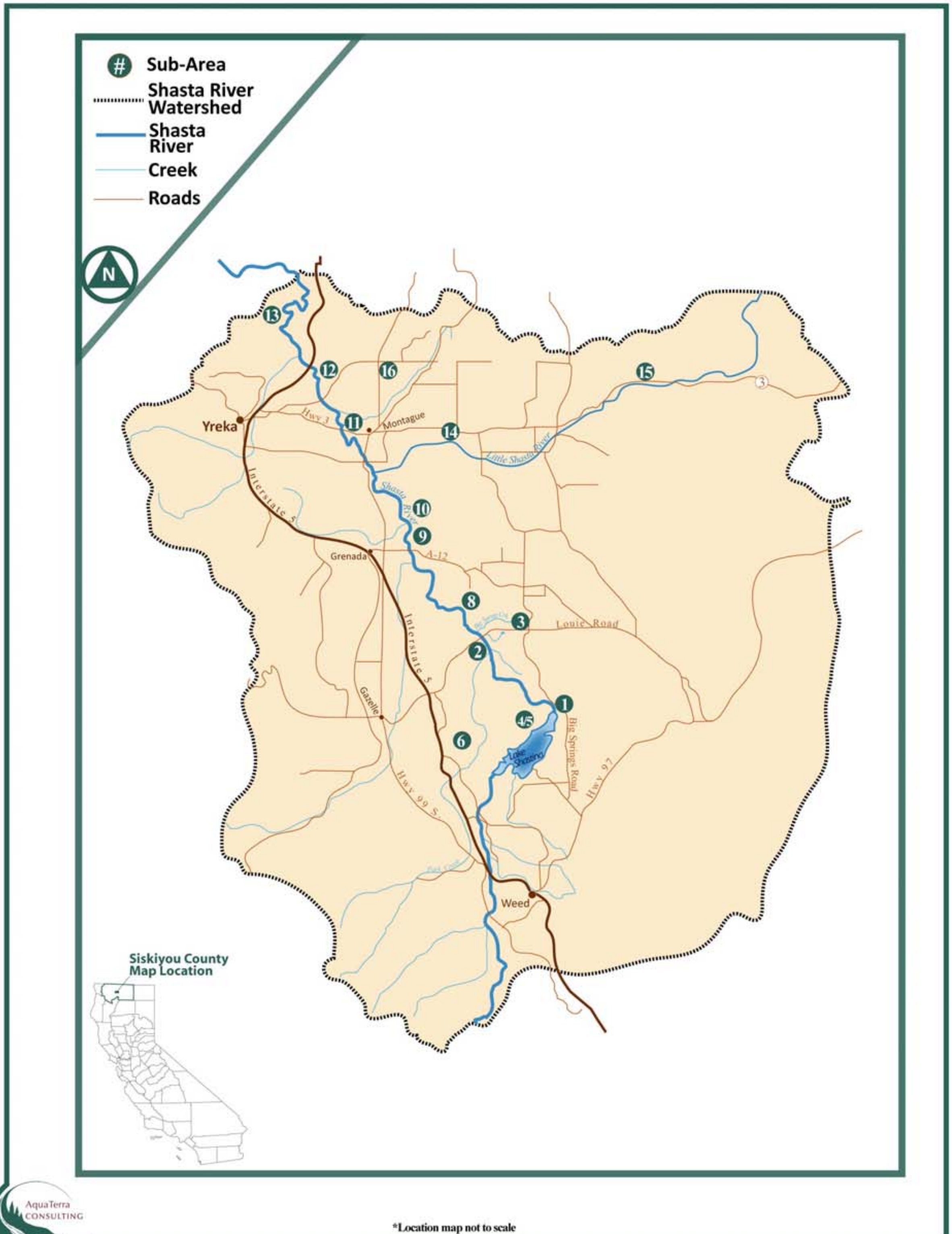
3. *Tailwater Reduction Project*
   - Tailwater treatment
     - Constructed wetland cell (NRCS 656/635)
     - Infiltration gallery/water spreading (NRCS 640)
     - Critical area planting (NRCS 342)
     - Filter strips (NRCS 393)
     - Riparian buffers/riparian fencing (NRCS 391/390)
     - Vegetative barrier (NRCS 601)

- Underground detention system (usually used for stormwater run-off detention)

- Stream-bank Berm building (to keep small quantities tailwater from returning in areas where flooding is not a concern)
- Capture and re-use (only if it reduces the amount of water diverted) (NRCS 447)
- Pick-up Ditch (transport tailwater to another downstream user in-lieu of diversion) (NRCS 607)

