Testimony of Alex Hildebrand
on Behalf of the South Delta Water Agency
June 25, 2009 SWRCB Hearing
Considering Changes to
WR 2006-0006

My name is Alex Hildebrand. I am currently the engineer for the South Delta Water Agency (SDWA), and was previously a Board member. My curriculum vitae is attached hereto.

The question before the Board is whether or not to modify the compliance schedule of WR 2006-0006 ("Cease and Desist Order" or "CDO"). That compliance schedule requires the Department of Water Resources ("DWR") and the Bureau of Reclamation ("USBR") to obviate the threatened violations of the Water Quality Objectives for Beneficial Uses in the southern Delta ("salinity standards"). We believe that compliance with the CDO should not be delayed.

SDWA and I personally on behalf of the Agency have informed the DWR and USBR since 2005, and perhaps earlier, of methods by which they could comply with the requirement that the South Delta salinity standards should be met. In a January 1, 2007 hearing before the SWRCB, SDWA gave testimony showing (1) that there was no salinity problem before the CVP and SWP went into operation (2) how the export operations caused the problem, and more importantly for purposes of this hearing, (3) how the CVP and SWP could comply with the salinity standards with simple measures that involve no significant water cost to any party and can do so with temporary barriers. My oral testimony at that hearing is included here as Attachment 1 (SDWA Exhibit 1).

As the Board knows, DWR and USBR continually assert that the only method by which they can meet the standards is through the permanent gate program of the South Delta Improvement Program ("SDIP"). Although the SDIP is necessary to assist in mitigating the various impacts of the projects on the South Delta, implementation of the SDIP is not needed in order to comply with a CDO as explained below.

During 2008 there were a series of meetings among SDWA, DWR, and USBR engineers to reach engineering consensus on measures, most of which could be implemented in 2009 and all of which could be implemented in 2010, with no significant water cost. The items/actions of consensus were raising the Middle River rock barrier and adding culverts if needed, and adjusting the relative height of barriers in order to distribute available flow among channels in proportion to local diversions in those channels. This can be done to a limited degree by just tying open the appropriate number of flap gates on the Tracy Old River rock barrier, and recirculation of water through the San Joaquin River and Delta Mendota Canal. Recirculation is an essential part of this, especially from July through mid-September and has already been tested by USBR in 2004, 2007, and 2008 during low Vernalis flows. The other measures are primarily to make efficient use of the waters in the channels, including the recirculated water, by creating net flows. This engineering consensus is explained in Attachment 2 (SDWA Exhibit 2) which is dated November 1, 2008.

Rather than evaluating and implementing the above measures well before the April 1, 2005 date by which the interior standards became fully effective, or before the July 1, 2009 CDO deadline, the DWR and USBR have instead asserted (1) they were not responsible for the violations of the interior standards; (2) that it would involve an unreasonable water cost to meet the standards; (3) that compliance measures were beyond their authority, (4) that the interior standards should be relaxed; and (5) that compliance can not be achieved without the SDIP. All of these contentions are false. For example, DWR has a power point presentation of an engineering analysis that shows the obvious fact that releases from the American River can not control South Delta salinity and then concludes that they therefore can't meet the standards. This is like hiring engineers to prove that one can't flush a toilet by running water in the kitchen sink, and by then pretending that there is no other way to flush a toilet.

It is important to note that meeting any of these standards, whether the existing ones or relaxed ones requires the creation of net flows in each of the channels, the very things described above and proposed by SDWA many years ago, and agreed to by the DWR engineers and modelers. No salinity standard can be complied with in a stagnant channel reach into which DWR and USBR operations introduce a salt load. The DWR and USBR have not submitted any plan that would avoid stagnant channel reaches. This is further explained below.

The DWR and USBR assertion that they cannot comply with the CDO until the SDIP is in operation is simply incorrect. It is clear from Attachments 1 and 2 (SDWA Exhibits 1 and 2) that the SDIP is not needed to comply with the CDO. Furthermore, implementation of the SDIP will not result in compliance with the CDO.

