### Assessment of Energy Intensity and Greenhouse Emissions of Proposed West Basin Desalination Plant and Water Supply Alternatives

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## **1.0 Executive Summary**

This report reviews the energy intensity and greenhouse gas emissions associated with the grid power demand of the proposed West Basin desalination plant and alternatives, including the expansion of recycled water use, brackish groundwater desalination, and conservation, to assure local water reliability. Desalination plants of two capacities, 20 million gallons per day (Mgd) and 60 Mgd, are evaluated. The electric "grid reliability" impacts of the desalination plant are assessed in the context of the electricity supply limitations of the Los Angeles Basin. Major findings of this report are:

- Potable water demand in West Basin Municipal Water District (West Basin) service territory is approximately 20,000 acre-feet per year (AFY) below the 2015 level forecast by West Basin in 2010. This is about equal to the annual production output of the proposed 20 Mgd desalination plant.
- The West Basin service area is built-out and little or no growth in water demand is anticipated.
- West Basin will increase conservation savings from 9,200 AFY to 18,400 AFY by 2020.
- West Basin anticipates expanding production of recycled water from 45,000 AFY to 78,000 AFY by 2020.
- West Basin's share of the proposed Regional Recycled Water Project is 15 Mgd (17,000 AFY). The project is expected to be online by 2027.
- Displacement of potable water uses with approximately 50,000 AFY of planned conservation and recycled water additions is a low-cost, low greenhouse gas (GHG) pathway to reducing West Basin reliance on imported water.
- West Basin has the potential to recycle 15,000 AFY from the 600,000 AF brackish groundwater plume trapped behind the seawater barrier and inject it back into the aquifer for indirect potable reuse.
- The cost of desalinated ocean water, in the range of \$2,400 per AF, is substantially greater than the cost of imported water (\$1,000/AF), recycled water (\$850/AF), or brackish groundwater desalination (\$1,000/AF).
- The energy intensity of ocean water desalination is about five times greater than that of purified recycled water.
- As a result, the carbon footprint of ocean water desalination is about five times greater than that of purified recycled water.
- The proposed 20 Mgd desalination plant will emit about 44,000 tons per year of carbon dioxide, from indirect power generation emissions, in the first year of operation.
- The continuous 14 MW electricity demand of the 20 Mgd desalination plant will be significantly greater than the electricity demand of all of the 14,173 households in Manhattan Beach.

### 2.0 Introduction

Los Angeles Waterkeeper contracted Powers Engineering to provide a technical assessment of the energy intensity, in terms of kilowatt-hours per acre-foot of water (kWh/AF), and associated greenhouse gas (GHG) emissions for a range of actual and potential water supply options for West Basin Municipal Water District (West Basin). The water supply options evaluated include:

- Conservation
- Recycled water (including indirect potable reuse)
- Brackish groundwater desalination
- Seawater desalination
- Imported water (Colorado River and State Water Project water transfers)

State Water Project and Colorado River Aqueduct water imports are used as the baseline for comparison purposes in this analysis. Most potable water utilized in West Basin service territory is supplied as imported water provided by the Metropolitan Water District of Southern California (MWD). Local groundwater resources, replenished through natural processes, are the other source of potable water. The majority of potable water consumed in Southern California as a whole is imported water. For this reason, the energy intensity and carbon dioxide ( $CO_2$ ) emissions associated with water imports are used as carbon intensity baseline values in this report.<sup>1</sup>

### 3.0 Description of West Basin and Proposed Desalination Project

#### 3.1 West Basin History and Water Resource Development Strategy

West Basin was formed in 1947 as an imported water wholesaler for the southwestern portion of Los Angeles County. The West Basin service area is composed of seventeen cities and several unincorporated areas. West Basin is a regional water wholesaler, and purchases water from MWD. MWD obtains water from the State Water Project and the Colorado River. West Basin serves a population of about one million within the Los Angeles coastal region and provides recycled water to over 400 sites.<sup>2,3</sup> West Basin service territory is shown in Figure 1.

<sup>&</sup>lt;sup>1</sup> Greenhouse gases, carbon intensity, and CO<sub>2</sub> are used as interchangeable synonyms in this report.

<sup>&</sup>lt;sup>2</sup> West Basin MWD, Notice of Preparation & Scoping Meeting Notice Environmental Impact Report for the West Basin Ocean Water Desalination Project, August 31, 2015, p. 1.

<sup>&</sup>lt;sup>3</sup> West Basin MWD Regular Board Meeting Packet, February 22, 2016, West Basin MWD Engineer's Report – Fiscal Year 2016-17 Standby Charge, pdf p. 160.



Figure 1. West Basin MWD service territory<sup>4</sup>

West Basin water demand is approximately 175,000 AFY. This demand is met with imported water from MWD (104,000 AFY), groundwater (36,000 AFY), recycled water (34,000 AFY), and desalted water (800 AFY).<sup>5</sup> The imported water comes from the Sacramento River Delta via the State Water Project and the Colorado River. Groundwater is extracted from the West Coast Groundwater Basin by West Basin customer agencies.<sup>6</sup>

<sup>&</sup>lt;sup>4</sup> Ibid, Exhibit 1. Potential West Basin desalination plant sites in El Segundo and Redondo Beach are also shown in Figure 1.

<sup>&</sup>lt;sup>5</sup> See Table 1.

<sup>&</sup>lt;sup>6</sup> West Basin webpage "Groundwater - Overview": <u>http://www.westbasin.org/water-supplies/groundwater</u>.

West Basin currently has the capacity to produce approximately 50 Mgd (54,000 AFY) of recycled water.<sup>7</sup> Approximately 35,000 AFY is used in West Basin to meet water demand and as salt water intrusion barrier replenishment supply.<sup>8</sup> West Basin forecasts that it will deliver approximately 41,725 (37 Mgd) AFY of recycled water in fiscal year 2016-2017.<sup>9</sup> About 17,000 AFY is also supplied outside of the West Basin service area to the City of Torrance and the City of Los Angeles.<sup>10</sup>

The West Basin water recycling program produces five types of "designer" recycled water to meet the needs of specific customer classes:<sup>11</sup>

- 1. Irrigation Water: Secondary treated wastewater<sup>12</sup> that has been filtered and disinfected for industrial and irrigation use.
- 2. Cooling Tower Water: Secondary treated wastewater that has been processed to remove ammonia for industrial cooling tower use.
- 3. Seawater Barrier and Groundwater Replenishment Water: Secondary treated wastewater filtered by microfiltration and reverse osmosis (RO) membranes and disinfected for use in maintaining a barrier against seawater intrusion and augmenting local well water supplies.
- 4. Low-Pressure Boiler Feed Water: Secondary treated wastewater filtered by microfiltration and RO membranes for use as low pressure boiler feed water.
- 5. High-Pressure Boiler Feed Water: Secondary treated wastewater filtered by microfiltration membranes and passed through RO membranes twice for use as feed water for high pressure boilers.

Figure 2 presents West Basin recycled water consumption by type of customer service.<sup>13</sup>

Figure 2. West Basin recycled water consumption by type of customer service



<sup>&</sup>lt;sup>7</sup> West Basin MWD Regular Board Meeting Packet, October 24, 2016, pdf p. 104, Agenda Item 14 – Water Facility Operations Update.

<sup>&</sup>lt;sup>8</sup> West Basin MWD Regular Board Meeting Packet, Monthly Water and Recycled Water Sales FY 2015-16, July 25, 2016, pdf p. 91. FY 2015-16 recycled water sales = 34,988 AF.

<sup>&</sup>lt;sup>9</sup> West Basin MWD Regular Board Meeting Packet, February 22, 2016, West Basin MWD Engineer's Report – Fiscal Year 2016-17 Standby Charge, pdf p. 147.

<sup>&</sup>lt;sup>10</sup> West Basin MWD, *2010 Urban Water Management Plan*, Table 3-6, p. 3-6. Forecast 2015 West Basin water sales to external agencies = 17,350 AFY.

<sup>&</sup>lt;sup>11</sup> West Basin MWD "About Recycled Water" webpage: <u>http://www.westbasin.org/water-</u> supplies/recycled-water

<sup>&</sup>lt;sup>12</sup> Ibid. Secondary treated wastewater is identified by the synonym "sewer water."

<sup>&</sup>lt;sup>13</sup> West Basin MWD Regular Board Meeting Packet, February 22, 2016, West Basin MWD Engineer's Report – Fiscal Year 2016-17 Standby Charge, pdf p. 165.

