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NHI's ENVIRONMENTALLY OPTIMAL ALTERNATIVE

FOR THE CALFED BAY-DELTA PROGRAM

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Executive Summary

NHI proposes that the CALFED Program study in detail one or more alternatives that are designed specifically to maximize environmental benefits. Under the regulations and case authorities governing the federal and state environmental review processes, we believe CALFED is not at liberty to ignore a reasonable and environmentally superior alternative. This paper describes one such alternative at a level of detail comparable to the "preliminary draft alternatives" generated by the CALFED Program. The alternative proffered by NHI would fully satisfy all of the objectives specified by CALFED[1]. In fact, it will provide far greater environmental benefits than any of the CALFED alternatives to date while providing comparable or higher levels of water supply reliability. This paper describes the alternative, estimates the benefits, discusses the legal and institutional requisites, and demonstrates the technical and economic feasibility, all in a preliminary manner. Like the three "preliminary draft alternatives" developed by the CALFED staff, the scale, cost and other operational details of the NHI alternative are left to further development within the CALFED process of defining, evaluating, and selecting alternatives.

The centerpiece of the NHI environmentally optimal alternative is the gradual, yet cumulatively dramatic, conversion of much of the delta lands below sea level -- and, thus, within the historic delta -- back to a vast mosaic of high quality aquatic, wetland, and terrestrial habitats, co-existing with agriculture, waterfowl forage crops, managed wetlands, and shallow and deepwater recreation. The planning area is comprised of the 350,000 acres of lands in the delta potentially subject to tidal influence. The extent of the habitat conversion would be defined in large measure by considerations of relative vulnerability of the levee system to seismic failure, the relative ease of filling the subsided lands, the relative value of the land in its current uses, and the willingness of the current landowners to transfer the necessary interests in the land.

At its full development, the restored habitat would include the largest complex of tidal wetlands west of the Texas coastal marshes and the largest wetland restoration project ever achieved in the world. In recognition of its national significance, we envision that the public lands within this area would be managed as a component of the national park system, such as a national wildlife refuge or national recreation area. In addition to the habitat benefits, this new mosaic would provide enormous recreational benefits with the attendant boost to the local economy, just as do all national parks and recreation areas. Creating a national reserve would also help secure the federal funding that will likely be needed to accomplish the land acquisition and restoration work.

The NHI alternative would also incidentally reduce fish entrainment and the impairment of water quality associated with current land uses. The alternative includes a mechanism for meeting environmental water needs inexpensively and voluntarily. Importantly, the NHI proposal may also provide substantially superior water supply benefits by including strategies to maximize conjunctive water management, improve efficiencies of use, foster

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[1] It largely solves the water quality and seismic problems in the delta without the need for targeted program elements. Therefore, water quality and seismic elements are largely absent from this alternative.

water transfers, and indemnify water users against regulatory changes. These largely non-structural, institutional innovations could provide as much as 2 million acre feet per year of new supply to meet the needs of all sectors.

The NHI alternative is likely to prove no more costly over the long-term than other alternatives because the costs of farmland acquisition and restoration would be offset by the avoided costs of levee maintenance and repair, screening of delta diversions, and drinking water treatments, not to mention the far larger potential costs to the water supply systems and aquatic resources associated with catastrophic failure of the levee system. Even under the NHI scenario, levee maintenance and repair will be needed on the islands for many years to come, as the lands are rebuilt to near sea-level. However, eventually the costs of ongoing levee maintenance will be avoided. At the outside, the cost of purchasing conservation interests in the delta islands should not exceed $700 million (based upon the purchase of 350,000 acres at around $2,000 per acre). This payment is a transfer payment rather than an actual social cost. Although the cost of habitat restoration is not yet well defined, it could be fairly low if natural peat regeneration techniques are used over a period of decades, or more expensive if fill material has to be imported into the islands. The cost to the local economy of lost agricultural production would be offset by the expected boost in the recreational and tourism sectors.

On the other side of the ledger, the following benefits should materialize quickly: (1) cumulative reductions in the risks and costs to delta farmers and the environment of catastrophic levee failures over time; (2) dramatic reductions in the impacts of delta diversions on the aquatic environment; (3) increased yield within the commercial and recreational fisheries; (4) major reductions in the cost of treatment for drinking water;[2] (5) significant improvements in the populations of endangered fish species (and attendant reductions in the constraints on water project operations); and (6) increased local revenue from recreational uses.

Which of the CALFED facility alternatives for delta conveyance and export would be most conducive to the maximum practical habitat restoration objective of the NHI proposal is inconclusive at the current level of CALFED analysis. The Program should study whether the habitat restoration proposal is compatible with the existing south delta export location, or whether a small isolated facility might also be needed.

In sum, the basic physical components of NHI's environmentally optimal alternative include:

- Large scale conversion of the delta lands below high tide to a mosaic of aquatic, wetland, and terrestrial habitats. Existing levees would be breached (except for those islands where water is to be stored seasonally under this scenario) after shallow water and riparian habitat has been restored through filling and natural deposition as marsh vegetation re-establishes itself.

[2] This would be true even if an isolated transfer facility is ultimately constructed. If restoration obviates the need for an isolated system, the savings would be even greater.

- Seasonal storage of water in some delta islands peculiarly suited to that use.

- Enhanced environmental flow and diversion patterns through market acquisitions by a new Delta Restoration and Adaptive Management Authority ("Delta Restoration Authority" or "DRAMA").

- Some form of enhanced delta transfer, whether through-delta or an isolated system.

- Targeted restoration in areas upstream of the delta, including screening of diversions and reduction in toxic effluents.

- Reductions in other anthropogenic sources of fish mortality, including reduction in the effects of commercial and recreational harvest, reduction in the effects of introduced aquatic species on delta native fishes, and continued research on fish biology and management requirements.

The NHI alternative links these physical components to an array of new institutional arrangements that include:

- A "Delta Restoration and Adaptive Management Authority" ("Delta Restoration Authority" or "DRAMA") that would be responsible for systemic restoration planning and management. This would include acquiring and restoring delta lands, determining flows and flow patterns required for restoration and preservation of the ecological system and the acquisition of such water, and pursuing other non-flow restoration activities (e.g. Category III initiatives).

- A maximal scale, state-wide conjunctive water management program to increase the yield of the developed water system to meet needs in all sectors, including improved water conveyance and groundwater management facilities.

- Demand management, predicated upon full implementation of the urban water conservation memorandum of understanding and market incentives for agricultural water conservation through facilitative arrangements involving water districts, changes in criteria governing transferability, and expedited approval processes.