Although SDWA continues to have concerns about the effectiveness of the SDIP, which only affects a portion of South Delta channels, and to what extent it will adequately mitigate the adverse effects of the projects, the eventual effectiveness of that program is not relevant to this proceeding. Whether or not SDIP works as DWR anticipates, the question before the Board is whether or not actions other than SDIP can or could have been taken by the projects to comply with the CDO. The Board should clearly understand, that after SDWA finally got DWR to analyze the other actions suggested by SDWA, DWR and USBR engineers and modelers agreed that those actions would create net flows in the channels, therefore controlling salt, and likely meeting the standards.

Hence, if there are/were actions to meet the standards that DWR and USBR did not consider or adopt, there can be no logical or justifiable reason to change the CDO's deadline. When a party ordered to do something fails to investigate and implement actions which will satisfy the order, there is no reason to extend the deadline. It would be more appropriate to punish them for not acting.

I would like to also note that the DWR/USBR quarterly reports to the Board under the CDO regularly specified that installation of the SDIP gates would occur after the July1, 2009 deadline. Therefore, they cannot allege they have now been caught unawares and need more time to comply. They have known for years the permanent gates would not be in before this July.

I also need to comment on this hearing's notice which asks how might the Board take into account the possible changes to the salinity standards resulting from the ongoing review of standards process. This is a shocking statement/question. The review of the salinity standards is supposed to be an unbiased review which may result in a stricter standard, no changes, or a relaxed standard. It is impossible to "take into account" a future possibility. The question itself suggests the Board is seeking some excuse for not enforcing the standards. It would seem to be bad policy as well as contrary to the law to not enforce existing standards because a review of the standards is pending. If the standards are made stricter, wouldn't that mean the deadline in the CDO should have been set for an earlier date?

I have also included a number of other attachments (see SDWA Exhibits 3 - 11) which are either letters or memos from SDWA or myself to DWR and the Bureau indicating that the other measures described above were raised a number of times over the past few years.

There is no valid reason to postpone enforcement of the CDO since compliance with salinity standards does not require the SDIP, and since there has been no determination that compliance with the ESA can be better with the SDIP than with temporary barriers, and since compliance with any salinity standards requires the creation/maintenance of net flows in the channels.

STATEMENT OF QUALIFICATIONS OF ALEX HILDEBRAND

Agriculturally Related Qualifications

° Director and Secretary of South Delta Water Agency 1973 -2004

° Engineer for South Delta Water Agency 2004 - present

° Past President of Delta Water Users Association and now a Director

° Past President of McMullin Reclamation District No. 2075 and now a Director

° President of San Joaquin River Water Users Company (non-profit water distributor within District #2075)

° Director of California Central Valley Flood Control Association

° President of San Joaquin River Flood Control Association

° Director (and member of Water Committee) of San Joaquin County Farm Bureau

° Past Member of California Farm Bureau Water Advisory Committee

° Owner (since 1944) and resident operator (since 1963) of 150-acre farm (in District #2075). Have made observations for several years of the depth of water percolation in two of my fields by use of Tensiometers, and have observed over many years the dramatic effect of variation in applied water salinity on the production and quality of produce from our family produce plot.

° Participated in development of South Delta Barrier Program

° Active participant in San Joaquin River Management Plan

° Expert witness in numerous hearings before the State Water Resources Control Board

° Former Member CalFed Bay/Delta Advisory Council

Professional Qualifications

° Honors Degree in Physics from U.C. Berkeley

° Registered Professional Engineer

° Former Assistant Chief Engineer of Chevron's Richmond Refinery

° Retired Director of Chevron's Oil Field Research Laboratory. The research in that laboratory covered a broad spectrum of science and engineering, including substantial research on the flow of fluids through permeable earth materials (both in laboratory and field tests) together with the movement of dissolved materials. This work required an understanding of the mechanisms of fluid flow, the physical chemistry involved, and the consequences of non-uniform permeability. Also responsible for analyzing and determining the applicability of these research results to commercial operations.

ATTACHMENT 1

Oral SDWA Testimony by Alex Hildebrand for presentation at the 1/16/07 Workshop of SWRCB re South Delta Salinity

My testimony is intended to provide an overview of where salts come from, where they go, why the concentration of salts causes salinity problems and how salinity can be managed.

Please interrupt me whenever you have questions.

The first three slides are merely introductory. One shows the existing salinity standards in the South Delta.

