Peripheral Canal Design and Implementation Options
Technical Appendix G

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Description

This document is an appendix to the Public Policy Institute of California report, *Comparing Futures for the Sacramento-San Joaquin Delta*, prepared by a team of researchers from the Center for Watershed Sciences (University of California, Davis) and the Public Policy Institute of California.

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Summary

Since the Central Valley Project came online in the 1940s, the Sacramento-San Joaquin Delta has served as the conduit for sending water exports from northern California to points south and west of the Delta, never without controversy. Recent policy and technical discussions have begun again to consider the similarly controversial alternative of taking water from the Sacramento River upstream of the Delta and diverting it around the Delta to the export pumps, an alternative often referred to as a peripheral canal. A peripheral canal or some form of other upstream diversion of water exports from the Delta is a strategic decision whose implementation entails a wide range of other important decisions. This brief report summarizes the range of infrastructure, operations, environmental, governance, finance, and other decisions and options which must be made to implement any Delta solutions containing peripheral conveyance. These decisions range from sizing and intake location, to policies governing operations and diversions, to finance and mitigations. While this listing (summarized in Table G.1) is not exhaustive, it does illustrate the many important implementation decisions associated with a peripheral canal, and the long time frame for making and revisiting these decisions. Several important decisions will require years before any construction; other decisions, particularly regarding operations, are likely to be revisited on a regular basis, even decades following the beginning of operations. Many of these decisions will imply trade-offs among competing interests and objectives. Some suggestions are made regarding how to approach these decisions. Quite a few of these initial and ongoing decisions will require political and technical leadership beyond that customarily seen in California water in recent decades.

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Introduction

The decision to employ an upstream diversion for water exports to urban and agricultural areas south and west of the Delta would alter fundamentally water resource operations in the Delta. However, the detailed decisions which implement such a strategic choice have large environmental and economic implications. The implementation details of peripheral conveyance can have greater overall effects on environmental and economic performance than the strategic decision to employ a peripheral canal and involve many long-standing controversies (Jackson and Paterson 1977; Lund et al. 2007). This appendix lays out the range of detailed design and operational decisions needed to implement a relocation of Delta export intakes upstream. These decisions are summarized in Table G.1 and can be discussed in several categories: infrastructure design options; operating policies; ownership, governance, regulation, and finance; accompanying Delta land and water management; and major adjustments and mitigations. This discussion of the details of design and operations is not intended to be exhaustive, but to illustrate the range and complexity of details which need to be orchestrated for any form of peripheral canal to be successful. Many of these decisions require complex and uncertain trade-offs to be made among competing users and interests. The political, legal, and technical processes required to make these decisions are neglected for the time being.

1. Conveyance Objectives

The detailed design, operation, and accompanying governance and adjustment decisions for any peripheral canal should be established based on the objectives of this facility, and how the facility interacts with other system objectives. Some objectives for an upstream diversion include:

- Reducing "take" of desirable species
- Improving in-Delta flows for ecosystem purposes
- Improving water quality for urban water users
- Improving water quality for agricultural users
- Improving export water delivery quantities and reliability
- Improving Delta region recreation opportunities
- Reducing entanglement of water supply and environmental management in the Delta, providing greater flexibility for both objectives
- Minimizing financial costs of facility construction and operations
- Improving the long-term sustainability of Delta exports with sea level rise, earthquakes, and other threats

These objectives will often conflict. Shifting some or all diversions from the south Delta to upstream off the Sacramento River would likely reduce intake-related environmental effects in the Delta, such as entrainment of Delta smelt, but could increase risks to migrating salmon and food webs of the northern Delta. The governance and finance of this facility and the related regulatory framework for Delta operations will determine how the many implementation decisions respond to these objectives. The implementation decisions made for a peripheral canal, perhaps more than the initial decision to build a canal, will reflect trade-offs among competing objectives and interests.

2. Infrastructure Design Options

Hundreds of major and detailed design decisions must be made to implement an upstream diversion for exports of Sacramento River water to regions south and west of the Delta. A subset of these design decisions appear in Table G.1. The most important—and potentially contentious--decisions include:

- intake location(s),
- facility capacity,
- outlet location(s),
- right-of-way,
- unlined canal vs. lined canal vs. pipeline,
- fish screens (type and fish salvage facilities),
- use of pumps,
- ancillary storage,
- finance, and
- coordination with other projects and users (both upstream, in the Delta, and the large existing Delta export projects (CVP and SWP).

Each of these design decisions has implications for overall project capital and operating cost, environmental impact, opportunities for addressing water quality problems for those who divert water from the Delta, and the adaptability of the operation of the facility for the purposes outlined above.

