MEMORANDUM

To: **Mark Schlosberg, Western Regional Director, Food and Water Watch**

From: **James Fryer, Consulting Environmental Scientist**

Date: **November 4, 2009**

Subject: **Marginal Cost Analysis for Proposed Carlsbad Desalination Project**

Project Description

As per our contractual agreement, provided herein are analyses of the projected marginal cost of the proposed 50 MGD Carlsbad desalination facility using the 25 MGD Tampa Bay desalination project as the basis of the cost analysis with adjustments to reflect local conditions for the proposed Carlsbad site.

Results

The results are marginal costs per acre-foot of water produced for each case of assumptions. Marginal cost results are provided in Attachment 1 along with the suite of assumptions for each individual case in Attachment 2. The marginal cost results are expressed in 2009 dollars.

If the proposed Carlsbad desalination project performed to the same level as the Tampa Bay facility has performed over its seven year operational life, the marginal cost of water produced by the Carlsbad facility would be $3,507 per acre-foot. If the proposed Carlsbad project does not experience the same operational problems experienced by the Tampa Bay facility, and functions and produces water at the rate of the post-rehabilitated Tamp Bay facility for its 30-year life, the marginal cost would be $2,175 per acre-foot.

A discussion of background issues, methodology, assumptions and analytical model inputs follows.

Background

Poseidon Resources, a private corporation, is proposing to construct and operate a 50 MGD desalination facility in Carlsbad, California. Poseidon Resources currently projects a capital cost of $534 million[1] for the project but has not publicly released detailed cost information. Since little cost information is available, as specified, this marginal cost analysis relies primarily on the cost of the Tampa Bay desalination facility adjusted for local conditions at the proposed Carlsbad site.

The Tampa Bay desalination facility is Poseidon Resources' only proposed desalination project that has been constructed and operated. The Tampa Bay facility is presently the largest desalination facility of its kind operating in the U.S. Original design and initial construction was conducted by Poseidon Resources and its associates. Before construction, Poseidon Resources projected a project capital cost of $110 million.[2]

The Tampa Bay desalination facility has a troubled history. A detailed description of the project's history is beyond the scope of this analysis but is documented in numerous publicly available reports.[3] However, for this analysis it is important to note that a major rehabilitation of the facility was necessary to correct operating problems that developed shortly after operations began in 2003. This added $48 million[4] in capital cost to the project, bringing the total capital cost to $158 million.[5] The post rehabilitated facility became fully functional in 2007 and is now owned by Tampa Bay Water, a public utility. The Tampa Bay desalination facility provides the best comparative project to derive potential

capital, operations and maintenance (O&M), and energy costs for a larger project proposed by Poseidon Resources in Carlsbad.

Methodology

Detailed capital, operations, maintenance, energy, financing, and relevant local water quality data[6] were collected from Tampa Bay Water. These data were used to develop a marginal cost analysis of the water produced by the Tampa Bay facility. This marginal cost analysis is based on actual capital costs and O&M records for the Tampa Bay facility since operations began in 2003.

Two marginal cost cases were developed for the Tampa Bay project. The first case reflects the marginal cost of operations for 2003 through 2009, the seven years since operations began. This case reflects the actual cost of the water produced by the facility thus far and assumes it will continue for the 30-year life of the facility. The second case reflects the average marginal cost of operations and water production for only 2008 and 2009, the two full years of operation after rehabilitation was completed in 2007. The second case assumes the facility functions and produces water in its improved, post-rehabilitation condition for its 30-year life.

The $534 million capital cost estimate released by Poseidon Resources served as a starting point for the Carlsbad project marginal cost estimate. Additional necessary data on local site conditions -- including intake water temperatures and salinity, energy costs, and regulatory issues, and shared operating facilities -- were collected. These data were used to adjust the Tampa Bay marginal cost figures to accurately reflect local conditions for the proposed Carlsbad project. In order to reflect a reasonable range of uncertainty with some of the assumptions and cost variables, the four cases of marginal costs were developed for the proposed Carlsbad project. The first two are based on the two marginal costs cases for the Tampa Bay facility. Two additional cases provide marginal cost results if the proposed Carlsbad project does not incur capital cost overruns.

Assumptions and Inputs

Key assumptions and inputs for the analytical model are listed in Attachment 2. Some assumptions required judgments on significant uncertainties. The rationales for those judgments are discussed below.

