



Appendix OO
Revised Life Cycle Cost Analysis

Renewal of NPDES CA0109223
Carlsbad Desalination Project

APPENDIX “OO”

Intake/Discharge Alternatives Life Cycle Cost Analysis

The Ocean Plan Amendment requires that the regional water board shall consider a host of factors in determining feasibility of intake and discharge alternatives, including life cycle cost. A detailed analysis of the life-cycle cost for 10 intake/discharge alternatives considered for the transition to stand-alone operations of the CDP is presented in this Appendix OO. The life cycle costs provide a relative comparison of the incremental cost and savings of each of the alternatives and include construction period costs, out of service costs, and operations and maintenance cost. Construction Capital Costs considered include permitting, design, land acquisition, financing, construction, operations, maintenance, mitigation, equipment replacement, insurance, taxes, management, and energy consumption over the lifetime of the facility. Out of Service Capital Costs considered include demobilization, standby maintenance, and remobilization of the plant, debt payments, equity payments, and associated financing costs for the period the plant is out of operation. The Total Annual Cost represents the amount of money that would need to be added to the annual budget of the Carlsbad Desalination Plant to pay for the capital and operating costs associated with each of the intake/discharge alternatives. The findings of this analysis are summarized in Table 1.

TABLE 1
Expanded CDP Subsurface Intake/Discharge Alternatives
Total Annual Life-Cycle Cost/ (Savings)
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Construction Capital Charge	4,077,205	37,464,471	100,112,270	59,971,724	24,952,799	50,416,311	11,100,609	36,409,907	7,060,814	35,466,357
O&M Charge	3,836,055	2,204,028	10,089,796	5,227,125	3,921,746	2,300,000	3,821,746	2,250,000	3,836,055	2,184,028
Other Charges	618,980	4,586,800	10,875,400	7,676,260	2,645,000	5,911,320	1,425,000	4,531,320	1,124,484	4,535,328
Out of Service Capital Charge	-	17,481,175	37,988,099	21,509,330	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175
Total Annual Cost	8,532,239	61,736,474	159,065,565	94,384,439	49,000,720	76,108,807	33,828,529	60,672,403	29,502,528	59,666,888

The determination of Total Annual Cost is composed of four separate charges: Construction Capital Charge, O&M Charge, Other Charges, and Out of Service Capital Charge. Each intake and outfall technology features unique engineering and constructability characteristics which will impact total annual cost. For example, longer construction and permitting periods will not only incur additional expense, but the total cost of the project will be spread over fewer operating years, resulting in a higher unit water cost.

TABLE 2
Permitting, Construction, and Operating Term
(Years)

(Yrs)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Permitting Term	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Construction Term	1.5	3.0	7.2	3.8	3.0	3.0	3.0	3.0	3.0	3.0
Total Duration	2.5	6.0	10.2	6.8	6.0	6.0	6.0	6.0	6.0	6.0
Operating Term	27.5	24.0	19.8	23.2	24.0	24.0	24.0	24.0	24.0	24.0
Total Term	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0

Construction Capital Charge:

The Construction Capital Charge is established by first calculating the total project cost and then amortizing the total project cost over the years of remaining water sales. Total Construction Cost shown in Table 3 is determined by summing direct and indirect expenses associated with the construction of the intake and outfall.

TABLE 3
Total Construction Cost
(\$)

