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October 9, 2015

Bradley K. Heisey
Senior Vice President
High Desert Power Project
14302 FNB Parkway I
Omaha, Nebraska 68154

Dear Mr. Heisey,

HIGH DESERT POWER PROJECT – Response to recycled water feasibility study summary report

Energy Commission staff have completed their review of the recycled water feasibility study and findings that High Desert Power Project (HDPP) submitted to the Energy Commission on November 3, 2014. The feasibility study was initially required as part of the Energy Commission's 2009 approval of the amendment for the HDPP to use recycled water. In the attached response, staff has provided an analysis of the opinions and conclusions given by the HDPP. Staff has concluded that it is feasible for HDPP to use 100% recycled water with the provision of an emergency backup water supply.

If you have any questions, please call me at (916) **653-4677**, or email me at **joseph.douglas@energy.ca.gov**.

Sincerely,

Original Signed by Joseph Douglas
JOSEPH DOUGLAS
Compliance Project Manager

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Staff Analysis of the High Desert Power Plant Recycled Water Feasibility Report

Abdel-Karim Abulaban

October 9, 2015

Summary

The project owner’s feasibility study for the use of 100 percent recycled water for project operation concluded that it would be infeasible for the project to use 100 percent recycled water. In summary, the reasons are 1) the supplier of the recycled water does not produce enough to meet project needs on an annual basis; 2) the supplier does not have the capacity to deliver the recycled water at the maximum instantaneous demand on a sustained basis; 3) due to the quality of the recycled water, the project onsite treatment facilities cannot operate reliably when using 100 percent recycled water and 4) capital costs associated with upgrading the treatment system are too high for a merchant power plant with no power purchase agreement (PPA) to afford.

Staff disagrees with the owner’s conclusions based on the following information: 1) supplier has the capacity to meet project needs on an annual basis with a few interruptions; 2) supplier has the capacity to deliver the recycled water at the maximum instantaneous demand for a reasonable amount of time; 3) capacity of treatment facilities can be expanded; and 4) costs to upgrade treatment system are economically feasible given the fact that several other power plants in the state with similar settings to the High Desert Power Plant (HDPP) have been successfully using recycled water and zero liquid discharge systems.

It is staff’s opinion that given the fact that the project was constructed in an area where a fresh water supply is already scarce, compounded with the fact that the state is experiencing the worst drought on record, there is no better time to fully pursue recycled water as an alternative and reliable source for project operation and make the project drought resistant for the project owner and the ratepayers of California.

Introduction

As part of the Energy Commission’s 2009 approval of the amendment for the High Desert Power Project (HDPP) to use recycled water, the Energy Commission required HDPP to study the feasibility of using up to 100 percent recycled water for evaporative cooling and other industrial uses (CEC 2009). A report summarizing the feasibility study and findings was submitted to the Energy Commission November 3, 2014. Staff is providing a summary of the report and an analysis of the arguments and conclusions given by the project owner below.

The project owner’s feasibility study report concluded that it is infeasible for the project to use 100 percent recycled water for HDPP operational needs. The reasons stated by the project owner are:

(i) HDPP's recycled water supplier is projected in some years in the future to not have sufficient recycled water supply to meet the project's 4,000 acre-feet per year (AFY) design basis and permitted requirement.

(ii) HDPP's recycled water supplier is unable to provide recycled water in sufficient quantities and qualities at peak demand, 24 hours per day on all days of the year, which is required by HDPP to maintain maximum availability for generating power.

(iii) The onsite water treatment system cannot operate reliably when using 100 percent recycled water supply. The existing water treatment system was not designed to treat and remove the higher amounts of impurities associated with using 100 percent recycled water. Adequate treatment capacity is required to maintain cooling tower PM10 emissions within the permitted limits and to protect the cooling systems and equipment from harmful deposits associated with higher amounts of impurities in cooling tower water.

(iv) The capital costs to upgrade the water treatment system would be extremely high and the costs of further treating additional quantities of recycled water so that it is of adequate quality for use at HDPP would be significantly higher than the cost of treating the other sources of water. Being a merchant power generation plant, HDPP does not have a retail customer base upon which it can recover the incremental capital and operating and maintenance costs associated with using 100 percent recycled water. Using 100 percent recycled water would not provide HDPP with increased energy or increased revenue opportunities; therefore it is not economically feasible for HDPP to incur the additional costs associated with the use of 100 percent recycled water. The project owner contends that additional recycled water may not be furnished for a reasonable cost, and that the use of additional recycled water at the project is not mandated by California Water Code section 13550.

Background

HDPP was licensed by the Energy Commission in 2000. During the licensing process, the issue of water availability was extensively debated since the project was going to be constructed in an area where water resources are limited and under adjudication. The project was permitted to use imported State Water Project (SWP) water as its main source of water and was prohibited from using any other source of water such as local groundwater - because of overdraft in the Mojave River groundwater basin, and even local reclaimed wastewater (recycled water) - because of its existing use to maintain Mojave River riparian habitat.

