TECHNICAL MEMORANDUM

DATE: February 14, 2012

TO: Dennis Diemer, Woodland-Davis Clean Water Agency

CC: Doug Baxter, City of Woodland
    Diane Phillips, City of Davis

FROM: Steve Macaulay, R.C.E. #C24878

REVIEWED BY: Jim Yost, R.C.E. #24137
              Dave Anderson, R.C.E. #27659

SUBJECT: Update to the 2009 Evaluation of the Tehama-Colusa Canal Intake
         Alternative for the Davis Woodland Water Supply Project

This technical memorandum (TM) updates the November 2009 TM entitled “Davis Woodland Water Supply Project, Additional Evaluation of Tehama-Colusa Canal as Potential Surface Water Intake” (attached as Appendix A). The November 2009 TM evaluated the potential benefits of using the existing Tehama-Colusa Canal (TCC) as an intake for the Davis-Woodland Water Supply Project (DWWSP) as an alternative to building a new intake on the Sacramento River east of Woodland. This TM summarizes past issues and findings, along with an update.

Use of the TCC as an alternative for diversion and delivery of water from the Sacramento River has been attractive from a conceptual standpoint since: (1) the water historically has been diverted by gravity from the Sacramento River, from which it is delivered by gravity to water users as far south as Dunnigan; (2) the TCC is an existing facility that has been delivering water since 1964; and (3) operators of the TCC Authority have long been interested in extending the TCC to serve more customers and more broadly distribute repayment obligations and operating costs for their facilities. Past evaluations of the potential use of the TCC for the DWWSP have identified significant cost, environmental and institutional challenges that make this option unattractive.

Appendix A described a number of reasons why the TCC was not considered as a credible alternative for delivery of Sacramento River water to the DWWSP. One of the principal reasons was lack of a reliable water intake for the TCC at Red Bluff, due to documented conflicts with migratory fish since the TCC was completed in 1964. Since 2009, a fish passage improvement project has begun which will soon solve this longstanding problem. Progress on the Red Bluff Fish Passage Improvement Project is documented on the U.S. Bureau of Reclamation’s (USBR) project web site: http://www.usbr.gov/mp/rbfish/.

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According to the USBR web site, the solution to longstanding fish and water supply conflicts at the intake to the TCC will be in place for water deliveries beginning in May 2012, with the project completed by the end of 2012. The solution has been construction of an entirely new intake, replacing the gravity facility (created in 1964 by putting a dam with removable gates on the Sacramento River at Red Bluff during the irrigation season) with a more classic pumping diversion. The Red Bluff Fish Passage Improvement Project is estimated to cost around $200 million. This new intake is expected to allow diversions of water from the Sacramento River into the TCC on a regular basis without harming migrating fish such as salmon and steelhead.

While the Red Bluff Fish Passage Improvement Project will provide a reliable water intake to the TCC, there are still the following factors which make the TCC unattractive from a water supply, financial, water quality, and fisheries standpoint (taken from the list of disadvantages on page 5 of Appendix A):

1. There will be conveyance system losses as water is transported in an open canal from Red Bluff to Yolo County.
2. There is a potential for water quality degradation, as described in Appendix A.
3. Conveyance charges for use of the TCC will apply, and will need to be negotiated. While not addressed in the 2009 TM, we expect that some portion of the $200 million costs of the Red Bluff Fish Protection Facility will be included in any use-of-facilities charges, plus operations and maintenance costs for the new pumps that replaced the longstanding gravity intake. This, and other factors and facilities, will contribute to an intake option that would be much more expensive than construction of a new intake in Yolo County.
4. A new pipeline would need to be constructed from the end of the TCC to the DWWSP water treatment plant, which would require a pumping plant.
5. We expect significant opposition, and therefore project delays, to changing the point of the intake under the DWWSP water right permit from the current planned location to Red Bluff. This opposition is expected to come from state and federal fishery agencies who would likely be opposed to reducing flows in the Sacramento River for the 100-mile+ stretch between Red Bluff and the Woodland area. In addition to risking project-halting opposition, the resulting project delay in resolving the protests and gaining State Water Resources Control Board water right modification approval would result in a significant project delay which would have very significant financial implications to the DWWSP.