West Basin has operated the C. Marvin Brewer Desalter Facility, which treats brackish groundwater from the inland side of the West Coast Seawater Barrier, since 1993.<sup>14</sup> This is a small facility, producing about 800 AFY.<sup>15</sup>

West Basin also has a widely variable demand for imported water to supplement the recycled water injected into the saltwater intrusion barrier. In the first half of Fiscal Year 2015-16, about 1,000 AF of imported water was used to supplement recycled water injected into the intrusion barrier. However, in the second half of Fiscal Year 2015-16, about 2,600 AF of imported water was injected into the intrusion barrier.<sup>16</sup>

#### 3.1.1 West Basin Potable Water Demand Reduction Strategy

West Basin initiated a water recycling program in the early 1990s in response to a period of severe drought.<sup>17</sup> The original West Basin goal was to produce 70,000 to 100,000 AFY of recycled water to displace imported potable water.<sup>18</sup> West Basin's water recycling plant, the Edward C. Little Water Recycling Facility in El Segundo, is designed for ultimate expansion to 100 Mgd.<sup>19</sup> Recycled water production progress has been slower than anticipated due to the higher than anticipated level of treatment necessary and lower revenue than anticipated due to imported water rates remaining flat for many years.<sup>20</sup>

The State initiated a voluntary urban water conservation program in the early 1990s. In 2009 state agencies with water policy responsibility developed a plan with a target of reducing urban water use through conservation measures by 20 percent by 2020 in response to the Governor's call for an aggressive urban water conservation plan.<sup>21</sup>

This target was incorporated into the 2009 Comprehensive Water Package that was passed by the California legislature in November of 2009. The Water Package included an \$11 billion bond issue allocating several billion dollars to fix the Sacramento River Delta, and funding for conservation and other water initiatives, including the development of Integrated Water Management Plans. Regional and local water districts were required to enact conservation and other measures to develop "diverse regional water supply portfolios that will increase water supply reliability and reduce dependence on the Delta."<sup>22</sup> Urban water agencies are required to report their baselines and targets to

<sup>&</sup>lt;sup>14</sup> West Basin MWD, Ocean Water Desalination Program Master Plan (PMP) Conceptual System Design and Program Requirements Report (CSDPR), January 2013, p. 2-13.

<sup>&</sup>lt;sup>15</sup> West Basin MWD Regular Board Meeting Packet, Monthly Water and Recycled Water Sales FY 2015-16, July 25, 2016, pdf p. 91. FY 2015-16 Brewer Desalter production = 778 AF.

<sup>&</sup>lt;sup>16</sup> West Basin MWD Regular Board Meeting Packet, Monthly Water and Recycled Water Sales FY 2015-16, July 25, 2016,, pdf p. 90.

<sup>&</sup>lt;sup>17</sup> West Basin MWD Regular Board Meeting Packet, February 22, 2016, West Basin MWD Engineer's Report – Fiscal Year 2016-17 Standby Charge, pdf p. 146.

<sup>&</sup>lt;sup>18</sup> Ibid, pdf p. 147.

<sup>&</sup>lt;sup>19</sup> CH2MHill, Water Reuse Case History – West Basin Water Recycling/Petroleum Refinery Reuse Program, El Segundo, California, (undated 1-page fact sheet).

<sup>&</sup>lt;sup>20</sup> Ibid, p. 147.

<sup>&</sup>lt;sup>21</sup> H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California: Assessing Water District Level Strategies*, November 2012, pp. vii-viii.

<sup>&</sup>lt;sup>22</sup> S.B. X7-7, Sect. 1, Part 2.55, Chapt. 10608 (c).

meet the 20 percent reduction by 2020 goals in their Urban Water Management Plans (UWMP). These plans are updated every five years.

West Basin's 2010 Urban Water Management Plan goal is to reduce overall imported water use by nearly one-half, from 63 percent in 2010 to 35 percent by 2035.<sup>23</sup>

The West Basin Water Reliability 2020 Program (WR 2020) goal is to reduce West Basin dependence on imported water from 66 percent to 33 percent by 2020,<sup>24</sup> and add a new desalination supply by 2023 to diversify future water supplies.<sup>25,26</sup> It is important to note that the West Basin WR 2020 goal of reducing imported water use by 50 percent by 2020 substantially exceeds the state mandated goal of a 20 percent reduction by 2020.

Given no clarifying information on the West Basin website or in relevant West Basin documents, it would appear that the WR 2020 goal of a 50 percent reduction in imported water use by 2020 is an aspirational goal, while the 2010 West Basin UWMP goal to reduce West Basin imported water use from 63 percent in 2010 to 35 percent in 2035, a 44 percent reduction,<sup>27</sup> is a regulatory target. In any case, the WR 2020 goal of reducing imported water use by 50 percent by 2020 can be achieved without a West Basin desalination plant.

#### 3.1.2 West Basin and Evaluation of Ocean Desalination

The West Basin desalination plant Environmental Impact Report (EIR) that is currently in development will assess the potential environmental effects of implementing a proposed ocean water desalination facility producing either 20 or 60 Mgd of potable drinking water. The proposed location is the NRG El Segundo Generating Station (ESGS). The EIR will also evaluate the AES Corporation (AES) Redondo Beach Generating Station (RBGS) as an alternative site for the desalination plant.<sup>28</sup>

West Basin started a program to explore the development of a full-scale ocean water desalination facility in 2001. A 20 gpm ocean water desalination pilot facility was operated at the El Segundo Power Plant in 2002.<sup>29</sup>

<sup>&</sup>lt;sup>23</sup> West Basin MWD, Attachment to the Notice of Preparation & Scoping Meeting Notice Environmental Impact Report for the West Basin Ocean Water Desalination Project, August 31, 2015, p. 1.

<sup>&</sup>lt;sup>24</sup> West Basin MWD, Ocean Water Desalination Program Master Plan (PMP) Conceptual System Design and Program Requirements Report (CSDPR), January 2013, p. 2-2. <sup>25</sup> Ibid, p. 2-13.

<sup>&</sup>lt;sup>26</sup> There is no guarantee that building a desalination plant will assure a reliable supply of desalinated water. The Voice of San Diego online newspaper reported on August 29, 2017 that the availability of the 50 Mgd Poseidon Carlsbad desalination plant had declined from 95 percent in its first year of operation in 2016 to 70 percent to date in 2017 due to operational challenges. Algal bloom caused 15 days of forced shutdown in April 2017 and present an ongoing challenge to desalination plant reliability. Voice of San Diego, Desal Plant Is Producing Less Water Than Promised, August 29, 2017:

http://www.voiceofsandiego.org/topics/science-environment/desal-plant-producing-less-water-promised/.  $\frac{27}{(0.63 - 0.35)}/(0.63) = 0.44$  (44 percent)

<sup>&</sup>lt;sup>28</sup> West Basin MWD, Notice of Preparation & Scoping Meeting Notice Environmental Impact Report for the West Basin Ocean Water Desalination Project, August 31, 2015, pdf p. 1.

<sup>&</sup>lt;sup>29</sup>West Basin MWD, 2013 Ocean Water Desalination Program Master Plan (PMP), Report TM1 -Conceptual System Design and Program Requirements Report, p. 2-13.

The data collected at the Pilot Project was used in the development of the Ocean Water Desalination Demonstration Facility (Demonstration Project) in Redondo Beach. The OWDDF was constructed at the decommissioned RBGS pump house, previously used by Southern California Edison (SCE) and AES. The Demonstration Project conducted larger scale testing and operated continuously from November 2010 through September 2013.<sup>30</sup> Passive ocean intake screens, known as "wedgewire" screens, were tested at the Demonstration Project.<sup>31</sup>

The Demonstration Project was subsequently used as the foundation for development of a full-scale desalination plant design, which was presented in West Basin's 2013 Ocean Water Desalination Program Master Plan (PMP).<sup>32</sup>

#### 3.2 West Basin Water Demand Trends

The PMP forecast a significant increase in West Basin potable and recycled water demand between 2010 and 2015, followed by relatively unchanged demand from 2015 to 2035, as shown in Figure 3. The August 31, 2015 *Notice of Preparation & Scoping Meeting Notice Environmental Impact Report for the West Basin Ocean Water Desalination Project* relies on the PMP as the design basis for the proposed 20 to 60 Mgd desalination plant. Figure 3 was originally presented in the West Basin 2010 Urban Water Management Plan, which presumes that approximately 20,000 AFY will be produced from a West Basin ocean desalination plant by 2020.<sup>33</sup>



Figure 3. Water demand trend and source of water in West Basin, 2008 to  $2035^{34}$ 

<sup>30</sup> Ibid, p. 2.

<sup>31</sup> Ibid, p. 2.

<sup>32</sup> Ibid, p. 2.