Table G.1 - Design and Operations Options for Peripheral Conveyance

Infrastructure Design

Upstream intake locations
- Hood; Freeport; Delta Cross-Channel; Yolo By-pass; Clarksburg; Other locations

Additional intake locations
- Current SWP and CVP intakes; other
- Multiple upstream intake locations

Outlet locations
- Current intakes for SWP and CVP
- Lower San Joaquin River
- Scattered outlets along right-of-way
- CCWD intakes; North Bay Aqueduct
- Multiple outlet locations; other locations

Total flow capacity
- 1,000 to 22,000 cfs

Fish screening
- None; Coarse mesh; Fine mesh; Bank filtration; Gravel screening; Multiple screens (in parallel); positive barrier; salvage or by-pass facilities; others
- Screen capacities and configurations

Sedimentation basin
- Size, type, and operations

Booster pumping
- Capacities, configurations and location(s)

Right-of-way
- Location: Eastern; Through-Delta; Western; Mixed (dual facilities); others
- Right-of-way widths and access roads

Channel elevations
- Pumping, flood, recreational, water quality, and other implications

Channel lining
- Pipe, lined canal, unlined canal, mixed

Stream channel crossings
- Small streams; Delta channels; Stockton Ship Channel/San Joaquin River

Associated operational water storage
- Upstream, near intake(s); Near-Delta; South-of-Delta

Associated recreational facilities
- Location, type, and capacity

Major Adjustments and Mitigations
- Delta farmers; Contra Costa Water District; North Bay Aqueduct; Delta towns; recreation; environmental; others

Operation Policies

Operating strategy
- Constant; Seasonal; Opportunistic in real time; Multiple intake operations (e.g., dual conveyance); Multiple outlet operations; adaptive operations
- Coordination with other in-Delta and near-Delta facilities and demands; water markets; Pulse flow operations; Batch flow operation

Constrained delivery policies
- Environmental, water quality, water rights, and regulatory constraints

Monitoring networks
- Locations, frequencies, and constituents

Delta Land and Water Management
- Aquatic and terrestrial habitat; Flood management; Levees; Agriculture; Recreation; anadromous fish passage (up and down)

Ownership, Governance, Regulation, and Finance

Ownership
- Single or multiple owners: SWP, CVP, environmental and resource agencies, water users, private organizations, NGOs

Governance
- Regional Authority (e.g Coastal Cssn); Joint Powers Authority; State Agency; other options (linked to ownership)

Regulatory oversight
- SWRCB (quality and rights); Central Valley RWQCB; USEPA; Army Corps of Engineers; DPH; Central Valley Flood Protection Board; USFWS, DFG, NOAA fisheries, other

Finance and repayment
- Capital infrastructure; Operating costs; Costs for land acquisition and habitat management; user contributions (financial and in-kind); taxpayer contributions

Terrestrial and aquatic habitat management
- Mitigations (terrestrial and aquatic); Contingencies; Environmental performance bonds

3. Operating Policy Options

Once a peripheral canal is built, there remains a degree of physical flexibility in its operations, regarding when and how much water can be taken into each intake and released from each outlet. The overall design of the physical facility constrains these operational decisions, along with upstream and downstream conditions (e.g., volume of flows and storage upstream, conveyance capacity downstream). Within this feasible range, decisions should be made to reflect overall environmental and water supply objectives.

- Many operational strategies are possible, and the strategy selected can vary in real time with prevailing conditions. Some broad operational strategies include:
- Constant intake, unvarying in time
- Seasonal intake, varying with seasonal conditions
- Opportunistic intakes, adaptively varying diversion rates in real time with local environmental conditions (food web, migrations, residence time, etc.) and objectives
- Multiple intake operations, varying intake from each location depending on local water quality and availability and fish conditions as well as downstream water quality and quantity objectives
- Multiple outlet operations, varying releases from the facility depending on environmental and water demand conditions at outlet location(s), as well as operational objectives for any operational storage facilities
- Coordinated intake and outlet operations with operations of reservoirs and conditions upstream and conditions downstream, including environmental pulse operations upstream and downstream of intakes and outlets.
- Batch flow operations, similar to pipeline operations in the petroleum industry. Using multiple inlets and with local operational storage, it might be possible to operate these facilities with downstream canals to segregate waters of different water qualities suitable for different delivery purposes.
- Constrained intake or outlet policies, which would limit operations over each year to a delivery quantity below the physical facility capability.

Operating policies would require many months of operational studies involving water operations modeling, integrated with hydrodynamic modeling and evaluations of biological implications. During and following project development, it would be desirable to continue operational studies to incorporate improved understanding of the Delta and its ecosystem and biological and hydrologic forecasting, and to explore a wider variety of operational solutions and coordination with other in-Delta, upstream, and downstream decisions (particularly operation of upstream and downstream reservoirs and aquifers).