While these five points are documented in the 2009 TM, we are also aware that the USBR has operational concerns with regard to water temperatures in the Sacramento River from Redding down to Sacramento. Water temperatures are controlled by release of colder water from Shasta Dam. If additional water is diverted out of the Sacramento River at Red Bluff, it is possible that compliance with USBR temperature control obligations would be made more difficult and could require the release of additional water from Shasta Dam. We believe this is a significant enough issue to expect that the USBR would oppose the change in intake location for the DWWSP water rights as having adverse impacts on USBR operations and water supply. These water temperature operational constraints exist due to regulatory requirements under the Federal Endangered Species Act.
Finally, a change in the location of the water supply intake from Yolo County to Red Bluff requires approval from the State Water Resources Control Board under their water rights authority. We expect that even if the change could be made successfully, it would require the preparation of a supplemental environmental impact report and the conduct of a water rights hearing with participation by parties opposed to the change. All this would increase DWWSP project costs, with the most significant costs being the delay of project construction by at least 2-3 years. The Woodland-Davis Clean Water Agency’s water rights attorney would provide the best estimate of the delays that might be experienced, and what the difficulties would be.

We have not updated cost estimates of the TCC alternative intake analysis in the 2009 TM. While this technical work could be done, I believe it is not warranted due to the magnitude of expected cost differences between the TCC and the planned DWWSP intake, combined with the very significant time delays, institutional and environmental issues associated with changing the water rights point of diversion to Red Bluff.
APPENDIX A

TM - “Davis Woodland Water Supply Project, Additional Evaluation of Tehama-Colusa Canal as Potential Surface Water Intake”
TECHNICAL MEMORANDUM

DATE: November 20, 2009

TO: Bill Emlen, City of Davis
     Mark Deven, City of Woodland
     Bob Weir, City of Davis
     Greg Meyer, City of Woodland
     Jacques DeBro, City of Davis
     Doug Baxter, City of Woodland
     Keith Smith, City of Davis
     Diane Phillips, City of Davis
     Dick Donnelly, City of Woodland
     Liz Houck, City of Woodland
     Sid England, UC Davis
     David Phillips, UC Davis
     Alan Lilly, BKS
     Richard Shanahan, BKS
     Leslie Moulton, ESA
     Paul Garcia, ESA

FROM: Steve Macaulay, P.E.
      Lindsay Sadler, P.E.

Reviewed By: Jim Yost
              Dave Anderson
              Monique de Barruel

SUBJECT: Davis-Woodland Water Supply Project, Additional Evaluation of Tehama-Colusa Canal as Potential Surface Water Intake

INTRODUCTION

The cities of Davis and Woodland and the University of California at Davis are working as Project Partners to develop a regional water supply project, known as the Davis-Woodland Water Supply Project (DWWSP), to divert and treat Sacramento River water and convey the resulting potable water to their distribution systems. The scope of the DWWSP as set forth in the October 2007 Final Environmental Impact includes replacing the unscreened intake owned by Reclamation District 2035 with a screened intake owned jointly by RD 2035 and the Project Partners, constructing a water treatment plant (WTP) east of Woodland, and constructing pipelines to convey raw water to the WTP and potable water to the Project Partners’ water storage and distribution systems.
In April 2009, City of Davis staff requested that West Yost Associates (West Yost) prepare an updated evaluation of costs for the Tehama-Colusa Canal (TCC) as a potential surface water intake for the DWWSP. The October 2007 Final EIR for the DWWSP rejected this alternative because the costs were significantly higher than the other alternatives being considered. The possibility of extending the TCC continues to come up – in part due to news earlier this year that a long-term solution to the problems with the TCC’s present water intake may soon be underway. Additional questions were raised at the first JPA Board meeting regarding the feasibility of the TCC as a potential conveyance option for Sacramento River water, either now or in the future. The purpose of this technical memorandum update is to revisit advantages and disadvantages of this option, including updated cost information.

A summary of current technical information on potential use of the Tehama-Colusa Canal as the DWWSP water intake was presented to Davis staff at a meeting in early May. That information summarized advantages and disadvantages based on information from the 2007 Final EIR and updated cost estimates. Subsequently, we were requested in mid-October by the Project Partners to prepare a final technical memorandum (TM) following the first meeting of the DWWSP Joint Powers Authority (renamed the Woodland-Davis Clean Water Agency) to document available information.