Tailwater Reduction Planning Matrix

The following matrix is a general planning guide for the types of tailwater reduction projects that would be recommended for ranches within any of the Shasta Valley Evaluation Areas, as listed at the beginning of Section 6. Each of the evaluation areas are further split into sub-areas, identifying any potential fisheries and water quality issues that were relevant at the writing of this document, as well as recommended tailwater reduction or water management strategies that could be employed within the sub-area. It should be noted that all ranches located within the listed sub-areas have their own unique water management and tailwater issues, and this plan can only be used as a guide. To best serve the resources involved, it is recommended that the Tailwater Evaluation questions included in this section be considered prior to expending any funds for any on-the-ground improvements to reduce tailwater regardless of the recommended strategies outlined in the following matrix. Figure 5 defines the Sub-Areas considered for this planning effort, it should be noted that tailwater issues above Dwinnell reservoir are included in the matrix, however extensive planning in this area was not considered a priority.



Source: Aqua Terra Consulting, 2011

Figure 5
Tailwater Evaluation Sub-Area

Evaluation Reach/ Area	Sub-Area	General Reach/Area Issues		Recommended Projects/Strategies for Tailwater Reduction or to Reduce Issues (Fisheries or Water Quality)	Additional Considerations
		Fisheries	**Water Quality**		
Above Dwinell Reservoir	Areas where water would go into Dwinell Res	Not used by species of concern (no fish passage)	Water goes into Dwinell (where temp increases, DO decreases, other potential nutrient issues)	Increase efficiencies to reduce diversion quantities	If less water is diverted and is then added to storage for MWCS, then less water should be diverted from Parks Creek for storage.
	Areas where water is shipped into other sub-drainages (China ditch, etc)	Not used by species of concern (no fish passage)	Water is being taken out of upper basin and could be contributing to base flow to lower reaches or groundwater to communities	Tailwater Treatment (if this water is able to return to system underground)	This water could be returning underground to the Shasta as base flow, along the Willow and Julian Creek channels
				Increase efficiency to reduce diversion quantities	Increasing efficiencies could cause more consumption of water and eliminating important baseflow coming from inefficiency
Big Springs Complex (Dam to 1 mile downstream of Big Springs Confluence)	***Sub-Area 1*** Shasta River (Dam to confluence of Parks Creek)	Spawning/Summer Rearing/Winter Rearing for Salmonids	Cold spring water used for irrigation	Using Dwinnell water (or Tailwater) for irrigation	Allow spring water to stay in river and not be used for irrigation purposes, must be used in conjunction with moving diversion point above spring
				Increase efficiencies where the diversion uses cold spring water	Beneficial if diversion is reduced
			Dwinnell water delivered to prior rights users (negatively impacting spring water resources in channel)	Moving all points of diversions above spring in-flow to ensure Dwinnell water is removed from system	Need to confirm this will be possible
				Using tailwater from upstream irrigator in-lieu of delivery from Dwinnell	Multiple landowner management would be important as a tailwater pond would be required for effective usage.
				Tailwater Treatment (if this water is able to return to system underground)	If infiltration sufficiently cools tailwater, could extend rearing habitat
	Sub-Area 2 Shasta River (Parks confluence to 1 mile DS of Big Springs confluence)	Spawning/Summer Rearing/Winter Rearing for Salmonids	Surges of hot water can be delivered from Parks Creek (diversion operations)	1-Management	Evaluate water usage per acre
			Tailwater returns to Park's creek historic/overflow channel (Shasta Springs Creek); confluence with Shasta in this reach	2- Efficiency, 3-Tailwater re-use	2- New diversion structure is needed for better management, 3- tailwater capture and re-use if diversion quanity can be reduced.
	Sub-Area 3 Big Springs Creek	Spawning/Summer Rearing/Winter Rearing for Salmonids	Cold spring water used for irrigation	Increase efficiencies where the diversion uses cold spring water	A project is beneficial if less water will be diverted and dedicated to instream flow
			Excessive tailwater returns	Tailwater Treatment (if this water is able to return to system underground)	Infiltration would have to be monitored for effectiveness. Care needs to be taken to avoid impacts to natural spring flow and temp.