<sup>33</sup> West Basin MWD, 2010 Urban Water Management Plan, Figure 3-2, p. 3-4.

<sup>34</sup> West Basin MWD, 2013 PMP Report TM1, p. 2-2.

In fact, West Basin overall water demand, and demand for potable water, continued to decline from 2010 to 2015. A comparison of the actual West Basin consumption of potable water, including imported water and groundwater, and recycled water is provided in Table 1.

Demand	2010 actual <sup>35,36</sup>	2015 forecast <sup>37,38</sup>	2015 actual <sup>39,40</sup>
	(acre-feet/year)	(acre-feet/year)	(acre-feet/year)
Potable water	140,805	160,687	139,638
(imported water +			
groundwater)			
Recycled water	37,162	36,848	34,998
(demand + intrusion barrier			
replenishment)			
Total	177,967	197,535	174,636

Table 1. West Basin Water Demand, 2010 and 2015

The 20,000 AFY increase in potable water demand in the West Basin between 2010 and 2015 that was forecast in the PMP did not materialize. No increase in water demand is forecast from 2015 to 2035, as shown in Figure 3. As a result, West Basin has already realized the 20,000 AFY imported water demand reduction that it intended the 20 mgd (~22,000 AFY maximum production) desalination plant to achieve.

#### 3.2.1 Three Reasons for Lack of West Basin Potable Water Demand Growth

Three reasons for the lack of potable water demand growth in the West Basin between 2010 and 2015 are: 1) little new development in the built-out service area,<sup>41</sup> 2) an effective water conservation program, and 3) expansion of the West Basin water recycling program. West Basin implemented its WR 2020 strategy in 2006.<sup>42</sup> WR 2020 includes a strong focus on water conservation measures and expansion of the water recycling program.

<sup>&</sup>lt;sup>35</sup> West Basin MWD, 2010 Urban Water Management Plan, Table 3-3, p. 3-5.

<sup>&</sup>lt;sup>36</sup> Ibid, Table 3-3 and Table 3-5, p. 3.5.

<sup>&</sup>lt;sup>37</sup> Ibid, Table 3-3, p. 3-5.

<sup>&</sup>lt;sup>38</sup> Ibid, Table 3-3 and Table 3-5, p. 3.5.

<sup>&</sup>lt;sup>39</sup> West Basin MWD Regular Board Meeting Packet, pdf pp. 90-91, Monthly Water and Recycled Water Sales FY 2015-16, July 25, 2016. FY 2015-16 imported water sales = 103,638 AF. FY 2015-16 recycled water sales = 34,988 AF.

<sup>&</sup>lt;sup>40</sup> West Basin MWD website, March 25, 2017: <u>http://www.westbasin.org/water-supplies/groundwater</u>. "The average amount of water extracted from the West Coast Groundwater Basin by our (West Basin) customer agencies is approximately 36,000 acre-feet (ac-ft.) per year."

<sup>&</sup>lt;sup>41</sup> See: <u>http://www.westbasindesal.org/environment</u>. "West Basin's 17 coastal cities are essentially built out."

<sup>&</sup>lt;sup>42</sup> West Basin, Water Efficiency 2011-2015 Master Plan - Part of West Basin's Water Reliability 2020 Program, 2011, p. 1.

West Basin is expanding recycled water production from about 40 Mgd to 70 Mgd (45,000 AFY to 78,000 AFY) by 2020.<sup>43</sup> West Basin will also double its conservation savings from 3 to 6 billion gallons (9,200 AFY to 18,400 AFY) by 2020.<sup>44,45</sup> The expansion of recycled water production and increased conservation represent an additional West Basin potable water demand reduction potential of 42,000 AFY by 2020.<sup>46</sup>

The Regional Recycled Water Project is under development by MWD and Los Angeles County Sanitation District.<sup>47</sup> West Basin is a member water agency of MWD.<sup>48</sup> The project would produce up to 150 Mgd of recycled water at the Joint Water Pollution Control Plant in Carson, California.<sup>49</sup> 15 Mgd (~17,000 AFY) of this 150 Mgd of recycled water output would be allocated to West Basin.<sup>50</sup> The project is anticipated to be online in 2027.<sup>51</sup>

West Basin used approximately 104,000 AFY of imported water in Fiscal Year 2015-16. The West Basin expansion of water conservation and recycling programs will offset 42,000 AFY of potable water by 2020. The 17,000 AFY of additional recycled water provided by the Joint Water Pollution Control Plant in Carson would increase the total additional recycled water and conservation supply to 59,000 AFY. The reduction of potable water demand from 104,000 AFY in 2015 to 45,000 AFY in 2027 represents a 57 percent reduction in imported water demand. This would substantially exceed the West Basin 2010 UWMP target of reducing imported water demand to 70,598 AFY by 2030.<sup>52</sup>

#### 3.2.2 Potential West Basin MWD participation in brackish groundwater desalination

The Water Replenishment District of Southern California (WRD) is located in southern Los Angeles County.<sup>53</sup> WRD manages the Central and Western adjudicated groundwater basins in its service territory.<sup>54</sup> WRD is evaluating the potential to develop the West

<sup>&</sup>lt;sup>43</sup> West Basin desalination webpage "Why Consider Desalination?," 2015:

http://www.westbasindesal.org/desal-debate.html. Note that although West Basin states it has a production capacity of 50 Mgd, production capacity and actual production are not necessarily equivalent. <sup>44</sup> Ibid.

<sup>&</sup>lt;sup>45</sup> West Basin MWD, 2013 PMP Report TM1, p. 2-2 and p. 2-3. Another aspect of WR 2020 is to expand its brackish groundwater program and ocean desalination proposal from 500 AFY to 21,500 AFY by 2030. <sup>46</sup> Increased recycled water production of 33,000 AFY + increased conservation of 9,000 AFY = 42,000

AFY.

<sup>&</sup>lt;sup>47</sup> Ibid, p. 2-20.

<sup>&</sup>lt;sup>48</sup> MWD "Who We Are" webpage: <u>http://www.mwdh2o.com/WhoWeAre/Member-</u>

Agencies/Pages/default.aspx. <sup>49</sup> MWD, Potential Regional Recycled Water Program, PowerPoint presentation to Orange County Water District, September 7, 2016

<sup>&</sup>lt;sup>50</sup> Ibid, p. 26.

<sup>&</sup>lt;sup>51</sup> Ibid, p. 28.

<sup>&</sup>lt;sup>52</sup> West Basin MWD, West Basin Municipal Water District 2010 Urban Water Management Plan, May 2011, Table ES-4, p. ES-4.

<sup>&</sup>lt;sup>53</sup> See "WRD Mission and History," accessed September 4, 2017: <u>http://www.wrd.org/content/mission-and-</u> <u>history</u>. <sup>54</sup> Ibid.

Coast Basin Brackish Water Reclamation Project.<sup>55</sup> This regional project, which will consist of multiple desalter treatment plants, will remove the saline plume in the Silverado Aquifer located in the West Coast groundwater basin in south Los Angeles County. Operation of seawater barrier injection wells has curtailed seawater intrusion into the West Coast Basin. However, a large residual saline plume is trapped inland of the barrier wells. This trapped saline plume occupies 600,000 AF of volume in the West Coast groundwater basin.<sup>56</sup>

This project will remediate the saline plume over a 40-year period by pumping and desalting 15,000 AF of brackish groundwater each year. This project would provide a significant new potable water supply in the West Coast Basin and will also reclaim groundwater storage capacity in the basin by removing the brackish plume. WRD's Groundwater Basin Master Plan assumes this project would operate on a regional basis, providing a new potable source of water for several groundwater pumpers located within that basin whose pumping options are currently limited by the saline plume.<sup>57</sup>

The first phase of this project is under development at the Robert W. Goldsworthy Desalter facility in Torrance. This desalter is owned by WRD and operated by Torrance Municipal Water personnel. The desalter plant currently produces up to 2 Mgd of desalinated water. The facility is in the process of being expanded to 5 Mgd and is expected to be online at this increased capacity by late 2017.<sup>58</sup>

#### 3.2.3 Potential of direct potable reuse

The California Health and Safety code states that the department "shall not issue a permit to a public water system or amend a valid existing permit for the use of a reservoir as a source of supply that is directly augmented with recycled water".<sup>59</sup> However, in 2013 the California Water Code was amended,<sup>60</sup> stating that "on or before December 31, 2016, the department, in consultation with the state board, shall investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for direct potable reuse." Without direct potable reuse (DPR) regulations, recycled water cannot be mixed directly into the potable drinking water supply without an environmental buffer. An example of an environmental buffer is indirect potable water reuse via groundwater replenishment.<sup>61</sup>

Current regulations restricting the practice of DPR have the effect of limiting the utilization of local water sources, such as recycled water and captured stormwater, on the

<sup>&</sup>lt;sup>55</sup> Water Replenishment District of Southern California (WRD), Water Storage Investment Program Concept Paper, West Coast Basin Brackish Water Reclamation Project, prepared for California Water Commission, 2016. A preliminary budgetary estimate by WRD for this project is \$82 million.