(\$)	Surface	Surface	Subsurface	Subsurface	Offshore	Offshore	Lagoon	Lagoon	Lagoon	Lagoon
	Screened Intake with Flow Augmentation	Screened Intake with Multiport Diffuser		Intake with Flow Augmentation	Intake with Multiport Diffuser	Wedgewire Screen with Flow Augmentation	Wedgewire Screen with Diffuser	Wedgewire Screen with Flow Augmentation	Wedgewire Screen with Diffuser	Traveling Screen with Flow Augmentation
Permitting	3,150,000	5,000,000	10,000,000	10,000,000	5,000,000	-	5,000,000	5,000,000	5,000,000	5,000,000
Additional Mitigation	-	4,400,000	(3,500,000)	3,500,000	-	4,400,000	-	4,400,000	-	4,400,000
Additional 1 Mo O&M Reserve	371,253	565,902	1,747,100	1,075,282	547,229	684,277	437,229	565,110	413,378	559,946
Additional 6 Mo Debt Reserve	1,361,613	12,736,231	33,565,782	20,479,103	8,482,830	17,139,260	3,766,915	12,377,727	2,400,274	12,056,957
Debt Underwriting	402,279	3,514,854	8,316,457	5,550,576	2,341,031	4,729,970	1,039,566	3,415,916	662,410	3,327,393
Transactions Costs / Legal	981,167	8,572,814	20,284,041	13,537,989	5,709,831	11,536,513	2,535,527	8,331,504	1,615,635	8,115,592
Intake/Outfall Construction	34,398,000	351,180,000	792,540,000	545,126,000	232,000,000	478,632,000	95,000,000	340,632,000	54,948,401	331,032,767
Capitalized Interest	2,105,323	28,627,168	120,306,106	51,262,326	19,067,928	38,749,177	8,219,121	27,802,563	5,083,289	27,064,973
Construction Management	2,500,000	5,000,000	9,200,000	6,800,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Construction Insurance	2,000,000	2,000,000	10,000,000	7,500,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Construction Rent	300,000	750,000	8,640,000	1,900,000	750,000	900,000	1,200,000	900,000	1,500,000	1,200,000
Post Construction Entrainment Study	1,200,000	1,200,000	-	-	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Outstanding Equity Fee	291,407	5,092,251	26,602,575	10,131,065	3,391,639	6,852,689	1,506,103	4,948,913	959,687	4,820,662
Total Construction Cost	49,061,041	428,639,220	1,037,702,060	676,862,341	285,490,487	576,823,886	126,904,462	416,573,734	80,783,075	405,778,290

Project Costs were determined as follows:

Permitting: Lump sum cost associated with additional permits required for intake and outfall construction and operation.

Additional Mitigation: Lump sum cost associated with the mitigation of construction impacts and permanent loss of habitat.

Additional One Month O&M Reserve: Capitalized Reserve for one month of operations and maintenance for the applicable intake/outfall facilities.

Additional 6 Month Debt Reserve: Capitalized Reserve for 6 months of debt service for the applicable intake/outfall facilities.

Debt Underwriting: Underwriting expenses associated with placing debt on project. Cost assumed to be 1% of total debt.

Transactions Costs / Legal: Underwriting expenses associated with placing equity on the project and other deal expenses. Cost assumed to be 2% of total project cost.

Intake/Outfall Construction: Lump sum of intake and outfall construction cost.

Capitalized Interest: Capitalized account for interest expense during construction period. Expense varies with construction term.

Construction Management: Annual expense associated with project construction oversight. Expense varies with construction term.

Construction Insurance: Annual expense associated with insuring project construction. Riskier construction is assumed to incur escalated insurance costs. Expense varies with construction term.

Rent: Annual Expense associated with permanent and temporary land needed for the applicable intake/outfall facilities. Expense varies with construction term.

Post Construction Entrainment Study: As required per the Ocean Plan (Section III.m.2.d.(2)(c)(4))

Outstanding Equity Fee: Annual fee of 2.2% on outstanding equity commitment for credit support.

Once Total Construction Cost is determined, the cost is amortized over the remaining operating term of the project after permitting and construction. The amortization of the Total Construction Costs has two components, a debt component and an equity component. The Carlsbad Desalination Facility was originally financed with 82% debt and 18% equity. For consistency, this analysis also assumes 82% debt and 18% equity, with an annual interest rate of 5% and 15% respectively. The Annual Construction Capital Charge shown in Table 4 is the Total Construction Cost split into debt and equity components amortized over the remaining operating term.