DESCRIPTION AND LOCATION OF TEHAMA-COLUSA CANAL

The Tehama-Colusa Canal is an agricultural water supply facility that diverts water from the Sacramento River at Red Bluff. Currently the diversion is made by gravity, made possible by damming the Sacramento River by means of operable gates that form an on-stream shallow reservoir behind the dam when the gates are closed. A long history of fish passage problems with this dam have resulted in it being targeted for removal, with replacement of the gravity intake by a pumping plant and fish screen. Existing facilities are limited to use for four months of the year due to conflicts with threatened and endangered fish species, principally Chinook salmon. The TCC is 140 miles long and provides irrigation water to 150,000 acres of farmland in the Tehama-Colusa Canal Authority service area. A map of the canal is shown in Figure 1 below.
An extension would need to be constructed to deliver water from the terminus of the TCC to the DWWSP water treatment facility. This is shown conceptually in Figure 2.
QUALITATIVE ADVANTAGES AND DISADVANTAGES

As indicated in the 2007 FEIR, there are a number of advantages and disadvantages to the TCC as compared to the RD 2035 intake (and other local water intake options). Principle advantages and disadvantages are summarized below and updated with new information.

Advantages

- Gravity flow, saves energy (this was identified as an advantage in the attached August 3, 2006 technical memorandum prepared by CH2M Hill, but will no longer be the case with the new TCC intake pumping plant).
- Better source water quality in the Sacramento River at Red Bluff.
- Diversion and conveyance facilities in place with sufficient additional capacity available to serve the DWWSP.
- Sustainable new diversion facilities being implemented (the TCC gravity diversion is planned to be converted to a screened and pumped diversion, which would eliminate past environmental issues).
- Potential to use canal to provide storage.
- New RD 2035 diversion would take time and expense.

**Disadvantages**

- Conveyance system losses (10 percent) through the TCC, reducing net delivered supplies.
- Unreliable for a municipal water system (this problem may be reduced when the new diversion facility is in operation, but, except for the DWWSP, the TCC still would be only for irrigation and therefore may not have the seasonal continuity in operations or the day-to-day reliability required for a municipal supply).
- While water quality at Red Bluff is high, water quality at the southern terminus of the TCC is likely not better than the planned location on the Sacramento River (particularly as it relates to salinity). Any savings from reduced cost of treatment would be negligible (CH2M Hill memorandum).
- Potential water quality degradation. Water quality in the TCC is affected by application of aquatic pesticides for control of aquatic weeds. This is a potential serious concern regarding use of the TCC for drinking water supplies.
- Red Bluff Diversion Dam not currently sustainable because of environmental problems (planned new diversion facilities will correct this).
- TCC substantially more expensive – details, including updated cost estimates, are provided below.
- Conveyance charges for use of TCC will apply and must be negotiated. This is subject to terms and conditions of the federal Warren Act, which provides for use of federal water project facilities by non-project customers. Such rates are typically much higher than those for federal water customers, since they cannot benefit from federal water project subsidies provided for in federal Reclamation Law.
- The pipeline extension from TCC will likely require a pumping plant (not accounted for in 2006 CH2M Hill memorandum).
- Changing the authorized point of diversion in the water right application from the specified points in Yolo County to the Red Bluff Diversion Dam probably would be opposed in the water right process (following the 2007 EIR’s rejection of the TCC alternative, the DWWSP Partners agreed in two protest-dismissal agreements that the Red Bluff Diversion Dam alternative would be deleted from the water right applications, so additional negotiations with these protesters, and possibly other interested parties, would be needed to add this point of diversion back to the application).
- This change in point of diversion will result in a reduction in Sacramento River flows from the TCC diversion in Red Bluff to the planned DWWSP diversion in Yolo County, which could raise environmental issues.
• New Red Bluff diversion facilities will be very expensive. The federal funding component now appears to be available, but a substantial portion is “reimbursable” (i.e. required to be repaid by users). The DWWSP would likely be expected to pay some portion of the costs of the new diversion facilities.

• Fewer options for summer water purchase, unless exchange agreements are developed and authorized for sellers downstream of TCC intake.

NEW TCC INTAKE AT RED BLUFF

Based on new information not available at the time of the FEIR, the TCC is planned to be converted to a long-term reliable water conveyance facility in the next few years through construction of a new water intake consisting of a pumping plant and modern fish screen. Plans for the new intake and settlement of litigation have advanced during 2009. The TCC Fish Passage Improvement Project is described on the Tehama-Colusa Canal Authority web site (http://www.tccanal.com/fishpassage.php). That web site also includes press releases from the Tehama-Colusa Canal Authority and the U.S. Department of the Interior indicating that the federal government will provide $110 million of the total estimated costs of $220 million for this major TCC intake facility. The remaining funding has not been secured, but is likely to be a combination of state bond funds and local cost share.

