Restoration of the Salton Sea

Volume 1: Evaluation of the Alternatives

Appendix 1C: Water Conveyance Features Design Criteria

WATER CONVEYANCE FEATURES DESIGN CRITERIA

The alternatives under consideration for restoration of the Salton Sea include components to manage reduced inflows and improve water quality. They also include air quality mitigation and habitat enhancement measures. The primary water conveyance features proposed to achieve these goals are river diversions with canals and pumping plants with pipelines. General assumptions and design criteria associated with these feature are discussed below.

Three rivers empty into the Sea, the New and Alamo Rivers on the south and the Whitewater River on the north. Most of the restoration alternatives require diversion and conveyance of a portion of these rivers to exposed playa areas for air quality mitigation. For certain alternatives, canals would originate at the New River and one would flow east to near the Alamo River and the other would flow around the southwest quadrant of the Sea. A canal would originate at the Alamo River and flow around the southeast quadrant of the Sea for some of the alternatives. Two canals would convey water from the Whitewater River to the northwest and northeast quadrants around the sea for some of the alternatives. Canal corridors were identified according to the required delivery water surface elevations. Canal alignments were drawn on U.S.G.S. topographic maps of the Salton Sea area.

For each canal alignment, a determination was made for the approximate number and type of canal structures that would be required by examining the topography and existing infrastructure shown on the maps. For the purposes of this study, it was assumed there would be three structure types: pipe siphons, trapezoidal road crossing bridges and cross-drainage culverts. Pipe siphons were used for the canals to cross major drainages and major roadways. Trapezoidal road crossing bridges were used for roadways to cross the canals. Pipe culverts were used for the cross-drainage flood flows. See Plates 1 and 2 for sketches of the siphons and road crossings.

The following tables list the major river diversions with conveyance canals and pumping plants with pipelines involved in the alternatives.

Alternative 1

FEATURE / ALTERNATIVE	Circulation Canal		Treatment Plant Sludge Conveyance		Pumping Plant and Pipeline			Diversion Crest Elevation
Salton Sea Authority Alternative	967 cfs		29 cfs		35 cfs	608 cfs	967 cfs	Alamo River (967 cfs)
Quadrant	Miles		Miles		Miles			
SE	19.8		7.6		16		0.5	-211
NE						8.4		

Alternative 2

FEATURE / ALTERNATIVE	Pup Fish / River Water Channel			River Water Channel		Pumping Plant and Pipeline		Diversion Crest Elevation				
Mid-Sea Barrier with South Marine Lake and 21,800 acres of Saline Habitat Complex	69 cfs	100 cfs	274 cfs	69 cfs	274 cfs	26 cfs	85 cfs	Alamo River (274 cfs)	New River (69 cfs east)	New River (69 cfs west)	Whitewater River (100 cfs east)	Whitewater River (100 cfs west)
Quadrant	Miles			Miles		Miles						
SW left	10.0			12.6						-157		
SW right				6.4					-203			
SE			6.7	7.4	8.0		15.2	-189				
NW	2.9	4.2		14.7								-168
NE	11.2	4.7		1.0		27.8					-183	

Alternative 3

	Length (miles)	Capacity (cfs)	No. of Drop Structures	Bottom Width (feet)
New River Canal	8	2,250	25	10
Alamo River Canal	5	3,200	16	24

Alternative 4

FEATURE / ALTERNATIVE	Pup Fish Channel		River Water Channel			Pumping Plant and Pipeline			Diversion Crest Elevation		
North-Sea Dam and Marine Lake with Habitat Enhancements	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	Alamo River (334 cfs)	New River (227 cfs east)	New River (271 cfs west)
	271	334	115	227	334	38	74	91			
Quadrant	Miles		Miles			Miles					
SW left	10.0		12.6			6.7		14.7			-185
SW right				6.4						-214	
SE		6.7	8.4		8.0		14.7		-191		
NE											

Alternative 5

FEATURE / ALTERNATIVE	Pup Fish / River Water Channel				River Water Channel				Pumping Plant and Pipeline			Diversion Crest Elevation				
Habitat Enhancement Without Marine Lake	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	Alamo River (288 cfs)	New River (181 cfs east)	New River (225 cfs west)	Whitewater River (102 cfs east)	Whitewater River (102 cfs west)
	69	102	225	288	69	102	181	288	22	74	91					
Quadrant	Miles				Miles				Miles							
SW left			10.0		12.6						22.2			-174		
SW right							6.4						-214			
SE				6.7	7.4			8.0		16.4		-189				
NW					10.5	4.2										-183
NE	11.0	4.2			1.1				27.4						-184	