As part of such adaptive operations, a monitoring network for water quality and biological constituents would be needed. The design of this network, with its locations and frequencies of samples for different chemical and biological constituents, is a related design problem and an ongoing problem, as it will be desirable to improve monitoring and data-gathering as more is learned. Fortunately, the monitoring system can be developed in parallel with other activities and with various monitoring configurations being explored simultaneously. Monitoring and data-gathering capability, integrated with scientific analysis, synthesis, and solution and decision development are necessary for long-term adaptive management.

4. Environmental Management

Many objectives for a peripheral canal are now environmental. Given the evolving nature of our understanding of the Delta ecosystem and how it might be managed, it is useful to discuss briefly some environmental benefits and potential environmental problems which arise from having a major upstream intake for water exports from the Delta. Some potential environmental benefits include:

- reducing fish "take" at the current in-Delta diversion location,
- reduction of confusing in-Delta flow patterns for fish migration,
- improving flood-ebb tidal flows in channels desirable for many Delta species,
- reduction in loss of in-Delta nutrients from exports,
- improving the overall Delta food-web, and
- reducing the interference of water supply operations for urban and agricultural water exports with environmental land and water management in the Delta.
- Potential problems from an upstream intake for water exports include:
- increased "take" of species and water from the lower Sacramento River and perhaps the North Delta,
- diversion of freshwater inflows from the Delta,
- increased residence time of contaminants in the Delta (e.g., wastewater discharges, pesticides and herbicides from urban and agricultural runoff and agricultural discharges) and
- reduced dilution of contaminants in the Sacramento River (such as urban wastewater treatment plant effluent and pesticide and herbicide residuals).

Any outflows from a peripheral canal into the San Joaquin River or east-side streams also have some potential to create straying of Sacramento-bound salmon and perhaps confusion of San Joaquin bound salmon.

In addition to these effects on land and water management in the Delta, a peripheral canal would be a large facility with its own environmental impacts, particularly for terrestrial and aquatic species and habitats occurring along any chosen right-of-way. Cost estimates and designs for this hardly isolated facility should include such mitigations.

Sorting out the environmental benefits and drawbacks of a peripheral conveyance and its operations will require many years and cannot be done in detail without field experiments, probably involving a real facility. These environmental operations and their compatibility with water supply operations will be restricted by physical locations and capacities, such as physical conveyance capacity. Therefore, the role of governance and regulation of peripheral conveyance is of major importance. In the interim it would be useful to develop a set of PC Principles for Environmental Management.

5. Ownership, Governance, Regulatory, and Finance Options

The ownership, governance, regulation, and finance of a peripheral canal would be fundamental to its approval, construction, operation, and long-term performance. A myriad of options are available, a subset of which is presented in Table G.1. More detailed discussions of these issues are underway in several forums (Delta Vision, Bay Delta Conservation Plan, the legislature). Although a variety of solutions may be workable, some necessary conditions are likely to include providing safeguards for environmental performance (e.g., by allocating a portion of conveyance rights to the environment and establishing a regular source of income for environmental mitigation actions). Safeguards for those water users most affected by the change are also an essential ingredient. Some novel means of distributing ownership and governance of a canal might be useful. These issues are discussed below, in Appendix A, and Chapter 7 of the main report.

6. Accompanying Delta Land and Water Management

A major aspect, and potential benefit, of a peripheral canal is that it decreases, or at least changes, the coupling of management of the Delta for water supply and for the Delta ecosystem, particularly under recent court decisions. In the best case, upstream relocation of major intakes might greatly improve prospects for some species. In the worst case, upstream diversions might remain significantly limited by a requirement to maintain larger net Delta outflows or inflows to particular parts of the Delta. It is almost certain that years of potentially substantial operational refinement will be needed.

The operation of an upstream diversion also is likely to affect local and regional habitat, flood management, agriculture, recreation, and land and water use decisions. Some coordination of these decisions with peripheral conveyance operation would be desirable. Planning and operational decisions for these other land and water uses would also affect the flexibility for the construction and operation of a peripheral canal. A larger governance, legal, and policy framework will be needed to reconcile Delta land management, water management, and upstream diversion operations.

7. Major Adjustments and Mitigations

For over 70 years, water suppliers and land owners have relied on the Delta's interior being maintained as an export location for fresh water. In-Delta farmers, Contra Costa Water District, and users of the state's North Bay Aqueduct rely on high quality water from the Delta, although some commonly receive poorer quality water. For urban water providers, these water quality problems are becoming increasingly difficult and expensive as a result of increasing federal drinking water standards and changes in Delta water quality. Recreational interests also have come to specialize in more fresh water fishing and recreation due to historical Delta management.