UPDATED COST COMPARISONS, TCC VS. RD 2035 INTAKE

Based on past cost estimates, using the TCC as the DWWSP water intake was estimated to cost at least $48 million, as compared to $28 million for sharing a new RD 2035 intake (August 3, 2006 memorandum, CH2M Hill). This estimate was based on a simple assumption for pipeline length – a straight line between the terminus of the TCC and the DWWSP treatment plant as shown in Figure 2. These costs also did not consider that the DWWSP would likely have to pay some share of new TCC intake costs and a possible pipeline pumping plant, and the fact that the DWWSP would likely also face at least $1 million of annual costs to use TCC facilities (October 2007 Final EIR).

Here are the assumptions used to develop a TCC cost update for comparison purposes:

1. Pipeline from TCC terminus to the new treatment plant would be 23.5 miles based on a realistic evaluation of potential alignment.

2. Based on the alignment, substantial costs were added for trenchless construction (boring) under Interstate 5 (2), railroad tracks (2) and a canal.

3. Pumping plant would likely be needed for this pipeline, given elevation differences, amount of water conveyed and the need to get the water into the water treatment plant (pumping plant not assumed in the CH2M Hill 2006 memorandum).
4. $8 million in allocated capital costs to the DWWSP for the $220 million new TCC intake structure at Red Bluff. This assumption for allocated cost is based on need for 80 cubic feet per second (cfs) of the 2,180 cfs of pumping capacity planned for the new TCC intake. This allocated cost is an educated guess since local cost shares are unknown at this point, and in any case would be negotiated. Additionally, the DWWSP is not a federal water customer. It is unclear whether “non-reimbursable” funding from the federal government would need to be reimbursed for the DWWSP allocated share – it is a subsidy intended to benefit federal agricultural water customers. Such costs could likely be higher, but it is unknown whether this would be a capital cost obligation or rolled into facility use fees for the TCC.

5. While not included in the table below, the uncertainties in water rights, the need to establish an urban water delivery priority through TCC facilities, and conveyance “use of facilities” fees are matters that will require extensive negotiations and are likely to increase costs by an unknown, but substantial, amount.

Table 1 below shows the comparison of costs, in 2006 dollars, (the original basis in the CH2M Hill memorandum) that was included in the CH2M Hill memorandum. The TCC cost estimate shown is no longer applicable due to the pending investment in the new intake at Red Bluff.

Table 1. Capital Cost Comparison between RD 2035 and Tehama-Colusa Canal Alternatives from the August 2006 CH2MHill Memorandum

<table>
<thead>
<tr>
<th>Component</th>
<th>RD 2035 Intake 2006 Memorandum $1, dollars</th>
<th>Tehama-Colusa Canal 2006 Memorandum $1, dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversion</td>
<td>11,500,000</td>
<td>0</td>
</tr>
<tr>
<td>Conveyance (pipeline)</td>
<td>16,800,000</td>
<td>48,000,000</td>
</tr>
<tr>
<td>Pipeline pumping plant</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28,300,000</td>
<td>48,000,000</td>
</tr>
</tbody>
</table>


Table 2 below summarizes the updated cost comparisons, in mid-2009 dollars, for the two potential water intakes. The RD 2035 diversion, intake, and pump station cost was updated by Montgomery Watson Harza and the conveyance pipeline between the intake and the water treatment plant have been updated by West Yost.
Table 2. Updated Capital Cost Comparison between RD 2035 and Tehama-Colusa Canal Alternatives

<table>
<thead>
<tr>
<th>Component</th>
<th>RD 2035 Intake Updated(^{(1)}), dollars</th>
<th>Tehama-Colusa Canal Updated(^{(2)}), dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversion</td>
<td>16,000,000</td>
<td>8,000,000</td>
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<tr>
<td>Conveyance (pipeline)</td>
<td>27,000,000</td>
<td>90,000,000</td>
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<tr>
<td>Pipeline pumping plant</td>
<td>0</td>
<td>9,000,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>43,000,000</td>
<td>107,000,000</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Costs for the RD 2035/DWWSP Sacramento River diversion/intake/pump station prepared in April 2009 by Montgomery Watson Harza (MWH).

\(^{(2)}\) Updated costs for the Tehama-Colusa Canal alternative prepared by West Yost as described in this section of the TM.