As a backup, in case the SWP water supply was interrupted for any reason, the project was required to create and maintain a groundwater bank. The water to be injected into the groundwater bank was also to be acquired from the SWP. The amount of water to be stored in the groundwater bank was intended to meet the project operational needs for three years, which, prior to the current drought, was the duration of the longest drought on the record in the state of California. Since the project was licensed to use up to 4,000 AFY, the amount of water to be stored in the groundwater bank was determined to be 12,000 AF, plus 1,000 AF as a reserve to be left in the bank. In addition to the 13,000 AF, the project was required to account for dissipation from the aquifer to the Mojave River by injecting an amount of water equal to what has been dissipated based on the results of a groundwater numerical model constructed for the aquifer underlying the project site. The project never accumulated the amount of water it was required to maintain in the bank. The maximum amount that the project had in the groundwater bank was 5,185 AF, which was in the third quarter of 2012. Subtracting the 1,000 AF reserve, 4,185 AF was available to the project, which was just over one year of supply based on the project's maximum water use.

In an interview with a Wall Street Journal reporter in September 1999 (Lifsher 1999) the project owner recognized the risk of potential cessation of delivery of SWP water to the project and vowed to shut the project down if the project lost its primary and backup water supply. The project owner was fully aware that the only options available in case of restricted or curtailed deliveries of SWP water were to shut down or switch to dry cooling at the owner's discretion.

In 2009 the project owner petitioned the Energy Commission to use recycled water at HDPP. That was after the Victorville II (VV2) power plant project, which had been certified by the Energy Commission to use recycled water for its operations, was put on hold, making the recycled water amount that was dedicated for it available. The Energy Commission approved the HDPP owner's petition. Since the recycled water is of different quality than the SWP water, it could affect the performance and efficiency of treatment facilities used to treat the SWP water. Use of recycled water also could reduce the number of concentration cycles in the cooling tower, thereby increasing the amount of water needed for project operation. Recognizing these effects, the Energy Commission recommended that the project owner conduct a feasibility study to determine what would be needed for the project to switch to 100 percent recycled water for its operations.

The feasibility study was initially due in November 2011. The project owner asked for two extensions of the feasibility study deadline: first until November 2013, and then until November 2014. The owner stated that the recycled water supplier, Victor Valley Wastewater Reclamation Authority (VVWRA) could not provide recycled water to the project for two consecutive summer seasons so they could adequately test feasibility. Both extensions were granted by the Energy Commission. In April 2014, due to curtailment of water delivery from SWP caused by the drought, the project owner petitioned the Energy Commission to allow it to get water from the adjudicated Mojave River Basin[1]. The Energy Commission permitted HDPP to acquire local Mojave River

[1] The Mojave River Basin has been under adjudicated groundwater management since 1993 where withdrawals are allowed for groundwater-right holders based on past uses. Under the adjudication, withdrawals are being ramped down each year, and State Water Project water is being imported in an attempt to stabilize water levels in the basin. While VVWRA is not a party to the adjudication, its recycled water is discharged to the Mojave River to maintain shallow groundwater and surface water flows that sustain valuable riparian habitat. Under a 2003 MOU between California Fish and Wildlife (DFW, formerly DFG), which is a party to the adjudication, VVWRA provides not less than 9,000 AFY and "not less than twenty percent (20%)" of increases that occur from regional growth of sanitary wastewater to the river.

Basin groundwater as a backup supply of no more than 2,000 AFY in water year 2014/15 and in water year 2015/16, while requiring the project owner to submit a Petition To Amend by November 1, 2015 to implement reliable primary and backup water supplies.

The project owner submitted the subject feasibility study report to the Energy Commission on November 3, 2014. HDPP has not used any groundwater from the Mojave River Basin as of the date of this analysis.

Analysis

Staff provides an analysis of each of the project owner's conclusions below.

<u>(i) Insufficient amounts of recycled water for some future years.</u>

The project owner analyzed three scenarios for future recycled water supply and demand in the region. A summary of each scenario is provided below.