Large capital projects, particularly novel projects such as the proposed Carlsbad facility, have a history of major cost overruns, as was the case with the Tampa Bay project. In November 2007, Poseidon Resources was projecting a capital cost of $300 million[7] for the proposed Carlsbad project. In October 2009, its capital cost projection increased to $534 million.[8] In recognition of this trend, the Carlsbad capital cost, presently projected as $534 million,[9] was adjusted to reflect the 44% cost overrun experienced by the Tampa Bay project. This assumption of cost overruns is also supported by the fact that in October 2009 Poseidon updated its bond request for permission to issue $550 million in bonds.[10] By assuming the same 44% cost overrun for the Carlsbad project that Tampa Bay experienced, the Carlsbad capital cost rises to $767 million. Two marginal cost cases for the proposed Carlsbad project were also provided which assume no capital cost overruns.

Financing is assumed to be 5.2% interest at 30 years. This was the case with the publicly financed Tampa Bay project. For the proposed Carlsbad project, Poseidon is known to be seeking financing mechanisms that include various forms of public subsidies such as tax-free public bonds.[11] It remains uncertain if low-cost publicly subsidized financing will become available, particularly for a project designed to generate private profits, but an assumed interest of 5.2% is used for all the cases in this analysis. If the actual financing cost is higher, it would result in a higher marginal cost for the Carlsbad project.

Since Poseidon Resources is a private corporation, it is reasonable to assume a profit margin would ultimately be necessary for the Carlsbad project to succeed as a privately owned and operated facility. Poseidon Resources has publicly indicated a willingness to forgo profit until the cost of alternative water supplies rises to the cost of desalinated water.[12] When this may actually occur is highly speculative. However, for the purpose of this analysis, a profit margin of 5% is assumed to begin in year 8 of the 30-year project life. This should not be interpreted as an indication alternative water supply costs actually will increase to the cost of desalination in 8 years. Since Poseidon is pursuing publicly subsidized financing instruments, and marginal costs in this analysis reflect the benefit of low-cost public financing, it was assumed that the 5% profit would only be accrued on O&M costs, and not from publicly subsidized financing. If profit was accrued from the capital cost, or begun sooner than year 8, it would significantly increase the marginal cost results for the proposed Carlsbad project.

Since the Poseidon Resources website indicates that the earliest the proposed project could become operational is sometime in 2012,[13] for the purposes of this analysis, the first full year of water production at Carlsbad is assumed to be 2013.

Average energy cost for the Carlsbad facility is assumed to be $0.116/kWh,[14] which is consistent with two independent analyses and differs from Poseidon Resources estimate of $0.075/kWh figure.[15] It should be noted that the Tampa Bay facility energy cost was originally projected to be $0.04/kWh.[16] However, records from Tampa Bay Water indicate that the actual average energy cost since operations began in 2003 is nearly $0.09/kWh. Since energy represents a large component of the O&M costs, if increases in the cost of energy outpace the assumed 3% inflation, a significant marginal cost increase not reflected in this analysis would result.

Based on records provided, Tampa Bay seawater intake temperature is assumed to average 29 degrees C.[17] Carlsbad intake water temperature is assumed to be 26 degrees C through the end of 2017.[18] Starting in 2018, with the assumed loss of warm intake water from the Encina Power Station turbines,[19] average intake water is assumed to be 17.5 C.[20]

Data from membrane manufacturers indicates a 3% reduction in product water production for every 1 degree Celsius temperature decline of feed water.[21] Several adjustments are possible to compensate for this factor. These include accepting lower production targets, adding facility capacity, and increasing feed water pressure. Cool feed water increases relative energy costs per unit of water produced to meet production targets compared to the use of warmer feed water. Of course, building increased facility capacity will increase capital and O&M costs. For the purposes of this analysis, energy use is assumed to increase 3% for each 1 degree Celsius decline in feed water temperature. Using this assumption, energy use for Carlsbad is adjusted for the lower feed water temperatures compared to Tampa Bay for the years 2004 through 2017. The energy use is again adjusted for Carlsbad with the assumed loss of warm feed water from the Encina Power Station in 2018.[22] No additional capital costs are assumed for increased Carlsbad capacity after 2017.