None of these costs include electrical energy or other costs of operation. It is assumed that the total pumping energy costs would be roughly the same for both the RD 2035 and TCC intake options, but detailed energy requirements have not been determined. Also not included are facility use fees for the TCC, which are required under federal law. These costs have not been annualized, but they were assumed in the FEIR to be at least $1 million per year. The potential TCC advantage of providing storage was not evaluated, but this is probably not realistic due to a conflict with the primarily agricultural operations of the TCC – particularly during the peak irrigation season when storage would be of benefit to the DWWSP.

**WATER QUALITY**

As discussed in the 2007 FEIR, the TCC intake would allow DWWSP to divert surface water flows higher up in the Sacramento River watershed at Red Bluff. Although the water quality at the downstream diversion site meets all applicable water quality standards, these supplies may contain trace amounts of agricultural runoff and municipal wastewater constituents that may be higher in concentration than at the TCC intake at Red Bluff.

On the other hand, the higher quality water diverted to the TCC may contain higher salinity levels by the time the water reaches its southern terminus, since it is subject to evaporation in the relatively small concrete-lined canal. A loss of about 10 percent in water supply, and a corresponding increase in salinity, is estimated to occur during conveyance from the TCC intake to the DWWSP service area (FEIR, 2007).
One additional potential concern is the chemicals added to TCC water to control algae. The Tehama-Colusa Canal Authority (TCCA) uses an integrated pest management approach to control aquatic weeds in the TCC, including cultural, mechanical and chemical techniques (“Use of Copper and Acrolein to Control Aquatic Weeds in Irrigation Canals”, California Environmental Quality Act Initial Study and Mitigated Negative Declaration, August 4, 2004). We have not gathered or evaluated water quality information related to the TCCA aquatic weed control program. Control of aquatic weeds (including algae) through introduction of aquatic pesticides is allowed under State Water Resources Control Board Water Quality Order 2004-0009-DWQ, a general statewide permit. This permit includes substantial requirements for pesticide application and monitoring, and is designed to protect the beneficial uses of the water body. However, all TCC water now is used for agricultural purposes. If the TCC were to be used for municipal water supply purposes in the future, any use of aquatic pesticides would be subject to regulations and requirements of the SWRCB and Central Valley Regional Water Quality Control Board, and would have to satisfy drinking water source requirements of the Department of Public Health’s Drinking Water Program. There could be substantial additional costs to the TCCA to comply with these regulations and requirements.

Regardless of the intake location, all water would go through a modern, state-of-the-art water treatment facility capable of treating the water to drinking water standards.

CONCLUSIONS AND RECOMMENDATIONS

The TCC as an intake and conveyance option continues to be substantially more expensive – more than 2.5 times the capital cost of the RD 2035 alternative. A more thorough evaluation of both options (including follow-up discussions with the U.S. Bureau of Reclamation and the Tehama-Colusa Canal Authority) would refine the costs, but a very large difference in costs would remain.

In addition, the uncertainties in water rights, municipal water delivery priority through agricultural conveyance facilities, and conveyance costs are matters that will require extensive negotiations and are likely to increase costs further and complicate and delay DWWSP implementation. There are also potential concerns about the impact of chemical aquatic weed control on source water quality for drinking water purposes. For these reasons, the TCC is not considered to be a viable alternative to the planned DWWSP diversion at a shared RD 2035 intake site.

SCM:LS:mal

Attachment
Introduction

This memorandum was prepared in response to a June 8, 2006 meeting between representatives of the Davis-Woodland Water Supply Project and the Tehama-Colusa Canal Authority (TCCA). The meeting was arranged following a public scoping meeting on the Davis-Woodland Water Supply Project where a canal extension was proposed as an alternative for consideration in the upcoming EIS/EIR. The focus of that meeting was a presentation by the TCCA outlining a possible extension of the Tehama-Colusa Canal (T-C Canal) to serve areas in Yolo County, particularly as a component of the Davis-Woodland Water Supply Project.

The Red Bluff Diversion Dam (RBDD) diverts water into the T-C Canal as part of the federal Central Valley Project. The facilities allow the U.S. Bureau of Reclamation (Reclamation) to deliver water to member districts of the TCCA, amounting to over 100,000 acres of irrigated lands with over 300,000 acre-feet of water service contracts. Additionally, T-C Canal operations are also coordinated with the Glenn-Colusa Irrigation District (GCID), the largest irrigation district in the Sacramento Valley, which has major interties with the T-C Canal, and senior water rights. Operations are also coordinated with the Orland Unit Water Users Association (OUWUA) near Stony Creek, another senior water rights holder in the valley.