a. Scenario 1: recycled water supply is assumed to increase due to residential and commercial growth in the service area, while base flows in the Mojave River (MR) at the Lower Narrows station for the 11 years from 2014 through 2024 are assumed to be a replicate of base flows in the previous 11 years from 2003 through 2013 (Exhibit A incorrectly stated the number of years as 10). Historic flows for the previous years were obtained from the Mojave Water Agency. Base flows (flows before VVWRA discharge) at the Lower Narrows station from 2003 through 2013 ranged from a 3,648 AFY low in 2003 to a 10,149 AFY high in 2011. The project owner's conclusion for this scenario is that there will still be insufficient recycled water to supply HDPP in 3 out of every 10 years.
b. Scenario 2: the project owner assumed that the growth rate would be lower and the recycled water supply would be less than assumed in scenario 1. The project owner also assumed that projected base flows in MR at the Lower Narrows station for the next 11 years are going to be 10 percent lower compared with the previous 11 years. This reduction in base flow would be made up with more recycled water from the VVWRA plant. For the 3,648 – 10,149 AFY range of flows stated above, reductions in projected flows for the future 11 years thus ranges from 365 AFY to 1,015 AFY. The owner concluded that there will be insufficient recycled water to supply HDPP in 5 out of every 10 years.
c. Scenario 3: in addition to the assumptions in scenario 1, both the HDPP and Victorville-2 (VV2) project would be built and use 100 percent recycled water for industrial applications. The owner's conclusion for this scenario is that there will be insufficient recycled water to supply HDPP in 8 out of 10 years.

Each of these scenarios assumed that the project would use the maximum permitted amount of 4,000 AFY. It was emphasized during the project licensing process in 1999

Also, the amount of recycled water to the river would be adjusted based on measured Mojave River flows at the 'Lower Narrows' gauge, allowing for credit to be given to VVWRA as the natural river flows improve, either due to the adjudication or hydrologic conditions.

that the 4,000 AFY was a maximum estimate that the project consumption would almost never reach.

Staff first evaluated actual water use and capacity factor (c.f.) data for the project to understand whether use of a maximum annual demand of 4,000 AF is an appropriate basis for comparison in the scenarios. Staff found the highest c.f. of 65 percent occurred in 2012 which coincides with the highest project water use of about 3,200 acre feet. Average water consumption for power generation by the project for the 11 years since it came online in 2004 has been 2,735 AFY. However, this average is biased by an extremely low volume of 1,368 AF from 2011, without which the average would be 2,872 AFY. Over the past 11 years the project has been operating the data shows that HDPP has averaged about 53 percent c.f.

The average annual water consumption indicates that the project has only used about 70 percent of the maximum permitted amount since it began operation. Staff believes that it is not realistic to use the maximum permitted amount of 4,000 AFY as the basis for analysis of annual availability of the recycled water supply. If the maximum water use of 3,200 AFY were used as the basis for comparison in these scenarios the project would have had recycled water available in all years for Scenario 1 and 2, and 7 out of 11 years for Scenario 3. Staff further notes that the deficit in the years that supplies are below project’s maximum historic water use is less than 300 AFY.

Staff evaluated the actual and future estimated availability of recycled water for project operation. Recycled water is provided to the project from VVWRA’s treatment plant and the City of Victorville’s (CVV or City) Industrial Wastewater Treatment Plant (IWWTP) through a contract with CVV which controls the distribution of effluent from both plants. The VVWRA plant is the larger of the two plants with an average effluent of about 13,000 AFY, fluctuating between about 12,000 to 14,000 AFY depending on economic and weather conditions. While it was designed for a capacity of 2 million gallons per day (MGD), IWWTP has been treating only about 0.5 MGD (about 600 AFY) due to the economic downturn in the area.

VVWRA and CVV officials informed the Energy Commission staff that the VVWRA treatment plant and IWWTP have the net capacity to deliver up to approximately 3,500 AFY or more for project use (CEC 2015b). The net amount depends on the condition of flow in the Mojave River because VVWRA is obligated to discharge a sufficient amount of reclaimed water to the Mojave River in accordance with the MOU between VVWRA and DFW. Given the historic water use described above, the net combined amount of 3,500 AFY that VVWRA and IWWTP can supply the project would have been more than sufficient to meet 100 percent of the needs of the project for all years HDPP has operated so far.

As mentioned above, VVWRA and DFW have an MOU that was ratified in 2003 regarding discharge of recycled water to the Mojave River to maintain a minimum annual flow in the river at the Lower Narrows station. The project owner invoked the 2003 MOU between VVWRA and DFW as a factor in limiting the amount of recycled water available to the project. According to the MOU, VVWRA is obligated to discharge a minimum of 9,000 AFY of recycled water to the Mojave River to maintain riparian resources. However, the MOU gives credit to VVWRA for flows over 15,000 AFY (base flow plus VVWRA discharge) at the Lower Narrows station. The credit can be exercised to reduce flow in the following year. For example, if the total flow consisting of base flow and VVWRA discharge at the Lower Narrows station happens to be 16,500 AF in one year then VVWRA is credited 1,500 AF towards their discharge in the following year. As such the minimum obligation for the following year becomes 7,500 AF. Conversely, if VVWRA discharges only 8,000 AF so that it can meet HDPP's demand in a given year then it will have to make up for the difference in the following year and the minimum VVWRA would have to discharge to the river would be 10,000 AF instead of 9,000 AF. Thus, VVWRA is allowed to discharge less to the river allowing them to meet the licensed maximum supply needed for HDPP operation provided it makes up for shortages in subsequent years.