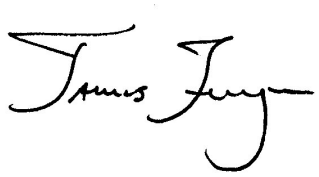
Based on records provided, Tampa Bay seawater intake salinity averages 29,000 ppm.[23] Average intake water salinity at the proposed Carlsbad site averages 33,520 ppm.[24] Given present membrane technology, the higher source water salinity for the Carlsbad site will result in either slightly higher product water salinity or the selection of membranes with lower water permeability, which correlates with lower salt permeability.[25] Membranes with lower water permeability require higher feed water pressure, which will result in higher energy use. [26] The specific design parameters of the Carlsbad facility were unavailable and beyond the scope of this study. However, it should be noted that the higher salinity at the proposed Carlsbad site will require a minor, but unknown increase in energy use

compared to Tampa Bay. The issue of salinity impact on either decreased production or increased energy use is not reflected in the marginal cost results.

Poseidon Resources indicates the intention of carbon-neutral operations for the proposed Carlsbad facility.[27] San Diego Gas & Electric, the power source for the proposed facility, indicates 780.22 lbs of CO2 production per MWh of electric energy produced.[28] For this analysis, carbon neutrality is satisfied with the purchase of carbon offsets at $15/metric ton of CO2.[29]

The replacement life for membranes is assumed to be 6 years with an annualized membrane replacement cost of $42,400 per MGD of facility design capacity.[30] Records from Tampa Bay Water indicate a rapidly increasing annual energy use compared to annual production of product water in the years after new membranes are installed. If this trend represents declining membrane performance as they age, this factor will be adequately captured in the 7-year average cases. However, the declining performance trend will not be adequately captured for the 6-year assumed life of the membranes in the 2-year average cases. With 6 actual years of full operation, declining membrane performance could significantly increase the marginal costs indicated in the 2-year cases. If increased salinity in the feed water contributes to the decline in membrane performance as they age, this effect would be further exacerbated with the higher salinity of Carlsbad feed water compared to Tampa Bay feed water.

The service-life replacement cost for pretreatment systems, pumps, and other necessary equipment and facilities is assumed to be 1% of the total capital cost per year.[31]



About James Fryer:
James Fryer is a water management and conservation professional with over 20 years experience with freshwater, estuarine, and marine conservation policies, programs, and projects. He was the head of Marin Municipal Water District's water conservation program from 1990 to 1999. He served as the Program Manager for The Nature Conservancy's Indian River Lagoon Program in Florida where he also represented the organization on the Indian River Lagoon National Estuary Program Advisory Committee and the Director of the Florida Keys Program where he also served on the Florida Keys National Marine Sanctuary Advisory Committee. In 1997, he served on the U.S./South Africa Bilateral Commission sent to South Africa to provide the Mandela government with watershed and water resources planning assistance. In 1996 he served as an advisor to the British Columbia Water and Wastewater Association for development of a regional planning effort. He has a M.S. in Environmental Management from the University of San Francisco where his Master's Thesis was developing an Integrated Floodplain Management model for the San Francisco Bay-Delta watershed.

He recently returned to California after spending the previous five years on a global sailing voyage.