Construction of RBDD - which is located just downstream from the city of Red Bluff - was completed by Reclamation in 1964, and placed in operation two years later. The dam has a series of spillway bays, each 60 feet wide, separated by 8-foot wide piers. When the spillway gates are fully open, the Sacramento River is essentially unimpeded as it passes through the spillway bays. When the dam gates are closed, the elevation of the Sacramento River rises and water can be diverted by gravity into the canal at a maximum rate of 2,500 cfs.
When the gates are in the raised position, water is diverted through a variety of pumps at the RBDD with a total capacity of 480 cfs. Additionally, up to 700 cfs of diversions are seasonally available from Stony Creek as well as approximately 100 cfs worth of existing turnouts connected to the OUWUA system.

The T-C Canal is a 111-mile concrete-lined conveyance facility originating at the RBDD and terminating near Dunnigan. The canal is kept full year-round to preserve the integrity of the canal panels, and typically holds approximately 10,000 acre-feet of water. Original designs for the canal called for a terminal reservoir of indeterminate size and/or further extension into Yolo County, possibly connecting to the Putah South Canal system. Full development of the system was shelved due to budgetary constraints during the Vietnam War.

The TCCA earlier this year adopted a policy to improve fish passage at RBDD and enhance water supply reliability by reducing or eliminating reliance on the dam. That policy builds upon a considerable body of work that the authority has undertaken in recent years. Well over 100 alternatives were refined down to a few which represented the most feasible alternatives, including one option that would move away from gravity diversion and instead pump the water out of the river through state-of-the-art fish screens, while maintaining the ability to divert up to 2,500 cfs. A final decision on the preferred alternative for the project is expected by the end of 2006.

**Description of Alternatives**

The Davis-Woodland Water Supply Project is currently evaluating three alternatives for delivery of surface water to Davis, UC Davis, and Woodland. These three purveyors currently supply customers with groundwater, and the proposed project would supplement existing groundwater supplies with surface water. Existing alternatives under consideration by the Davis-Woodland Water Supply Project rely on pumped diversions from the Sacramento River, conveyance to a surface water treatment plant, and subsequent storage and distribution to customers. Three points of diversions from the Sacramento River are currently under consideration, each providing approximately 100 cfs of diversion capacity. Water would be appropriated through initiation of county of origin water rights and transfers from willing sellers. Evaluation of the predictability and reliability of these water right actions is beyond the scope of this memorandum, although project proponents acknowledge that the Water Supply Project would have relatively junior water rights on the Sacramento system.

As originally envisioned, the T-C Canal alternative would replace the Water Supply Project’s Sacramento River diversions with the existing T-C diversion at the RBDD. Conveyance from the T-C Canal would potentially allow for gravity flow into the proposed Water Supply Project facilities (compared to the pumping that would be required in the existing alternatives), and would accommodate a proposed water treatment plant at a location along the proposed conveyance route that would maximize the benefits of gravity-flow water, rather than at one of the sites proposed in the existing alternatives. It is also possible that the storage in the T-C Canal could replace some or all of the proposed reservoirs outlined in the existing alternatives.
Cost Comparisons and Assumptions

Based on planning-level unit cost estimates provided by West-Yost Engineers, the T-C Canal extension would be more expensive than the alternatives currently under consideration because the conveyance distance would be longer. However, the T-C Canal extension would eliminate the need for a new diversion on the river, which partially offsets the increased cost from the longer conveyance route. Additional cost savings would also accrue from O&M savings because the T-C Canal extension could potentially supply water via gravity -- eliminating the need for pump stations required to move Sacramento River water to the western edges of the service areas. Storage reservoirs included as part of the proposed project might be eliminated by virtue of the existing storage in the 111-mile canal. However, further operational analysis is needed to compare the two systems, which is beyond the scope of this memorandum.

It is also important to note the uncertain nature of planning-level cost estimates. Although the estimates presented here provide a sense of relative costs, actual costs may differ widely after accounting for environmental, engineering, construction management, and other “soft” costs. Accordingly, the alternatives outlined here are considered to have comparable capital costs. Final project costs for all alternatives described here are likely to be higher. Table 1 provides a comparison of the four alternatives based on the West Yost planning-level construction cost estimate, based on the following assumptions:

- **Alternative 1 – Shared Diversion at RD 2035**
  - **Diversion:** Upgrade of existing RD 2035 diversion, with separate pumping station for conveyance to Water Supply Project (construction estimate based on 25 percent share of current estimate for RD 2035 upgrade and $150,000 per MGD pumping capacity).
  - **Conveyance:** 5.0 miles of conveyance via 60” diameter pipe (construction estimate based on $10/diameter-inch per LF of standard construction and $25/diameter-inch per LF of trenchless construction).