Another factor that could affect availability of supply, as stated by the project owner, is the construction of sub-regional treatment plants in Hesperia and Apple Valley, which would reduce flows to VVWRA. These treatment plants would intercept about 2 million gallons per day, or about 2,000 AFY, of wastewater that would otherwise go to the VVWRA regional plant and be processed to recycled water. The VVWRA board of directors awarded the contracts for construction of those two sub-regional plants in January 2015. Construction is expected to be completed 28 months from the award date. However, information provided by VVWRA staff, as well as projections made by the project owner, showed that the impact of the construction of those sub-regional plants on the availability of a sufficient amount of recycled water to the project would be limited to 1 or 2 years immediately following the commissioning of those plants. Projected population growth is expected to make up for flows intercepted by those plants shortly thereafter.

The MOU allows for discharge from the VVWRA plant to the river to fall below 9,000 AFY due to construction of the proposed sub-regional treatment plants. When those sub-regional plants commence operation, the remaining effluent is all that must be discharged by the VVWRA plant to the Mojave River, even if it is less than the 9,000 AF minimum specified in the MOU. Flow projections presented by the project owner showed that the amount available to HDPP might be affected, but they also show that it would be only for two or three years. Even during those two or three years, the lowest predicted available amount of recycled water was more than 2,500 AFY in any given year, which is more than 85 percent of the average project consumption since it commenced operations.

In light of the foregoing, staff concludes that CVV and VVWRA have the flexibility under the MOU to serve the necessary supply for HDPP operation for most of the years, with the exception of a limited number of years right after commission of some sub-regional treatment plants. Combined with the amounts of water the project has been able to bank from the SWP, there should be sufficient amounts of water to meet the project needs in those limited low flow years.

Another factor discussed by the owner that would limit availability of recycled water is the revival of the VV2 project, which was licensed by the Energy Commission in 2008. It recently received a license extension to 2018. Staff believes, however, that VV2 is unlikely to be built and compete for recycled water. This assessment is based on the following factors:

a. Lack of investors: Since the license was issued, CVV, the VV2 license owner, has attempted to sell it but has been unsuccessful;
b. VV2 is not in a California ISO-designated local reliability area; an area in which threshold amounts of dispatchable generation capacity are necessary to meet system reliability standards.
c. The operating characteristics of the VV2, designed years ago, may or may not be suitable for the California high renewables electricity market;
d. It could pursue an amendment, like Palmdale and Blythe II/Sonoran amendment proceedings at the Energy Commission, but this is not certain to arrive at a positive outcome or a project design that can secure a power purchase agreement;
e. It has not secured a power purchase agreement with a utility; and
f. In contrast, HDPP has a contract for resource adequacy of 120MW with Southern California Edison (SCE).

(ii) <u>Inadequate capacity to supply the water at a rate and quality needed by the project 24 hours a day for all days of the year.</u>

The project owner stated that the project needs an instantaneous supply of water at a rate of about 4,000 gallons per minute (gpm). The project owner states that it is unknown when this peak demand will occur and how long it will last, and therefore the owner requires the ability of the water supplier to deliver the water at that rate every hour of every day. Staff disagrees with the project owner's arguments and conclusions for the reasons discussed below. Water quality is discussed in (iii) that follows.

While the instantaneous demand is relevant to sizing the supply and delivery system, it is unrealistic to use instantaneous demand to size annual supply. In this case, 4,000 gpm would equate to 6,400 AFY – HDPP is permitted for no more than 4,000 AFY, and has not exceeded 3,200 AFY, or an average use of about 2,200 gpm. It is commonplace that California power plants experience both seasonal as well as diurnal fluctuations in power generation. However, peak generation occurs a limited number of hours per year, and generally only once per day. In addition, as more renewable resources are integrated into the system, some natural-gas plants may operate only twice a day; once during the morning ramp and then again during the evening ramp. Therefore, it is not reasonable to require a project water supply to meet the peak demand every hour, 24 hours a day.

Although maintaining this instantaneous flow rate at all times is not needed, CVV indicated that the VVWRA plant, the larger of the two plants that can supply recycled water to HDPP, has two pumps rated at 2,400 gpm, for a total of 4,800 gpm. Also CVV and VVWRA are planning on adding a third pump for redundancy. This would be more than adequate to deliver the 4,000-gpm peak demand by HDPP.