By establishing a program for gradual, compensated reconversion from agriculture to tidal marsh and other habitats, the NHI alternative would provide for a smooth transition from costly and unsustainable land uses to a sustainable, lower cost future in a manner that provides a fair, voluntary and attractive option to the current landowners. If funds that could be saved by avoiding the need for levee maintenance, fish screening and drinking water treatments were dedicated to voluntary purchases of lands or conservation easements in the most vulnerable islands, ***all stakeholders, including the delta farmers, would be better off than under the status quo***. The truth of this proposition is obvious: farmers would sell only if they prefer that alternative to the open-ended risks associated with the current land use. Farmers who prefer not to sell at the offered price could keep their island in agriculture (assuming they are willing to pay the costs of levee maintenance not defrayed by the public). There would be no

condemnation or forced sale of delta lands. The public fisc would benefit because one-time payments for acquisition would be substituted for public monies that would have to be expended indefinitely in artificial maintenance of current land uses. The environment would be benefitted enormously by vast new areas or aquatic and terrestrial habitat. And, local communities would benefit from the increases in recreational and tourism revenues which are a predictable result of the creation of a large new preserve on the threshold of the one of the largest metropolitan areas in the nation. In short, this scenario produces only winners; there would be no losers.

Section I
The NHI Environmentally Optimal Alternative

A. Introduction

The delta formed by the confluence of the two great river systems of the central valley is one of the defining environmental assets of the nation, and the entire San Francisco Bay Area community is enriched by its fish, wildlife, and native plant habitats, as well as its exceptional economic, recreation and aesthetic qualities. Once a massive wetland, the heart of the delta was covered not so long ago by some 350,000 acres of tidal freshwater marsh, surrounded by 200,000 to 300,000 acres of non-tidal marshes or seasonal wetlands, riparian woodlands on natural alluvial levees, and some upland woodlands and grasslands. But this resource has been tragically compromised over the past century and a half by progressive land transformations and hydrologic modifications, which have been greatly accelerated by the largest water development projects in the world. Altogether, over 97% of the delta's tidal wetlands have been diked, filled, and transformed into farmland to the point where not just individual species but the ecosystem as a whole is endangered.

The centerpiece of the NHI environmentally optimal alternative is the gradual, yet cumulatively dramatic, conversion of much of the delta lands below sea level -- and, thus, within the historic delta -- back to a vast mosaic of high quality aquatic, wetland, and terrestrial habitats, co-existing with agriculture, waterfowl forage crops, managed wetlands, and shallow and deepwater recreation. The planning area is comprised of the 350,000 acres potentially subject to tidal influence. The extent of the habitat conversion would be defined in large measure by considerations of relative vulnerability of the levee system to seismic failure, the relative ease of filling the subsided lands, the relative value of the land in its current uses, and the willingness of the current landowners to transfer the necessary interests in the land.

At its full development, the restored habitat would include the largest complex of tidal wetlands west of the Texas coastal marshes and the largest wetland restoration project ever achieved in the world. In recognition of its national significance, we envision that the public lands within this area would be managed as a component of the national park system, such as a national wildlife refuge or national recreation area. The resulting mixture of private economic uses and publicly protected lands within the same management unit exemplifies a new paradigm that is emerging nationally and internationally in the management of ecological preserves, called "integrated conservation". Instead of creating an enclave segregated from local economic activity, we are proposing an environmental restoration program that fosters the recreational economy, and a sustainable agricultural program that supports waterfowl, spawning habitat and nurseries, and protection of endangered terrestrial species. This can only be accomplished in concert with the current land and rights holders who must also foresee a better future for themselves. Our approach would provide them with alternatives to farming which can only be maintained artificially and temporarily. In addition to the habitat benefits, this new mosaic would provide enormous recreational benefits with the attendant boost to the local economy, just as do all national parks and recreation areas. Creating a national reserve would also help secure the federal funding that will likely be needed to accomplish the land acquisition and restoration work.

To determine the feasible and practical areal extent of this habitat restoration option, we propose that the CALFED Program examine such factors as:

(1) the environmental and economic costs and benefits resulting from major conversion of land to environmental purposes;

(2) the long-term sustainability of the delta islands, given the economics of farming, the risks of permanent flooding from seismic and other causes, and the costs of levee maintenance and repair and subsidence control; and

(3) the feasibility of restoring productive aquatic habitat on islands where substantial subsidence has occurred.

We expect that the restoration would be accomplished progressively, with the early phases confined to the islands that are at greatest seismic risk and nearest to sea level, and expanding at later stages to islands where restoration takes more time and resources. In all cases, the areas restored to habitat would be limited to those where the necessary property interests (ranging from conservation easements to fee interests) can be acquired from willing sellers. The long-term savings in levee maintenance and repair, land recovery, and fish screening subsidies may permit the acquisition authority to offer premiums above fair market value.

Consistent with this consensual approach to land use conversions, a final feasibility constraint is that the delta restoration plan will need to be developed in concert with affected delta landowners and residents. The NHI option should be regarded as one that creates better prospects not only for the delta environment but also for its human residents, both of which must be able to envision a future. That is not to say that our proposal will not be controversial. But, we believe that good public policy comes from good science and dialogue, not from the avoidance of controversial topics. As that dialogue progresses, CALFED and the stakeholders, including NHI and delta agriculture, may well converge on a solution which diverges from the proposal outlined here.

NHI's comprehensive plan also includes facilities, groundwater storage, water transfer, and other elements designed to meet the water supply and water quality needs of all sectors. These features should make the NHI alternative very attractive to all stakeholders in the CALFED Program, environmentalists and water users alike.

B. Justification for reconversion of substantial portions of the delta to habitat: The diked farmlands pose high risks and costs to farmers, the environment and the public fisc.

1. *Risk of catastrophic failure of the levees and inundation of subsided lands*

Before it was developed into agricultural lands, the delta was a vast brackish tidal marsh with upland areas defined by natural stream meanders. Even 100 years ago, delta agricultural land was at sea level and sat behind minor artificial levees. However, agriculture on peat soil leads inevitably to land subsidence as a result of oxidation. On

some of the eastern islands, the peat has been eliminated and subsidence has ended. In the central and western islands, comprising some 150,000 acres, significant peat deposits remain and subsidence continues. Subsidence is quite variable within the delta, ranging from near sea-level at the eastern, southern and northern fringes and increasing in the interior and western sectors to more that 25 feet below sea level at the extreme. Constructed of unconsolidated clays, muds, or silts, the levees were never meant to withstand the increased hydrostatic loads caused by subsidence. Nearly every island in the delta has been flooded once or more; several islands have been permanently abandoned and are now inundated. This risk can only increase as sea levels rise in the future due to global warming.

Of greatest concern is the vulnerability of the islands to earthquake. According to a report written by DWR, there is a 50% chance that the levees in the western half of the delta will sustain significant damage in an earthquake within 30 years.[3] The consequences of permanent and unplanned levee failures would be severe. If multiple islands were lost simultaneously to earthquake, it is unclear whether the islands could be repaired before wave action caused major damage to the interiors of the levees. In this scenario, hundreds of thousands of acres of delta land might be permanently abandoned. Land levels have subsided to such a depth that many islands, if flooded without prior modification, would be incapable of supporting a productive aquatic ecosystem. There would in fact be few offsetting environmental benefits for many decades. Furthermore, loss of the islands would lead to salt intrusion, which could degrade drinking water quality and aquatic habitat.[4]

In sum, current land uses in the delta can only be maintained artificially through levees that are costly to maintain and are more or less susceptible to failure by natural events. Probabalistic analyses conclude that it is only a matter of time before greater or lesser areas of the delta become inundated. If this occurs in a planned and phased manner, the result could be large areas of productive habitat; if it occurs in an unplanned and sudden manner, the loss could be devastating to the farmland owners, the water supply system and the aquatic environment.