[1] Poseidon Resources application to The California Debt Limit Allocation Committee, p.10.
[2] Ehrlich, David. "Tampa Bay Desalination Plant Rises Again." CleanTech Group, January 28, 2008. p.1.
[3] "Desalination – With a Grain of Salt." Pacific Institute, Appendix C.
[4] "Desalination Construction Cost by Major Category," spreadsheet provided by Tampa Bay Water.
[5] "Desalination Construction Cost by Major Category," spreadsheet provided by Tampa Bay Water.
[6] Records received from Tampa Bay Water include: Annual Desalination Budget Reports for FY 2003 through 2009, Desalination Product Water Production Report for 2003 through 2009, kWh energy usage per MG product water, Desalination Construction Cost by Major category spreadsheet, intake water temperature and salinity tables and graphs.
[7] Conaughton, Gig. "Carlsbad seawater plan heads to commission." North County Times. November 12, 2007.
[8] Poseidon Resources application to The California Debt Limit Allocation Committee, p.10.
[9] Capital cost from Poseidon Resources application to The California Debt Limit Allocation Committee. "Application for an Allocation of the State Ceiling on Qualified Private Activity Bonds for an Exempt Facility Project" July 30, 2009 Hearing Date. P.10.
[10] "Notice for Public Hearing." Issued by on October 7, 2009 by Roma Cristia-Plant, Assistant Executive Director, California Infrastructure and Economic Development Bank. Hearing date: October 21, 2009.
[11] "Notice for Public Hearing." Issued by on October 7, 2009 by Roma Cristia-Plant, Assistant Executive Director, California Infrastructure and Economic Development Bank. Hearing date: October 21, 2009.
[12] Conaughton, Gig. "Carlsbad seawater plan heads to commission." North County Times. November 12, 2007.
[13] Poseidon resources website: http://www.carlsbad-desal.com/
[14] Coleman, Matt, review of Energy Expense for Proposed Carlsbad desalination Plant, p.1.
California Coastal Commission staff report. http://documents.coastal.ca.gov/reports/2008/8/W4a-8-2008.pdf. p.34.
[15] California Coastal Commission staff report. http://documents.coastal.ca.gov/reports/2008/8/W4a-8-2008.pdf. p.33.
[16] "Desalination – With a Grain of Salt." Pacific Institute, Appendix C.
[17] Intake water temperature and salinity tables and graphs provided by Tampa Bay Water.
[18] The 26 degrees C figure was derived from the difference in water temperature form the receiving seawater at the Encino Power Station discharge pipe noted in "Marin Mammal Protection act Small Take Exemption Permit Appliaction for Continues Operation of the Encina Power Station Cooling Water System." Prepared for Cabrillo Power by URS. January 3, 2001. p.1. The 24.6 degrees C figure was adjusted to 26 degrees C to account for some cooling before discharge water reaches the end of the seawater discharge pipe.
[19] State Water Resources Control Board "Draft Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling." June 2009. Available at:
http://www.waterboards.ca.gov/water_issues/programs/npdes/docs/cwa316/draft_otcpolicy.pdf
[20] The near shore water temperature of 17.5 degrees C cited in the Carlsbad EIR was increased 2 degrees to 19.5 C to reflect warmer water temperatures in the lower Aqua Hedionda Lagoon. See:
EIR for Carlsbad Desalination Facility. December 2005. p.4.7-14, and
Le Page, Steve, "Potential Adverse Changes in Agua Hedionda Lagoon resulting From Abandonment of the Lagoon Intake." May 18, 2007. p.3.
[21] http://www.membranes.com/docs/trc/desparam.pdf and www.excelwater.com
[22] State Water Resources Control Board "Draft Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling." June 2009.
[23] Salinity figure of 29,000 ppm was derived from records provided by Tampa Bay Water Records Department.
[24] EIR for Carlsbad Desalination Facility. December 2005. p.4.7-14.
[25] www.dow.com/PublishedLiterature
[26] www.dow.com/PublishedLiterature
[27] "The Carlsbad Seawater Desalination Project Energy Minimization and Greenhouse Gas Reduction Plan." July 3, 2008. p.3.
[28] SDGE website report: http://www.sdge.com/documents/environment/ab32/nancyPresentation-0910.pdf. p.7.
[29] Carbon offset cost was calculated from mid point North American based carbon offset cost of $15/metric ton found in Ecobusinesslink.com Carbon Offset Survey.
[30] "Engineering Report – Seawater Desalination Pilot Program." Kennedy/Jenks Consultants with CH2MHill, for the Marin Municipal Water District, January 26, 2007. p. 190.
[31] Engineering Report – Seawater Desalination Pilot Program, Kennedy/Jenks Consultants with CH2MHill, for the Marin Municipal Water District, January 26, 2007. p. 189.

Attachment 1 - Marginal Cost Results

Tampa Bay:
Case 1

Based on Tampa Bay Total Capital and 7-Year Average O&M, Financing 30 Years at 5.2%,
Water Production Average of All 7 years From 2003 - 2009.

Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$7,250,167	$9,620,560	9,240	**$1,826**

Tampa Bay:
Case 2

Based on Tampa Bay Total Capital and 2-Year O&M Average, Financing 30 Years at 5.2%,
Water Production Average of 2008-2009 Production.

Ann Cap Cost	Avg Ann O&M	Avg AF/Yr Produced	Marginal Cost/AF
$7,250,167	$16,953,837	20,173	**$1,200**

Poseiden/Carlsbad:
Case 3

Carlsbad Marginal Cost Based on Tampa (Case 1) with 7-Year Average Production, Capital, and O&M.
Financing 30 Years at 5.2%, Energy Cost Adjusted to $0.116 per kWh, 5% Profit on O&M and
Adjustments Starting Year 8, Warm Intake Water Through 2017, Carbon Offset Cost.