While instantaneous spikes in power generation and demand for cooling water are inevitable, they could also be managed with the use of equalization (or buffer) storage facilities. The City already has a 1-million gallon tank and a 600,000-gallon pool which have been used to collect the recycled water from both the VVWRA plant and IWWTP. In addition, the VVWRA treatment plant has an additional onsite storage tank with a capacity of approximately 460,000 gallons that can be utilized to store recycled water for HDPP use. Even at the peak project water use of 4,000 gpm, the combined storage (2.06 million gallons) could last the project well over 8 hours even if regular supplies were cut off. Using the average project water consumption of about 2,600 gpm, the combined storage of all three storage units could last the project for more than 13 hours, and that's assuming that no additional recycled water is being delivered from either treatment plant. If the stored water is used to supplement average recycled water supply deliveries (2,600 gpm) from the wastewater treatment plants, such as during times of peak demand, the storage would allow HDPP to operate for over 24 hours at peak generation/peak water use (4,000 gpm).

The elevated tank and pool currently used to collect the recycled water from VVWRA and IWWTP can still be used for equalization to meet peak demand. The tank and pool, as well as the storage area at the VVWRA plant, can be filled during off-peak hours for use during an interruption or just to supplement supply from the treatment plants in case supply falls below project demand.

Recently, CVV informed Energy Commission staff that it is considering pumping the water directly from the treatment plants to HDPP which would reduce the length of the delivery pipe by about 9,200 feet thereby reducing pumping costs due to a reduction in head loss of about 26 ft. A pumping test was carried out recently by VVWRA to see if the recycled water can be delivered directly to the project without the need to pump it to the elevated tank, which would result in substantial savings in pumping costs. The test showed that one pump was run up to its design pressure and was found to be capable of delivering 2,850 gpm, while the second pump, which was run up to a pressure head of only 139 feet, or about 86 percent of the maximum pressure head the pump is rated for, was found to be capable of pumping as much as 2,050 gpm (CEC 2015a). The second pump would be capable of pumping at a higher rate if it was run up to its design pressure head of 159.9 feet. Thus, both pumps are capable of delivering a total of at least 4,900 gpm, which is about 22 percent more than the maximum need of the project.

CVV and VVWRA staff indicated that there are signs of economic recovery in the area. Thus population growth is expected to rebound towards projected levels, which means that wastewater flows to the VVWRA treatment plant in general are expected to increase. In addition, water conservation being undertaken pursuant to the Governor's executive order is not really affecting waste water flows since most savings is coming from reduced outdoor irrigation and runoff which does not flow to a wastewater treatment plant. As the data supplied by VVWRA staff and the project owner suggests, however, there is a limited potential for shortage in supply to meet high project demand, during the two or three years immediately following the construction of the two sub-regional plants. Although data presented by HDPP indicates outflow from VVWRA will exceed project maximum needs for 7 out of the next ten years, staff notes that considering the project's historic maximum demand of approximately 3,200 AFY there would be sufficient supply for about nine out of the ten years – tank storage and use of the existing groundwater storage bank already licensed for this project could address the potential shortfalls in delivery.

(iii) Onsite water treatment system was not designed to treat and remove the higher amount of impurities if 100 percent recycled water is to be used by the project.
Staff agrees with the project owner that the capacity of current on-site treatment facilities is not adequate to treat all the recycled water needed for the project since those facilities were designed to treat SWP water which has different water quality characteristics. However, the use of recycled water, even though it requires expansion of treatment facilities at the project, presents a reasonable alternative to transient or permanent shut down of the project. Staff concurs with the project owner that the treatment facilities will have to be expanded to handle all the recycled water needed by the project. But staff disagrees with the project owner that it would be infeasible to use 100 percent recycled water just because the treatment facilities were not designed to treat the full amount of recycled water to make it suitable for use by the project. It should be noted here that the project has managed to use up to 33 percent of its water needs from recycled water even though it was also treating SWP water for injection purposes. This indicates that the treatment capacity of the current system is capable of treating more than 33 percent of the total project water need of recycled water.

The most important water quality parameters specified in the contract between HDPP and CVV are the total dissolved solids (TDS) and silica concentrations. The contract specifies 450 mg/l (or ppm) and 40 mg/l for TDS and silica concentrations, respectively, both on a three-day rolling average basis. While silica concentration is not monitored frequently for the recycled water, TDS is monitored continuously. As stated by the project owner in a separate Petition To Amend (TN # 202996) for water treatment equipment, TDS concentrations for the recycled water produced by the VVWRA plant are within specified limits. Only recycled water from IWWTP has slightly elevated TDS levels (but mostly less than 600 ppm), which is due to the industrial nature of the wastewater treated by IWWTP. However, IWWTP produces a fraction of the amount produced by VVWRA, and is used only in case the VVWRA plant is producing less than the project currently uses. Even though IWWTP was designed to process up to 2.5 MGD of wastewater, it has been processing only about 0.5 MGD due to the downturn in the economy which affected wastewater flow to IWWTP. HDPP has used a blend of IWWTP recycled water and water from the groundwater bank to dilute the TDS concentrations to below 400 ppm, which may be an indication that TDS levels in the IWWTP are not too high for use in emergency situations.