TABLE 4
Annual Construction Capital Charge
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Construction Debt Charge	2,723,225	25,472,461	67,131,563	40,958,206	16,965,659	34,278,521	7,533,830	24,755,454	4,800,547	24,113,915
Construction Equity Charge	1,353,980	11,992,010	32,980,707	19,013,518	7,987,140	16,137,791	3,566,778	11,654,453	2,260,267	11,352,442
Construction Capital Charge	4,077,205	37,464,471	100,112,270	59,971,724	24,952,799	50,416,311	11,100,609	36,409,907	7,060,814	35,466,357

O&M and Other Charge:

As shown in Table 5, the O&M charge is determined by summing the following annual expenses:

Chemicals: The subsurface intakes would allow for a 50% reduction in Fe2SO4 consumption at \$0.30/kgal of seawater processed by the pretreatment system.

Pump Station: Maintenance, repair and replacement.

Dredging Maintenance: Includes maintenance dredging of the Agua Hedionda Lagoon inlet and additional dredging associated with the subsurface intake.

Membrane Replacement and disposal: Expected 10% increase in membrane life with the subsurface intake.

Reduced Membrane Cleaning: Expected 30% reduction in cleaning frequency with the subsurface intake.

Operator Fee: Includes labor costs associated with maintenance and operation of applicable intake/outfall alternatives.

Biological Monitoring: As required per the Ocean Plan (Section III.m.4)

Marine Life Mitigation: Annual cost (savings) associated with mitigation maintenance and management.

Power: Assumes \$0.12 cents per kWh for energy demand associated with applicable intake/outfall facilities.

TABLE 5
Annual Operation and Maintenance Expense
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Chemicals	-	-	(300,000)	(300,000)	-	-	-	-	-	-
Pump Station	100,000	100,000	1,000,000	600,000	500,000	350,000	400,000	300,000	100,000	100,000
Maintenance Dredging	1,200,000	1,200,000	2,400,000	2,000,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Membranes	-	-	(150,000)	(150,000)	-	-	-	-	-	-
Reduced Membrane O&M	-	-	(84,000)	(84,000)	-	-	-	-	-	-
Operator Fee	500,000	500,000	2,500,000	1,750,000	500,000	500,000	500,000	500,000	500,000	500,000
Biological Monitoring	250,000	250,000	-	-	250,000	250,000	250,000	250,000	250,000	250,000
Marine Life Mitigation	-	20,000	(22,000)	15,000	-	-	-	-	-	-
Power	1,786,055	134,028	4,745,796	1,396,125	1,471,746	-	1,471,746	-	1,786,055	134,028
O&M Charge	3,836,055	2,204,028	10,089,796	5,227,125	3,921,746	2,300,000	3,821,746	2,250,000	3,836,055	2,184,028

As shown in Table 6, Other charges are determined by summing the following annual expenses:

Management Overhead: Incremental project oversight, accounting and reporting.

Rent: Annual expense for additional land needed.

Intake Insurance: Incremental insurance for new system

Outfall Insurance: Incremental insurance for new system

Property Taxes: Assumed 1% of Construction Cost

TABLE 6
Other Annual Expenses
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Management Overhead	50,000	50,000	250,000	225,000	50,000	50,000	50,000	50,000	50,000	50,000
Rent	200,000	250,000	1,200,000	500,000	250,000	300,000	400,000	300,000	500,000	400,000
Intake Insurance	25,000	25,000	1,500,000	750,000	25,000	25,000	25,000	25,000	25,000	25,000
Outfall Insurance	-	750,000	-	750,000	-	750,000	-	750,000	-	750,000
Property Taxes	343,980	3,511,800	7,925,400	5,451,260	2,320,000	4,786,320	950,000	3,406,320	549,484	3,310,328
Other Charge	618,980	4,586,800	10,875,400	7,676,260	2,645,000	5,911,320	1,425,000	4,531,320	1,124,484	4,535,328

Out of Service Capital Charge

The Out of Service Charge is established by calculating the costs associated with a shutdown of the desalination plant for an extended period of time and then amortizing the total cost over the years of remaining water sales. The out of service period is calculated by summing any permitting or construction term beyond 2018, the expectation for the shutdown of the Encina Power Station. Total Out of Service Cost is shown in Table 7 which is determined by summing direct and indirect expenses associated with the financing of the out of service period.