<sup>&</sup>lt;sup>56</sup> Ibid. <sup>57</sup> Ibid.

<sup>&</sup>lt;sup>58</sup> City of Torrance, 2015 Urban Water Management Plan, Section 1: Introduction, July 27, 2016, p. I-8.

<sup>&</sup>lt;sup>59</sup> California Health and Safety Code §116551, 1998.

<sup>&</sup>lt;sup>60</sup> California State Water Code §§13560-13569 (2013).

<sup>&</sup>lt;sup>61</sup> K. Sanders, *The energy trade-offs of adapting to a waterscarce future: case study of Los Angeles*, published in International Journal of Water Resources Development, published online October 22, 2015, pp. 14-15.

large scale, as these non-potable water supplies require an additional purple-pipe distribution system that is expensive to build.<sup>62</sup>

The State Water Board, in its December 2016 report to the Legislature, identified two DPR projects currently operating worldwide as permanent sources of drinking water.<sup>63</sup> Both projects, one in Texas and one in Namibia, are in current operation under permit by regulating agencies in the absence of DPR regulations.<sup>64</sup> Texas, the first state to approve the operation of a DPR project, does not have any regulations for DPR.<sup>65</sup> DPR projects in Texas have been evaluated on a case-by-case basis with site-specific requirements.<sup>66</sup>

The State Water Board convened two independent expert panel of scientists and engineers in early 2014 to advise the Board on issues related to the investigation of the feasibility of developing uniform water recycling criteria for DPR that is protective of public health.<sup>67</sup>

The expert panel determined that it is technically feasible to develop uniform water recycling criteria for DPR in California, and that those criteria could incorporate a level of public health protection as good as or better than what is currently provided by conventional drinking water supplies and indirect potable reuse.<sup>68</sup>

#### 3.3 Proposed Desalination Plant

The proposed seawater desalination project at ESGS would convert seawater into drinking water using a reverse osmosis (RO) desalination process. The 20 Mgd desalination plant would draw approximately 40 Mgd of ocean water and produce 20 Mgd of potable drinking water. The remaining 20 Mgd would be discharged back to the ocean as seawater with an elevated salt concentration, as the salts in the 20 Mgd of potable water would be concentrated in this 20 Mgd discharge stream. The 20 Mgd of concentrated discharge from the RO process would be discharged through a dedicated discharge pipe or through the existing Hyperion WWT ocean outfall discharge pipe. A schematic drawing of the proposed 20 Mgd West Basin desalination plant is shown in Figure 4.

<sup>&</sup>lt;sup>62</sup> Ibid, p. 15.

<sup>&</sup>lt;sup>63</sup> State Water Resources Control Board, *Report to the Legislature: Investigation on the Feasibility of Developing Uniformwater Recycling Criteria for Direct Potable Reuse*, December 29, 2016, p. IV.

<sup>&</sup>lt;sup>64</sup> Ibid.

<sup>&</sup>lt;sup>65</sup> Ibid, p. 6.

<sup>&</sup>lt;sup>66</sup> Ibid, p. 6.

<sup>&</sup>lt;sup>67</sup> Ibid, p. IV.

<sup>&</sup>lt;sup>68</sup> Ibid, p. IV.



Figure 4. Location of desalination plant and ocean intake and discharge piping<sup>69</sup>

A 60 Mgd alternative is also being evaluated. The 60 Mgd desalination plant would draw approximately 120 Mgd from the intake structure and produce 60 Mgd of potable drinking water. The remaining 60 Mgd would be seawater with an elevated salt concentration and would be discharged back to the ocean.

The proposed desalination project would consist of a seawater intake system, pretreatment facilities, a seawater desalination facility utilizing RO technology, pretreatment and post-treatment facilities, product water storage, residuals handling and disposal, chemical storage, and an on-site pump station. The project would also include 7.5 miles of 36-, 24-, 16-, and 12-inch diameter pipelines for the 20 Mgd plant, or 8.1 miles of 54-inch diameter pipeline for the 60 Mgd plant.<sup>70,71</sup> The proposed pipeline routes for the 20 Mgd and 60 Mgd El Segundo desalination plants are shown in **Attachment A**.

The seawater intake system has been a focus of concern given the potential marine impact, especially the entrainment of eggs and small larvae, of withdrawing 40 to 120 Mgd of coastal ocean water to supply the desalination plant. To address this concern, West Basin has evaluated "wedge wire" screen technology and various subsurface intake technologies. The State Water Resource Control Board desalination policy adopted on May 5, 2015 states that a 1 millimeter (mm) slot screen will be the largest slot opening

<sup>&</sup>lt;sup>69</sup> West Basin MWD, 2013 PMP Report TM1, p. 197.

<sup>&</sup>lt;sup>70</sup> West Basin MWD, 2013 PMP Report TM6, p. 2-5.

<sup>&</sup>lt;sup>71</sup> West Basin MWD, 2013 PMP Report TM7, p. 4-1.

allowed for ocean water desalination intakes.<sup>72</sup> West Basin consultant Geosyntec determined in late 2015 that subsurface intakes are not feasible at El Segundo for West Basin's proposed desalination plant.<sup>73</sup>

Wedge wire screens with 1 mm slot size were proposed by Pacific Gas & Electric (PG&E) in 2013 for the Diablo Canyon nuclear plant as an alternative to closed-cycle cooling to achieve compliance with California's once-through cooling (OTC) phase-out policy. However, intervenors in the State Water Resources Control Board OTC phase-out proceeding for Diablo Canyon demonstrated that a wedge wire screen with 1 mm slot opening was unlikely to function reliably in the California coastal (and tidal) marine environment due to extended periods of time with no sweep flow across the screens.<sup>74</sup>

Wedge wire screens are suitable for marine environments where the screens are continuously swept with a cross flow of water, such as a river with constant flow in one direction, to prevent debris from clogging the slot openings.<sup>75</sup> The narrower the slot openings, the more susceptible the screens are to biofouling. A 1 mm slot opening is very narrow and highly susceptible to clogging and biofouling, especially in a tidal marine environment that does not provide a continuous sweep of flowing water across the slots.<sup>76</sup>

The only technology that can protect the marine environment and reliably provide the necessary ocean water flow to the desalination plant is a subsurface intake. Numerous examples of subsurface intakes are provided in the subsurface intake report prepared by Geosyntec Consultants for West Basin.<sup>77</sup> However, Geosyntec determined that subsurface intakes are too costly and high risk at the El Segundo site.<sup>78</sup> As a result, West Basin has provided itself with no good options to protect the marine environment and reliably supply the ocean water needed for the desalination plant.

#### 3.4 Comparative Cost of Desalination

West Basin identifies the cost of potable water production from the proposed desalination plant as \$1,900/AF for the 20 Mgd plant and \$1,600/AF for the 60 Mgd plant.<sup>79</sup> However, the West Basin consultant that prepared the cost-of-production estimate for

<sup>&</sup>lt;sup>72</sup> West Basin desalination webpage: <u>http://www.westbasindesal.org/environmental-stewardship.html</u>.

<sup>&</sup>lt;sup>73</sup> Geosyntec Consultants, *Feasibility Study of Subsurface Seawater Intakes West Basin Municipal Water District's Proposed El Segundo Desalination Facility*, PowerPoint presentation, Bureau of Reclamation Project No. R14AP00173, November 16, 2015, p. 60.

<sup>&</sup>lt;sup>74</sup> Pisces Conservation and Powers Engineering, *Comments on September 2013 Bechtel Phase 2 Final Technologies Assessment for Alternative Cooling Technologies at Diablo Canyon Power Plant*, prepared for Friends of the Earth, November 19, 2013 pp. 4-5.

<sup>&</sup>lt;sup>75</sup> Ibid, p. 4.

<sup>&</sup>lt;sup>76</sup> Ibid, p. 4.

 <sup>&</sup>lt;sup>77</sup> Geosyntec Consultants, Draft Final - Feasibility Assessment of Subsurface Seawater Intakes Proposed Desalination Facility El Segundo, California, November 9, 2015, p. 8.
 <sup>78</sup> Ibid, ES-18.