The development of peripheral conveyance for a major part of water exports provides both opportunities and problems for these users of the Delta. For the major urban supplies (particularly Contra Costa Water District and users of the North Bay Aqueduct), peripheral conveyance could provide a long term solution to persistent and worsening water quality and treatment problems. But taking advantage of this opportunity will involve major capital expenses to re-locate their intakes to connect to a peripheral canal and perhaps additional ongoing pumping costs. Public contributions to these infrastructure expenses, financed by taxpayers and the beneficiaries of conveyance capacity, may be an appropriate form of mitigation.

Due to limited impacts on water quality or stage, many in-Delta farmers in northern and eastern parts of the Delta are unlikely to be directly affected by a peripheral canal. Western, central, and southern Delta farmers could see increases in San Joaquin River salinity due to peripheral diversion operations (although under some circumstances they could see water quality benefits, see Appendix C and main report Chapter 4), leading to changes in their annual irrigation practices and increases in their operating expenses. Easements for such impacts or other forms of mitigation might be appropriate until the time when, following flooding due to levee failure, these islands are no longer deemed economically viable.

Recreation is a major industry and employer in the Delta. Many parts of the Delta's recreation industry should be fairly adaptable to changes in the Delta, including both natural long-term changes as well as changes accompanying operation of a peripheral canal. Nevertheless, local and individual impacts would be important. Large additional areas might be opened to recreational land and water uses and some areas currently used might become more restricted, for example to reduce the effects of boat wakes on levee erosion or environmental habitat. Additional study of this industry and the effects of changing Delta water operations for this sector would be useful in assessing what mitigations, if any, would be desirable.

8. Design Process for a Controversial and Complex Problem

The design of the infrastructure, operations, and other aspects of a peripheral canal would occur in a controversial and complex context which involves a wide variety of competing interests (Lund et al., 2007). It is clear that the ultimate design will be controversial and hard-fought, even if all parties stand to benefit. Great changes are anticipated for the Delta, along with growing upstream water use. However, there are large uncertainties regarding the timing and exact nature of these changes and how ecosystems and economies will respond. It is clear that a design specified in advance, while useful and necessary, will be significantly in error in some regards, even with considerable prior study. Thus, it is important that the governance and financing arrangements, as well as the infrastructure and operating rules, be capable of adapting to the changing Delta.

As a public policy problem and as a practical matter, the decision to build peripheral conveyance will need to precede the specification of the many details required to implement such a decision. However, a policy decision to build peripheral conveyance should be accompanied by a process for addressing these details, perhaps in a decentralized way, separating regulatory from operational aspects, with incentives for all parties to come to agreement within a reasonable time frame.

Conclusions and Recommendations

The decision to employ a peripheral canal as part of a solution to the water and environmental problems of the Delta and California requires a host of important implementation decisions regarding the infrastructure itself, its operations, and accompanying institutions, regulations, and impacts. Most of these decisions would need to be made before permitting and construction. However, many decisions could, even should, be made or modified during and after a period of construction and operation. Given long-term change in the Delta and elsewhere, many operational and regulatory decisions are likely to be subject to change for a period of several years to many decades after construction. The diverse parties involved in this problem are likely to benefit from initially specifying an institutional framework which can provide financially responsible, accountable, and transparent oversight, adaptive capability, and substantial political leadership for what will remain a controversial and difficult problem.

A decision to construct peripheral conveyance should be followed by a variety of decisions.

Before construction:

- Legal arrangements for governing institutions and finance
- An institutional mechanism for designing facilities and prescribing their range of operations
- An institutional mechanism for designing and implementing improvements in Delta habitat and environmental management
- A funded effort for the design and implementation of environmental management of the Delta
- An institutional mechanism for coordinating land and water management in the Delta
- A mechanism for resolving disputes expeditiously
- A funded independent scientific and technical mechanism to gather baseline data and prepare for longer-term adaptive management studies of ecosystem and economic effects and operations.
- Development of a suite of performance measures explicitly linked to project goals and objectives

After construction:

- Monitoring studies conducted as part of a systematic scientific and basic research program that addresses critical uncertainties and is linked to performance measures
- Operational studies

- Environmental management activities
- Oversight (auditing) of governing institutions and finance and regular evaluation of project performance
- An institutional mechanism for designing and implementing new adaptive environmental management projects and adjustment of project goals and objectives
- A funded effort for the design and implementation of adaptive environmental management of the Delta

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