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$35,196,267	$22,941,119	$2,714,217	$3,345,999	$619,046	18,480	$1,220,627	**$3,507**

Poseiden/Carlsbad:
Case 4

Carlsbad Marginal Cost Based on Tampa (Case 2) with 2-Year Average Production, Capital, and O&M,
Financing 30 Years at 5.2%, Energy Cost Adjusted to $0.116 per kWh, 5% Profit on O&M and
Adjustments Starting Year 8, Warm Intake Water Through 2017, Carbon Offset Cost.

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$35,196,267	$37,607,673	$6,547,964	$7,086,827	$1,311,139	40,347	$1,898,956	**$2,175**

Poseiden/Carlsbad:
Case 5

Carlsbad Marginal Cost with $534 Million Capital Cost and Based on Tampa (Case 1) with 7-Year Average Production and O&M, Financing 30 Years at 5.2%, Energy Cost Adjusted to $0.116 per kWh, 5% Profit on O&M and Adjustments Starting Year 8, Warm Intake Water Through 2017, Carbon Offset Cost.

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$24.503,730	$22,941,119	$2,714,217	$3,345,999	$619,046	18,480	$1,220,627	**$2,929**

Poseiden/Carlsbad:
Case 6

Carlsbad Marginal Cost with $534 million Capital Cost and Based on Tampa (Case 2) with 2-Year Average Production and O&M, Financing 30 Years at 5.2%, Energy Cost Adjusted to $0.116 per kWh, 5% Profit on O&M and Adjustments Starting Year 8, Warm Intake Water Through 2017, Carbon Offset Cost.

Ann Cap Cost	Avg Ann O&M	Energy Cost Adj	Temp Impact Adj	Carbon Offset Adj	Avg AF/Yr Produced	Profit	Marginal Cost/AF
$24,503,730	$36,607,673	$6,547,964	$7,086,827	$1,311,139	40,347	$1,898,956	**$1,910**

Attachment 2 - Assumptions and Inputs

Fields highlighted in dark yellow are primary data input fields that affect numerous calculations
Fields highlighted in light yellow indicate calculated results generated elsewhere in model

Tampa Bay Design Capacity	25	MGD
Tampa Bay - Poseidon Projected Capital Cost	$110,000,000	
Tampa Bay Capital Cost (Initial and Remediation)	$158,000,000	
Tampa Bay Financing Term	30	Years
Tampa Bay Financing Rate	5.2%	
Tampa Bay Project Life	30	Years
Tampa Bay Average Energy Cost per kWh (7 Year Average)	$0.08675	kWh
Tampa Bay Average Energy Cost per kWh (2 Year Average of 08-09)	$0.08975	kWh
Tampa Bay Average Water Intake Temperature	30	Degrees C
Tampa Bay Average Intake Water Salinity	29,000	ppm
Carlsbad Design Capacity	50	MGD
Carlsbad Capital Cost - Poseidon Projection	$534,000,000	
Carlsbad Adjusted Capital Cost Based on Tampa Capital Cost Overrun	$767,018,182	
Carlsbad Financing Term	30	Years
Carlsbad Financing Rate	5.2%	
Carlsbad First Year of Production	2013	
Carlsbad Intake Average Temperature Through End of 2017	26	Degrees C
Carlsbad Intake Average Temperature During and After 2018	17.5	Degrees C
Membrane Performance Increase for Every 1 Degree C Temperature Rise	3%	
Carlsbad Intake Average Salinity	33,520	ppm
Carlsbad Average Energy Cost per kWh	$0.116	kWh
Carlsbad Additional Pumping Energy Use During and After 2018	3%	
San Diego Gas & Electric Carbon Production	780.22	lbs/MWh
Carbon Offset Cost	$15	Per Metric Ton
Poseidon Profit Margin	5%	on O&M only
Operating Year Poseidon Begins Profit on O&M Costs	8	
Carlsbad Project Life (Assumed)	30	Years
Average Membrane Life	6	Years
Service-Life Annualized Replacement Costs for Pretreatment Systems, Pumps, Equipment and Facilities	1%	of Total Capital Cost/Yr
Consumer Price Index	3%	
Real Discount Rate	2.2%	