Alternatives 6 and 7

FEATURE / ALTERNATIVE	River Water Distribution Channel			Diversion Crest Elevation				
No-Project Alternative	69 cfs			Alamo River (69 cfs)	New River (69 cfs east)	New River (69 cfs west)	Whitewater River (69 cfs east)	Whitewater River (69 cfs west)
Quadrant	Miles							
SW left	22.7					-157		
SW right	6.3				-203			
SE	19.8			-166				
NW	15.8							-179
NE	18.9						-175	

Hydraulics

The water surface to which the conveyance canals would deliver water to the habitat enhancements was assumed to be elevation -228. Canals were sized for the following flow rates which represent possible future flow extremes.

New River – 2,510 ft^3/s
Alamo River – 10,281 ft^3/s
Whitewater River – 6,376 ft^3/s

Manning's equation for open channel flow was used to size the canals, assuming Manning's "n" of 0.014 and bottom grade which produced a canal velocity of about 3.0 ft/sec to reduce river water sedimentation dropout. Canal sizing, freeboards and bank heights are in accordance with current Bureau of Reclamation requirements as presented in Chapter 1, "Canals and Laterals," *Design Standards No. 3*, "Canals and Related Structures," Bureau of Reclamation, 1967. The ratio of bottom width to depth was chosen to be between 1 and 2 for hydraulic efficiency. It was assumed the canals would be in partial cut sufficient to balance cut and fill earthwork quantities. For bank stability, side slopes of 1½h:1v were assumed, except for Alternative 3 canal sides where 2½h:1v were used.. Operation and maintenance roads would be provided on both canal banks and the canal would have 3-inch unreinforced concrete lining to limit seepage and facilitate cleaning. Details of the typical canal sections are shown on Plate 1.

To limit head losses and maintain sediment transport, siphons were sized for approximately 3 to 5 ft/s velocity. Siphon barrel friction loss was calculated using Manning's equation with Manning's "n" of 0.013. Each siphon was assumed to have a check-inlet structure with radial gates that could be closed for isolating a reach of canal in the event of a canal break. Each siphon was assumed to have an outlet transition. Transition losses were calculated as 0.4 and 0.7 times the difference in velocity heads between canal and pipe for the inlets and outlets, respectively. For simplicity, each siphon was assumed to be 200 feet long.

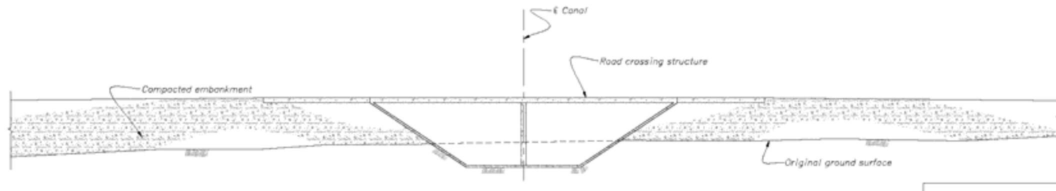
Assumed head loss at each trapezoidal road crossing was assumed to be 0.1 foot.

Canal friction loss, siphon losses and road crossing losses were summed and 10% additional loss was added to provide for limited excess capacity to obtain the total hydraulic head loss for each canal alignment. The diversion water surface elevations were determined by adding the total head loss for each canal flow to the delivery water surface elevation. The diversion water surface elevations required necessitates routing the canals upstream along the rivers to a point where the water surface diverted can deliver water to the end of the canal.

Spillways would be required at each diversion structure to pass flood events, except for the Alternative 3 canals. The spillways were sized for 20 $ft^3/s/ft$ of width for the 100-year floods below. The crest elevations were set 1 foot above the minimum diversion water surface elevations. The spillways were assumed to be rock-fill structures with 4:1 upstream slopes and 6:1 downstream slopes.

Large sediment basins would be constructed in the canals below the diversion structures to trap sediment. The sediment would require periodic removal or possibly could be sluiced to the sea if a sluice channel with steep slope could be constructed.

