EXECUTIVE SUMMARY

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INTRODUCTION

This report presents results of an effort to identify and evaluate, at an appraisal level, 54 alternatives submitted for consideration to improve the physical, chemical, and biological conditions of the Salton Sea (Sea).

Fifty-four alternatives, representing a wide variety of solutions, were considered during this study. They were categorized as follows:

Table 1
Categories of Alternatives

Type of salinity control	Number of alternatives
Diked impoundment	9
Pump-out	16
Combination	4
Salt removal	5
Water importation	2
Other	18
Total	54

An evaluation and screening process was developed and applied to all 54 alternatives. This process was two-fold in that (a) four elimination criteria were developed to eliminate those alternatives which had no realistic potential for correcting the problems of the Sea; and (b) 18 evaluation criteria were developed and applied to rank those remaining alternatives which met the elimination criteria.

BACKGROUND

The Sea is located in the Salton Basin, which extends from Palm Springs, California, on the north to the Gulf of California on the south. The level of the Sea has risen steadily since the importation of water for irrigated agriculture to its present level of approximately -227 feet mean sea level (msl). Since there is no natural outlet for this largest man-made water body in California, salinity concentration has also risen. It is now at about 44 parts per thousand (ppt), some 30 percent higher than average ocean salinities. High elevations and salinity have contributed to declines in land, recreation, economic, and ecological values.

APPROACH

This study was conducted under an agreement among the Salton Sea Authority (Authority), a joint powers authority, established under California law; the California Department of Water Resources (DWR); and the Bureau of Reclamation (Reclamation). Over the past 25 years, many proposals have been suggested for managing salinity of the Sea; however, in an effort to ensure inclusion of all possible solutions to the salinity and elevation problems of the Sea, media announcements and public meetings were used to invite submission of any new alternatives.

Four elimination criteria were developed to narrow the list of 54 alternatives down to those alternatives that matched project requirements. These criteria were discussed and approved at an Authority workshop on October 19, 1995. This exercise resulted in a list of five alternatives proposed as a solution to the Sea's present challenges. Elimination criteria applied to evaluate all submitted alternatives are as follows (no criterion was given higher priority than another):

(1) Proposal must achieve and maintain target salinity level of 35 to 40 ppt;

(2) proposal must achieve and maintain target elevation level of -230 to -235 feet msl;

(3) proposal must utilize proven technology and not involve research; and

(4) proposal must not exceed $10 million per year in operation, maintenance, energy, and replacement (OME&R) costs.

In addition to the elimination criteria, 18 evaluation criteria were developed at an Authority public workshop on April 8, 1996, which included representation from Reclamation, U.S. Fish and Wildlife Service, California Department of Parks, DWR, California Department of Fish and Game, Authority Board members, and the general public. To facilitate alternative evaluation, a technique involving a Paired Comparison Matrix (PCM) was developed to determine the order of importance of a list of evaluation parameters. An Analysis Matrix was developed to determine the order of preference of a number of viable alternatives.

The evaluation criteria were assigned weighted values and ranked in order of relative importance (see Appendix A) to issues facing the Sea as follows:

TABLE 2
Evaluation Criteria and Weighted Values

Criteria	Value	Criteria	Value
Agricultural interest	33	Construction costs	14
Wildlife	32	Sport fishery	14
Elevation control	31	Recreation benefits	12
Disposal	24	Economic development	11
Water quality-salinity	24	Intergovernmental cooperation	9
Water quality-other	21	Land	7
OME&R costs	19	Time to solution	6
Finance costs	17	Time to construct	3
Location	17	Partnering opportunity	2

FINDINGS

After evaluation of all 54 alternatives submitted for consideration, the following selections remained for further evaluation as a Salton Sea management alternative, as decided upon at the Authority's Board of Directors meeting on September 26, 1996:

- 40- to 50-square mile (mi^2) diked impoundment;
- 127-mi^2 diked impoundment;
- phased impoundment; and
- no action.

Table 3 on the next page presents an elimination summary which categorizes the 54 alternatives proposed and delineates those alternatives which were retained for further consideration from those which were eliminated from further consideration.

