Memorandum

May 1, 2019

To: Eli Naffah		Ref. No.:	11185172
From:	Patrick Sullivan	Tel:	(707)267-2238
CC:	Becky Price-Hall, Bryan Buckman, Ryan DeSmet		
Subject:	**Water Treatment Plant Production Rate Test and Analysis**		

1. Purpose

The purpose of this memo is to provide an analysis to determine the theoretical effective maximum water production capacity of Trinidad's drinking water production facility under current conditions.

This analysis does not address policy issues related to providing additional connections or obligating the City to provide additional water. This analysis did not consider or address potential water storage needs, distribution network needs, nor any risk analysis of different system components. It is recommended that the City evaluate their policy for considering new service requests. Additional evaluations are needed before making obligations for additional water to meet additional service requests.

2. Background

The City of Trinidad serves treated water to approximately 1,000 people within the City service area. The City's diversion and water plant is located at 1313 Westhaven Dr. Trinidad CA, adjacent to Luffenholtz Creek. Water for the plant is pumped from a wet well that is filled through an infiltration gallery located approximately 10 feet below the creek bed. The point of diversion is just upstream of the Westhaven Dr. culvert. The City has current water rights limiting the rate of diversion, the annual maximum diversion, and required bypass flow requirements, which is the minimum flow rate that must be allowed to bypass the water intake. In addition to water right limitations, the effective water production rates are currently limited by physical constraints in the processing of the water which include: infiltration gallery limitations, flocculator flow rates, filter fouling rates, backwash periods, and chlorine contact time requirements.

3. Water Rights

The City can extract a maximum of 0.56 cubic feet per second (cfs) (251 gallons per minute) from Luffenholtz Creek through appropriative water rights permit numbers 15984 and 17255, which corresponds to a daily maximum extraction of 361,440 gallons per day. The City's water right permit 17255 stipulates that the City shall bypass 0.25 cfs except when the natural flow in Luffenholtz Creek is lower than 0.86 cfs and then the City must leave at least 0.15 cfs in the creek, including enough flow for the 0.0054 cfs worth of water rights downstream from the City. This results in a total of 0.1554 cfs or approximately 70 gpm that must bypass the City's water intake during low flows below 0.86 cfs.

4. Water System Process

The raw water from Luffenholtz Creek is extracted through an infiltration gallery that feeds a wet well. The infiltration gallery is made up of three perforated pipe buried approximately ten feet below the surface of Luffenholtz Creek and flows into a wet well with intake pumps. When the intake pumps are not running, the water surface elevation in the wet well matches the water surface elevation in the creek. When the pumps operate, the level in the wet well drops and the difference in hydraulic head between the water surface elevation in the creek and the elevation in the wet well provides the force to drive the water through the gravels in the creek bed and into the wet well. As gravels become clogged with sediments, the rate at which water can travel through the gravel for a given head is reduced. The dry season elevation of water in the creek is lower than in the wet season and hence reduces the static elevation in the wet well.

Water is pumped from the wet well to a flocculator where polymer is added to aid in particulate clumping and settling, which reduces turbidity. The water is then pumped through a series of mixed media filters with additional polymer and then through a chlorine contact pipe prior to entering the water delivery system.

One of the factors limiting the capacity of the system is the turbidity of the raw water that flows into the wet well from the infiltration gallery. The turbidity in the creek varies seasonally and with rain events the turbidity is generally higher. The water entering the wet well is naturally pre-filtered through the creek bed to some degree, but raw water turbidity in the wet well typically increases with higher creek flow rates. Higher turbidity rates require more polymer and a slower feed rate to the flocculator and also results in more frequent backwashing of the mixed media filters. During a backwash cycle, clean water from the distribution system flows backwards through the filters to flush out sediment. The backwash water is routed to a holding tank where the sediment is allowed to settle to the bottom of the tank. Backwash water is decanted of the top of the holding and routed back into the water processing filter train.

5. Evaluation Approach

Production of potable water from the treatment plant is a function of three factors: legal water right conditions including bypass flow requirements, infiltration gallery intake limits, and treatment plant component limits. This evaluation focuses on the infiltration gallery intake limits and treatment plant component limits.

The approach to evaluating the maximum potable water production rate under current conditions is to operate the treatment plant at various discrete flow rates for a period of time and monitor, record and evaluate performance measurements to determine the limiting factors to water rate production. The highest sustainable flow rate is the rate that does not violate the water right constraints or system limitations. The parameters monitored to evaluate the system capacity include: flow rate, wetwell water levels, chemical addition, and pressure drop across the filter trains, and turbidity of the raw and processed water.