There are two primary sources of salt load in the San Joaquin watershed. First, there is a substantial indigenous salt load per Slide 4. That is the salt load that derives primarily from the weathering of soils that reduces rocks to gravel to coarse soils to silt. The chemical composition of this salt varies between soils that derive from granite on the east side of the valley and soils that derive from marine shales on the west side. These indigenous salts are released to the river system and flushed to the ocean primarily during high flows. Those high flows dilute the indigenous salt load to low, non-damaging salinity as it is conveyed to the Bay and ocean. Since these indigenous salts are not a problem, they do not need to be regulated except when they are mobilized by irrigating unleached lands during low river flows.

The second major source of salt load is salt that is imported into the San Joaquin watershed and South Delta by CVP and SWP operations. Referring to Slide 5, tidal flows bring salty Bay water into the western Delta. CVP and SWP export operations then draw Sacramento water from the north Delta to the South Delta by reducing water levels and depths in the South Delta. This flow across the Delta entrains some of the salty Bay water that is in the western Delta as a result of tidal flows. That entrained Bay salt is greatly diluted by Sacramento water. However, about half a million to a million tons of this entrained salt is then delivered each year to the CVP's west side service area per Slides 6 and 7. It is delivered either directly via the Delta Mendota Canal (DMC), or indirectly via the San Luis Dam where CVP and SWP export waters are commingled with their salt loads.

After the Delta Mendota Canal went into operation the salinity at Vernalis increased, as shown on Slides 8 and 9. The reason for this is that DMC water is delivered to westside farm lands (including the "exchange contractors") and to wetlands. Most of this water is then consumed by crop and wetland plants in the CVP service area as shown on Slide 10. The root systems of plants take up water and evaporate it through the plants' leaves. This consumption of water is a necessity of plant growth. However, the osmotic root systems reject the salt that is in the consumed water. The rejected salt is thereby substantially concentrated and then flushed from the root zone with a small 'leach fraction" of water which is excess to the water consumed by the plants. This concentrated salt then either accumulates in the soils and ground waters, below the root zone or it flows to the river. The flow to the river is primarily via the drainage water pumped from the "tile" drains, and by subsurface accretions that flow into the river, and by intermittent drainage of water from wetlands. Roughly forty million tons of this imported salt has so far accumulated in the soils and groundwaters below the crop roots. However, hundreds of thousands of tons of this salt also flow into the river in most years. This is by far the major source of salt load in the San Joaquin River and South Delta, particularly in summer months. Waste discharges from growing cities also add salt load to the river at salinities above the salinity of their source waters. This exacerbates the problem, but it is not a large portion of the total load.

The availability of low salinity water to dilute the imported salt load that drainage water brings into the river and South Delta has been substantially decreased. This is primarily due to CVP exports south from Friant Dam, and to increased exports of Tuolumne River water to the Bay Area, and to a managed reduction of summer flows in the river when the inflow of drainage salt is greatest. This is done in order to shift the time of flow to increase spring flows for fish. The reduction is also due to increased consumptive use of water to grow food crops for the growing population. The FERC flows required from the Merced and Tuolumne Rivers only assure a very low San Joaquin flow during dry summers. The June 1980 technical report by USBR and SDWA determined the decrease in Vernalis flow that occurs due to operations of the CVP. Slide 11 shows the reduction in Vernalis flow that is caused by the CVP in various types of water years.

The human population in California is about three-and-a-half times what it was in 1950 when the CVP went into operation in the San Joaquin watershed. This increased population needs three-and-a-half times as much food as well as fiber to make clothes. Meeting that need consumes a lot of water. Furthermore, the rest of the nation relies on California for a large portion of the nation's fruits, nuts, and vegetables. Agricultural Code 411, which is shown in Slide 12 stipulates that neither the State nor the nation should be allowed to become dependent on a net importation of food. Farmers have until now had enough water to respond to that need. But this has substantially increased the consumptive use of water and decreased the inflow to the Delta. Much of the salt that was in the consumed water still flows to the Delta.

Slides 13 and 14 introduce the subject of salinity versus crop yields. In prior proceedings we have presented information showing significant crop damage resulting from the use of water above the 0.7 EC standard as well as testimony estimating the economic impact to the area as a whole resulting from incremental increases in salinity.

