COMMITTEE FOR DELTA RESOURCES IMPROVEMENT

WORKING PAPER

REGARDING

THE SACRAMENTO-SAN JOAQUIN DELTA/ SAN FRANCISCO BAY ESTUARY

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DEDICATION

This paper is dedicated to the memory of James B. Krieger, who devoted his professional life to ensuring that the increasing demand for a clean, abundant supply of water for all Californians was satisfied.

PURPOSE OF THIS PAPER

California relies on an extensive system of dams and canals for transferring water from water surplus areas to areas of need to meet the increasing demands of population growth and increased farm production. Over the past 20 years, however, there has been a growing debate over the environmental and economic costs and benefits of traditional water development projects. More recently, debate has focused on the role of nonstructural measures such as water conservation, water pricing and water marketing in meeting California's water needs.

As the debate continues, there is growing evidence that even with additional water conservation and other refinements in water management practices, the statewide demand for water will continue to exceed existing, dependable supplies. Today's actual water use is about 1.8 million acre-feet more than present dependable supplies. The resulting shortage is being met primarily through groundwater overdraft.

Much of the controversy has centered on the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The inability to reach agreement on acceptable solutions to the water quality, water transfer and fisheries problems of the bay-delta estuary has seriously impeded progress in solving any of these problems for more than a decade. This impasse has hurt bay-delta interests, the fisheries and millions of urban and agricultural water users who depend on good quality water supplies from the delta.

This paper represents an effort to break through this water project development impasse and assist in developing the statewide consensus necessary to move forward with programs to solve bay-delta water quality, water transfer and fisheries problems.

OVERVIEW

The San Francisco Bay-Sacramento-San Joaquin Delta Estuary is one of the world's largest and most valuable estuaries and directly affects the economic and aesthetic life of bay and delta residents and indirectly affects all Californians. The estuary includes the San Francisco, San Pablo, Suisun, Grizzly and Honker bays, the Sacramento-San Joaquin Delta and the Suisun Marsh, the latter of which is the largest, contiguous brackish water marsh in the nation and a key wintering area for waterfowl in the state. San Francisco Bay extends about 50 miles between the cities of San Jose and Richmond and varies in width from 1 to 11 miles. Bay waters are relatively shallow and are fed by two major sources: tidal inflow from the Pacific Ocean, and outflow from the rivers and streams tributary to the delta.

Located at the confluence of the Sacramento and San Joaquin rivers, about 50 miles northeast of San Francisco, the delta consists of about 738,000 acres of mostly reclaimed swamp and tule marsh land. About 550,000 acres of the delta are devoted to farming. Agricultural products from these lands have an average annual gross value of $375 million.

Most of the delta lands lie below the surrounding water level, with some as much as 20 to 25 feet below that level at mean tide. The low-lying lands are protected from high tides and floods by an extensive network of levees, which delineate more than 700 miles of waterways. These waterways provide important habitat for many fish and wildlife species. Salmon, steelhead, striped bass, sturgeon and American shad utilize the delta for spawning, passage to and from other spawning areas and as a nursery area for their young. The thousands of acres of grain fields and wetlands in the delta provide a major winter stopover on the Pacific Flyway for ducks, geese and numerous other migratory birds. The resident warm water fisheries and wildlife populations also support major recreational uses.

The principal rivers of the delta are the Sacramento and San Joaquin, and their tributaries including the American, Calaveras, Cosumnes, Feather, Merced, Mokelumne, Stanislaus and Tuolumne rivers. They drain nearly the entire Central Valley and contribute about 47 percent of the state's total runoff.

Upstream diverters take water from these rivers before they reach the delta to serve local municipal, industrial and agricultural uses. San Francisco and the East Bay Municipal Utility District import water from these rivers via aqueducts which divert water upstream of the delta and bypass the bay-delta estuary. These upstream diversions reduce the flows in the Sacramento and San Joaquin river systems significantly before they reach the bay-delta estuary.

The remaining flows reaching the delta, supplemented by trans-basin imports from the Trinity River, supply water to people, industry, agriculture, recreation, fish and wildlife. Water supplies are transferred through the delta for export to public agencies which have long-term contracts with the federal Central Valley Project (CVP) and the State Water Project (SWP). These supplies meet all or part of the water needs of more than 16 million of the state's 23.8 million residents and more than 4 million of the state's 10 million acres of productive, irrigated farmlands.

A number of complex interactions impact the quality of waters and the fish and wildlife resources of the bay-delta estuary. Sacramento and San Joaquin river flows, Pacific Ocean conditions, water exports, local consumptive uses, upstream diversions, tidal action, levee failures, waste discharges, urban runoff, agricultural irrigation return flows, fishing and hunting are all recognized factors. Although no one factor can be singled out as the predominant influence, the overall cumulative negative impacts have nevertheless resulted in the continual deterioration of the bay-delta estuary, which is manifested by delta levee problems, the decline of the bay-delta fisheries and water quality problems at various locations.