As shown in Table 7, the O&M charge is determined by summing the following annual expenses:

Out of Service Remobilization: Termination payment to O&M service provider and cost to demobilize and maintain the plant in long-term standby (mothball) and the cost to remobilize the O&M service provider and recommission the plant.

Out of Service Debt Payments: Payment required to service existing debt during out of service period.

Out of Service Equity Distribution NPV: Make whole payment to equity partner in lieu of project distributions.

Out of Service Additional 6 Month Debt Reserve: Capitalized reserve for 6 months of debt service.

Out of Service Debt Underwriting: Underwriting expenses associated with additional debt. Cost assumed to be 1% of total debt.

Out of Service Transactions Costs / Legal: Underwriting expenses associated with additional equity and other deal expenses. Cost assumed to be 2% of total cost.

Out of Service Capitalized Interest: Capitalized account for interest expense during construction period. Expense varies with construction term.

Out of Service Outstanding Equity Fee: Annual fee of 2.2% on outstanding equity commitment for credit support.

TABLE 7
Total Out Of Service Cost
(\$)

(\$)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Out of Service Remobilization	-	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000
Out of Service Debt Payments	-	103,204,035	239,286,783	128,036,178	103,204,035	103,204,035	103,204,035	103,204,035	103,204,035	103,204,035
Out of Service Equity Distribution NPV	-	57,682,144	102,499,942	67,993,041	57,682,144	57,682,144	57,682,144	57,682,144	57,682,144	57,682,144
Out of Service 6 Mo Debt Reserve	-	5,942,775	13,233,916	7,344,281	5,942,775	5,942,775	5,942,775	5,942,775	5,942,775	5,942,775
Out of Service Debt Underwriting	-	1,640,044	3,278,913	1,990,565	1,640,044	1,640,044	1,640,044	1,640,044	1,640,044	1,640,044
Out of Service Transactions Costs / Legal	-	4,000,108	7,997,350	4,855,037	4,000,108	4,000,108	4,000,108	4,000,108	4,000,108	4,000,108
Out of Service Capitalized Interest	-	10,908,234	33,331,236	14,623,078	10,908,234	10,908,234	10,908,234	10,908,234	10,908,234	10,908,234
Out of Service Outstanding Equity LOC Fee	-	2,547,972	10,142,052	3,854,231	2,547,972	2,547,972	2,547,972	2,547,972	2,547,972	2,547,972
Total Out of Service Cost	-	199,925,313	423,770,193	242,696,411	199,925,313	199,925,313	199,925,313	199,925,313	199,925,313	199,925,313

Once the Out of Service cost is determined, the cost is amortized over the remaining operating term of the project after permitting and construction. The amortization of the Out of Service Cost has two components, a debt component and an equity component. The Carlsbad Desalination Facility was originally financed with 82% debt and 18% equity. For consistency, this analysis also assumes 82% debt and 18% equity, with an annual interest rate of 5% and 15% respectively. The Annual Out of Service Capital Charge shown in Table 8 is the Total Out of Service Cost split into debt and equity components amortized over the remaining operating term.