An increase in the permitted salinity in South Delta channels has been advocated in previous proceedings by parties who believe that they would benefit by decreasing the protection of South Delta crops. They have not demonstrated that they would actually benefit from their proposed increase in salinity. These parties have asserted that South Delta farmers would not be adversely impacted by irrigating with channel water having salinities higher than the 0.7/1.0 EC standard. As explained in prior proceedings this contention is erroneously based on an invalid rehash of old crop salinity sensitivity data without regard to limitations of that data as applied to

South Delta crops and soils. These limitations were explained in expert testimony by the U.S. Salinity Laboratory, the U.C. Extension Service and others. Dr. Glenn Hoffman of the U. S. Salinity Lab testified and I quote, "the basic root zone salinity tolerance data on which the tables are based are difficult to relate to field conditions. They were based on large part on tests using weekly irrigation and 50% leach fractions on highly permeable soils. There was no pretense of coping with such factors as variations in salinity tolerance at different stages of growth, cultural soil compaction, commercially necessary departures from 'as needed' irrigation, variations in leach fraction with time during the crop season, root aeration problems which occur when soaking for high leach, soil variations within fields, or soil damage by precipitation."

Slide 15. The parties wanting to increase salinity have ignored the fact that the salinity sensitivity of crops varies during different stages of plant growth. They have only addressed established plants. Seedlings are typically more salt sensitive than established plants. Terry Prichard's testimony will address this.

Slide 16. Proponents of increased irrigation water salinity have assumed that soil salinity will be diluted by rainfall. This is only true of "effective" rainfall. Terry Prichard will explain this. Beans and other crops do not germinate until the days are long enough and the soil temperature is high enough. By that time, most or all of the rain moisture has evaporated from the shallow soils around the seeds.

Slide 17. Proponents of increased salinity have also assumed that "leach fractions" of 25% or more are commercially feasible for South Delta crops on South Delta soils. Extensive prior testimony established that a large portion of South Delta soils have very low permeability (slow percolative capacity). This high "leach fraction" therefore often can not be achieved in commercial practice. This is particularly the case with alfalfa. The result is that, although alfalfa can tolerate higher soil moisture salinity than beans, the irrigation water salinity that can provide full crop yield is about the same for alfalfa as it is for beans, carrots, onions, and berries.

Consequently a 0.7/1.0 EC salinity is only marginally adequate for important crops grown on South Delta soils.

Let's next discuss damage resulting from periods when salinities are above the salinity standard as would be permitted by SDIP.

The operation of CVP and SWP export pumps draws down water levels and depths throughout the South Delta on order to induce a north to south flow across the Delta. This reduction is shown on Slides 18 and 19. This reduction in level and depth is more at high tide than at low tide because of the way Clifton Court is operated. The tidal excursion is therefore also reduced. Slide 20 shows the most recent example of a southern Delta channel being almost dry while exports were high. Temporary barriers have been used to largely correct this depth problem in the short term. However, the temporary barriers do not now control salinity.

Slide 21 illustrates the flow and salinity distribution with temporary barriers. As you can see, there is a very small net flow over the Middle River (as well as the Old River) barrier which indicates the large null zone behind it. The same is true of Old River. To correct this problem in the future, the SDIP proposes to install tidal barriers that capture high tide waters for diversion during low tides. However, the high tide water captured by the barriers would often be insufficient, particularly during neap tides, to supply irrigation needs. A substantial flow of water is therefore required into the head of Old River from the San Joaquin channel to maintain adequate water depth. In summer months during periods of above normal temperature this required inflow is forecast by DWR to be about 700 cfs during periods of neap tides that occur twice in each lunar month.

Slides 22 and 23 introduce problems with the SDIP. Slide 24 shows how the SDIP proposes to operate at lower water levels than exist with the temporary barriers [discuss problems]. Slide 25 shows a possible operating scenario under the SDIP.

In 2004 the flow at Vernalis was about 1,000 cfs during the summer. We asked DWR to furnish an analysis of how the SDIP would have operated during the summer of 2004. They furnished this slide. I want to explain the problems with that operation [discuss OR null zones, salinity rise from Vernalis, OR head depth, flow at Brandt Bridge, operation at depth cusp].