In focusing on the bay-delta estuary, this paper addresses problems attributable to water resources development;

particularly, the CVP and SWP which have a significant influence on the estuary. It is not the intent of this paper, however, to imply that the CVP and SWP are the only factors negatively impacting the bay-delta estuary, or to imply that the two projects are responsible for solving all of the problems caused by water development or other factors. The CVP and SWP are not the only water development projects impacting the estuary, and water development itself is but one of many factors contributing to the degradation of the estuary.

While the issues concerning the bay-delta estuary do not encompass all of the issues and water problems of the state, it is true that more than two-thirds of the state's population is directly affected by the quality of the waters and environment of the bay-delta estuary. This paper is predicated upon the belief that solving delta water quality and fisheries problems is a primary step in developing a plan to meet other statewide water needs.

Toward this end, this paper recommends certain operational measures and additional facilities that can help solve the problems resulting from the operation of the federal and state projects, while at the same time allowing the two projects to export additional water from the delta to help in meeting the state's water needs.

None of the recommendations in this paper calls for development of the North Coast rivers and streams, whose wild and scenic river status is protected under federal and state law. In addition, consistent with state law, the priority rights of areas of origin are wholly respected.

COORDINATED OPERATION OF PROJECTS

Cooperation between the federal and state governments and the coordinated operation of the CVP and SWP are critical elements in the sound and effective management of the water supplies flowing into, flowing out of and being diverted from the delta.

The CVP is the largest water project in the state and plays a major role in almost all of the issues relating to the bay-delta estuary. Without the cooperation of the federal government, the following bay-delta issues could not be adequately addressed: (1) water quality protection for the bay-delta estuary; (2) protection of CVP and SWP export water quality and dependable water supplies; (3) mitigation of federal and state project impacts on delta and Suisun Marsh fish and wildlife resources; (4) rehabilitation and protection of delta levees; (5) solution of San Joaquin Valley agricultural drainage problems, and (6) south delta water quality and water level problems.

Execution of the Coordinated Operations Agreement (COA) between the United States Bureau of Reclamation (USBR) and the California Department of Water Resources (DWR), on November 24, 1986, was a key step toward federal and state cooperation. The COA allocates the responsibility of the two projects' share of flows necessary for maintaining delta water quality between the CVP and the SWP. With the agreement, there is now assurance the CVP will be operated to maintain its share of the necessary water quality in the bay-delta estuary.

Previously, neither project could accurately determine the quantity of water available for export from the delta. The COA avoids the lengthy, divisive and expensive litigation that would otherwise have been necessary to determine the rights and obligations of each project. It also removes a major obstacle for the marketing of remaining CVP water supplies, which will be a significant step toward maximizing use of existing developed water supplies.

DELTA LEVEES

There have been more than a dozen levee failures in the delta during the last six years. Preservation of the levee system is critical for providing flood control protection, preserving the valuable agricultural and fish and wildlife resources in the delta, and protecting highways and other public facilities. Delta levees protect major state and local highways, a transcontinental railway, water aqueducts supplying the Bay Area, a major underground natural gas storage facility and a fuel pipeline used for military and other purposes. In addition, the levees are essential in controlling salinity intrusion from the Pacific Ocean, which is important in the protection and maintenance of acceptable water quality levels for municipal, industrial, agricultural, fish, wildlife and state and federal project export uses.

Long term or permanent flooding of certain islands in the western and southwestern delta would cause increased mixing of salt and fresh waters and shorten the travel path for ocean derived salinity to the SWP and CVP export pumps. As a result, salt water would move into the central delta and increase the salinity at the project export pumps, thus requiring increased releases of SWP and CVP stored water to repel the salt water.

The levee system also serves as a transportation system and diversion point for the CVP and SWP, which move water from the Sacramento Valley and other areas through the delta channels to export pumps for distribution to the south Bay Area, San Joaquin Valley and Southern California. Transportation of project water through these natural channels will, at times, increase the level and velocity of water, thereby adding to local concerns about seepage and erosion, which also deserve consideration.

Preservation of the levees and the existing channel configurations is critical to protect the many uses of the delta. Some of the delta levees, however, were built many years ago and were not designed to withstand current conditions. Continuing land subsidence has increased hydrostatic pressure on many of the levees. In addition, the underlying peat soils in some parts of the delta provide an unstable foundation for what are now very large and heavy levees. Existing levee-maintenance programs of some of the local reclamation districts and the state are inadequate and cannot effectively prevent additional levee failures now or in the near future.

A long-range delta levee rehabilitation program involving local, state and federal participation has been developed by the U.S. Army Corps of Engineers, but probably will not be funded for a number of years due to federal budget constraints and the need to develop an acceptable basis for participation by state and local interests.

In the interim, some action must be taken to preserve the delta levee system. A flood hazard and mitigation plan for the delta, adopted by the state and approved by the federal government in 1983, calls for a $10 million annual state contribution to a levee-rehabilitation program, which would significantly help but not totally solve all of the delta levee problems. Under this program, funds would be made available to local interests who participate in the program on a 75-25 cost-sharing basis, with the local interests contributing the 25 percent share. This plan should be funded and implemented without further delay. The funds invested by state and local interests under this program should be credited as a local contribution to the Corps' long-range program when it is authorized and implemented.