The degree of this risk has not been well-characterized or factored into the long-range planning for the delta. The CALFED process provides a unique opportunity to do both and, in the process, create an alternative that represents a lifeline for all stakeholders in the delta that is less risky and less costly than current patterns. The costs associated with the status quo are both environmental and economic, as described below. NHI's alternative is predicated on the belief that it would be financially attractive to delta farmers, the public fisc, and the environment if the monies saved in avoiding these costs were directed toward purchasing the delta islands where farming is least sustainable over the long-term in voluntary and well-compensated

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[3] This estimate represents a middle range between the large uncertainties associated with whether peat soils amplify or attenuate seismic shocks. DWR, "Review of Seismic Stability Issues for Sacramento-San Joaquin Delta Levees", July 1993.

[4] NHI's alternative would change the diversion point for drinking supplies to avoid this problem.

transactions.

2. ***Environmental costs***

The biological damage caused by agricultural production to the delta has been severe. Consider the following:

- *Loss of habitat*: Between 1860 and 1930, 97% of the delta's 450,000 acres of freshwater wetlands were diked and planted with crops. Very little of the predisturbance wetland habitat now exists within the delta, reducing or altogether eliminating the wildlife species dependent on this resource. Wetlands provide vital spawning and nursery grounds for fish, and important sheltering, feeding, and nesting areas for many species of birds, some of which are endangered. Wetlands can also improve water quality by trapping sediments and by removing nutrients and some chemical contaminants.

- *Diversions*: The peak diversion season in the delta coincides with the months when large numbers of young chinook salmon, striped bass, American shad and other fish are present in the system. There are about 1900 unscreened diversions in the delta, pulling in large numbers of fish, eggs, and larvae. Some rough estimates indicate that the losses of young bass (generally less than 16 mm in length) is on the order of several hundred million and the loss of juvenile chinook salmon may be in the range of a few hundred thousand.[5]

- *Drainage*: The application of fertilizer and pesticides on delta farmlands can be problematic not only for local wildlife, but for inhabitants of (and visitors to) the downstream estuary. Crops rarely absorb more than half of the nutrients in fertilizers; as a result, ammonia (toxic to fish) and nitrate (which in excess can cause rapid, oxygen-depleting growth of algae) leach into agricultural drainage water. While some pesticides decompose quickly, most are more resistant to chemical breakdown and leach into drainage water unaltered. Some studies indicate pesticides to have been a significant factor in reducing population levels of striped bass in the estuary during the period 1973-1986.

3. ***Public costs***

The sustainability of delta agriculture from an economic perspective depends upon the profits and costs of doing business and the level at which society is willing to subsidize agriculture. The overall costs of delta agriculture include:

(1) the cost of levee maintenance, levee repair, and island rehabilitation after flooding events;

(2) the economic costs associated with allowing diversions to be unscreened (such as

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[5] DWR report, "Screening Agricultural Diversions in the Sacramento-San Joaquin Delta."

reduced commercial salmon catch) and the costs of screening them;

(3) the economic costs associated with treating delta agricultural discharges for drinking water;

(4) the contribution of delta agriculture to endangered species problems; and

(5) the economic risks associated with temporary and permanent flooding -- loss of agricultural production and disruption of exports.

Some of these costs are borne by delta farmers; most of these costs are borne by society as a whole. The key question is whether the benefits of delta agriculture, as it is currently configured, are worth the costs in the long run.

Information exists for the costs of only a few of these impacts -- levee costs, the cost of screening, and drinking water treatment costs. However, even this subset of the costs imposed upon society by delta agriculture is sufficient to call into question the desirability of maintaining delta agriculture as a matter of public policy.

- *Levee subsidies*: From 1980 - 1986 (the last date for which we have information as of yet), emergency subsidies for levees cost the state and federal governments over $90 million or about $15 million per year. State subsidies for routine maintenance and repair of non-project have recently been running between $2 million and $5 million annually. In addition, the state has spent $27 million since 1989 for a special Flood Protection Program for eight delta islands and two delta communities (with a total commitment of $35 million through 1997). These costs will only increase in the future as islands continue to subside.

- *Screening*: Virtually none of the approximately 1900 diversions in the delta are screened. Current screening policies may be changing, however. The Department of Fish and Game (DFG) has recently written a "Plan of Action for Screening Diversions," and there is some indication that the US Fish and Wildlife Service is advocating a more rigorous screening policy in the delta.

  If DFG were to order diversions in the delta screened, it would wind up bearing most of the costs.[6] The potential costs for installing screening are roughly estimated at $3000 - $5000 per cfs at each siphon type intake (where average maximum flow for delta diversions is about 10-15 cfs); it is estimated that screening the multitude of delta diversions would cost more than $100 million. Operation and maintenance costs would also be significant.

- *Drinking water*: The incremental cost for drinking water treatment caused by delta island discharges will probably be in the range of $500 million per year in the future.

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[6] Under the Fish and Game Code, DFG is responsible for installation and maintenance costs for diversions installed prior to 1972, and smaller than 250 cfs--which includes most delta diversions)

Putting all the costs together -- quantifiable economic costs, non quantifiable economic costs, and environmental costs -- the long-term continuance of delta agriculture as the predominant land use cannot be justified as a matter of public policy.

NHI believes that reconversion of substantial portions of the delta from agriculture to habitat represents a low cost alternative, when all economic and environmental factors are considered. In any event, the NHI alternative is likely to prove no more costly over the long-term than other alternatives because the costs of farmland acquisition and restoration would be offset by the avoided costs of levee maintenance and repair, screening of delta diversions, and drinking water treatments, not to mention the far larger potential costs to the water supply systems and aquatic resources associated with catastrophic failure of the levee system. Even under the NHI scenario, levee maintenance and repair will be needed on the islands for many years to come, as the lands are rebuilt to near sea-level. However, eventually the costs of ongoing levee maintenance will be avoided. At the outside, the cost of purchasing conservation interests in the delta islands should not exceed $700 million (based upon the purchase of 350,000 acres at around $2,000 per acre). This payment is a transfer payment rather than an actual social cost. Although the cost of habitat restoration is not yet well defined, it could be fairly low if natural peat regeneration techniques are used over a period of decades, or more expensive if fill material has to be imported into the islands. The cost to the local economy of lost agricultural production would be offset by the expected boost in the recreational and tourism sectors.

On the other side of the ledger, the following benefits should materialize quickly:

(1) cumulative reductions in the risks and costs to delta farmers and the environment of catastrophic levee failures over time;

(2) dramatic reductions in the impacts of delta diversions on the aquatic environment;

(3) increased yield within the commercial and recreational fisheries;

(4) major reductions in the cost of treatment for drinking water;[7]

(5) significant improvements in the populations of endangered fish species (and attendant reductions in the constraints on water project operations); and

(6) increased local revenue from recreational uses.