- **Alternative 2 – New Diversion at River Mile 67.75**
  - **Diversion:** New construction at RM 67.75 (construction estimate based on $250,000 per MGD pumping capacity).
  - **Conveyance:** 7.9 miles of conveyance via 60” diameter pipe (construction estimate based on $10/diameter-inch per LF of standard construction and $25/diameter-inch per LF of trenchless construction).

- **Alternative 3 – New Diversion at River Mile 63.5**
  - **Diversion:** New construction at RM 63.5 (construction estimate based on $250,000 per MGD pumping capacity).
  - **Conveyance:** 5.5 miles of conveyance via 60” diameter pipe (construction estimate based on $10/diameter-inch per LF of standard construction and $25/diameter-inch per LF of trenchless construction).

- **TC Canal Alternative – Existing Diversion at Red Bluff Diversion Dam**
- **Diversion:** Existing diversion capacity at RBDD sufficient to meet needs of Water Supply Project.

- **Conveyance:** 15 miles of conveyance via 60” diameter pipe (construction estimate based on $10/diameter-inch per LF of standard construction).

### TABLE 1
Planning-level Construction Cost Estimates of Alternatives

*Note: Estimates developed from existing West Yost unit costs*

<table>
<thead>
<tr>
<th>Component</th>
<th>Alternative 1 – RD 2035</th>
<th>Alternative 2 – RM 67.75</th>
<th>Alternative 3 – RM 63.5</th>
<th>TC-Canal Alternative A</th>
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<td>Diversion</td>
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<td>$34,000,000</td>
<td>$48,000,000</td>
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*Note: Estimates do not include environmental, financial, engineering, legal services, contingencies, or other related project costs. These estimates are for comparison purposes only, and are likely accurate within 30-50 percent, per industry standards.*

^ Potential cost savings from reduction or elimination of storage reservoirs in the Water Service Project Alternatives are not included here. Further analysis is required to evaluate the feasibility of eliminating surface water storage reservoirs.

### Pumping Costs

An important consideration in the comparison of alternatives described here is operation and maintenance cost of the alternatives, specifically related to the cost of pumping. Water Supply Project Alternatives would all require pump stations to lift water from the Sacramento River (approximate elevation 16 feet MSL) to the western edge of Woodland (approximate elevation 75 feet MSL). Based on an assumed electric rate of 12 cents/kWh and total deliveries of 43,800 acre-feet per year, pumping costs would be approximately $600,000 per year. Pumping may not be necessary under the T-C Canal Alternative. Depending on assumptions for interest rates and project life, this additional cost adds $8,000,000 to $10,000,000 in present value cost to the Water Supply Project alternatives.

### Other Considerations

There are other important considerations in assessing the strengths and weaknesses of the proposed alternatives, several of which do not easily lend themselves to financial comparisons. Important non-financial considerations affect feasibility, constructability, operational flexibility, and reliability. Following are some important non-financial considerations which would differ between the Water Supply Project Alternatives and the T-C Canal Alternative.

### Scalable Implementation

Full implementation of the current Water Supply Project Alternatives requires construction of all facilities before operation – for example, potable water cannot be delivered from the
river until treatment plants are built and operational. The total cost of these alternatives (including diversion and conveyance) is currently estimated at $350 to $400 million. There are several permutations of the T-C Canal Alternative that would allow for a phased implementation, thus reducing the need for comprehensive project implementation. For example, it may be possible to implement an Aquifer-Storage-Recovery (ASR) project to address groundwater quality concerns over the short-term. This type of approach would use injection wells to supplement the intermediate groundwater aquifer with surface water. ASR would likely require treatment and conveyance to the service areas, but would eliminate storage and likely some distribution pipe. The ASR approach would potentially allow for a reduced pipe diameter of the conveyance pipeline because the water could be delivered at a consistent flow rate, thus reducing costs. Another advantage would be the short timeframe under which this approach could be implemented. Shorter time to implementation would allow for water rights claims to be perfected sooner. Feasibility of this option would require additional technical analysis, as it is difficult to estimate the length of time it would require for groundwater quality benefits to manifest themselves or the most beneficial locations for the injection wells.