<sup>&</sup>lt;sup>79</sup> S. Deshmukh, D. Gatza – West Basin MWD, *West Basin's Ocean Water Desalination Program*, PowerPoint, February 26, 2015, p. 15. 20 Mgd plant = \$1,887/AF. 60 Mgd plant = \$1,579/AF.

West Basin also states that the cost estimate is accurate to -30 percent and +50 percent.<sup>80</sup> As a result, the cost of production from either the 20 Mgd or 60 Mgd West Basin desalination plants could be much higher than the \$1,600/AF to \$1,900/AF cost figures typically cited by West Basin and still be within the range of accuracy of the West Basin consultant's cost-of-production estimate.

The West Basin consultant report that addresses desalination plant cost calculates a baseline cost of 1,771/AF for the 20 Mgd plant and 1,531/AF for the 60 Mgd plant at the El Segundo site.<sup>81,82</sup> The upper bound cost of production for these two scenarios is 50 percent higher than the baseline cost. The upper bound cost of production for the 20 Mgd and 60 Mgd plants, 2,657/AF and 2,297/AF respectively, are shown in Table 2.

Desalination plant capacity	West Basin consultant upper-bound cost of production
(Mgd)	(\$/AF)
20	2,657
60	2,297

Table 2.	West	Basin	consultant	upper-bound	l desalination	plant cost of	production

These upper bound desalination plant cost of production values are consistent with the production cost of the 50 Mgd (56,000 AFY) Poseidon desalination plant in Carlsbad, California. The cost of potable water from the Poseidon Carlsbad plant ranges from \$2,125/AF to \$2,368/AF.<sup>83</sup> The higher cost is paid on the first 48,000 AFY of Poseidon Carlsbad potable water production, and pays for the fixed costs of the project and the variable costs of water production.<sup>84</sup>

West Basin implies that the \$2,400/AF cost of production it identifies for the Poseidon Carlsbad desalination plant is due to the fact that Poseidon cost includes a 10-mile, 54-inch diameter pipeline.<sup>85,86,87</sup> West Basin states that, "One of the conditions that raised

<sup>&</sup>lt;sup>80</sup> West Basin MWD, 2013 PMP Report TM7, p. 2-1. "The cost opinions provided herein are considered by the American Association of Cost Engineering (AACE) criteria as a Class 4 estimate. A Class 4 estimate is defined as a Planning Level or Design Technical Feasibility Estimate. Typically, engineering is from 1 percent to 15 percent complete. The expected accuracy for Class 4 estimates typically range from -30 percent to +50 percent, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination."

<sup>&</sup>lt;sup>81</sup> Ibid, p. 2-31.  $1,771/AF \times 1.5 = 2,657/AF$ .  $1,531/AF \times 1.5 = 2,297/AF$ .

<sup>&</sup>lt;sup>82</sup> Ibid, p. 2-31. The high cost calculated for a 20 Mgd plant at El Segundo is \$1,887/AF. The high cost calculated for a 60 Mgd plant at El Segundo is \$1,626/AF. The ocean water desalination cost of \$1,600/AF to \$1,900/AF cited by West Basin WMD apparently represents the "high cost" calculated in TM7. The "high cost" is approximately 6 percent higher than the "baseline cost" in TM7, and not the +50 percent accuracy of the cost estimation methodology utilized.

<sup>&</sup>lt;sup>83</sup> San Diego County Water Authority, Seawater Desalination (fact sheet) -The Claude "Bud" Lewis Desalination Plant and Related Facilities, 2016, p. 3.

<sup>&</sup>lt;sup>84</sup> Telephone communication between J. Crutchfield, SDCWA and B. Powers, Powers Engineering, April 18, 2017.

<sup>&</sup>lt;sup>85</sup> Telephone communication between J. Crutchfield, SDCWA and B. Powers, Powers Engineering, March 29, 2017.

<sup>&</sup>lt;sup>86</sup> Carlsbad CoC webpage: <u>https://www.carlsbad.org/construction-on-10-mile-pipeline-for-carlsbad-desal-plant/</u>.

*the cost of the Poseidon project was the need for a long pipeline to link up with the existing distribution system. That will not be the case with our project.*<sup>\*\*8</sup> As noted previously, the 20 Mgd West Basin desalination plant would require 7.5 miles of mixed pipeline diameters and the 60 Mgd plant would require 8.1 miles of 54-inch diameter pipeline. The routes these pipelines will follow pass through some of the most densely populated and developed areas in the LA Basin, whereas the 10-mile Poseidon Carlsbad pipeline route has both urban and rural segments. Urban pipeline construction adds a premium on the order of 30 percent above rural pipeline construction.<sup>89</sup>

West Basin claims pumping, storage, and pipeline costs of \$33 million and \$42 million respectively for the 20 Mgd and 60 Mgd desalination plants.<sup>90</sup> The \$42 million assumed by West Basin MWD for 8.1 mile, 54-inch pipeline associated with the 60 Mgd desalination plant is about one-quarter the actual \$159 million cost of the 10-mile, 54-inch pipeline associated with the 50 Mgd Poseidon Carlsbad desalination plant.<sup>91</sup> However, West Basin offers no supporting justification to explain why its pipeline and related infrastructure costs will be substantially different, at least on a proportional basis, than those actually incurred by the Poseidon Carlsbad project.

The comparative cost of operational Southern California potable water alternatives is provided in Table 3.

<b>Table 3. Cost of Operational Desalination</b>	, Recycled	Water,	and	Imported	Water
Produc	tion				

Resource	Cost (\$/AF)
Poseidon Carlsbad, < 48,000 AFY	2,368
Orange County GWRS	850
West Basin treated wastewater recycling (intrusion	853
barrier) <sup>92</sup>	
Brackish groundwater desalination <sup>93</sup>	1,000
MWD imported water <sup>94</sup>	1,006

<sup>&</sup>lt;sup>87</sup> The \$80 million spent to upgrade the receiving raw water Twin Oaks treatment plant was not included in the overall cost of the Poseidon project (or the calculated cost of production). J. Crutchfield, San Diego County Water Authority, telephone communication with B. Powers, Powers Engineering, March 27, 2017.

<sup>&</sup>lt;sup>88</sup> West Basin webpage "Desalination – Economics": http://www.westbasindesal.org/economics.html.

<sup>&</sup>lt;sup>89</sup> Texas Senate Bill 1, Final 2016 Region C (North Texas) Water Plan, Appendix Q – Cost Estimates, Table Q-1, Pipeline Costs. December 2015. See:

http://www.regioncwater.org/Documents/index.cfm?Category=Final+2016+Region+C+Water+Plan.

<sup>&</sup>lt;sup>90</sup> West Basin WMD, 2013 PMP Report TM7, p. 2-16 and p. 2-22.

<sup>&</sup>lt;sup>91</sup> West Basin WMD, 2013 PMP Report TM7, p. 22.

<sup>&</sup>lt;sup>92</sup> Water Replenishment District of Southern California, 2017 Engineering Survey and Report, Table 2: Quantity and Cost of Replenishment Water for the Ensuing Year, March 2, 2017, pdf p. 48: http://www.wrd.org/sites/pr/files/170302%20ESR%20Final.pdf.

<sup>&</sup>lt;sup>93</sup> Pacific Institute, *The Cost of Alternative Water Supply and Efficiency Options in California*, October 13, 2016, p. 13: <u>http://pacinst.org/publication/cost-alternative-water-supply-efficiency-options-california/</u>.

<sup>&</sup>quot;We estimate that the cost of a large project with a capacity of more than 10,000 acre-feet ranges from \$840 to \$1,200 per acre-foot, with a median cost of \$1,000 per acre-foot."

<sup>&</sup>lt;sup>94</sup> Water Replenishment District of Southern California, 2017 Engineering Survey and Report, Table 2: Quantity and Cost of Replenishment Water for the Ensuing Year, March 2, 2017, pdf p. 48.

The projected cost of West Basin ocean desalination is provided in Table 4.

Table 4. Trojected Cost of West Dasin Ocean Desannation		
Resource	Cost (\$/AF)	
West Basin 20 Mgd desalination	1,887 - 2,657	
West Basin 60 Mgd desalination	1,579 - 2,297	

Table 4. Projected Cost of West Basin Ocean Desalination

# 4.0 Greenhouse Gas Emission Rate of Purchased Utility Power

The West Basin desalination project would purchase all of its electricity from the local investor-owned utility, Southern California Edison (SCE). The 2014 power mix of SCE, meaning the mix of power generation sources and the quantity of power generated by those sources, is shown in Figure 5. An accurate accounting of the power mix allows precise calculation of the composite  $CO_2$  emission rate of SCE grid power.