Each of the alternatives retained were rated against the evaluation criteria shown in Table 2, the results of which are presented in an Analysis Matrix on page xviii. The scores obtained through the use of the PCM in Appendix A were used to determine the ranking order of an alternative's ability to fulfill the overall established project requirements.

On page xix, a strength graph is depicted which is a graphic representation of the five alternatives retained for further consideration as applied against the 18 evaluation criteria.

SALTON SEA ALTERNATIVES
Table 3 - Elimination Summary

DIKED IMPOUNDMENTS

6. 30 mi^2 with pumping *(4)*
7. 30 mi^2 max pump *(4)*
13. 190 mi^2 - Plastic Curtain *(3)*
14. Various Sized Impoundments - Plastic Curtain *(3)*

PUMP-OUT

8. Onshore Evaporation Ponds *(4)*
9. Enhanced Evap/Solar Pond/Power *(4)*
10. Dry Lake Bed (Palen, Clark, or Ford) *(4)*
11. Pipe to Pacific Ocean/Camp Pendleton *(4)*
12. Navigable Waterway/Mexicali Seaport *(4)*
15. Canal/Dam to Base of Chocolate Mts *(1)*
16. Diked Impoundment to Gulf of CA *(4)*
17. Frontier Aquadyne Enhanced Evaporation *(3,4)*
18. Solar Still Desalt/Colo River Replenish *(3)*
19. SNAP Technology *(3)*
20. Aquaculture/Evaporation Ponds *(1,2)*
21. Pump to Gulf of CA (415K AF) *(4)*
22. Pump to Laguna Salada/Gulf of CA (415K AF) *(4)*
23. Pumped Storage Canal to Gulf of CA *(4)*
24. Solar Membrane Distillation *(3)*
25. Disposal of Reject Stream to Yuma *(1,2)*

COMBINATION

26. Impound/EvapPond/Pipe to Gulf of CA/YDP *(4)*
27. Impound/Power Generation/Wetlands *(4)*
28. Freshwater Shore/Pumped Storage/Wetlands *(4)*
29. Solar Power/Pumped Storage/Wetlands with Laguna Salada Disposal *(4)*

REMOVAL OF INFLOW SALT

30. Move Yuma Desalting Plant to Sea *(2,4)*
31. Poplar Tree Constructed Wetlands *(1,2)*
32. Special Pre-Treatment Reservoirs *(1,2,3)*
33. U.S. Filter-New River Desalting *(1,2,4)*
34. Groundwater Pump for Selenium Mgmt *(1,2)*

WATER IMPORTS

35. Freshwater Blending - Calexico *(2)*
36. Replenish - Colorado River Surplus *(2)*

OTHER

37. Venturi Air Pump *(1,2)*
38. Foraminifera Studies (Research) *(1,2,3)*
39. Potential Use Study Ponds (Research) *(1,2,3)*
40. Injection Well Salt Disposal *(4)*
41. Air Diffusion/Ultraviolet Ozone System *(1,2)*
42. Surface Aeration *(1,2)*
43. Gravel Berm *(1,2)*
44. Sea Water Filtration *(1,2)*
45. Enzyme-Activated Removal *(1,2)*
46. Power/Freshwater Cogeneration *(1,2)*
47. Water Conservation *(1)*
48. Drainage Water Reuse or Blending *(1)*
49. Pulsed Plasma *(3)*
50. Hydropower/Filtration System Resort *(3,4)*
51. Slow Sand Reverse Osmosis Filtration *(1,2,4)*
52. Electrochemical Extraction *(2,3)*
53. Mexican Cleanup of New River *(1)*
54. Land Speed Racetrack *(1,2)*

Note: Numbers in italics following an alternative's title indicate which elimination criteria were applicable in dismissing the proposal from further consideration as follows:
(1) Salinity 35-40 ppt *(2)* Elevation -230 to -235 ft msl *(3)* Unproven Technology *(4)* OME&R > $10 M

FIGURE 1
ANALYSIS MATRIX

Decision Table for selection of the preferred alternative for Salton Sea management.