EXPORT WATER QUALITY

Delta water quality is vulnerable to degradation from many sources, including sewage and industrial waste discharges, salt water intrusion from the bay, agricultural wastewater within and upstream from the delta, urban storm water runoff and recreational activity. This vulnerability is of critical concern to those public agencies who export water from the delta to supply drinking water to two-thirds of the state's population.

Delta water quality is routinely monitored for all substances for which drinking water quality standards have been established under state law. Treated delta water currently meets those standards. In addition, synthetic organics, trihalomethane precursors, asbestos and pesticides, for which the state has not established drinking water quality standards, are also monitored. Concentrations of organic chemicals in the delta and its tributaries are lower than existing limits established in state and federal drinking water quality standards.

Constant monitoring of water for organics in the delta and in the export systems is necessary because of the water's vulnerability to organic degradation. For example, certain organic compounds that can combine with other substances to form trihalomethanes (which are suspected carcinogens) have been found in the delta. Many public agencies relying on delta water have changed their treatment methods to assure public health protection and to comply with federal and state drinking water quality standards. Additional treatment or improved processes may be required in the future, however, as new standards are adopted or greater concentrations of contaminants are detected in delta water.

Although treatment methods may be available to reduce or eliminate a particular contaminant, the preferred objective is to protect the water supply from the contaminant. Such is the case with the potential for degradation of the San Joaquin River by irrigation runoff and agricultural subsurface drainage. Although no data indicate that runoff and agricultural drainage being released into the San Joaquin River presently threaten the quality of drinking water supplies, continued discharges into this water source are reason for concern. This situation, which is more fully addressed in the following section of this paper, must be carefully evaluated in the context of the potential risks to public health.

While present operational practices assure acceptable water quality for export use of delta water by California residents, efforts to strengthen protections for existing water supplies and to improve water quality in the future should continue. Any delta improvement program must recognize the significance of the delta as a source of drinking water for most of the state's residents, and care must be taken not to foreclose physical options that may prove to be in the interest of public health protection.

AGRICULTURAL DRAINAGE

Agricultural drainage has been a concern for decades. More recently, waterfowl deaths and deformities in the CVP's Kesterson Reservoir that have been attributed to selenium toxicity have heightened public concerns about potential contamination of drinking water supplies from the San Joaquin River and the bay-delta estuary. Although the public focus is presently on the Kesterson situation, agricultural drainage problems exist throughout the San Joaquin Valley and in other areas of the state. The drainage problems in the arid San Joaquin Valley began in the valley's geologic origins. Much of the valley, which is one of the most productive farming regions in the world, has underlying layers or lenses of clay 10 to 40 feet beneath the surface. These lenses restrict the downward leaching movement of irrigation water that is applied to crops. With continued application of irrigation water, which carries salts with it, the perched water table rises into the crop root zone, where the salt concentrations reduce and ultimately eliminate crop productivity.

In addition to the salts that are brought in with irrigation water, the perched water also contains salts and elements that are indigenous to the soils of the area. Selenium is a naturally occurring trace element in the soils along the west side of the San Joaquin Valley and is essential in small amounts for human and livestock health. Selenium in high concentrations is toxic and can even be fatal.

About 250,000 acres of highly productive agricultural lands in Westlands Water District and other water districts in the federal San Luis and Delta-Mendota Canal service areas must have a drainage solution in the near future if they are to remain productive. The amount of valley lands that need drainage could reach 400,000 acres within the next 15 to 20 years. The loss to the state's economy could be as high as $200 million annually if no long-term drainage solution is found for these lands.

It is in the state and national interest to protect California's rivers, estuaries and groundwater from potential

agricultural drainage contamination while maintaining the viability of these highly productive lands. The quality of San Joaquin River flows must be protected for fish and wildlife resources and the municipal, industrial and agricultural water users who depend on the river for water supplies.

Many years ago, a San Joaquin Valley Master Drain was planned to transport agricultural drainage from the west side of the valley to the delta for disposal. The master drain was never completed due to political and environmental opposition and lack of funding. Drainage problems and perched water conditions in the valley have continued to increase. Some of the areas that would have been served by the originally envisioned master drain are managing their drainage problems and maintaining acceptable salt balances through on-farm drainage systems, local evaporation ponds, or other methods. Other areas with especially severe drainage problems may go out of production or, in the case of some portions of the federal Delta-Mendota Canal service area, are continuing to discharge subsurface drainage effluent into the San Joaquin River and its tributaries.

About a third of the proposed master drain—known as the San Luis Drain—was constructed to serve Westlands Water District in the CVP's San Luis Unit Service Area. The San Luis Drain ended at Kesterson Reservoir, a series of evaporation ponds which bordered a national wildlife refuge. The Kesterson ponds were constructed as part of a regulating mechanism originally envisioned for the master drain.

In response to the selenium problems that have developed at Kesterson Reservoir, the U.S. Department of the Interior and Westlands Water District entered into an agreement which has now eliminated discharges of subsurface agricultural drainage into the San Luis Drain and Kesterson Reservoir. Alternative drainage measures will now be pursued. Farmers in the district are currently participating in on-farm recycling, water conservation and programs to improve irrigation management practices. However, these are only interim measures; a long-term solution must be found.