There are two sources of  $CO_2$  emissions in the 2014 SCE power mix: 1) natural gas, 2) "unspecified sources" of power. Unspecified sources of power signifies wholesale power generated in the western U.S. The most recently available California Energy Commission (CEC) analysis of unspecified sources of power indicates this power is 41.9 percent natural gas and 33.7 percent coal.<sup>96</sup> This 2008 analysis of the composition of unspecified sources of California utility power remains reasonably accurate, as coal-fired power generation in the western U.S. declined less than 5 percent over the 2007-2015 time

<sup>&</sup>lt;sup>95</sup> SCE, 2014 Corporate Responsibility Report, October 19, 2015, p. 29.

<sup>&</sup>lt;sup>96</sup> CEC, 2008 Net System Power Report, July 2009, Table 1, p. 3. The CEC discontinued analysis of the composition of undisclosed sources of power, also known as net system power, with this July 2009 report.

period.<sup>97</sup> All other sources of unspecified sources of power besides natural gas and coal are carbon-free, and include large hydro, renewables, and nuclear.

To corroborate the carbon footprint of 2014 SCE power mix, it is necessary to have accurate information on: 1) the  $CO_2$  emission factor for natural gas combustion, 2) the CO<sub>2</sub> emission factor for coal combustion, and 3) the percentages of natural and coal-fired power in the unspecified sources of power that comprised 40 percent of SCE's power sales in 2014.

#### CO<sub>2</sub> Emission Factors for Natural Gas, Coal, and 4.1 **Unspecified Sources of Power**

#### 4.1.1 Natural Gas

The composite California 2013 natural gas-fired combustion heat rate = 8,537Btu/kWh.<sup>98</sup>

The natural gas  $CO_2$  emission factor = 117 lb/MMBtu.

Therefore, 8.537 Btu/kWh  $\times$  1000 kW/MW  $\times$  117 lb CO<sub>2</sub>/10<sup>6</sup> Btu = 999 lb/MWh.

The composite California 2013 natural gas-fired combustion  $CO_2$  emission factor = 999 lb/MWh.

#### 4.1.2 Coal

The sub-bituminous coal CO<sub>2</sub> emission factor = 2,160 lb/MWh.<sup>99</sup>

#### 4.1.3 Unspecified sources of power

The CO<sub>2</sub> emission factor for unspecified sources of power is sum of the natural gas (41.9 percent) and coal (33.7 percent) combustion components of the unspecified power mix:

 $(0.419 \times 999 \text{ lb/MWh}) + (0.337 \times 2,160 \text{ lb/MWh}) = 1,147 \text{ lb/MWh}.$ 

<sup>&</sup>lt;sup>97</sup> EIA, Power sector coal demand has fallen in nearly every state since 2007, April 28, 2016.

<sup>&</sup>lt;sup>98</sup> CEC, Thermal Efficiency of Gas-Fired Generation in California: 2014 Update, September 2014, Table

<sup>1,</sup> p. 1. <sup>99</sup> EIA, Frequently Asked Questions - How much carbon dioxide is produced per kilowatthour when generating electricity with fossil fuels?, February 29, 2016. Powers Engineering assumes the predominant form of coal burned in Western coal plants is sub-bituminous coal mined in Wyoming and Montana.

#### 4.2 SCE CO<sub>2</sub> Power Generation Emission Factor

The SCE  $CO_2$  power generation emission factor is the weighted average of the  $CO_2$ emission factors for natural gas, unspecified sources of power, and clean energy resources that produce no CO<sub>2</sub> emissions. The SCE CO<sub>2</sub> emission factor is calculated below for 2014 and for 2030. SCE is assumed to reach a 50 percent renewable portfolio standard (RPS) by 2030.

#### 4.2.1 2014

As shown in Figure 5, the two sources of  $CO_2$  emissions in the SCE generation mix are natural gas (27 percent) and unspecified sources of power (40 percent). Therefore, the CO<sub>2</sub> emission rate for the 2014 SCE power mix is:

 $2030 \text{ SCE CO}_2 \text{ EF} = (0.27 \times 999 \text{ lb/MWh}) + (0.40 \times 1.147 \text{ lb/MWh}) = 729 \text{ lb/MWh}$ 

The CO<sub>2</sub> emission factor identified by SCE in its 2014 Corporate Responsibility Report of 0.26 metric ton/MWh is low when accurate assumptions are used to characterize the carbon footprint of the unspecified sources of power in the SCE power mix.<sup>100</sup> 0.26 metric ton/MWh equals approximately 570 lb/MWh.<sup>101</sup> The actual 2014 SCE CO<sub>2</sub> emission factor is approximately 28 percent higher, at 729 lb/MWh, than the reported 570 lb/MWh.

#### 4.2.2 2030

SCE is under a legal mandate to achieve a 50 percent RPS by 2030.<sup>102</sup> In 2014, 24 percent of SCE's power came from renewable energy sources.<sup>103</sup> Assuming that additional renewable energy displaces in equal parts the natural gas and unspecified components of SCE's 2014 electricity supply, in 2030 natural gas will supply 14 percent and unspecified power 27 percent of the SCE power mix. The 2030 SCE CO<sub>2</sub> emission factor will be:

 $2030 \text{ SCE CO}_2 \text{ EF} = (0.14 \times 999 \text{ lb/MWh}) + (0.27 \times 1.147 \text{ lb/MWh}) = 450 \text{ lb/MWh}$ 

<sup>&</sup>lt;sup>100</sup> SCE, 2014 SCE Corporate Responsibility Report, p. 28.

 $<sup>^{101}</sup>$  0.26 metric ton/MWh × (1.1 ton/metric ton) × 2,000 lb/ton = 572 lb/MWh.

<sup>&</sup>lt;sup>102</sup> Los Angeles Times, Gov. Brown signs climate change bill to spur renewable energy, efficiency standards, October 7, 2015: http://www.latimes.com/politics/la-pol-sac-jerry-brown-climate-changerenewable-energy-20151007-story.html. <sup>103</sup> See Figure 4.

### 5.0 Energy Intensity of Water Supply Alternatives

#### 5.1. Energy Intensity of West Basin Desalination Plant

#### 5.1.1 20 Mgd Desalination Plant

West Basin estimates a continuous electricity demand of 14 MW to produce 20 Mgd of potable water.<sup>104</sup> This represents an energy intensity of 5,477 kWh/AF.<sup>105</sup>

The electricity demand of the 20 Mgd desalination plant is equivalent to the GHG emissions associated with electricity demand of about 18,185 California homes, as shown in the following calculations:

2014 Energy Information Administration (EIA) data for California, annual average residential customer load = 6,744 kWh-yr (562 kWh-month).<sup>106</sup>

West Basin desalination plant annual electricity demand = 14,000 kW  $\times$  8,760 hr/yr = 122,640,000 kWh-yr.

West Basin electric demand, converted to number of homes = 122,640,000 kWh-yr  $\div$  6,744 kWh-yr/home = 18,185 homes.

The electricity demand of the West Basin 20 Mgd desalination plant will be substantially greater than that of the 14,173 households in Manhattan Beach.<sup>107</sup>

#### 5.1.2 60 Mgd Desalination Plant

West Basin estimates a continuous electricity demand of 46 MW to produce 60 Mgd.<sup>108</sup> This represents an energy intensity of 5,998 kWh/AF.<sup>109</sup> This is an electricity consumption rate equivalent to the GHG emissions of about 59,751 California homes.<sup>110</sup> This is substantially greater than the electricity consumption of the combined number of households in Manhattan Beach (14,173) and Redondo Beach (33,141).<sup>111</sup>

<sup>&</sup>lt;sup>104</sup> West Basin MWD, 2013 PMP Report TM2, p. 2-1.

 $<sup>^{105}</sup>$  (14,000 kW × 24 hr/day) ÷ [(20,000,000 gallon/day)(1 AF/326,000 gallon)] = 5,477 kWh/AF.

<sup>&</sup>lt;sup>106</sup> U.S. EIA, 2014 Average Monthly Bill – Residential (Data from forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U), Table 5A.

<sup>&</sup>lt;sup>107</sup> See: <u>http://www.point2homes.com/US/Neighborhood/CA/Los-Angeles-County/Manhattan-Beach-Demographics.html</u>.

<sup>&</sup>lt;sup>108</sup> West Basin MWD, 2013 PMP Report TM2, p. 2-1.

<sup>&</sup>lt;sup>109</sup> (46,000 kW × 24 hr/day)  $\div$  [(60,000,000 gallon/day)(1 AF/326,000 gallon)] = 5,998 kWh/AF. <sup>110</sup> West Basin annual electricity demand = 46,000 kW × 8,760 hr/yr = 402,960,000 kWh-yr. West Basin

electric demand, converted to number of homes = 402,960,000 kWh-yr  $\div 6,744$  kWh-yr/home = 59,751 homes.