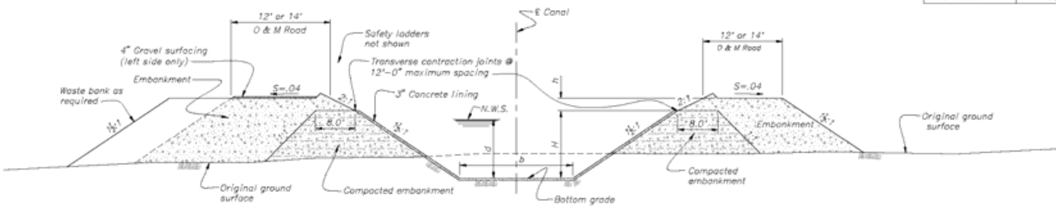
Since no hydrology information was available for sizing cross drainage culverts, 4-foot diameter pipe culverts were assumed. During final design, it may be determined that overchutes may be more suitable than culverts for cross-drainage of the flat terrain.



TYPICAL TRAPEZOIDAL ROAD CROSSING

(NO SCALE)

CROSSSINGS					
LOCATION	Mid-Sea Barrier with south Marine Lake	Habitat Enhancement	North-Sea Dam and Marine Lake	Salton Sea Authority	No-Project
SW Quadrant left	9	9	21	0	9
SW Quadrant right	1	1	1	0	1
SE Quadrant	10	10	3	10	10
NW Quadrant	15	15	0	0	15
NE Quadrant	10	10	1	0	10



TYPICAL CANAL SECTION

10 0 10 20 30
SCALE OF FEET

HYDRAULIC PROPERTIES – Mid–Sea Barrier with south Marine Lake										
LOCATION	A	V	Q	r	n	s	b	d	H	h
SW Quadrant left	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
SW Quadrant right	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
SE Quadrant	91.06	3.01	274	3.26	0.014	0.00017	7.0	5.80	6.8	1.60
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NW Quadrant	33.25	3.01	100	1.97	0.014	0.00032	4.25	3.50	4.16	1.34
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NE Quadrant	33.25	3.01	100	1.97	0.014	0.00032	4.25	3.50	4.16	1.34
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17

HYDRAULIC PROPERTIES – North–Sea Dam and Marine Lake										
LOCATION	A	V	Q	r	n	s	b	d	H	h
SW Quadrant left	89.27	3.04	271	3.23	0.014	0.00017	6.9	5.75	6.75	1.59
	37.97	3.03	115	2.11	0.014	0.00030	4.5	3.75	4.46	1.37
SW Quadrant right	74.16	3.06	227	2.95	0.014	0.00020	6.25	5.25	6.19	1.53
SE Quadrant	110.72	3.02	334	3.60	0.014	0.00015	7.7	6.40	7.47	1.67
	37.97	3.03	115	2.11	0.014	0.00030	4.5	3.75	4.46	1.37
NE Quadrant	33.25	0	0	1.97	0.014	0.00000	4.25	3.50	4.00	0.70

HYDRAULIC PROPERTIES – Habitat Enhancement										
LOCATION	A	V	Q	r	n	s	b	d	H	h
SW Quadrant left	74.16	3.03	225	2.95	0.014	0.00019	6.25	5.25	6.18	1.52
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
SW Quadrant right	59.46	3.04	181	2.64	0.014	0.00022	5.6	4.70	5.56	1.46
SE Quadrant	96.00	3.00	288	3.35	0.014	0.00016	7.0	6.00	7.02	1.62
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NW Quadrant	33.25	3.07	102	1.97	0.014	0.00034	4.25	3.50	4.17	1.34
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NE Quadrant	33.25	3.07	102	1.97	0.014	0.00034	4.25	3.50	4.17	1.34
	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17

HYDRAULIC PROPERTIES – No–Project										
LOCATION	A	V	Q	r	n	s	b	d	H	h
SW Quadrant left	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
SW Quadrant right	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
SE Quadrant	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NW Quadrant	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17
NE Quadrant	22.77	3.03	69	1.63	0.014	0.00042	3.5	2.90	3.53	1.17