A technical advisory committee established by the State Water Resources Control Board will recommend water quality objectives for the San Joaquin River Basin in 1987. Standards will be adopted and enforced by the Central Valley Regional Water Quality Control Board for selenium, boron, molybdenum and total dissolved solids. The regional board will establish waste discharge requirements based on those standards.

Farmers and districts like Westlands will have to satisfy these discharge requirements in order to drain their fields into the San Joaquin River or its tributaries. Drainage water will have to be held in surface evaporation ponds, injected into deep wells or treated before its discharge into the waters of the state. All of these options will be very expensive to implement.

The federal government should fully acknowledge and carry out its obligation to provide drainage service to its water users in the San Luis Unit Service Area of the CVP. Any drainage solution must meet waste discharge requirements established by the regional and state boards.

The state should continue to cooperate with the federal government and local agencies to develop alternative drainage solutions, and should concentrate its efforts on alternatives that do not involve discharge into the bay-delta estuary or Monterey Bay. Alternatives such as improvements in irrigation and drainage management practice improvements, evaporation ponds, deep well injection, desalinization and other treatment technologies should continue to be seriously investigated.

Funds should be designated annually in both the federal and state budgets for agricultural drainage and selenium-related research. A major goal of the federal-state interagency task force that has been formed to coordinate efforts is to avoid duplication of research efforts and to recommend positive steps toward a long-term solution as soon as possible.

SOUTH DELTA

The south delta experiences many of the problems commonly associated with the delta: (1) water quality degradation due to upstream diversions; (2) reduced water levels due to diversions by the CVP, the SWP and upstream and local users; (3) water quality degradation caused by agricultural irrigation return flows within and upstream of the delta, and (4) the San Joaquin River salmon fishery has been virtually eliminated due to reduced flows and physical barriers to upstream fishery migrations.

An improvement program for the south delta that will solve some of these problems has been developed by DWR and the South Delta Water Agency. Specific measures agreed upon include: (1) installing a barrier in Middle River near its intersection with Victoria Canal, which will improve water levels in the immediate area; (2) and dredging Tom Payne Slough to increase water levels in the slough (if dredging alone is not sufficient siphons will be added at the Tom Payne Slough diversion structure to increase flows into the slough).

A long-term solution to south delta problems will now be pursued by DWR, the U.S. Bureau of Reclamation and the South Delta Water Agency which must include the participation of the federal government. Specific measures under consideration include: (1) installing barriers and dredging in some channels and widening and deepening channels near Victoria Island; and (2) constructing a new intake for Clifton Court Forebay.

An additional approach to south delta problems which is currently under active study, and which would assist in providing water quality and streamflow benefits to the south delta as well as other benefits to the delta fishery and export water users, is to improve the quality and quantity of San Joaquin River flows with water available from

the Stanislaus River. Under this approach, additional Stanislaus River water from the New Melones Reservoir would be utilized on a conjunctive basis with groundwater supplies.

Local water users in eastern and central San Joaquin County do not have the financial capability to construct surface water distribution systems to bring New Melones Reservoir supplies into their service area. These facilities could be used to maximize surface water use during years of ample surface water availability. By maximizing use of surface supplies and minimizing groundwater use during wet years, local groundwater supplies would be enhanced and recharged. These distribution systems could be paid for by state project water contractors in exchange for that surface water supply in dry years.

The surface water released from New Melones would be allowed to flow down the Stanislaus River in dry years to be used for improving fishery flows in both the Stanislaus and San Joaquin rivers, improving water quality in the south delta and providing additional water for export and/or for delta outflow.

SOUTH BAY AREA AND CONTRA COSTA COUNTY

Contra Costa County and major portions of the south bay area water users receive a portion of their water directly from the delta through facilities that have virtually no storage available. This situation sometimes causes water quality problems because they do not have the flexibility to export good quality water during periods of high freshwater inflows to the delta and store it for use at later times. Additional storage capacity would provide regulatory capability that could maximize water quality control and treatment efficiency by making good quality water available for blending with poorer quality water when necessary.

The feasibility of constructing a storage reservoir at the Kellogg or Los Vaqueros sites for the purpose of providing water quality benefits to South Bay Aqueduct and Contra Costa Canal water users, should be further investigated. In the interim, efforts in Contra Costa County to purchase or reserve property for a reservoir site should be supported. The reservoir should be of sufficient size to allow water deliveries from the reservoir during periods when delta water quality is poorer than desired for municipal and industrial water use. Such a reservoir would also provide an emergency water supply for the two systems, additional operational flexibility that could be used to benefit the delta fishery and additional firm water supplies for the state and federal projects.

SAN FRANCISCO BAY

The two major sources of water in the San Francisco Bay—salty ocean water and fresh water from the delta—form a unique salt and fresh water environment for wild life in the bay-delta estuary.

The bay has seen enormous changes since pre-gold rush days when it encompassed about 680 square miles. About 35 percent of the surface of the bay has been filled for urban and industrial development since 1850, and today the bay encompasses only about 450 square miles. Numerous factors have affected the quality of the bay's waters and marine life, including upstream diversions, discharges into the bay from upstream and local municipal and industrial sources, upstream agricultural discharges and urban runoff into the bay.