Staff also recently learned through a phone conversation with Sean McGlade, City of Victorville on January 29, 2015 that the city was close to issuing a permit requiring the primary discharger to the IWWTP to reduce TDS to a fixed limit of 450 ppm (CEC 2015c). This would result in significant improvement in water quality from this plant so that it meets HDPP contractual requirements for delivery. This change would make the supply from IWWTP a permanent dependable supply. Mr. McGlade also pointed out that TDS concentrations in the recycled water from the IWWTP at the time of phone call were at about 420 ppm.

The HDPP recycled water samples for silica showed that the silica concentrations have always been less than the contractual limit of 40 ppm. In fact the measured silica concentrations have been approximately half the maximum specified. Even though the project owner stated on several occasions that silica causes fouling of the microfilters, the owner did not give any details as to the way silica causes the fouling of the microfilters, or what options might be used, like pretreatment, to enable silica removal.

The project owner provided engineering analyses of three design options to treat recycled water for project use. The three options were:

1) Pretreatment of all makeup water where the recycled water would go through treatment to remove TDS, hardness, and silica before it is run in the cooling tower (Cost $37.3+ million);
2) Side-stream treatment, where cooling water would be drawn out of the cooling tower and treated to remove fouling constituents (Cost $40.4 million); and
3) Replacement of the cooling water blowdown unit with an evaporator (Cost $52.7 million).

Based on discussions with experts involved in water treatment, the costs quoted by the project owner seem to be too high, especially since the backbone of the treatment system is already in place. The fact that seven power plants regulated by the Energy Commission use 100 percent recycled water of similar characteristics for cooling purposes while they also employ Zero Liquid Discharge (ZLD) systems indicates that it is economically viable for HDPP to use recycled water. Staff has learned from a recent visit to a power plant that uses tertiary treated recycled water that perhaps a reconfiguration of the same treatment processes might give better results and therefore be less costly. For example, staff was told that if hardness is removed from the incoming water before removing or reducing silica, the treatment process could be more effective and efficient. Also, staff has learned that when the other plant used an ultrafilter before the reverse osmosis step instead of the microfilter, the behavior of the treatment system improved considerably. The other plant also experienced frequent operational and maintenance issues due to processing of blow down in the ZLD system, but when the ultrafilter was added, those issues were overcome.

The engineering analysis presented by the project owner in Appendix B proposes to use a cold lime softening method to deal with the hardness in the incoming recycled water. The analysis also mentioned that warm lime softening is a more efficient method for removal of hardness. However, the analysis ruled out this method due to the high costs associated with heating the incoming recycled water. It might be possible to use heat that is being dissipated by the cooling tower to heat up the incoming recycled water so that warm lime softening can be used. This seems to be a logical thing to consider since it would help in the cooling process by use of the waste heat while also reducing the potential for water consumption. Given the efficiency that can be achieved with the warm lime softening method, staff recommends that the project owner consider this as a way to come up with a less costly treatment system.

While the third option was readily ruled out by the project owner as being the most costly of the three, the project owner stated that the other two options are also too expensive to implement by a merchant power plant that does not have the customer base and a long term contract to recover the capital costs involved.

(iv) The capital costs to upgrade the onsite water treatment system and to further treat the additional quantities are extremely high.

Staff acknowledges that the treatment facilities at the project would need to be expanded in order to be able to handle 100 percent tertiary treated recycled water. However, the costs quoted by the project owner for Option 1 and Option 2 are likely high since the backbone of the treatment system is in place and all it needs is to be expanded to be able to treat the larger volume of water.

In lieu of doing a detailed cost and economic analysis prior to the owner's submittal of the Petition To Amend, staff attempted to quantify what the potential increase in cost of electricity would be if the capital costs for the two least expensive water treatment options cited in the feasibility study were expended and the plant operated at an average capacity factor of 48 percent. Staff used the Energy Commission's 2014 Cost of Generation Model (http://www.energy.ca.gov/2014publications/CEC-200-2014-003/index.html) developed by the Energy Commission to calculate levelized costs, the total costs of building and operating a power plant over its economic life converted to equal annual payments, in dollars per megawatt-hour ($/MWh) and dollars per kilowatt-year ($/kW-yr). The levelized costs provide a basis for comparing the total costs of one power plant against another. In summary, staff used the model to estimate the cost of a similar plant with and without the additional water treatment facility, assuming both are new facilities built in 2015.