By establishing a program for gradual, compensated reconversion from agriculture to tidal marsh and other habitats, the NHI alternative would provide for a smooth transition from costly and unsustainable land uses to a sustainable, lower cost future in a manner that provides a fair, voluntary and attractive option to the current landowners. If funds that could be saved

[7] This would be true even if an isolated transfer facility is ultimately constructed. If restoration obviates the need for an isolated system, the savings would be even greater.

by avoiding the need for levee maintenance, fish screening and drinking water treatments were dedicated to voluntary purchases of lands or conservation easements in the most vulnerable islands, ***all stakeholders, including the delta farmers, would be better off than under the status quo***. The truth of this proposition is obvious: farmers would sell only if they prefer that alternative to the open-ended risks associated with the current land use. Farmers who prefer not to sell at the offered price could keep their island in agriculture (assuming they are willing to pay the costs of levee maintenance not defrayed by the public). There would be no condemnation or forced sale of delta lands. The public fisc would benefit because one-time payments for acquisition would be substituted for public monies that would have to be expended indefinitely in artificial maintenance of current land uses. The environment would be benefitted enormously by vast new areas or aquatic and terrestrial habitat. And, local communities would benefit from the increases in recreational and tourism revenues which are a predictable result of the creation of a large new preserve on the threshold of the one of the largest metropolitan areas in the nation. In short, this scenario produces only winners; there would be no losers.

C. Design premises of NHI's environmentally optimal alternative

1. The NHI alternative is designed to maximize environmental benefits while ***fully satisfying the other objectives of the CALFED process***. It largely solves the water quality and seismic problems in the delta without the need for targeted program elements. Therefore, water quality and seismic elements are generally absent from this alternative. The proposal is targeted at assuring that current levels of demand can be met with a higher degree of reliability. Demands beyond the current average annual levels of diversion and export for the consumptive water users will be met through additional water efficiency improvements, additional transfers and additional groundwater storage.

2. The environmental objective assumed by this proposal is significant improvement in the ecosystem compared to a baseline level of ecosystem health. That baseline includes the 1995 WQCP, full implementation of the Category III commitments, full implementation of the CVPIA and the anadromous fish restoration program, continuation of the biological opinion and reasonable and prudent alternatives for the winter run salmon and the delta smelt, the Corps of Engineers' restrictions on south delta pumping rates, and normal operations of the water projects. We use the term "restoration" as a shorthand term for these improvements. Restoration does not suggest a return to a perfect state of nature. Instead, given the radically altered state of the delta estuary, NHI has attempted to construct an alternative that builds on the current reality and provides highly leveraged opportunities to reestablish critical ecological functions and processes, with particular emphasis on hydrological functions. The alternative adopts an ecosystem approach, meaning that it attempts to address the restoration comprehensively throughout the entire Central Valley watershed.

3. The proposal emphasizes non-structural solutions (institutional reforms) over structural solutions (physical and facility changes) to the maximum extent feasible. However, some of the institutional improvements (e.g. conjunctive water management

and reductions in fish entrainment) will necessitate structural elements.

D. Physical and functional description of the environmentally optimal alternative

The NHI Environmentally Optimal Alternative has seven basic physical components:

1. Large scale conversion of much of the delta islands to high quality terrestrial, wetland and aquatic habitat; while leaving other areas in agriculture, managed wetlands, waterfowl forage crops, water storage, and deep water recreation.

2. Seasonal storage of water in some delta islands peculiarly suited to that use.

3. Enhanced environmental flow and diversion patterns.

4. Enhanced delta transfer.

5. Reductions in other anthropogenic sources of fish mortality.

6. Targeted restoration in areas upstream of the delta.

7. Improved water conveyance and groundwater management facilities.

8. Demand management through improvements in the urban water conservation accord and through market incentives for agriculture.

1. Conversion of delta islands to habitat

NHI proposes the purchase up to 350,000 acres of land in the delta which is currently below sea level, and convert that land, over time, back to the tidal wetland conditions (and terrestrial habitat) which existed in the 19th century.[8] Some of the islands can be readily converted into a mosaic of terrestrial, riparian, and shallow habitats connected by new delta channels. Deeper islands will require measures to raise the elevation of the land before they can be converted.

The gradual transformation of land to habitat would be accomplished through voluntary acquisition and management by a Delta Restoration and Adaptive Management Authority ("Delta Restoration Authority" or "DRAMA"). Where desired, fee interests will be acquired subject to a life estate in the existing owners. Several small towns exist within the targeted portion of the delta; the NHI proposal does not envision buying out these areas, but would enclose them in high quality levees as inholdings.

Islands acquired for habitat would be managed and modified, over time, to provide high quality wetland, terrestrial and aquatic habitat as follows:

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[8] A map of the target area is attached.

- Continued maintenance of levees until such time as island interiors have been prepared for habitat not dependant upon levee protection.

- Interim management for optimum wetland and terrestrial habitat. Modification of diversion patterns to reduce entrainment problems.

- On the shallower islands, immediate modification of the land surface to create a mosaic of terrestrial, riparian, and shallow habitats connected by new delta channels, then flooding of the islands.

- On the deeper islands, peat regeneration programs designed to build up the depth of the islands over a period of decades.[9] Recent field experiments reveal that the reintroduction of tule marshes into the islands could rebuild the peat at a rate of several inches per year. Once the islands were restored to depths near sea level, the islands would be prepared, then flooded, as above.

These strategies would be implemented by the Delta Restoration Authority in an adaptive fashion, through pilot projects and scientific study. The intensity of restoration activity would interact with the Delta Restoration Authority's water management responsibilities. That is, through time the Delta Restoration Authority would gain greater insight into the key leverage points for ecosystem restoration. As these leverage points become clearer, the Delta Restoration Authority's resources will shift accordingly. Thus, the Delta Restoration Authority could emphasizing any permutation of elements including land acquisition and habitat restoration, acquisition of new flows, and physical restoration actions of the type contemplated by "Category III", depending upon which combination proves optimal.

2. Conversion of delta islands into reservoirs

Some of the deeper islands might be converted into seasonal storage facilities for a period of years, or permanently. Storage islands would be owned and managed by the Delta Restoration Authority and either used to increase delta outflow during critical periods, or connected to the export pumps via siphons and canals to generate environmental storage south of the delta.

3. Improved environmental flow and diversion patterns

In the NHI alternative, improved environmental flow patterns would be the responsibility of the Delta Restoration Authority. The Delta Restoration Authority would be endowed with some combination of funds and or water, which, in the context of a functioning water market (also part of the NHI alternative) would be interchangeable, although funds would be more versatile. The Delta Restoration Authority would determine on the basis of its

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[9] Various alternatives for physical and economic feasibility will be researched, including: (1) silt deposition; (2) peat regeneration; (3) dredge spoils; (4) application of rice straw; and (5) the transfer of peat from one island to another through slurry lines.

own expertise, and in an adaptive management mode, the optimal combination of flow enhancements, diversion patterns changes, habitat improvements and physical measures to implement. Thus, the Delta Restoration Authority might:

- Develop storage on one or more delta islands.
- Develop new supplies through conjunctive use arrangements.
- Purchase water on the open market.
- Purchase or lease diversion rights.
- Purchase storage rights in existing reservoirs.
- Exchange Sacramento River water for increased tributary outflows.