There are some definite problems in the bay for which complete solutions have not yet been found, such as the decline of its striped bass and Dungeness crab populations, and the "hot spots" in which high levels of toxic substances have been found in some species that live in the bay.

The last 25 years, however, have seen a distinct improvement for other aspects of bay water quality and aquatic life. Levels of dissolved oxygen, critical for aquatic life, are now consistently at acceptable levels in the extreme south bay for the first time in years, and shellfish from the bay are now safe for human consumption for the first time in decades. In addition, the City of San Francisco's beaches between the Golden Gate Bridge and the Bay Bridge are now safe for swimming except for a few times each year after large storms, and there are now 10 times as many miles of shoreline access open to the public as there were 25 years ago. These improvements are partly the result of a comprehensive effort to improve municipal sewage treatment systems.

While the impacts of sewage and municipal and industrial wastes on the bay have been greatly reduced, there is concern about the long-term impacts of small amounts of toxic substances in treated discharge.

Another issue of concern is the effect of fresh water outflows from the delta on the bay. Less water now flows out of the delta annually into the bay than in the past. It is not clear what effect this has on the bay in general, nor is it presently possible to accurately determine the impacts of all the factors affecting the bay.

Much of the data needed to accurately evaluate these impacts is being developed in joint federal-state studies on the hydrodynamic and biological systems of the bay. The results of these studies will help determine the effect of freshwater flow changes on salinity patterns within the bay and the movements of fish and the organisms on which they feed. These studies will allow the State Water Resources Control Board to address the following issues: (1) how fish and wildlife populations in the Bay can be maintained and improved; (2) the extent to which waste discharges into the bay from local and upstream municipal, industrial, agricultural and nonpoint sources can be reduced; (3) the manner and the extent to which the quality of local waste discharges into the bay can be further improved, and (4) the manner and extent that freshwater inflows from the delta can be better managed.

SUISUN MARSH

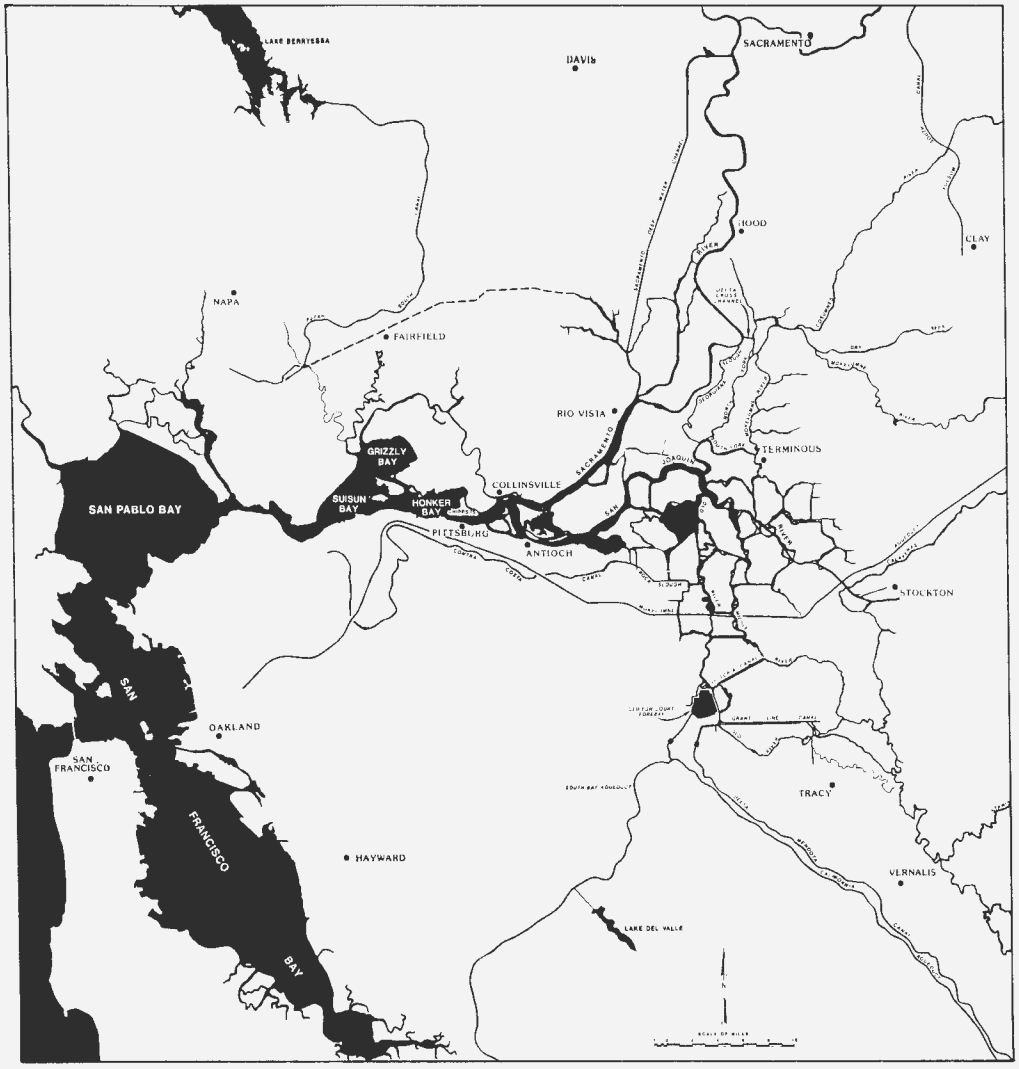
At times, the water quality within the Suisun Marsh is degraded to the point that without the channel improvement and water control facilities currently under construction, the marsh cannot sustain the high quality feed and habitat conditions needed for the waterfowl and other marsh-related wildlife. This intermittent water quality degradation is caused by diversions of water upstream, within and from the delta.