There are means by which the 0.7/1.0 EC standard can be met throughout the South Delta at all times except during extreme drought. Proponents of increased salinity have asserted in past proceedings that compliance with the 0.7/1.0 EC standard may not be possible, and would require an unreasonable release of stored project water. It is obvious to anyone who understands Delta hydraulics that releases from Folsom can not control salinity in South Delta channels. Yet DWR has analyzed that ineffective option while continuing to refuse to analyze effective options that SDWA has proposed for a long time. The effective options include the following, per Slide 26.

First, install fish friendly, low lift pumps at one or more of the tidal barriers, per Slide 27. These would be the type of pump that fish agencies have installed at Banta Carbona and in the Sacramento Valley. These pumps would supply on an as needed basis most of the flow and volume deficit which the barriers can not capture. They would thereby assure that adequate water depth is maintained at all times. They would also assure that unidirectional flow is maintained in each channel reach to avoid periods of stagnation and loss of salinity and DO control. Furthermore, they would bring in export quality water. That water is better than the salinity standard, and hence would permit some concentration of the salt in the inflow water as it flows toward the exit in each reach. This recirculation of water within the South Delta involves no water cost to any party, and requires only a modest power cost. This measure would also reduce the DMC recirculation required to comply with the Brandt Bridge standard. A modified version of this option could reduce salinity violations even with temporary barriers.

Second, recirculate water from the DMC to the river and back to the Delta, as shown on Slide 28. During summer months (July through September) there appears to be no unacceptable net fishery impact when water is recirculated by delivering Delta water to the San Joaquin River via the DMC and the Newman Wasteway, and then back down the river to the Delta. This recirculation was demonstrated in August of 2004 at a time when Vernalis flow was about 1000 cfs. That 1000 cfs flow was only marginally adequate to maintain water depth from Vernalis to the head of Old River, and the salinity at Brandt Bridge could then not meet the standard with 0.7 EC at Vernalis. 250 cfs was released through the Newman Wasteway while New Melones releases were kept constant. This flow increased the water depth at Vernalis by about half a foot and lowered salinity by about 0.1 EC. When there is 0.6 EC at Vernalis, it comes close to providing 0.7 EC at Brandt Bridge providing the inflow to the head of Old River is sufficiently reduced by low head pumps at the tidal barriers so that an adequate downstream flow continues past Brandt Bridge. This option could be implemented now. It does not have to wait for new barriers. It could achieve compliance with the Brandt Bride standard.

If it is desirable for upstream reasons, DMC water could be circulated via the Mendota Pool, per Slide 29. Thirty years ago John Garamendi and I requested and then witnessed a modest circulation via the Westley Wasteway to augment Vernalis flow. This option is shown on Slide 30.

From mid-May to July 1 the above type of DMC recirculation might be detrimental to fisheries. At those times the increase needed in Vernalis flow and quality can be obtained by using borrowed water which is replaced later. For example, water can be borrowed from San Luis Dam in June and replaced in July and August. Or it can be borrowed from deliveries being made to subsurface or surface storage south of the Delta during June and replaced in July and August. It may also be possible to provide spring fish flows in ways that do not reduce Vernalis flows from mid-May to July 1. During a low flow year the Department of Fish and Game arranged this type of recirculation to convey Merced salmon smolts to the Delta.

These and perhaps other measures can be combined in ways that are optimum for each situation. It is not clear that any substantial releases of stored water are necessary to comply with the 0.7/1.0 EC salinity standard. If a somewhat higher salinity was permitted, essentially the same measures would still be needed. Nothing would be gained by raising the standards.

<u>Summary</u>

Prior to operation of the CVP and SWP there was no salinity problem in the South Delta except briefly during extreme drought. Natural processes release a substantial salt load into the river system, but these native salts enter the system during high flows. They are therefore flushed through the South Delta toward the Bay with ample dilution and low salinity.

Operations of the CVP and SWP cause a large importation of salt into the San Joaquin watershed that was not previously there. This imported salt is greatly concentrated by consumptive use of water in the CVP Service Area. Part of it then drains to the river via drainage from farm lands and wetlands. This imported salt thereby creates the South Delta salinity problem. Farmers in the South Delta add very little salt.