There is no need to specify exactly how the environmental flow patterns would be improved. In general, however, we may speculate that the Delta Restoration Authority would seek to acquire water through storage, purchase, and exchange to boost tributary and delta flows during dry years.

4. Delta transfer facility: Improved hydrodynamics for habitat and diversion benefits

The conversion of the delta from a region of large islands separated by narrow channels to a mosaic of habitats may resolve the conflict between south delta exports and fisheries protection. The restoration efforts outlined above would have the effect of (1) reducing entrainment into the delta islands; (2) improving fishery habitat; and (3) reducing average channel velocities toward the pumps. The combination of increased productivity and reduced mortality may allow restoration of ecosystem function without the need to shift exports from the south delta. Moreover, the reduction in organics from agricultural discharges may allow urban water agencies to meet future drinking water standards at a lower cost. On the other hand, a south delta export location may turn out to be incompatible with fisheries restoration due to entrainment of fish -- even with a large-scale habitat restoration effort. Moreover, large-scale restoration might increase salinity intrusion or might have other water quality impacts which are not well understood at present.

An alternative approach would be to construct a small isolated system (on the order of 6 kcfs) in order to reduce entrainment problems caused by the export pumps, improve water quality, and increase the security of water supplies. The facility would operate year round, except to the extent that closures might be necessary to protect down-migrating salmon or pulses of eggs and larvae. Thus, the isolated system would provide in the neighborhood of 4 million acre feet per year. Additional exports would be generated through pumping from the south delta. A low level of background pumping might be necessary to keep water quality in the south delta at acceptable levels. Additional south delta exports would be extracted during low impact periods (e.g., during winter storms). Urban water quality would be maximized by

keeping delta water segregated from water from the isolated system to the degree possible. Feeder lines from an isolated facility might also be built to connect to east side and San Joaquin water users. Water acquired by the Delta Restoration Authority from the Sacramento basin could be sent through these lines to east side agriculture in exchange for increased side and San Joaquin tributary flows.

At the current state of analysis in the CALFED process, it would be premature to make a recommendation with respect to these two approaches at this time. All things being equal, a through-delta approach is preferable because it may be cheaper and has greater political support. We are inclined to believe, however, that an impartial analysis will show that a small isolated facility will be needed to enable a maximum extent of environmental restoration while meeting the needs of other stakeholders. With either approach strong assurances will be needed to guard against the risk of misoperation.

5. Reductions in other anthropogenic sources of mortality

Actions beyond improved habitat and flows and diversion patterns are desirable. Such actions have been discussed in detail elsewhere and include, in brief:

- Reduction in the damaging effects of commercial and recreational fish harvest.
- Reduction in the damaging effects of introduced aquatic species on delta native fishes.
- Continued research on fish biology and management requirements.
- Measures to protect spring run salmon, possibly including closure of the cross delta channel for the entire period of October-December. (Note that such closure would no longer pose a constraint on delta exports due to the new isolated facility on the Sacramento; yet closure may not in fact be necessary because of less entrainment at the south delta pumps.)

6. Upstream habitat improvements

There is little doubt that degradation of upstream habitat, as well as the altered hydrodynamics of the delta, have played a major role in the decline of delta-dependant species, and anadromous species in particular. Other non-flow factors (such as toxic loading and unscreened diversions) bear responsibility for species declines as well. The NHI alternative calls for systemic restoration, targeting areas that have substantial potential for recovered ecological processes and benefits to targeted species and habitats. Important areas for key aquatic species that are currently healthy will be candidates for management to avoid degradation and ensure that future development is compatible with maintaining high quality habitat where it now exists.

Under the NHI alternative, habitat improvements upstream of the delta will be based on a comprehensive planning structure similar to that now contemplated by CALFED's proposal for a coordinated approach to ecosystem restoration. All federal, state and local

planning efforts would be coordinated by a single entity capable of developing annual and long-term targets and concomitant action plans. Ideally, this entity would be empowered to decide how best to improve habitat on both an annual and long-term basis, employing the full range of options from restoration projects, to water acquisitions, to land purchases.

7. Groundwater storage

High level winter and spring flows, particularly during years of above average precipitation, represent the primary source of "new" supply that remains untapped in California. By new supply, we mean only water that is not subject to water right, contract delivery obligations, environmental regulation, or that does not provide significant environmental benefits. Some of these flows can be captured for beneficial uses without new surface storage reservoirs through the coordinated use of existing surface and groundwater storage capacity. Such "conjunctive water management" banks water under the ground during periods in which surface water is plentiful. That water is later retrieved for use when surface water is scarce. Thus, conjunctive use utilizes groundwater for water storage, while avoiding evaporation losses and the high economic and environmental costs associated with surface storage. While it is a well-established water management technique, California has never sought to realize the full physical potential of conjunctive use, outside of several small regulated groundwater basins in Southern California.

NHI is well along in the process of conducting a feasibility study of the physical potential for conjunctive use and the institutional changes which might be necessary to allow conjunctive management to dramatically increase the total amount of water available for beneficial use in the State. The type of conjunctive program that NHI envisions would use groundwater basins to store water in just the way water engineers have traditionally used surface reservoirs--to capture water that would otherwise be lost to the system, for subsequent delivery to uses that are not appurtenant to the area of storage. For the agricultural and urban water users, that means enhanced reliability of their water supplies and/or financial benefits. For the Bay-Delta ecosystem, it means additional delta freshwater through flows. These benefits provide the incentives that will be necessary to induce voluntary cooperation in a state-wide conjunctive use program.

NHI's preliminary estimate is that the Central Valley tributaries could yield up to 1.4 million acre feet per year on average (before taking into account conveyance or percolation constraints). This compares favorably with the estimate of the Bureau of Reclamation in their 1995 Water Augmentation Study. NHI is now in the progress of testing the feasibility of actually achieving these levels of yield. Our analysis is looking both at facilities and operational constraints as well as geohydrologic, land use and other factors. In general, the achievement of full conjunctive use potential may involve additional facilities such as canals and even offstream surface storage.

NHI is also investigating the institutional and legal framework that would be necessary to foster a maximal scale, state-wide conjunctive use program. We conclude that, notwithstanding the absence of a statutory groundwater management regime in California, there are no substantial legal or institutional constraints, and new legislation may not be

necessary.

The NHI alternative does not include specific conjunctive use projects. Rather, these projects will be developed over time by water users and the Delta Restoration Authority. However, we would propose to include conveyance facilities which provide needed infrastructure capability.

For example, improved infrastructure for conjunctive use east of the delta might be provided through feeder lines which would move east and south from an isolated system. The primary purpose for these feeder lines would be to provide exchange water to free up additional instream flows in these tributaries. However, additional capacity might be made available to provide water for groundwater storage. The storage would be used to boost local reliability, provide environmental flows, and to increase export reliability.