Mitigating the impacts of water diversions on water quality within the Suisun Marsh, solely with freshwater flows from the federal and state projects, would have a devastating and unacceptable impact on project water supplies and the ability of both projects to meet contractual commitments.

Therefore, DWR, USBR, the Department of Fish and Game (DFG) and the Suisun Resource Conservation District negotiated a four-party agreement which calls for the construction of specified marsh facilities and requires the state and federal projects to be operated to maintain required Suisun Marsh water quality. The construction of these facilities will enable the state and federal projects to meet the water quality needs of the marsh without unduly depleting the projects' dependable water supplies.

Funding will be provided on a cost-sharing basis by the State of California, the federal CVP, the SWP contractors and the state's general fund. State Water Project contractors have already committed their share of the funds and every effort should be made to secure State of California funding as well. Congressional approval of the agreement and federal funding have been obtained.

In the meantime, the state has initiated construction of a key marsh water quality facility, the Suisun Salinity Control Gates. This facility will significantly improve the water quality of the marsh by forcing the flows of fresher water from east to west through the marsh and, therefore, help maintain proper salt balances for the wildlife habitat.



Bay Delta Estuary

DELTA FISHERIES

The San Francisco Bay-Sacramento-San Joaquin Delta Estuary is the single most important fishery habitat in California. In addition to being the collection and distribution point for almost half the state's runoff, the estuary's meandering waterways and bays form a unique environment for a variety of fish and other aquatic life. About 25 percent of all warm water and anadromous sportsfishing in California and about 80 percent of the state's commercial salmon fishery depend on the bay-delta estuary.

Delta fishery populations have declined dramatically over the last 25 years. The striped bass population, for example, has declined to less than a million today, compared to more than 3 million 25 years ago. Statewide, salmon runs have declined from an estimated average of 387,000 fish in the 1950's to about 250,000 fish today. All of the historic salmon habitat in the Sacramento and San Joaquin river systems has been negatively impacted in one way or another, and as much as 80 to 90 percent has been lost. Pollution, diversions for power plant cooling, Pacific Ocean conditions like El Nĩno, urban development, timber harvesting practices and water development are all factors contributing to the decline of the state's fishery resources. The severity of these impacts on the fishery habitat is such that actions must be taken immediately if we are to effectively restore and preserve this precious resource.

There have been legislative attempts to deal with fishery habitat restoration, including the commitment of funds for land acquisition, restoration or creation of spawning areas, construction of fish screens or fish ladders, stream rehabilitation and installation of pollution control facilities. A preference has been given to habitat restoration over hatchery production which should lead to an increase in the fisheries population through natural means. State funding for these habitat restoration projects received support from such diverse interests as agricultural, business and environmental groups.

There remain, however, several serious water quality and fishery problems associated with the present method of transferring water from the Sacramento River across the delta to the SWP and CVP pumps, and with pumping water from the south delta.

The reversal of lower San Joaquin River flows is a good example of these problems. Channel capacities in the north delta limit the amount of water that can be transferred through the central delta to the pumps. When the amount of water pumped by the two projects exceeds north delta channel capacities, San Joaquin River flows are reversed between the mouth of the Mokelumne River and the City of Antioch. These reverse flows harm the delta fisheries, particularly the striped bass. Elimination of these reverse flows would dramatically reduce the loss of young striped bass.

The reversal of the lower San Joaquin River flows not only draws water to the pumps, but also draws salty water from the San Francisco Bay further into the delta. Consequently, the SWP and CVP must release more water from project reservoirs upstream of the delta in order to maintain State Water Resources Control Board-mandated water quality standards for the delta and the Suisun Marsh and the CVP and SWP exports. Elimination of the reverse flows would allow the projects to maintain delta water quality standards and utilize existing project water supplies with greater efficiency. Elimination of the reverse flows will also improve the quality of the water being exported from the delta by the SWP and CVP in all but the most critically dry years.