To do this, staff took the "550MW Combined Cycle with Duct Firing" technology option in the model and adjusted the megawatt (MW) capacity and capacity factor to match those of HDPP. (The "550 MW Combined Cycle with Duct Firing" models a two turbine system, yet HDPP has three. However, since the model was adjusted on a per-MW basis, this should not significantly affect the results.) Staff ran the model to provide the deterministic mid case levelized cost, then added the additional capital cost of the water treatment plant and re-ran the model. The difference in the levelized costs between the cases estimates the difference in levelized cost between the two plants, one with and one without a water treatment plant, over their lifetimes. While the difference between levelized costs is small, it is assumed that the cost of the water treatment plant is spread out over the remaining life of the project, and that a shorter useful life may increase the levelized cost beyond this estimate.

Further, this estimate only uses the deterministic mid case; it does not take into account project-by-project variability, which can be much larger than the difference in levelized costs presented below in **Table 1**. In addition, the model assumes a capacity factor of 48 percent, which is less than the average capacity factor of 53 percent that the project has operated at for the past 11 years. The higher capacity factor means that the levelized costs would be even less than what was estimated by the model, therefore the project could be expected to recover the capital costs sooner than that predicted by the model.

Table 1 – Levelized Cost of Electricity for Water Treatment Options 1 and 2

Combined Cycle - 2 CTs With Duct Firing 855 MW						
Merchant Fossil	**Mid Case**		**$37.3M Case (Option 1 - Pretreatment)**		**$40.4M Case (Option 2 – Sidestream Treatment)**	
Start Year = 2015 (2015 Dollars)	**$/kW-Yr**	**$/MWh**	**$/kW-Yr**	**$/MWh**	**$/kW-Yr**	**$/MWh**
Capital & Financing - Construction	$98.74	$24.77	$104.21	$26.15	$104.66	$26.26
Insurance	$6.64	$1.67	$7.01	$1.76	$7.04	$1.77
Ad Valorem Costs	$9.68	$2.43	$10.21	$2.56	$10.26	$2.57
Fixed O&M	$45.31	$11.37	$45.31	$11.37	$45.31	$11.37
Corporate Taxes (w/Credits)	$32.52	$8.16	$34.34	$8.62	$34.49	$8.65
Fixed Costs	**$192.89**	**$48.39**	**$201.07**	**$50.45**	**$201.75**	**$50.62**
Fuel & GHG Emissions Costs	$305.20	$76.57	$305.20	$76.57	$305.20	$76.57
Variable O&M	$3.31	$0.83	$3.31	$0.83	$3.31	$0.83
Variable Costs	**$308.51**	**$77.40**	**$308.51**	**$77.40**	**$308.51**	**$77.40**
Total Levelized Costs At Interconnection Point	**$501.40**	**$125.80**	**$509.59**	**$127.85**	**$510.27**	**$128.02**

*All cases assume 48% capacity factor

*Capacity changed from 550MW in model to 855MW

*Model assumes no change in the cost per MW capacity even though HDPP has 3 turbines

Using the cost estimates provided by the owner, the model results show the increased cost for Option 1 is only $2.05/MWh and $2.22/MWh for Option 2. This is the equivalent of about 0.2 cents/KWh. Based on these estimates staff concludes that the incremental cost in the levelized cost of electricity is small and should not result in a significant change in economics for the plant given an assumed remaining life of operation of 18 years.

Another mitigating factor for cost to convert to 100 percent recycled water is the difference in cost for recycled versus fresh water. Based on information provided by the owner (Exhibit F of the feasibility report), the current costs are $402/AF for recycled water and $473/AF for SWP water. With average water use of 2,872 AFY there would be annual savings of about $204,000 with the use of recycled water. Staff understands that there may be a slightly higher volume of recycled water needed compared to fresh water because of the difference in quality but with anticipated rising costs of freshwater over time the difference is inconsequential and total savings would increase. Staff notes that these savings also do not include avoided costs associated with procurement, treating, pumping, and recovering SWP water to and from the groundwater bank. These savings could be used to offset capitol or operations and maintenance costs.

Conclusions

1) Overall, the annual total amounts of recycled water from the VVWRA plant and IWWTP would be sufficient to meet HDPP needs,
2) The VVWRA treatment plant has adequate capacity to meet project peak demand of 4,000 gpm. In addition, using the existing equipment and storage infrastructure, VVWRA has the capacity to meet the project peak demand during an interruption for a minimum of 8 hours and up to 24 hours depending on demand and concurrent deliveries. This should be more than adequate to meet the project peak demands for the time when this short term need occurs. VVWRA currently has two pumps with a combined capacity of more than 4,900 gpm, which exceeds the project's maximum demand. As an added redundancy, the city is going to install an additional pump to be used when either of the two existing pumps is down for maintenance, thereby adding another layer of assurance that HDPP would receive all the recycled water it needs.
3) Based on the contractual requirements for recycled water supply between HDPP and VVWRA, and staff experience with other power plants using 100 percent recycled water and ZLD, the recycled water is of sufficient quality for delivery and use by the project.
4) Staff acknowledges that the onsite water treatment system was not designed to treat and remove the higher amount of impurities if 100 percent recycled water is to be used by the project. However, with minor modifications the owner has been able to use up to 33 percent recycled water. This is an indication that with incremental expansion of the existing system the project owner could reasonably use up to 100 percent recycled water. The Energy Commission also regulates seven other power plants that already use 100 percent recycled water and a ZLD for wastewater treatment which further indicates use of these treatment systems is economically feasible.
5) Staff recognizes that the cost to expand the treatment system appears to be significant. However, staff believes the incremental increase in the levelized cost of electricity due to installation of one of the water treatment options would be minimal and could be recovered over the remaining life of the project.

