Comment on "CalAm MONTERREY PENINSULA WATER SUPPLY PROJECT; Draft Environmental Impact Report"

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I had commented previously on the potential for significant release of greenhouse gases (GHG) from feed waters sourced in subsurface intakes, such as is the case for the proposed CalAm slant wells. Compositional data for fluids sampled from the exploratory boreholes contained in the draft EIR (Appendix C3, Tables 3A and 3B) allow for quantified estimates of GHG release from the fluids at the Moss Landing and Marina well sites. These estimates, described below, range from less than 1000 to over 12,000 tons carbon dioxide per year for the planned 9.6 MGD plant. The data confirm the potential for significant GHG release, and also indicate a high variability in source water GHG content, and the need for including GHG release estimates in the plant siting process.

I used the compositional data from Table 3 of Appendix C3 of the EIR to compute the partial pressure of carbon dioxide in each of the water samples, 31 samples total. The input data needed for this calculation are the fluid alkalinity, pH, calcium concentration and salinity, all of which are provided in Table 3. The potential carbon dioxide release is calculated assuming the feed water eventually equilibrates with the atmosphere, releasing the contained carbon dioxide. On average, the Moss Landing samples have partial pressures of carbon dioxide that are 120 times higher than atmospheric values. This corresponds to a yearly release of carbon dioxide of about 5500 tons for a plant size providing the planned 9.6 MGD of permeate. For the Marina site the corresponding numbers are 50 for carbon dioxide partial pressure enrichment over atmospheric and 2200 tons/year carbon dioxide release, significantly lower than for the Moss Landing samples.

The calculated tonnages of released carbon dioxide are listed for each well in the Table below. The assumption in each case is that the 9.6 MGD plant would be fed entirely by a fluid with the composition of the particular well water sample indicated. The wide range of CO_2 release tonnages (for example, ranging from 1051 to 14877 metric tons per year for the Moss Landing wells) shows a great amount of variability of fluids being sampled in the subsurface. In addition, these compositions will almost certainly change over time as these highly variable water sources are pulled into the intake system.

These calculated release rates are conservative minimum values. They are based on an assumption that the measured field pH was obtained without any release of carbon dioxide. If

the pH were not measured immediately after sampling, the pH would rise as carbon dioxide escapes. The higher the pressure of carbon dioxide, the more rapid the release of CO_2. There is no information on the sampling procedure that could be used to evaluate this issue. Any carbon dioxide loss that might have taken place prior to the pH measurement would not be accounted for in the estimated release tonnages and could be significant. Our reported carbon dioxide emissions and GHG tonnages are therefore minimum values.

The fact that carbon dioxide is actively being degassed from these samples is strongly supported by the observation that for 30 of the 31 well fluid analyses reported in Table 3, the pH measured at a later time, presumably after transport of the sample back to the laboratory, was significantly higher than the field measured pH. This increase in pH over time is consistent with CO2 loss (degassing) which is commonly observed for many natural water samples.

Our estimated release tonnages based on waters sampled at the Moss Landing and Marina sites as representative of the feed are significant and likely to be above the reporting minimums for the California Air Resources Board. Our results also show a significant difference between the Moss Landing site and the Marina site, with significantly less carbon dioxide in fluids in the Marina wells. The data show a large degree of site variability that is not predictable. Proper sampling and analysis must be made for fluids at each site to determine the expected release of greenhouse gases.

The estimates can only be made for carbon dioxide as data for methane was not reported. The methane flux has the potential to be more significant than that for carbon dioxide given its greater potency as a greenhouse gas. Both methane and carbon dioxide are common products of microbial activity in recent sediments, and some amount of methane is expected to be present in the pore waters. If we assume a sediment pore water gas content for both methane and carbon dioxide of one atmosphere (reasonable gas contents for some sediment pore waters), the estimated GHG release would be about 5700 tons CO2e per MGD feed. For a 50 MGD sea water desalination plant operating at 40% recovery, the GHG emission would be about 360,000 tons/year CO2e. Clearly there is the potential for large releases of GHG from desalination plants fed by subsurface wells and these releases should be of concern to regulators.

A separate comment has to do with the chemical characteristics of the fluids. Few of the fluids reported in Tables 3A and 3B are as saline as sea water, indicating they are not sea water pulled into the wells during pumping. Their pH values are 1-2 units lower than ocean water and therefore have the potential for increased metal content (in particular from metal desorption from mineral surfaces). The fluids are also are significantly enriched in silica with typical values of 30-40 mg/L versus values of 1-2 mg/L or less in typical ocean water. The concentrate will therefore be very silica-enriched relative to seawater which may affect the dynamics of silica-

secreting microorganisms when the concentrate is returned to the ocean. The same is true for calcium in many of the wells where its concentration is much higher than is normal for seawater. And finally, several of the fluids have salinities less than 5000 ppm TDS (seawater is around 35,000), and one as low as 423 ppm (from well ML-1) which is in the acceptable range for potable water. These wells are not sampling seawater.

Based on this analysis, I conclude the following :

- Significant greenhouse gas release is likely for desalination feeds obtained from subsurface wells
- A procedure for sampling the fluids and carrying out the greenhouse gas analysis needs to be part of the permitting process.
- Chemical analysis of the fluids should include methane as well as other potential greenhouse gases
- The sampling should continue over time as the system evolves due to water withdrawal
- There may be issues associated with disposal of desalination brine into the ocean that arise due to compositional differences that are not present when the feed is taken directly from the ocean

Table. Calculated carbon dioxide release in metric tonnes per year based on fluid compositions from well samples listed in Appendix C3, Tables 3A and 3B, for a plant producing 9.6 million gallons per day of permeate at a permeate recovery of 40%.

CEMEX Marina site

CX-B1WQ						CX-B2WQ				CX-B4				
1	2	3	4	5	6	1	2	3	4	1	2	3	4	5
4542	**2576**	**3279**	**1543**	**1893**	**1210**	**3037**	**2529**	**1344**	**1309**	**2582**	**2401**	**1827**	**1992**	**822**

average for Marina wells = 2192 tonnes/year

Moss Landing Area

PR-1		ML-1		ML-2		ML-3		ML-4		MK-6		MDW-1			
1	2	1	2	1	2	1	2	1	2	1	2	1	2	3	4
3825	**2967**	**6075**	**5143**	**14877**	**4054**	**3021**	**3295**	**9555**	**5048**	**12395**	**9445**	**2328**	**2990**	**2458**	**1051**

average for Moss Landing wells = 5533 tonnes/year