Although elimination of the reverse flows in the lower San Joaquin River would significantly reduce the adverse impacts of the projects on the delta fishery, exporting water from the south delta would still cause some harm to the delta fisheries. The existing fish screens at the CVP and SWP pumping plants allow the projects to screen and salvage a high percentage of the fish for transport to areas outside of the influence of the pumps. However, the losses incurred during this salvaging process and the losses of young fish that are too small to be screened are still significant. The state departments of Water Resources and Fish and Game, along with water development, sports and commercial fishing interests, have reached agreement on ways to offset those fish losses directly attributable to the State Water Project export pumping plant. Unrelated to losses at the screens is the inadvertent diversion of young salmon, shad and striped bass from the main river beds into central delta channels. Although many of the fish drawn into these channels return to the western delta, recent studies show the overall survival rate is lower than for those fish travelling directly down the Sacramento River. In addition, lowered flows in the main river channel also seem to reduce the survival rate of young salmon migrating to the ocean. Studies to date are inconclusive, but they raise serious questions concerning the amount of flows needed in the Sacramento River to ensure adequate survival rates for young salmon. A problem associated with the operation of water development facilities concerns the proper location of the striped bass nursery in the western delta.

If these facilities divert too much water before it reaches the delta, or export too much water from the delta, the amount of fresh water flowing from the delta into the bay is reduced. When this happens, the nursery moves further upstream into a much less suitable area for rearing young striped bass.

Sufficient delta outflows are critical to maintain the striped bass nursery in its proper location in the western delta. Each water development project should provide the flows demonstrated to be needed to offset its respective impact on the location of the striped bass nursery in the western delta. At the same time, no project should be required to provide more flows than would have been available in the absence of that project.

Most of the negative impacts associated with the operation of the CVP and SWP cannot be adequately offset

without additional project facilities unless the projects simply stop pumping during much of the year. The result would be a devastating impact on the state's economy and on the well-being of the millions of Californians who depend on water exported from the delta.

There are some positive measures that would not jeopardize the economy or water supplies, but would offset adverse impacts of the projects. These measures could include:

(1) Eliminating reverse flows in the lower San Joaquin River by enlarging the south fork of the Mokelumne River and constructing a new connecting channel or channels between the Sacramento and Mokelumne River systems if the latter is demonstrated to be needed.

(2) Each project providing the flows demonstrated to be needed in the Sacramento River below the points of diversion into the central delta to offset its impact on the survival and migration of anadromous fish.

(3) Constructing fish screens at the Sacramento River diversion point if and when new connecting channels are built and the DFG and the DWR conclude that no other acceptable alternative is available to protect the fishery.

(4) Enlarging delta channels near the pumping plants and bordering the east, west and south sides of Victoria Island.

These channel enlargements would allow the State Water Project to pump more water during periods of surplus winter flows, a period in which impacts on the delta fishery would be minimized. The benefits from this additional channel capacity can be most fully realized if additional storage capacity is made available south of the delta, either in surface reservoirs like Los Banos Grande or in artificial groundwater recharge facilities. Such additional storage would increase project supplies and provide operational flexibility which could be used to provide delta fishery benefits.

(5) Each project providing the flows demonstrated to be needed to offset its impact on the location of the striped bass nursery in the western delta.

Offsetting project impacts on the fishery habitat may have to be accomplished by improving other portions of that habitat. It may be physically impossible or financially impractical to fully offset a specific adverse impact. In those instances, alternative habitat improvement measures would have to be instituted to provide benefits to the fishery which compensate for the specific adverse impact not directly offset.

When choosing between alternative measures available to prevent or offset specific project impacts, consideration should be given to the benefits versus the costs. The overall evaluation should be as balanced as possible, with preference given to the alternative or alternatives which utilize natural means of alleviating impacts, unless the cost is deemed to have an unreasonable impact on the projects when compared to other alternatives, such as fish hatcheries.

The measures to offset the SWP impacts should be implemented through an agreement between the Department of Water Resources and the Department of Fish and Game. The agreement must be executed prior to construction of any new delta facilities and should describe in detail how the adverse impacts of existing and future delta facilities on the fisheries would be prevented or offset.

ADDITIONAL WATER CONSERVATION

While wise water use and efficient conservation of existing water supplies cannot eliminate the need for additional statewide water development and exports from the delta, the potential benefits of increasing and enhancing existing water conservation efforts should continue to be pursued.

Further efforts to maximize the use of existing developed water supplies, such as marketing remaining CVP water supplies, use of state-of-the-art irrigation efficiency technology and urban wastewater reclamation can help meet existing water needs and alleviate groundwater overdraft conditions.

In pursuing additional water conservation and resulting enhanced water supplies, it is important to focus efforts in the areas that will achieve a real water supply savings. Technical studies have confirmed that reduced water use results in real water supply savings for use elsewhere only when the water being saved would otherwise: (1) be discharged to the sea or a saline body of water, (2) seep into unusable groundwater reserves; or (3) escape into the atmosphere.

Recent DWR studies show that increased conservation efforts throughout the state could slow the predicted growth in water use by as much as 1.6 million acre-feet a year through 2010. Most this annual reduction is expected to occur in the coastal zones (where much of the water being saved would otherwise be discharged to the ocean) and in the Imperial Valley (where excess irrigation runoff is presently discharged into the Salton Sea). In order to achieve the water savings potential estimated by the DWR, refinements in the wise management of the state's water resources must be continued.