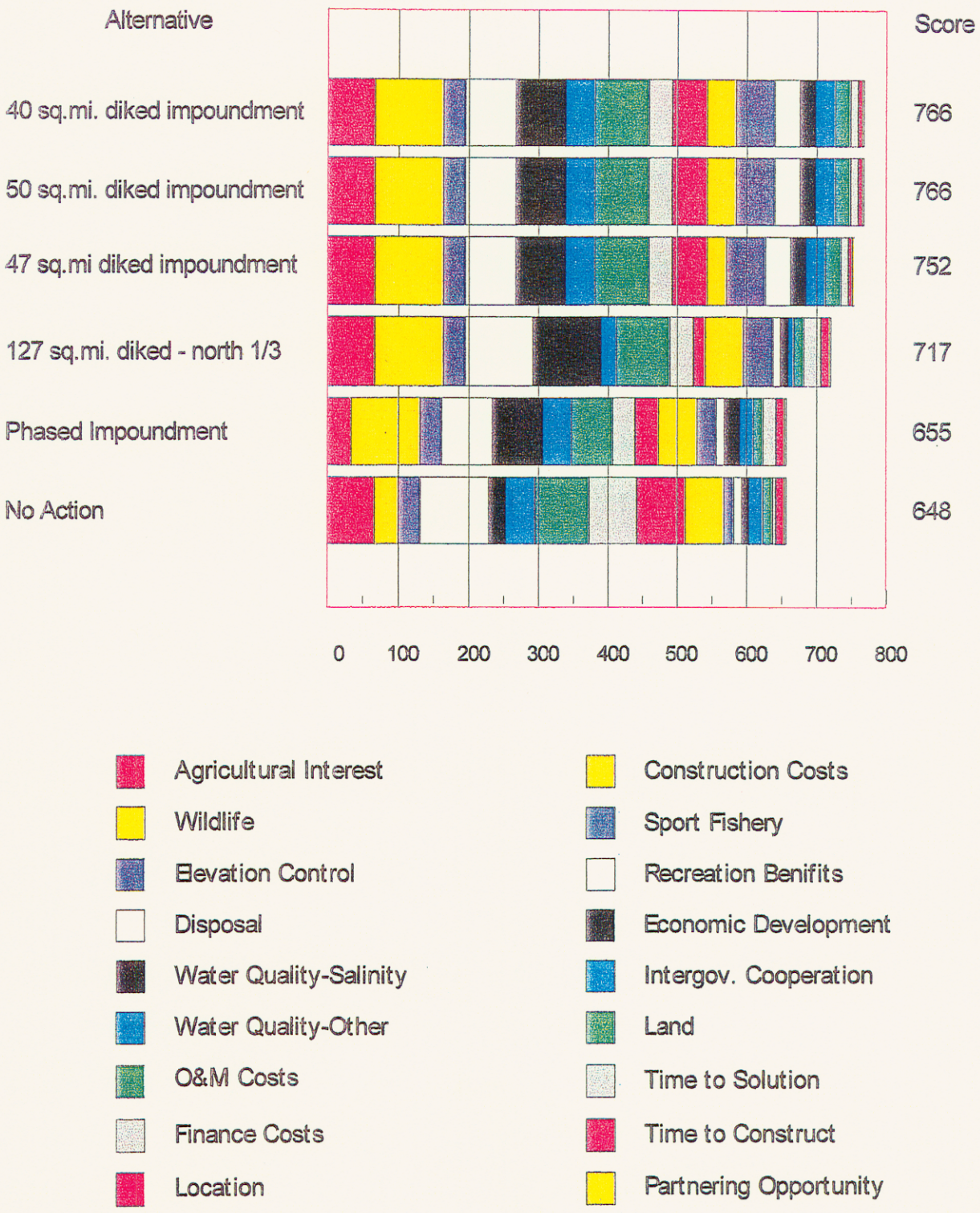
	Agricultural Interest 33	Wildlife 32	Elevation Control 31	Disposal 24	Water Quality-Salinity 24	Water Quality-Other 21	OME&R Costs 19	Finance Costs 17	Location 17
40 mi² diked impoundment	F/66	G/96	P/31	G/72	G/72	F/42	E/76	F/34	G/51
50 mi² diked impoundment	F/66	G/96	P/31	G/72	G/72	F/42	E/76	F/34	G/51
47 mi² diked impoundment	F/66	G/96	P/31	G/72	G/72	F/42	E/76	F/34	G/51
127 mi² diked north 1/3	F/66	G/96	P/31	E/96	E/96	P/21	E/76	F/34	P/17
Phased Impoundment	P/33	G/96	P/31	G/72	G/72	F/42	G/57	F/34	F/34
No Action	F/66	P/32	P/31	E/96	P/24	F/42	E/76	E/68	E/68