<sup>&</sup>lt;sup>111</sup> See: <u>http://www.point2homes.com/US/Neighborhood/CA/Los-Angeles-County/Redondo-Beach-Demographics.html</u>.

#### 5.2 Energy Intensity of Potable Reuse

The energy intensity of recycling treated wastewater to potable quality, 1,055 kWh/AF, is based on 2015 data for the Groundwater Replenishment System (GWRS) operated by the Orange County Water District.<sup>112</sup>

Operational since January 2008, the GWRS originally produced 70 Mgd of purified water. The project was expanded in 2015 to produce 100 Mgd (103,000 AF-vear). Ultimate capacity for the GWRS is projected at 130 Mgd (128,000 AF-year) after infrastructure is built to increase wastewater flows from the Orange County Sanitation District to the GWRS.<sup>113</sup>

The GWRS uses less than half the energy required to transport water, on average, from Northern California to Southern California.<sup>114</sup>

Purifying wastewater in the GWRS, at an unsubsidized cost of \$850/AF,<sup>115</sup> is about onethird the cost of ocean desalination. There are far fewer dissolved solids (salts) to remove from wastewater, about 1,000 ppm as compared to 35,000 ppm in ocean water. Removing the high concentration of salts in ocean water requires three times more energy, additional membranes, and shortens reverse osmosis membrane life-span.<sup>116</sup>

#### Comparison of Energy Intensities of Potable Water 5.3 Alternatives

Table 5 compares the energy intensity and annual CO<sub>2</sub> emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the Orange County GWRS, 3) Colorado River water transfers, and 4) State Water Project water transfers, and 5) West Basin desalination plant.

Alternative	Energy intensity (kWh per AF)
Conservation <sup>117</sup>	0
Indirect potable reuse <sup>118</sup>	1,055

Table 5. Comparison of energy intensity of water supply alternatives

<sup>&</sup>lt;sup>112</sup> J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, email to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016. <sup>113</sup> 2016 GWRS technical brochure, p. 4: <u>http://www.ocwd.com/media/4267/gwrs-technical-brochure-</u>

<sup>&</sup>lt;u>r.pdf</u>. <sup>114</sup> Ibid.

<sup>&</sup>lt;sup>115</sup> Orange County Water District GWRS webpage: <u>https://www.ocwd.com/gwrs/frequently-asked-</u> questions/.

<sup>&</sup>lt;sup>116</sup> 2016 GWRS technical brochure, p. 4: <u>http://www.ocwd.com/media/4267/gwrs-technical-brochure-</u> <u>r.pd</u>f.

Conservation strategies include, for example: smart irrigation and landscaping, water efficient appliances. See OCWD webpage on water conservation strategies: http://www.ocwd.com/learningcenter/water-use-efficiency/conservation-strategies/.

Brackish groundwater desalination <sup>119</sup>	980 - 1,630
Imported water - Colorado River water transfers <sup>120</sup>	2,223
Imported water - State Water Project West water	2,817
transfers <sup>121</sup>	
West Basin 20 Mgd desalination plant	5,477

### 6.0 Greenhouse Gas Emissions of Water Supply Alternatives

#### 6.1 Annual CO<sub>2</sub> emissions from West Basin desalination plant

West Basin estimates a continuous power demand of 14 MW for the desalination plant, an annual electricity consumption of 122,640 MWh per year.<sup>122</sup> The expected annual CO<sub>2</sub> emission associated with this level of power consumption would be:

The West Basin 20 Mgd desalination plant indirect  $CO_2$  emissions from electricity generation, based on the actual 2014 SCE  $CO_2$  emission rate, would be:

729 lb/MWh × 122,640 MWh/yr × 1 ton/2,000 lb = 44,702 ton/yr

By 2030, the annual  $CO_2$  emission rate of the West Basin 20 Mgd desalination plant would decline to 27,594 ton/yr, assuming SCE reaches the 50 percent RPS target.<sup>123</sup>

The West Basin 60 Mgd desalination plant indirect  $CO_2$  emissions from electricity generation, based on the actual 2014 SCE  $CO_2$  emission rate, would be:

729 lb/MWh × 402,960 MWh/yr × 1 ton/2,000 lb = 146,879 ton/yr

#### 6.2 Comparison of CO<sub>2</sub> Emission Rates of Potable Water Alternatives

Table 6 compares the energy intensity and annual CO<sub>2</sub> emission rates for five potable water supply alternatives: 1) conservation, 2) potable reuse based on the Orange County Water District GWRS, 3) Colorado River water transfers, 4) State Water Project water

<sup>&</sup>lt;sup>118</sup> J. Kennedy – Executive Director of Engineering and Water Resources, Orange County Water District, email to J. Geever detailing calculation of GWRS energy intensity in kWh/AF for calendar year 2015, September 19, 2016.

<sup>&</sup>lt;sup>119</sup>Water Reuse Association, *Seawater Desalination Power Consumption - White Paper*, November 2011, Table 2, p. 15: <u>https://watereuse.org/wp-content/uploads/2015/10/Power\_consumption\_white\_paper.pdf</u>.

 <sup>&</sup>lt;sup>120</sup> H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California:* Assessing Water District Level Strategies, Chapter 9, November 2012, Appendix 3, p. 251.
 <sup>121</sup> Ibid.

<sup>&</sup>lt;sup>122</sup> Ibid, p. 7.

 $<sup>^{123}</sup>$  450 lb/MWh × 122,640 MWh/yr × 1 ton/2000 lb = 27,594 ton/yr.

transfers, and 5) West Basin desalination plant. The annual  $CO_2$  emission rate calculation assumes a production rate of 20 Mgd. 20 Mgd is equivalent to approximately 22,400 AFyr of potable water.<sup>124</sup>

supply alternatives				
Alternative	Energy	GHG emissions for 22,400 AF-yr		
	intensity	production, using 2014 SCE CO <sub>2</sub>		
		emission factor		
	(kWh per AF)	(tons CO <sub>2</sub> per year)		
Conservation	0	0		
Potable reuse <sup>125</sup>	1,055	8,614		
Colorado River water transfers <sup>126</sup>	2,223	18,150		
State Water Project West water transfers <sup>127</sup>	2,817	23,000		
West Basin 20 Mgd desalination plant	5,477	44,702		

Table 6. Comparison of energy intensity and annual GHG emissions of watersupply alternatives

#### 7.0 Impact of Proposed West Basin Desalination Plant Electric Load on LA Basin Grid Reliability

The 14 MW West Basin 20 Mgd desalination plant electricity demand is equivalent to adding the electric load of 18,185 homes to the LA Basin grid.<sup>128</sup> The LA Basin is classified as a local reliability area that must maintain a minimum amount of local generation to assure supply reliability in the event that major transmission lines are unavailable at times of peak demand. According to SCE, available generation may not be sufficient to meet peak summer demand within a few years. In that context, SCE recently received authorization from the California Public Utilities Commission (CPUC) to add supply resources in the LA Basin to address projected grid reliability issues in 2022.<sup>129</sup>

<sup>&</sup>lt;sup>124</sup> (20,000,000 gallon/day)(1 AF/326,000 gallon)(365 day/yr) = 22,393 AF-yr.

 $<sup>^{125}</sup>$  1.055 MWh/AF × 56,000 AF/yr × 729 lb/MWh × (1 ton/2000 lb) = 21,535 ton/yr.

 <sup>&</sup>lt;sup>126</sup> H. Blanco – USC Center for Sustainable Cities, *Water Supply Scarcity in Southern California:* Assessing Water District Level Strategies, Chapter 9, November 2012, Appendix 3, p. 251.
 <sup>127</sup> Ibid.

<sup>&</sup>lt;sup>128</sup> 265,778,400 kWh-yr  $\div$  6,744 kWh-yr/home = 39,410 homes

<sup>&</sup>lt;sup>129</sup> CPUC, Decision 15-11-041, Decision Approving, in Part, Results of Southern California Edison Company Local Capacity Requirements Request for Offers for the Western LA Basin Pursuant to Decisions, 13-02-015 and 14-03-004, November 19, 2015.

#### 7.1 Impact of Loss of Aliso Canyon Natural Gas Storage Field on LA Basin Grid Reliability

The SoCalGas Aliso Canyon natural gas storage facility suffered a catastrophic well blowout in October 2015 that resulted in the emergency closure of the storage field. Aliso Canyon is the largest storage field in the SoCalGas system. As a result of the emergency closure of Aliso Canyon, the grid operator may now impose limits on natural gas usage by electric generators under certain peak demand conditions.<sup>130</sup> A map of the affected electric generators in the Aliso Canyon delivery area is shown in Figure 6.<sup>131</sup> El Segundo and most of the West Basin service area is in the delivery area.