The State Legislature has taken steps to encourage the development and implementation of additional feasible water management and conservation programs and projects throughout the state. In its 1985-86 Regular Session, the Legislature enacted measures to (1) authorize the Department of Water Resources to finance water conservation programs and facilities, (2) authorize $150 million in bonds for water conservation, groundwater recharge and agricultural drainage water containment and treatment programs, and (3) creates a statewide program for groundwater recharge.

CONCLUSIONS AND RECOMMENDATIONS

This paper is predicated upon the belief that solving delta water quality and fishery problems is a primary step in developing any plan to meet the state's water needs. More

than two-thirds of the state's population is directly affected by the quality of the waters and environment of the bay-delta estuary. Solving the fishery, water quality and water supply problems of the bay-delta estuary would be a major step toward carrying out a sound water policy for the State of California.

Following are recommendations for certain operational measures and additional facilities that would help solve the problems of the bay-delta estuary. Many of the recommended measures are designed to correct specific problems caused by the SWP and CVP, while at the same time allowing the two projects to export water from the delta to meet the state's water needs.

* The flood hazard and mitigation plan for the delta levee system, adopted by the state and approved by the federal government in 1983, should be funded and implemented without delay. Seepage and erosion impacts of water transfers upon delta islands and levees should be mitigated.

* Any delta improvement program must recognize the significance of the delta as a source of drinking water for most of the state's residents, and care must be taken not to foreclose physical options that may prove to be in the interest of public health protection and an assured water supply.

* The federal government should acknowledge and carry out its obligation to provide drainage service for the federal San Luis Unit Service Area of the CVP. The state should cooperate fully with the federal government and local agencies to develop alternative drainage solutions, and should concentrate its efforts on solutions that do not involve discharge of drainage effluent into the bay-delta estuary or Monterey Bay.

* Funds should be designated annually in both the federal and state budgets for agricultural drainage, selenium-related research. A major goal of the federal-state interagency task force that has been formed to coordinate efforts is to avoid any duplication of effort and to recommend positive steps toward a long-term solution as soon as possible.

* Specific measures that should be implemented to help solve some of the south delta water level, water quality and fishery problems include: dredging, maintaining, widening and deepening certain channels as needed; installing barriers to maintain proper water levels, and constructing a new intake for Clifton Court Forebay.

* Water quality and streamflow benefits for the south delta, the delta fishery and export water users should be provided by improving the quality and quantity of San Joaquin River flows with available flows from the Stanislaus River through a conjunctive-use water management program.

* The feasibility of constructing a storage reservoir at the Kellogg or Los Vaqueros sites for the purpose of providing water quality benefits to South Bay Aqueduct and Contra Costa Canal water users should be further investigated. Such a reservoir would also provide an emergency water supply for the two systems, additional operational flexibility that could be used to benefit the delta fishery and additional firm water supplies for the state and federal projects.

* The impact of upstream municipal, industrial and agricultural discharges; local municipal and industrial discharges; upstream diversions and urban runoff on the San Francisco Bay should be determined through the current joint studies on the bay's hydrodynamic and biological systems.

* The following operational measures and facilities will help solve delta water quality and fishery problems. They address problems resulting from the past operations of the state and federal projects and would allow them to safely export water from the delta to meet statewide water needs.

—Eliminating the reverse flows in the lower San Joaquin River by enlarging the South Fork of the Mokelumne River and constructing a new channel between the Sacramento and Mokelumne river systems if such a new channel is demonstrated to be needed to assure the elimination of the reverse flows.

—If any new connecting channel or channels are built, a fish screen should be constructed at the Sacramento River diversion point if the Department of Fish and Game and Department of Water Resources conclude no other acceptable alternative is available to protect the fishery.

—Delta channels near the pumping plants and bordering the east, west and south sides of Victoria Island should be enlarged to allow more water to be pumped during periods of surplus winter flows.

—Each project should provide its share of the flows demonstrated to be needed in the Sacramento River below the points of cross-delta diversion to offset its impacts on the survival and migration of anadromous fish.

—Each project should provide its share of flows demonstrated to be needed to offset its impacts on the location of the striped bass nursery in the western delta.

* Programs that improve other portions of the fishery habitat should be implemented in those cases where project impacts cannot otherwise be reasonably or effectively mitigated.

* Construction of any new delta transfer facilities should not begin until the Department of Fish and Game and Department of Water Resources have entered into an agreement to implement measures to prevent or offset the State Water Project's impacts on the delta fishery.

* The potential benefits of increasing and enhancing existing water conservation efforts should continue to be pursued. Maximizing the use of existing developed water supplies can further help meet existing water needs and alleviate groundwater overdraft conditions.

The following organizations participated in the drafting of this paper:

Association of California Water Agencies
California Association of Reclamation Entities of Water
California Central Valley Flood Control Association
California Chamber of Commerce
California Farm Bureau Federation
California Waterfowl Association
Central Delta Water Agency
Central Valley Project Water Association
Kern County Water Agency
Metropolitan Water District of Southern California
Mid Valley Water Authority
North Delta Water Agency
Pacific Coast Federation of Fishermen's Association
South Delta Water Agency
State Water Contractors
Tulare Lake Basin Water Storage District

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