	Construction Costs 14	Sport Fishery 14	Recreation Benefits 12	Economic Development 11	Intergovernmental Cooperation 9	Land 7	Time to Solution 6	Time to Construct 3	Partnering Opportunity 2	Table Summary
40 mi² diked impoundment	G/42	E/56	G/36	F/22	G/27	G/21	F/12	F/6	F/4	766
50 mi² diked impoundment	G/42	E/56	G/36	F/22	G/27	G/21	F/12	F/6	F/4	766
47 mi² diked impoundment	F/28	E/56	G/36	F/22	G/27	G/21	F/12	F/6	F/4	752
127 mi² diked north 1/3	E/56	G/42	P/12	P/11	P/9	F/14	E/24	E/12	F/4	717
Phased Impoundment	E/56	F/28	P/12	F/22	F/18	F/14	G/18	E/12	F/4	655
No Action	E/56	P/14	P/12	P/11	F/18	F/14	P/6	E/12	P/2	648

E = Excellent (4) G = Good (3) F = Fair (2) P = Poor (1)

The numeric score is the rating of the alternative's ability to support the evaluation criteria (E, G, F, or P) times the criteria's weighted value.

FIGURE 2. STRENGTH GRAPH OF EVALUATED ALTERNATIVES



The three options receiving the highest score were variations of the same option—a 40- to 50-mi^2 diked impoundment. Both the 40- and 50-mi^2 diked impoundment were considered to be better choices than a 47-mi^2 diked impoundment in one of the 18 evaluation criteria considered (refer to Table 3, Analysis Matrix). However, the difference between these alternatives was minimal enough that construction costs were considered to be the only significant factor leading to the choice of a 40- or 50-mi^2 diked impoundment over a 47-mi^2 diked impoundment.

The scale used for construction costs was as follows:

Table 4
Construction Costs Ratings

Construction Costs Rating	Value
4	Less than or equal to $100 million
3	From $100 million to $150 million
2	From $150 million to $200 million
1	Greater than $200 million.

Because of the similarity between the 40-, 47-, and 50-mi^2 diking options, they were combined into one alternative called the 40-50 mi^2 diked impoundment. The option of No Action was included to address California Environmental Quality Act and National Environmental Policy Act requirements.

CONCLUSIONS

This report is intended to be used as a decision document which will enable the participants to move forward in implementing a viable solution to the problems currently facing the Sea. Five of 54 alternatives proposed were retained, as a result of this appraisal, for further consideration.

All five proposals retained for further consideration involve diking as a major feature to solve the salinity and elevation problems of the Sea. Final selection of a preferred alternative will be dependent on many factors. The location, size, and operational details of the diked impoundment will have both economical and environmental effects on the surrounding area. These effects will need to be evaluated in greater detail in order to implement an alternative that will bring the greatest overall benefit to the area. In addition, biological, chemical, and pathogenic studies will have to be performed to provide assurance that correcting the salinity and elevation problems of the Sea will also minimize mortality events and maintain a safe environment for migratory and resident wildlife.

It is anticipated that the next step toward project implementation will be further evaluation of the diking concept to formulate a specific preferred project based on engineering, biologic, economic, and public acceptance criteria. Detailed environmental, geologic, engineering, economic, and other technical studies will then be performed for the preferred project. These studies will contain sufficient detail to secure construction financing and complete State and Federal environmental compliance processes.