River flows that can dilute this imported salt have been reduced by exports from the watershed, by shifts in time of river flow away from the periods of largest drainage inflow, and by increases in consumptive use of water to grow the food that is needed by population growth.

Even when dilution water from New Melones is provided to comply with the Vernalis salinity standard, the imported salt load is still there. Farm crops in the South Delta necessarily consume water and reconcentrate that salt load, just as CVP water users concentrate the salt in water from the DMC. The salinity therefore again rises as the Vernalis flow goes downstream.

Determining the channel water salinities that can provide irrigation water that is adequate to provide full crop yields in the South Delta is a very complicated process, as shown by the testimony which led to the 0.7/1.0 EC standard. The permeability of many South Delta soils is very low. High "leach fractions" are not feasible. The salt sensitivity of seedlings is greater than the sensitivity of established plants, and it is difficult to control soil moisture salinity in the shallow root zone of young plants. There has been no change in the science involved in salinity versus crop yields. We see no reason to expect that a change in EC standard would result from a repetition of the thorough analysis that took place at the time the standards were established. We <u>do</u> believe that the implementation of the standards should avoid large fluctuations in salinity during a lunar month, and that there should be monitoring that better represents the location of maximum salinity within each channel reach during each mode of in-channel flows caused by barrier operations and recirculation via the DMC or with low head pumps.

I have explained why we have a salinity problem and how it can be cured. I look forward to your questions.

ATTACHMENT 2

11/1/2008

Measures Which Can Meet All Regulatory Requirements in South Delta Channels
By Alex Hildebrand, Engineer for South Delta Water Agency

Introduction

Recent discussions have been held among engineers in the Department of Water Resources, (DWR), the U.S. Bureau of Reclamation (USBR), and the South Delta Water Agency (SDWA) These discussions served to clarify and define methods, most of which have been previously proposed, by which DWR and USBR can comply with salinity, dissolved oxygen (DO), and water level requirements in South Delta channels while using temporary barriers and current methods of export. Those regulatory requirements apply throughout the portions of the San Joaquin channel, Middle River, Grantline Canal, Old River and other channels that are within the SDWA. Upstream diverters would not be impacted. The measures meet in-channel water requirements. They are not designed to benefit any individual diverter.

Cause of the Degradation of Channel Waters

Sixty-five years ago, prior to the CVP, there was always low salinity in South Delta channels, and tidal water levels in those channels were not depressed by the drawdown of CVP and SWP pumps. The SWRCB, therefore, made compliance with South Delta salinity standards a permit condition for exports by CVP and SWP.

The tides bring Bay salt into the western Delta. Some of this salt is entrained in the north to south flow of Sacramento water toward the pumps. One half million to one million tons per year of this entrained salt is in water conveyed by the DMC to the westside CVP service area in the San Joaquin watershed. Crop plants and wetlands plants in the service area consume most of the water and reject the salt. Drainage waters from the service area therefore put several hundred thousand tons of this imported salt into the river in most years. This salt is diluted at Vernalis by releases from New Melones. However, the salt is not removed. It, therefore, is reconcentrated as it flows into South Delta channels. No significant amount of salt is added by local diverters, but South Delta crops can not consume water as a necessity of crop growth without reconcentrating the imported salt that is in the consumed water but is rejected by crop plant roots and flows back to the channels in return flow waters.

Unless and until this imported salt load is kept out of the river, there must be enough dilution water in each channel to meet the salinity standard, and enough flow to avoid local concentrations of salt. The flow can be provided by measures to recirculate water. The dilution to control salinity can be provided by recirculating water of sufficient quality and input location to avoid channel reaches with increased salinity.

In order to meet those requirements there must be a net unidirectional flow through each channel to prevent stagnant reaches where the salt contained in flows entering each channel can accumulate and where DO is depleted. This must be done while complying with established minimum water level needs. It must also be accomplished during neap tides and during periods of above normal temperature when local diversions exceed monthly averages.

<u>The following measures can collectively meet those requirements:</u>

1) Recirculation of water must be provided from the DMC into the San Joaquin River through the Newman or Westley Wasteway and back past Vernalis into the South Delta. It is currently assumed that the resulting minimum flow at Vernalis must be maintained at about 1000 cfs, but this flow requirement can be adjusted by the degree to which downstream measures are provided to distribute that flow among downstream channels in proportion to local diversions in each channel and by the total magnitude of local diversion at different times of the year.