Continued use of SWP and groundwater from the adjudicated Mojave Groundwater Basin does not appear sustainable and is inconsistent with Energy Commission Water Policy. Staff believes that the hurdles presented by the project owner can be overcome, to provide a reliable water supply.

When the facility was originally licensed, the final commission decision noted that the use of dry cooling should be considered. This may be the only other alternative to keep the plant operating in an area where there is limited fresh water supply. Costs for a retrofit to use dry cooling would be far more expensive than use of recycled water. Staff believes that making maximum use of the available recycled water supply would be a viable alternative compared to retrofitting the project to use dry cooling or shutting down.

Recommendations

Given the fact that the state is experiencing the worst drought on record and the project was constructed in an area where fresh supply was already scarce, there is no better time to fully pursue recycled water as an alternative and reliable source for project operation. At the time of licensing, the owner and the Final Commission Decision acknowledged the risk of losing the project's main water source. Now that conditions have changed in the region and recycled water has become available, it is to the advantage of the project owner to fully utilize this resource.

The project owner is required to file a Petition To Amend by November 1, 2015, in accordance with the September 2014 Energy Commission Order. Staff recommends that the project owner be required to amend the project to use 100 percent recycled water. Alternatively, the project owner could also pursue dry cooling in accordance with the Final Commission Decision or shut down if neither SWP nor recycled water is available.

With the project's use of 100 percent recycled water, staff recommends that the owner be allowed to use freshwater supplies from CVV as a backup supply for project operation in case of short term interruptions of recycled water delivery and as temporary make up for the effects of any flow diverted by the sub-regional treatment plants on recycled flow rates to the project.

Staff notes that based on discussions with VVWRA plant staff, interruptions necessary for maintenance purposes typically last for less than 7 days because the capacity of percolation ponds is only enough to hold an amount of raw wastewater equivalent to that many days. In addition, an interruption cannot exceed 10 days in duration since the VVWRA plant is obligated to send water to the river within 10 days of an interruption in the worst case. The treatment plant occasionally has to go offline either due to routine maintenance shutdowns or because of random equipment failure or treatment process upsets. VVWRA staff informed Energy Commission staff that the frequency of shutdowns due to equipment failure has improved substantially due to improvements to the asset monitoring system adopted by the treatment plant.

The average daily consumption is 3.6 MGD. Assuming a modification factor of 1.5 in order to account for summer months where water use will be at its maximum, the worst case daily consumption comes to 5.4 MGD. If the VVWRA plant is assumed to experience two 7-day interruptions due to equipment failure or routine maintenance, the amount of water needed to cover the shortage comes to 75.6 million gallons, or 232 acre-feet. That's assuming that the interruptions occur while the HDPP is online and consuming the daily maximum amount of water, which is an unlikely situation since the power project has been operating at an average c.f. of 53 percent. Staff therefore believes that it would be reasonable to allow the project to use up to 232 AFY of fresh water as a backup in case of interruption in the delivery of recycled water.

Therefore, staff recommends that where fresh water is used as a backup supply, it should not be used unless: 1) there is inadequate instantaneous flow to meet the project demand; 2) there is a short term interruption in delivery of recycled water from VVWRA that is beyond the control of the owner; and, 3) the volume of freshwater used as a backup supply is no more than 232 AFY.

The availability and use of a backup supply for short term interruptions is standard industry practice. There are always periods when there are outages that occur at wastewater treatment plants, planned or not, which are beyond the control of a power plant owner. Staff would also recommend requirements for reporting that would ensure these performance measures are achieved.

References

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CEC 2015a – California Energy Commission. Report of Conversation between Energy Commission staff and city of Victorville regarding results of a pump test conducted at the VVWRA treatment plant in June 2015. TN# 206295. October 2015.

CEC 2015b – California Energy Commission. Report of Conversation between Energy Commission staff and representatives from VVWRA treatment plant and Victorville Water District regarding issues of recycled water delivery to the HDPP. TN# 206296. October 2015.

CEC 2015c – California Energy Commission. Report of Conversation between Energy Commission staff and representatives from city of Victorville and VVWRA treatment plant regarding issues of recycled water delivery to the HDPP. TN# 206296. October 2015.