ALWAYS THINK SAFETY

UNITED STATES
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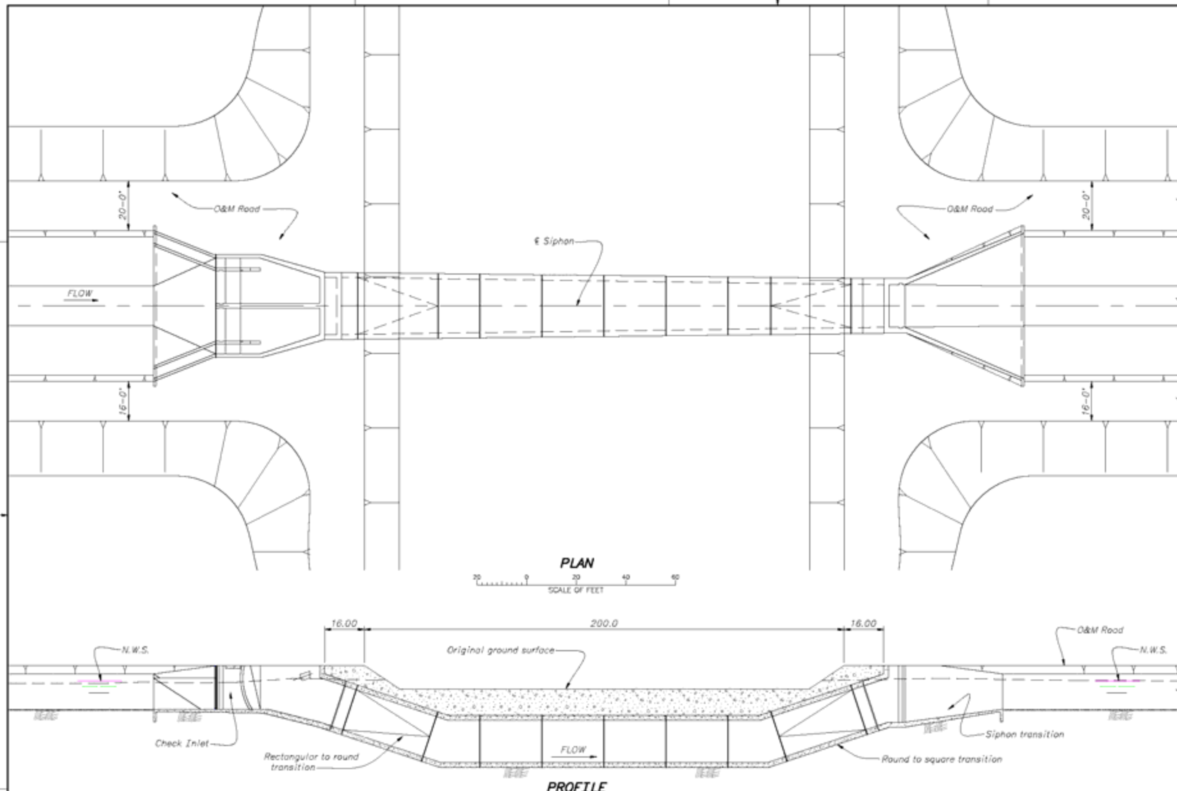
SALTON SEA RESTORATION ALTERNATIVES
CONVEYANCE FACILITIES
TYPICAL CANAL SECTIONS AND
TRAPEZOIDAL ROAD CROSSING

DESIGNED KEN SAYER CHECKED CHECKER
DRAWN P. DUNBAR TECH. APPR. TECH APPR.
APPROVED APPROVED

PLATE 1



SIPHONS															
LOCATION	Mid-Sea Barrier with south Marine Lake			Habitat Enhancement			North-Sea Dam and Marine Lake			Salton Sea Authority			No-Project		
	Dia.	No.	Q (cfs)	Dia.	No.	Q (cfs)	Dia.	No.	Q (cfs)	Dia.	No.	Q (cfs)	Dia.	No.	Q (cfs)
SW Quadrant left	4'	20	69	7.5'	12	225	8.5'	12	271				4'	20	69
				4'	8	69	5.5'	11	115						
SW Quadrant right	4'	10	69	7'	10	181	7.5'	10	227				4'	10	69
SE Quadrant	8.5'	17	274	8.5'	17	288	9.0'	17	334	15.5'	17	967	4'	17	69
							5.5'	5	115						
NW Quadrant	4'	12	69	4'	12	69							4'	12	69
NE Quadrant	5'	5	100	5'	5	102	4'	2	0				4'	9	69
	4'	4	69	4'	4	69									

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SALTON SEA RESTORATION ALTERNATIVES CONVEYANCE FACILITIES

SIPHON WITH CHECK INLET

PLAN AND PROFILE

DESIGNED KEN SAYER CHECKED CHECKER
DRAWN B. DUNBAR TECH. APPR. TECH APPR.
APPROVED APPROVED

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME PLATE 2.DWG
DENVER, COLORADO SEPTEMBER 23, 2004

PLATE 2