#### Figure 6. LA Basin electric generators served by the Aliso Canyon storage field

#### 7.2 Grid Reliability Alternatives for West Basin Electric Load

The possible addition of a continuous 14 MW load in an area where state authorities have implemented fast-track mitigation measures to address a potential grid reliability deficit underscores the need for any West Basin desalination GHG offsets to be generated by real projects in the LA Basin grid reliability area, and not by offset credits associated with projects that are likely to be outside of the LA Basin.

One alternative available to address grid reliability, and effective storage of renewable energy, is battery storage. As a result of CPUC decision D.13-10-040, SCE is required to have 580 MW of energy storage capacity under contract by 2020.<sup>132</sup> To date SCE has approval for installation of 264 MW of energy storage resources in its service territory.<sup>133</sup>

http://www.energy.ca.gov/2016\_energypolicy/documents/index.html#08262016.

 <sup>131</sup> Aliso Canyon Summer Action Plan, April 5, 2016, Figure 2, p. 11: <u>http://www.energy.ca.gov/2016\_energypolicy/documents/#04082016</u>.
 <sup>132</sup> See D.13-10-040, October 17, 2013, Table 2, p. 15:

http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF.

<sup>&</sup>lt;sup>130</sup> Aliso Canyon Winter Action Plan, August 22, 2016:

<sup>&</sup>lt;sup>133</sup> See CPUC Decision D.15-11-041, November 19, 2015, p. 5.

This means SCE has an obligation to have over 300 MW of additional energy storage resources under contract by 2020. At a minimum 14 MW of battery storage, with sufficient capacity<sup>134</sup> to produce 14 MW for several hours to address peak demand events, can and should be located at the West Basin 20 Mgd desalination site to offset the additional load the desalination plant will impose on the LA Basin grid.

Energy storage projects are being fast-tracked to address, in part, the unavailability of Aliso Canyon to supply natural gas to electric generation plants during periods of peak demand. Tesla announced on September 15, 2016 that it would complete a 20 MW battery storage project at SCE's Mira Loma substation by the end of 2016.<sup>135</sup> The Tesla project was completed in December 2016.<sup>136</sup> This project is part of a suite of 100 MW of battery storage projects built to address the loss of Aliso Canyon.<sup>137</sup> In addition, a 100 MW battery installation was also approved by the CPUC in November 2015 for the AES Alamitos Generating Station in Long Beach.<sup>138</sup> AES has a proposal to expand the Alamitos battery project to 300 MW in the future.<sup>139</sup>

Further, a project composed of battery storage to help resolve water reliability and the "water-energy nexus" is proposed for the Irvine Ranch Water District, a member agency of Orange County Water District. The project will be the largest of its kind at a public water agency in the U.S. The 7 MW, 34 megawatt-hour (MWh) storage system will utilize Tesla batteries to store power at eleven of Irving Ranch Water District's most energy-intensive points, including three water treatment plants, six pumping stations, a deepwater aquifer treatment plant and a groundwater desalter facility.<sup>140</sup>

Local solar can be deployed to offset the continuous 14 MW electric load the West Basin 20 Mgd desalination plant would impose on the LA Basin. Approximately 70 MW of solar capacity would be necessary to offset the 14 MW continuous demand of the desalination plant.<sup>141</sup> A rule-of-thumb for solar power generation is that approximately 6 acres are required for each 1 MW of production capacity. Therefore, to produce 70 MW,

<sup>&</sup>lt;sup>134</sup> Measured in megawatt-hours, or MWh. Sufficient capacity was defined as the ability to operate for 4 hours at rated MW capacity on three consecutive days in SCE's July 1, 2015 Reply Brief, Application A.14-11-012, Application of SCE for Approval of the Results of Its 2013 Local Capacity Requirements Request for Offers for the Western Los Angeles Basin, p. 15. "The ability to run four hours/day for three consecutive days for a total of 24 hours per month specifies the capability required for a resource to count for resource adequacy ("RA")."

<sup>&</sup>lt;sup>135</sup> Los Angeles Times, September 15, 2016: http://www.latimes.com/business/la-fi-tesla-edison-20160915-

snap-story.html. <sup>136</sup> GreenTechMedia, Tesla, Greensmith, AES Deploy Aliso Canyon Battery Storage in Record Time, January 31, 2017: https://www.greentechmedia.com/articles/read/aliso-canyon-emergency-batteriesofficially-up-and-running-from-tesla-green.

<sup>&</sup>lt;sup>137</sup> Ibid.

<sup>&</sup>lt;sup>138</sup> See CPUC Decision D.15-11-041, November 19, 2015, p. 5.

<sup>&</sup>lt;sup>139</sup> Utility Dive, AES to partially replace California gas plant with 300 MW of battery storage, July 25, 2016: http://www.utilitydive.com/news/aes-to-partially-replace-california-gas-plant-with-300-mw-ofbattery-storag/423171/.

<sup>&</sup>lt;sup>140</sup> See: http://www.irwd.com/liquid-news/ams-and-irwd-partner-on-energy-storage-project.

<sup>&</sup>lt;sup>141</sup> The capacity factor of fixed solar panels in coastal Southern California is about 20 percent. This means that over the course of a 24-hour day, on average 70 MW of solar panel capacity would produce an average output of: 70 MW x 0.20 = 14 MW.

approximately 420 acres (two-thirds of a square mile) of rooftops, parking lots, and brownfield land would be required.

Kauai Electric (HI) entered into a power purchase agreement (PPA) with AES in late 2016 for utility-scale battery storage with solar for a price of \$0.11 per kilowatt-hour (kWh).<sup>142</sup> In 2015 Kauai Electric entered into a PPA with Solar City to provide utility-scale battery storage with solar for a price of \$0.145 per kWh.<sup>143</sup> This represents a year-to-year price decline rate of about 30 percent. In contrast, the cost of peaking gas turbine power in SCE territory ranges from \$0.07 to \$0.10 per kWh at a time of historically low natural gas prices.<sup>144</sup> Batteries combined with solar power are cost-competitive with the conventional alternative, a peaking natural gas-fired power plant.

# 8.0 Conclusions

West Basin does not need a desalination plant to meet its imported water reduction targets. Potable water demand in West Basin service territory in Fiscal Year 2015-16 was 20,000 AFY less than projected by West Basin in 2010 when it included a ~20,000 AFY (20 Mgd) desalination plant in its 2010 UWMP to contribute to reducing imported water demand. The West Basin service area is built-out and little growth in demand is projected by West Basin.

The energy intensity of ocean water desalination is about five times greater than that of purified recycled water. As a result, the carbon footprint of ocean water desalination is about five times greater than that of purified recycled water.

The grid reliability impacts of adding a continuous load of 14 MW in the LA Basin must be addressed locally. SCE is under regulatory mandate to have at least another 300 MW of energy storage under contract by 2020. At least 14 MW of battery storage at the West Basin desalination site, and 70 MW of solar capacity in the local area, will be necessary to offset the grid reliability impacts of the 20 Mgd desalination plant.

 <sup>&</sup>lt;sup>142</sup> Utility Dive, *Hawaii co-op signs deal for solar+storage project at 11¢/kWh*, January 10, 2017 :
 <u>http://www.utilitydive.com/news/hawaii-co-op-signs-deal-for-solarstorage-project-at-11kwh/433744/</u>.
 <sup>143</sup> Ibid.

<sup>&</sup>lt;sup>144</sup> Southern California Edison Company, 2015 FERC FINANCIAL REPORT, FERC FORM No. 1: Annual Report of Major Electric Utilities, Licensees and Others and Supplemental Form 3-Q: Quarterly Financial Report, April 14, 2016, p. 402.1 and p. 403.

# Attachment A

# Legend

★ Plant Location
 Scenario 2 Conveyance (ES)
 Pipe Size

 36" - 14,600 LF
 24" - 13,500 LF
 16" - 9,300 LF
 12" - 3,400 LF
 Service Connections
 MWD Feeders
 Freeways

Major Streets



WEST BASIN MUNICIPAL WATER DISTRICT 17140 S AVALON BLVD, STE 210, CARSON, CA 90746 OCEAN WATER DESALINATION PMP CONTRACT NO. 05052016.0000

EL SEGUNDO SITE - LOCAL CONNECTIONS CONVEYANCE PIPING SCENARIO 2: 20-MGD FACILITY

FE





HK. 0.5 Miles PIRNIE/ARCADIS U.S.

JANUARY 2013

FIGURE 2-7