Southern San Joaquin infrastructure for conjunctive use might involve increased conveyance and distribution system and surface storage. The general idea is to allow for much higher summer deliveries to the southern San Joaquin Valley during wetter years so that more water can be stored via percolation and in lieu. That water can then be accessed during dry years by water users and the Delta Restoration Authority. Additional modeling will show the degree to which water can be put into the ground with the facilities proposed in this alternative. If groundwater storage is infrastructure limited, then the CALFED Program should consider improving either conveyance capacities in the southern San Joaquin, offstream storage capability, or both.

Far more detail on the state-wide potential of conjunctive water management is provided in the current working draft of NHI's feasibility study, which will be incorporated into the final version of the NHI proposal as a technical appendix. The final report is being synchronized with the CALFED program and will be completed within the same time frame.

8. Demand management

Demand management measures are discussed in the next section.

E. Institutional Structures

The NHI alternative links the various physical components described above to an array of new institutional arrangements. These include:

1. A new Delta Restoration and Adaptive Management Authority ("Delta Restoration Authority" or "DRAMA") that would be responsible for systemic restoration planning and development of comprehensive watershed preservation and management programs.

2. Institutional arrangements for an expanded conjunctive use program.

3. The institutional basis for aggressive agricultural and urban efficiency programs.

4. A liberalized water transfer system.

All of these elements are feasible to implement, technically and economically. NHI has worked out most of the improvements in considerable detail in other papers and studies which will be incorporated into the final version of this proposal as technical appendices. Some will require new legal authorization and modest changes in existing law, as would most, perhaps all, of the CALFED alternatives. As discussed in the "Guarantees" section following, the additional authorities should be enacted at both the state and federal levels to give the institutional structures stability and predictability

1. Environmental water purchase and restoration regime: The Delta Restoration Authority

Existing mechanisms for environmental protection and restoration are highly unsatisfactory. Minimum environmental flows are secured only through cumbersome and time consuming regulatory processes. Water for users is allocated through water rights processes. Responsibility for habitat restoration is parceled out between numerous state and federal agencies. Environmental advocates have no incentive to consider the economic impact of new regulations on water users. Water users have no incentive to consider the environmental impact of their water rights on the environment. Thus, there is need for change, not only in the physical and biological spheres, but in the institutional sphere as well.

To solve these institutional problems, NHI proposes the creation of a Delta Restoration Authority. The Authority would function as an environmental counterpart to the other supply water agencies, except that it would combine a broader array of functions and powers than the purchase of water rights, water storage rights and conveyance rights. In addition, this environmentally optimal alternative identifies several other functions pertaining to fishery habitat and tidal wetlands restoration in the delta that would best be combined within a single agency with a high degree of technical expertise. There are also an array of pre-existing obligations of a similar type that comprise the environmental baseline for the estuary that require a similar degree of expertise and coordination.

Ideally, all of these functions would be entrusted to a new, special purpose agency exercising both state and federal powers to maximize environmental benefits in an efficient manner. It could meet regulatory requirements for flows or habitat, and provide enhancements above and beyond regulatory minimums. Funding could come from a variety of sources, including general funds and water user fees. In order to assure that its limited budget was being spent to greatest effect, the Delta Restoration Authority would want to establish a high quality adaptive management program of testing, monitoring, and analysis.

The Environmental Delta Restoration Authority approach would solve many of the institutional problems which complicate restoration today:

- The Delta Restoration Authority would acquire water and land on the market. There would be no need for additional water rights proceedings to meet regulatory requirements, provided that the Delta Restoration Authority is sufficiently endowed.

For enhancements above regulatory requirements, the Delta Restoration Authority would be able to shift spending priorities as knowledge about the needs of the ecosystem changes, without the need for lengthy regulatory hearings.

- The creation of a Delta Restoration Authority with authority to purchase environmental enhancements within a fixed budget will encourage environmental efficiency, since managers will have an incentive to invest their limited resources where they will do the most good, whether that investment is in habitat, flows, reduced diversions, and other means.

- Because the Delta Restoration Authority would have both the authority and the means to restore the environment to an acceptable level, it would be in a position to grant a partial or full indemnity against future ESA listings. (This provision would give the Delta Restoration Authority an incentive to deploy its resources so as to head off future listings, while providing reliability to water users).
- The Delta Restoration Authority could stabilize the management system during extended periods. Normal "operational" guarantees might confront water agencies with the choice of either suffering great hardship during long droughts, or attempting to breach minimum environmental standards. By contrast, the Delta Restoration Authority could sell part of its water supply during dry periods (when urban agencies would be willing to pay very high prices for the water), if benefits outweighed the costs. In this way, the environment would benefit and urban areas would be benefit and confrontation would be avoided.

The main questions for the Delta Restoration Authority approach are the responsibilities, governance and funding for such an entity:

- ***Responsibilities:*** *On condition that it is endowed with sufficient means,* the Delta Restoration Authority would assume the ultimate responsibility for complying with federal and state water quality, endangered species, and other environmental regulatory requirements with respect to the Bay-Delta resources. This would provide a very large "water supply reliability" premium that none of the CALFED alternatives can match. We do not propose changing the applicable state or federal environmental laws that impose regulatory burdens on the delta water users. Rather, we propose that the Delta Restoration Authority would *indemnify*, in some degree, these parties against the loss of water that might be associated with these programs.

- ***Creation:*** The Delta Restoration Authority could be created either by special legislation at the state or federal level or through a joint powers authority with appropriate memoranda of understanding with private sector interests. If it were incorporated as a tax exempt entity, it could receive taxable deductible gifts of delta farmlands. This would expedite and lower the costs of the acquisition program. In any case, its single mission should be environmental restoration and management, with an expert staff.

- ***Governance:*** The governance of the Delta Restoration Authority should reflect the manner in which regulatory liabilities are allocated. If the Delta Restoration Authority takes responsibility for compliance with requirements of the Clean Water Act and Endangered Species Act in the delta and indemnifies the water users with respect to those liabilities, it should quite clearly be governed exclusively by environmental interests (from both the private and public sectors) and be assured a relatively generous level of resources. If the water users remain ultimately liable under those acts, the board should be more broadly representative.

- ***Funding:*** Funding should come from four sources: 1) Category III commitments; 2) fees for extractions of water out of the central valley water system, with appropriate differentials reflecting relative impacts on aquatic environments and the economic value of water in the agricultural and urban sectors, and with appropriate credits for payments already assessed under the CVPIA; 3) recapture of a portion of the excess profits accruing in water transfers, and 4) public funds from the U.S. Department of Interior and the California state government appropriate to the creation of a national wildlife refuge or recreation area.

Summary of Delta Restoration Authority Functions:

	Environmental Baseline Functions	*CALFED-Environmentally Optimal Alternative*
Environmental water & flow augmentation	Implement the delta inflow requirements of the Bay-Delta WQCP. Implement the Anadromous Fish Restoration Program.	Implement CALFED delta throughflow recommendations that go beyond WQCP.
Physical restoration	Category III restoration program. CVPIA restoration program.	
Tidal wetlands restoration		Tidal wetland restoration program.
Fisheries habitat restoration		Adaptive management program: monitoring and data gathering, development and implementation of fishery restoration plan.
Project operations	Participation in the Operations group.	Manage share of capacity of any isolated delta facility.
Joint water development projects (e.g., conjunctive use)		Engage in joint water development projects with water users--e.g., conjunctive water management to provide environmental water.