**Water Quality**

In the Sacramento River, water quality generally degrades as the water flows downstream. The T-C Canal diverts water at Red Bluff at River Mile 244, while the Water Supply Project Alternatives would divert water near River Mile 70, a difference of over 170 miles. Recent water quality testing in the lower reaches of the canal demonstrates that water quality in the canal is similar to the Sacramento River near Red Bluff. Water quality parameters are summarized in the following graph, demonstrating superior water quality near Red Bluff as opposed to West Sacramento (River Mile 62).
However, in spite of the fact that water quality in the T-C Canal is better than water quality at the proposed diversions near West Sacramento – overall, water quality in both places is good. Any savings from reduced cost of treatment would be negligible.

**Water Transfers**

The Notice of Preparation (NOP) for the Water Supply Project outlines several potential water transfers that would be implemented in dry years when the project partners experience drought-year shortages. Potential transfers would involve:

- Anderson-Cottonwood Irrigation District
- Browns Valley Irrigation District
- Natomas Central Mutual Water Company
- Reclamation District 108
- River Garden Farms
- Swanston Properties

Additional transfers may be available through a T-C Canal Alternative, as the T-C Canal has direct connections to both the OUWUA and GCID systems as well as the member districts of the TCCA. Access to additional water transfers would improve drought year reliability.
Additional Partners
The T-C Canal Alternative may benefit the Water Supply Project by providing service to other potential partners in the region. Access to additional partners could help defray costs associated with the project. Potential partners include other water purveyors to the south (Solano I.D., Cities of Vallejo and Fairfield). Potential partners south of the proposed Water Supply Project would likely require access to untreated water, making them potential partners for conveyance. Additional parties north of the Water Supply Project (Dunnigan, and Arbuckle, for example) currently have plans for residential development. These northern entities would likely require treated water.

Warren Act Contract
Use of the T-C Canal and associated federal facilities would require initiation of a Warren Act contract with Reclamation. Warren Act rates refer to Section 1 of the Warren Act of February 1, 1911, which requires Reclamation to charge water contractors for the cost of conveying non-project water through project facilities. The Warren Act also provides authority to store non-project water within project facilities. Both non-project M&I and irrigation water can be stored or conveyed in project facilities.

The Warren Act contract would establish quantities, timing, conditions and rates for use of federal facilities. Recent examples of these contracts include Reclamation agreements with the City of Roseville, Sacramento Suburban Water District, and the El Dorado Irrigation District. Further discussions relating to possible terms and conditions in a Warren Act contract would need to be determined to assess feasibility and desirability of the T-C Canal Alternative.

River Diversions
The T-C Canal would provide an opportunity to use an existing, screened diversion on the Sacramento River – which is likely to be updated, while the Water Supply Project alternatives require new or updated diversions on the river. River construction in itself is often problematic in that it requires construction in a dynamic, ecologically sensitive environment. These challenges are most apparent in the physical requirements of river construction (sheet pile installation, pumps to work “in the dry,” etc.) as well as in the permitting requirements (timing of construction windows, wetland mitigation, endangered species consultations, etc.). Physical and ecological concerns can significantly affect cost and timeline of construction. New and improved river diversions can also result in unexpected changes in the river that can affect maintenance of the facilities through increased dredging, erosion control, or other factors common in a dynamic river environment.

The preferred Water Supply Alternative also has the additional challenge of coordinating CALFED funds to proceed with construction of screens at the existing RD 2030 diversion. Experience has shown that successful coordination and acquisition of approval and funding of CALFED-funded screen projects can be surprisingly difficult and time-consuming.

Recommendation
As outlined above, the T-C Canal Alternative, when compared against existing Water Supply Project alternatives, is more expensive in terms of capital cost. However, the T-C
Canal alternative may be the preferred alternative considering O&M savings, water quality benefits, drought-year reliability, and environmental advantages. Inclusion of the T-C Canal alternative in the environmental document would be especially prudent in the event that currently unforeseen problems develop with the existing alternatives – for example, if improvements to river diversions in the lower Sacramento River encounter administrative or environmental hurdles that prove difficult to overcome. The T-C Canal Alternative would be especially beneficial in the event that additional partners could be identified that could participate in a share of construction funding.

There is also a significant opportunity for a conjunctive use project using the T-C Canal as a source of recharge in the region. This concept potentially has major advantages over existing alternatives in terms of cost, scalability, reliability, and environmental impact. All factors considered, the T-C Canal alternative warrants further consideration and more detailed investigations.