TABLE 8
Annual Out Of Service Charge
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Out of Service Debt Charge	-	11,885,550	26,467,832	14,688,563	11,885,550	11,885,550	11,885,550	11,885,550	11,885,550	11,885,550
Out of Service Equity Charge	-	5,595,625	11,520,267	6,820,767	5,595,625	5,595,625	5,595,625	5,595,625	5,595,625	5,595,625
Out of Service Capital Charge	-	17,481,175	37,988,099	21,509,330	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175

Life Cycle Cost Summary

The life cycle costs provide a relative comparison of the incremental cost and savings of each of the alternatives. Costs considered include permitting, design, land acquisition, financing, construction, operations, maintenance, mitigation, equipment replacement, insurance, taxes, management, and energy consumption over the lifetime of the facility, as well as out of service costs when the plant is unable to operate. Savings considered include operational savings due to reduced chemical consumption, extended membrane life, and reduced membrane cleaning frequency that is applicable to the intake/discharge alternatives. The findings of this analysis are summarized in Table 9 and Table 10. The Total Annual Cost represents the amount of money that would need to be added to the annual operating budget of the Carlsbad Desalination Plant to pay for the capital and operating costs associated with each of the intake/discharge alternatives.

TABLE 9
Expanded CDP Subsurface Intake/Discharge Alternatives
Annual Life-Cycle Cost/ (Savings)
(\$/Year)

(\$/Year)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Construction Capital Charge	4,077,205	37,464,471	100,112,270	59,971,724	24,952,799	50,416,311	11,100,609	36,409,907	7,060,814	35,466,357
O&M Charge	3,836,055	2,204,028	10,089,796	5,227,125	3,921,746	2,300,000	3,821,746	2,250,000	3,836,055	2,184,028
Other Charges	618,980	4,586,800	10,875,400	7,676,260	2,645,000	5,911,320	1,425,000	4,531,320	1,124,484	4,535,328
Out of Service Capital Charge	-	17,481,175	37,988,099	21,509,330	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175	17,481,175
Total Annual Cost	8,532,239	61,736,474	159,065,565	94,384,439	49,000,720	76,108,807	33,828,529	60,672,403	29,502,528	59,666,888

Table 11 provides a relative comparison of the incremental unit cost (\$/acre-foot) of each of the intake/discharge alternatives. The Total Cost Increase represents the amount of money that would need to be added to the cost of each acre-foot of water produced at the Carlsbad Desalination Plant to pay for the capital and operating costs associated with each of the intake/discharge alternatives.

TABLE 1
Expanded CDP Subsurface Intake/Discharge Alternatives
Annual Life-Cycle Cost/ (Savings)
(\$/AF)

(\$/AF)	Surface Screened Intake with Flow Augmentation	Surface Screened Intake with Multiport Diffuser	Subsurface Intake with Flow Augmentation	Subsurface Intake with Multiport Diffuser	Offshore Wedgewire Screen with Flow Augmentation	Offshore Wedgewire Screen with Diffuser	Lagoon Wedgewire Screen with Flow Augmentation	Lagoon Wedgewire Screen with Diffuser	Lagoon Traveling Screen with Flow Augmentation	Lagoon Traveling Screen with Diffuser
Construction Capital Charge \$/AF	\$72.81	\$669.01	\$1,787.72	\$1,070.92	\$445.59	\$900.29	\$198.23	\$650.18	\$126.09	\$633.33
O&M Charge \$/AF	\$68.50	\$39.36	\$180.17	\$93.34	\$70.03	\$41.07	\$68.25	\$40.18	\$68.50	\$39.00
Other Charges \$/AF	\$11.05	\$81.91	\$194.20	\$137.08	\$47.23	\$105.56	\$25.45	\$80.92	\$20.08	\$80.99
Out of Service Capital Charge \$/AF	\$0.00	\$312.16	\$678.36	\$384.10	\$312.16	\$312.16	\$312.16	\$312.16	\$312.16	\$312.16
Total Cost Increase \$/AF	\$152.36	\$1,102.44	\$2,840.46	\$1,685.44	\$875.01	\$1,359.09	\$604.08	\$1,083.44	\$526.83	\$1,065.48