The potential for salinity compliance is not limited to summer months. However, the group of engineers has focused on the period of July 1 through September 15. That period involves the largest local diversions and the least potential for conflict with fishery concerns.

Also, the needed minor alterations to temporary barriers are not affected significantly by a typical range of summer Vernalis flows. The modeling is, therefore, being based on the actual Vernalis flows that occurred in 2008 including recirculation flows.

During recirculation, releases from New Melones must be maintained at the rate that would be required in the absence of recirculation. (During 2004 and 2007 the Vernalis flow absent recirculation did not drop below about 750, but in August and September of 2008 it has been down to a little over 600 cfs)

2) When item (1) is being provided, the salinity standards at Brandt Bridge are expected to be met. The flow at that location will some times be a reverse flow. However, it now appears that consequent intermittent stagnation during periods of reversal will not cause salinity violations. High tidal flows and the large volume of water in that channel serve to dampen the effect of brief periods of stagnation. In years after 2009 a method should be provided to control the flow split at the head of Old River.

The engineering group has so far focused on the recently typical situations where recirculation has been needed to maintain an adequate minimum Vernalis flow. Under those conditions, the flow split at the head of Old River appears to be about as desired. However, it may not be optimum, and over a wider range of Vernalis flows we will need some sort of adjustable weir, or deflector to more efficiently control that split. We do not assume that this measure would be accomplished in 2009. However, a determination of how best to do this should be authorized so that it can be considered for 2010.

3) Salinity and DO control in Old River between Doughty Cut and the barrier can be provided by shifting some of the water flowing into Grantline Canal to flow instead into Old River. A small shift is now provided by opening and closing flap gates at the Old River barrier. However, this shift is limited by the need to avoid a loss of water level in Old River. Further, if this method is vigorously pursued it may require increased pumping into Tom Paine Slough. Modeling has shown that with 1000 cfs flow at Vernalis, there is more than enough downstream flow through Grantline Canal, but an insufficient flow into Old River. There needs to be an engineered increase in height of the Grantline barrier so that the flow split between the channels is in proportion to the local diversions in those channels. This is not expected to require a large increase in height.

(4) In Middle River, stagnation can be avoided and salinity standards met, and water level needs maintained by creating a net upstream flow from the barrier to Old River. This can be done by an engineered combination of adding culverts in the barrier, raising the barrier, and, if necessary or desirable, pumping to increase water capture at the barrier. This will also decrease the Vernalis flow requirement by supplying local diversions in Middle River with water from the central Delta.

The water elevation in Old River at the head of Middle River will be affected by measures one through three above, which in turn affects the needed magnitude of this measure. Upstream flow could also be facilitated in future years by doing the dredging in Middle River that is contemplated in the SDIP. Any significant flow of Middle River water into Old River would have the further benefit of contributing to salinity control in Old River and minimizing the flow needed at Vernalis.

5) Diverters from Tom Paine Slough and elsewhere are diverting water which contains the salt load that entered the channel system at Vernalis. This salt is then concentrated by crops and drains into Paradise Cut. Diverters in the tidal portion of Paradise Cut also concentrate the incoming salt in their return flows. There is very little circulation in Paradise Cut, but tidal flows draw salt into Old River as the salinity in Paradise Cut rises. This problem can be corrected by pumping some of the San Joaquin flow over the Paradise Cut weir. Some of the Vernalis flow which now flows to the head of Old River will then instead be conveyed to Old River by flowing through Paradise Cut. This is part of the need to control circulation to avoid local reaches with high salinity. The size of this pump is still being considered, but is expected to be within the range that is now done into Tom Paine Slough.

6) Operation of the above measures requires that salinity be monitored in channel reaches that would be the most likely to experience stagnation, particularly in Old River. Modeling can determine these most probable locations and monitoring at those locations can then be established.

Almost all of the above measures have been discussed in prior years in less detail and can be implemented next year, and thereafter providing the necessary engineering and other permitting and preplanning is done and so that the measures are implemented before the barriers are installed in 2009.