2. *Institutional arrangements for conjunctive water management*

A state-wide, maximal scale conjunctive use program can be set up without new legislation, purely on the basis of voluntary, contractual arrangements among the essential interests. These include the owners and operators of the terminal reservoirs on each of the controlled tributaries to the central valley water system (U.S. Department of Interior, California Department of Water Resources, Merced, Modesto, Turlock Irrigation Districts, and the Yuba County Water Agency), the owners of the conveyance and transfer facilities (USBR and DWR), the water districts and farmers who will provide the groundwater storage services (either direct recharge or in lieu), the municipal water agencies who will purchase portions of the yield, and the other end users of the new yield, including the fish and wildlife agencies and/or the Delta Restoration Authority. While complex, there is nothing in the master agreement that will require additional powers or authorities or that would pose practical barriers.

3. *Demand management--water efficiency*

Urban efficiency is currently weak in two areas: 1) not all urban agencies are implementing Best Management Practices at the levels required by the Urban Conservation MOU; and 2) conservation programs for residential landscaping have not been implemented. Urban reclamation is improving rapidly, but many desirable reclamation programs have not been implemented because the environmental benefits of the programs have not been incorporated into the benefit side of the analysis.

Agricultural conservation is highly sensitive to the cost and alternative value of water. In many agricultural districts, the cost and alternative value of water remains too low to justify further improvements in efficient water management. In our view, further progress in agricultural water efficiency improvements is constrained not by technology and techniques--which are readily available--but by the lack of financial incentives to make economically rational from the standpoint of the farmer and the district. NHI, the Bureau of Reclamation, the University of California, and several agricultural water districts are exploring the conservation potential of various types of incentive programs. Our preliminary conclusion is that the easiest and most efficacious device is simply to structure market incentives so that agriculture has incentives to manage efficiently in its own self interest.

NHI proposes the following actions to improve water user efficiency:

- ***Improved water transfer regime.*** The creation of the institutions and the infrastructure needed to support a vigorous market in water (discussed below).

- ***Water diversion fees.*** Much of the funding needed for the NHI alternative will be generated through water diversion fees. These fees can be structured so that at least a component is roughly proportional to the environmental impacts caused by the diversions. Thus, water users that continue to draw large amounts of water from the delta during dry years may pay a large price per acre-foot, while those that only divert water during wet years will pay a much lower price per acre foot. By explicitly

assessing the environmental costs of diversions, not only can money be generated for environmental restoration, but signals can be sent to water users which will encourage more efficient water use.

- ***Make Compliance with the urban MOU enforceable.*** Urban areas are much less likely to respond to market incentives than agricultural areas. At the same time, BMP approaches are easier to implement. The SWRCB should certify whether urban agencies are in compliance with the BMPs (based upon recommendations from the CUWCC). Sanctions should be enforced against agencies which are not in compliance with the MOU. For instance, eligibility to transfer water from agricultural to urban uses could be made conditional upon the transferee being certified as in compliance with the MOU. The creation of sanctions stringent enough to assure high compliance rates may require state legislation.

- ***Upgrade the urban conservation pricing BMP to mandate increasing block rate pricing.*** These measures would encourage a gradual shift in residential landscapes toward higher efficiency without the need for expensive district level programs.

4. Facilitated water transfer regime

Enhanced water transfers are essential to all of the existing CALFED alternatives. Transfers play an even larger role in the NHI environmentally superior alternative. Indeed, if current constraints and impediments to water transfers could be overcome, the market itself would provide for the incremental water needs of all sectors in California (including the environment, assuming that it has the purchasing power to enter that market, as the NHI proposal would provide).

Water used in agriculture has varying productivity depending on the crop and location of use, as well as on individual grower characteristics. Analysis by the University of California shows the least productive 20% of all water used in California agriculture generates only 4% of all state farm sales.[1] A functioning water market could readily mobilize the surface water fraction of the 20%, amounting to over 1 million acre feet per year,[2] for all unmet needs in California, including use in higher value agricultural applications. Moreover, both the theoretical and empirical evidence confirms that the most efficacious method for tapping that low-productivity water is by creating market incentives for more efficient use.

Water transfers can also be a "least-cost" method of complying with the environmental water requirements of existing laws and regulations, including the Bay-Delta Water Quality Control Plan and the Anadromous Fish Restoration Plan of the CVPIA. Thus, a proactive program of removing the artificial constraints to water transfers is a key part of the NHI alternative.

In sum, transfers are a key mechanism for:

- providing for increased freshwater throughflows in the delta;

- increasing water supply for both environmental and consumptive uses through conjunctive water management;

- stimulating water efficiency improvements in agriculture; and

- augmenting water supplies for consumptive users.

NHI recommendations for removing the artificial constraints to water markets are presented at length in other papers which will be attached to the final version of this proposal as technical appendices.

F. Guarantees

A key attribute of a viable long-term alterative will be the ability of that option to provide some measure of assurance to all sectors that their respective benefits are safe from future corrosion. This is challenging because some sectors will receive their benefits before others, and in some cases, the costs will have to be incurred before the benefits accrue. Moreover, there is always an appreciable risk that putative benefits will fail, that laws will be broken or promises will be breached. Thus, NHI recommends that guarantees be premised to the maximum extent possible on physical limits. For example, an east side facility is desirable to permit abandonment of the delta levees and wholesale conversion of the delta to wetlands. It is also desirable to facilitate conjunctive water management. But a smaller facility is recommended to physically limit the potential for increases in north-south diversions.

The best guarantee of reliability for all sectors is a long-term solution that works; that is, one that provides increased water supply reliability for agricultural and urban water users and results in the recovery and maintenance of a diversity of natural habitats and key species. NHI is confident that we have proposed the broad outline of such a solution. Nevertheless, the NHI proposal includes several basic institutional mechanisms to insure, to the maximum degree possible, a level playing field:

- ***Adopt CALFED concept of phased linkage of environmental and water supply/quality benefits.*** This would involve, for example, creating institutional tools prior to plumbing. Thus, the Delta Restoration Authority would be fully operational prior to the construction of the isolated transfer facility.

- ***Implement water transfer and other reforms that would allow the market to play a greater role in water allocation.*** Water will be allocated efficiently if the market is allowed to function. Thus, water transfer reforms must be linked to changes that allow the environment to be a full partner in resource allocation decisions, such as a guaranteed income stream for the Delta Restoration Authority.

- ***Composition and governance of the Delta Restoration Authority.*** The Delta Restoration Authority is at the center of the NHI proposal. The physical components of the proposal will not function effectively or provide significant environmental

benefits without this institutional overlay. Thus, the most significant institutional checks and balances will be required with regard to the functioning of this institution. These should include at a minimum:

* Political insulation re: selection of governing body.

* A guaranteed and politically isolated income stream.

* Specific legal authority to carry out responsibilities.