Evaluation Reach/ Area	Sub-Area	General Reach/Area Issues		Recommended Projects/Strategies for Tailwater Reduction or to Reduce Issues (Fisheries or Water Quality)	Additional Considerations
		Fisheries	**Water Quality**		
Parks Creek (I-5 to confluence with mainstem)	***Sub-Area 4*** Kettle Spring Complex	Spawning/Summer Rearing/Winter Rearing for Salmonids	Cold spring water used for irrigation	Increase efficiencies where the diversion uses cold spring water	A project is beneficial if less water will be diverted and dedicated to instream flow
	Sub-Area 5 Bridgefield Complex				
	Sub-Area 6 Parks Creek		Low to no flows in late summer	2-Efficiency	A project is beneficial if less water will be diverted and dedicated to instream flow
Parks Creek (Above I-5)	***Sub-Area 7*** Parks Creek	Juvenile Coho, Steelhead, historic spawning	Large quanty of cold water diverted to Dwinnell		
Mid-Mainstem Shasta River (Big Springs Complex to Little Shasta Confluence)	***Sub-Area 8*** 1 mile DS of Big Springs confluence to GID diversion	Spawning/Summer Rearing/Migration for Salmonids	Solar gain significant in this reach	Tailwater not a major concern in this sub-area	No TW project recommended at this time
	Sub-Area 9 GID Diversion to 2 miles DS of A-12		Cold water acreation maybe significant in this sub-area both natural (Willow Creek and Julien Creek underflow and Pluto's Cave Basalt) and from Huseman ditch and irrigation applications	1-Management	Evaluate water usage per acre for crop needs
				2- Efficiency	Only after understanding surface water/ base flow interaction
	Sub-Area 10 2 miles DS of A-12 to Little Shasta Confluence	Spawning/Migration for Salmonids/Winter rearing	Significant tailwater creation in this sub-reach	1-Management	Evaluate water usage per acre for type of crop grown/ evaluate fee structure for SRWA
				Tailwater Treatment	If infiltration or underground detention proves to sufficiently cools tailwater, if implemented in this reach could help meet TMDL temp goals
Lower Mainstem Shasta River (Little Shasta Confluence to Canyon)	***Sub-Area 11*** Little Shasta Confluence to Yreka Ager Road	Spawning/Migration for Salmonids/Rearing (canyon)	Significant tailwater creation in this sub-reach	1-Management	Evaluate water usage per acre/ evaluate fee structure for SRWA
				Tailwater Treatment or use by another irrigator	If infiltration or underground detention proves to sufficiently cools tailwater, if implemented in this reach could help meet TMDL temp goals
	Sub-Area 12 Yreka Ager Road to I-5		Significant tailwater (irrigation ditches end) in this sub-reach	Tailwater Treatment or use by another irrigator	If infiltration or underground detention proves to sufficiently cools tailwater, if implemented in this reach could help meet TMDL temp goals
	Sub-Area 13 I-5 to Canyon		Solar gain significant in this reach	Tailwater not a major concern in this sub-area	No TW project recommended at this time
Little Shasta River	***Sub-Area 14*** Lower Little Shasta	Spawning/Summer Rearing/Winter Rearing for Salmonids	Cold spring water used for irrigation	Tailwater not a major concern in this sub-area	No TW project recommended at this time
	Sub-Area 15 Upper Little Shasta			Increase efficiencies to reduce diversion quantities only if the net result is increased instream flow	Beneficial if diversion is reduced

Evaluation Reach/ Area	Sub-Area	General Reach/Area Issues		Recommended Projects/Strategies for Tailwater Reduction or to Reduce Issues (Fisheries or Water Quality)	Additional Considerations
		Fisheries	Water Quality		
Off-Channel Districts	Affected Reaches				
Montague Irrigation District	***Sub-Area 16*** Oregon Slough	Not used by species of concern	Significant tailwater in this sub-reach	Tailwater Treatment or use by another irrigator	If infiltration or underground detention proves to sufficiently cools tailwater, if implemented in this reach could help meet TMDL temp goals
	Various Sub Areas Dam to 2 miles DS of A-12, Big Springs and Parks	Spawning/Migration for Salmonids/Rearing	Tailwater not a major factor in these districts, however water use could affect groundwater recharge and river base flow, water quality of water released from Dam for prior rights users	Study needed to determine interaction between surface applied water and Shasta River base flow.	
	Sub- Area 12 Lower Shasta River		End of the District's ditch creates tailwater issue with affect reach	Tailwater Treatment or use by another irrigator	If infiltration or underground detention proves to sufficiently cools tailwater, if implemented in this reach could help meet TMDL temp goals
Big Springs Irrigation District	***Various Sub Areas*** Dam to 2 miles DS of A-12 and Big Springs	Spawning/Migration for Salmonids/Rearing	Tailwater not a major factor in these districts within this reach, however water use could affect groundwater recharge and river base flow	Study needed to determine interaction between surface applied water and Shasta River base flow.	
Grenada Irrigation District	***Sub-Area 9*** Mid and lower Mainstem Shasta			Study needed to determine interaction between surface applied water and Shasta River base flow.	

Notes:

1- Due to the unique conditions of ranches in this reach, no specific blanket management recommendation is evident at this time . Please use list of potential mangement strategies included in this section of the Tailwater Reduction Plan when evaluating individual ranches for reduction projects.

2- Due to the unique conditions of ranches in this reach, no specific blanket efficiency recommendation is evident at this time . Please use list of potential efficiency strategies included in this section of the Tailwater Reduction Plan when evaluating individual ranches for reduction projects.

Table 4- Tailwater Reduction Evaluation Matrix