As discussed above, the authority, autonomy and means of the Delta Restoration Authority to protect the environment should be linked to its responsibility to cover environmental liabilities. Thus, the greater the means placed at its disposal, the greater should be the degree of regulatory relief that the Delta Restoration Authority provides the water users. Only if environmental interests are accorded autonomy in governing the institution would it provide regulatory indemnification to water users. Conversely, if the water users are represented on the governing body, then these users must remain ultimately liable for compliance with the state and federal environmental laws. Moreover, indemnification by the Delta Restoration Authority should be made expressly conditional upon the water users compliance with all of the commitments and obligations incumbent upon them in the CALFED solution that is ultimately selected. That solution must be structured so that defaults, such as has occurred in connection with the Category III obligations out of the Delta Accord, will have tangible consequences.

- ***Build into the CALFED solution "insurance" against unusual risks.*** In addition to defaults, the gravest risk to stakeholders is that anticipated benefits or costs will be reduced or exacerbated by crisis events, such as a prolonged drought. The best coping mechanism is to set up the system with maximum resilience, such as tradable rights, groundwater banking, adequate funds for environmental water acquisitions, etc. The additional costs, if any, should be regarded as insurance premiums that will insulate the beneficiaries against future risks that, while infrequent, are inevitable.

G. Feasibility

Is it feasible to utterly transform the San Francisco Bay-Delta Estuary, the heart of the most developed water system in the world, into the largest system of restored wetlands ever created? This project is designed to push the art of the possible to the maximum extent. Here are some important factors in assessing the feasibility:

1. This proposal merely accelerates land use changes in the delta that are inevitable over the longer run because the subsidies and other special conditions on which current uses depend are simply not sustainable. It is only a matter of time before seismic events will cause a massive failure of the levee system. No amount of money can prevent this from happening. Our scenario would provide an opportunity for the delta farmers to

rescue themselves before an inevitable disaster occurs. This is an alternative that is bound to be attractive at some price. We need to determine that price and factor it into the economic analysis. Buyouts would certainly be less expensive than the cost to both landowners and water exporters of a massive failure of the levees.

2. The land and water transfers necessary to make this alternative work will be wholly voluntary. Borrowing from techniques that have been developed elsewhere, we may, for instance, propose approaches that permit existing land uses to be continued during the lifetime of the current owner.

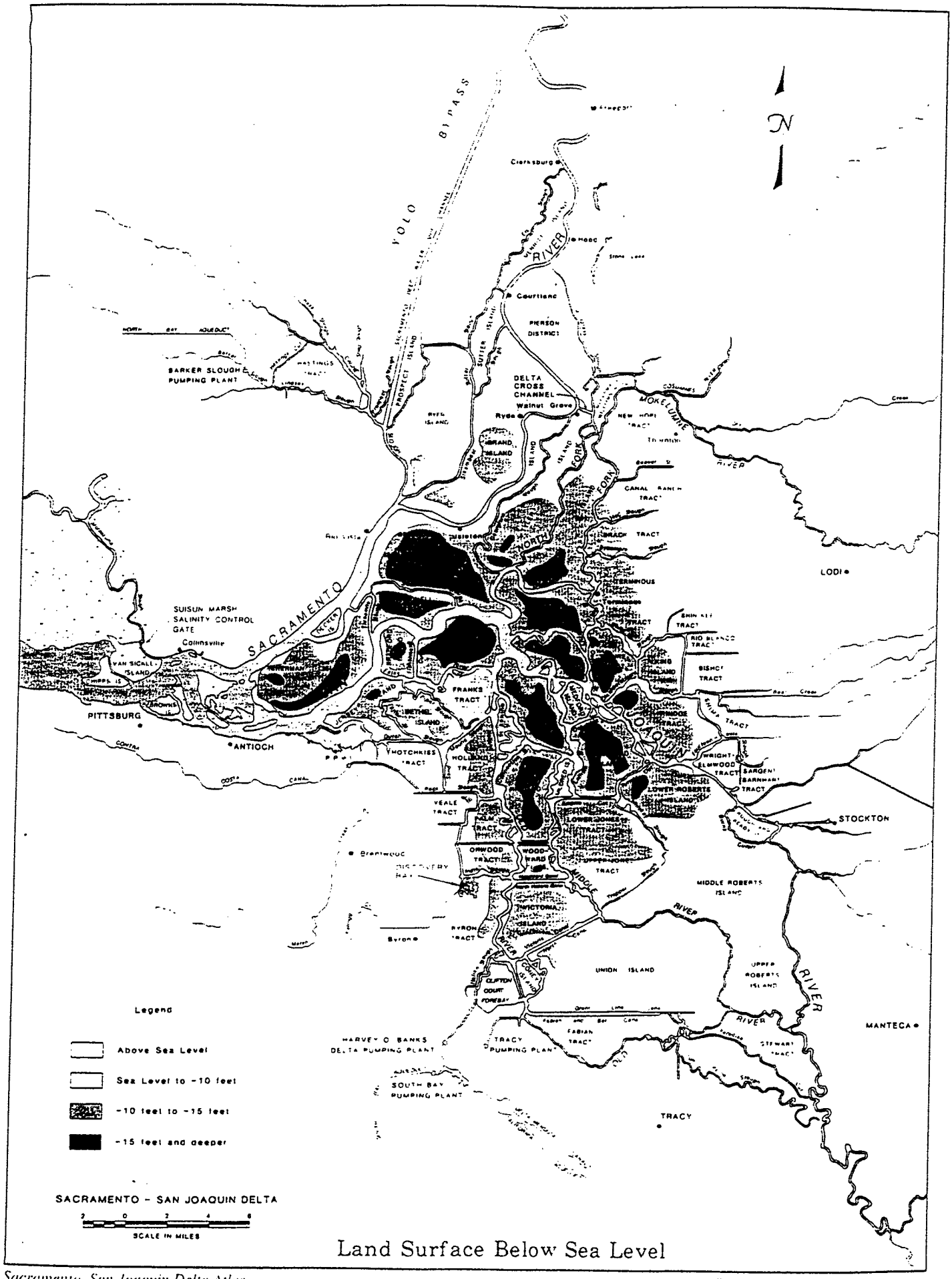
3. This project will not be the first one in which wetlands were created on lands that were tens of feet below sea level. The engineering challenge has more to do with scale than with technique. By harnessing the most experienced wetland ecologists and engineers in the business, a feasible program can be described. Once again, the fundamental issue is likely to be the cost of various solutions. This can only be determined by a program of investigation of the sort outlined here.

4. The institutional innovations called for in this alternative are based upon precedents that have sufficient operating experience to allow the necessary adaptations to be described with reasonable confidence. NHI has already done a great deal of research and design work on this component.

5. The benefits of a new national wildlife refuge of these dimensions on the threshold of the San Francisco Bay Area should be politically compelling. This could be simply the most exciting environmental restoration project ever attempted adjacent to a major metropolitan area.

6. The costs of this program would be substantial, but not excessive in comparison to 1) the obvious benefits, 2) the costs of other alternatives being considered by the CALFED process, or 3) the costs, especially, to landowners and water users in the case of a catastrophic failure of the current levees.

In sum, there are no technical or economic reasons to shrink from the bold thinking that this alternative requires.



Land Surface Below Sea Level

Sacramento–San Joaquin Delta Atlas

Department of Water Resources

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