The capacity tests consisted of operating the system at a specified pumping rate to meet the existing daily water demand. The tests were performed and data recorded by the City staff. To perform each test City staff performed the following steps:

- Back wash the system,

- Set the pump speed to produce the desired flow rate,
- Run the test for 7 days or until failure to meet normal performance criteria,
- Monitor the pressure across the filter trains multiple times daily,
- Monitor plant parameter for normal system compliance: chlorine residual, turbidity, bypass flow, filter train pressure, wet well water level,
- Compile data and measurements.

5.1 Evaluated Flow Rates

The flow rate of water through the treatment plant is instantaneous flow through the system typically considered in gallons per minute (gpm). How much water can be made in a day depends on how long the system can run and how much finished water must be used for backwashing. The flow rate through the system dictates the velocity or speed at which water moves through the flocculator, filters and chlorine contact basin. The length of time that the plant runs in any given day determines the daily volume of water produced. The amount of time that the plant typically runs varies with the daily fluctuations in demand and the ability to operate the system during high turbidity in the creek.

The flow rates evaluated in this analysis were determined based upon interviews and consultation with City treatment plant operators. The City can extract a maximum of 251 gpm from Luffenholtz Creek based on water rights; however, the existing pumps can only achieve a maximum flow rate of 175 gallons per minute. However, the operators report that when the plant runs at flow rates greater than 120 gpm the raw water increases and the wetwell level drops significantly. Therefore, 120 gpm was established as the maximum test flow rate and the following eight flow tests were performed:

- Test #1 - 120 gpm
- Test #2 - 115 gpm
- Test #3 - 110 gpm
- Test #4 - 105 gpm
- Test #5 - 100 gpm
- Test #6 - 95 gpm
- Test #7 - 90 gpm
- Test #8 - 85 gpm

The highest flow rate test was performed first, when the flows in Luffenholtz Creek were the lowest and draw down in the wetwell would be greatest.

6. Flow Test Results and Analysis

The flow rate tests were performed over a period of several months starting in mid-November and ending in February. The runtimes of each test was determined by the time between filter backwash cycles. Each test started directly after a filter backwash cycle and was ended when the next backwash was required or 7 days, which ever was less. The first test was performed prior to the first rains of the season and at the highest pumping rate when the bypass flows would be most critical. A summary of all the test run rates and dates is shown in Table 1 below.

Table 1. Treatment Plant Flow Rate Tests and Dates.

Test	Flow Rate (gpm)	Start Date	End Date
Test # 1	120	11/13/2018	11/19/2018
Test # 2	115	11/20/2018	11/21/2018
Test # 3	110	11/26/2018	12/2/2018
Test # 4	105	12/4/2018	12/6/2018
Test # 5	100	1/28/2019	2/3/2019
Test # 6	95	2/4/2019	2/9/2019
Test # 7	90	2/12/2019	2/18/2019
Test # 8	85	2/19/2019	2/25/2019

Table 2. Summary of Flow Study Data.

Test Number	Flow Rate (gpm)	# of Days Testing	Total Water Volume Produced (gallons)	Amount of Flocculants Added (gallons)	Amount of Chlorine Added (gallons)	# of Backwashes Required
Test # 1	120	5	411,614	2.50	7.89	1
Test # 2	115	2	96,830	1.25	1.93	1
Test # 3	110	5	269,970	5.75	7.37	1
Test # 4	105	3	141,540	3.50	4.05	1
Test # 5	100	5	292,077	3.25	4.67	1
Test # 6	95	5	241,303	2.75	4.06	1
Test # 7	90	4	218,055	2.25	3.87	1
Test # 8	85	6	324,755	2.50	5.73	1

6.1 Water Rights Compliance Assessment

The existing water right provides a substantial source of water when there is ample water in the creek. It is low flow conditions and the requirements for bypass flows that can significantly restrict the amount of water the City is allowed to extract. As discussed above, the City's water right permit stipulates that the City shall bypass a total of 0.1554 cfs or approximately 70 gpm.

Based on previous analyses, there is no known documentation indicating that the creek flow has previously decreased to the point that the City's intake rate needed to be reduced. However, periods of drought, long term changes in the climate, and increased extractions in the upstream watershed could result in restrictions in the future. It is important for the City to remain mindful of these future potential changes in creek flow, and not over commit the water supply, which could become restricted due to low flow in the creek at some point.

To demonstrate compliance with water right requirements, the City measures the flows in Luffenholtz Creek with a stream gauge located directly below the City's point of diversion, below the Luffenholtz Creek culvert on Westhaven Drive.

The first significant rains of the season started on November 20th, 2018. The average flow below the City's diversion was 1.2 cfs. The lowest bypass flow observed was 0.81 cfs and occurred November 13th, 2018, during Test #1. The bypass flow is therefore greater than the required 0.25 or 0.1554 cfs. The Luffenholtz Creek flows are presented in Figure 1 along with an indication of when each pumping rate test was performed. Note that the stream flow data was not reported during Test # 8, however, the creek flows were observed to be "significantly higher than normal" for that time of year. This indicates that the bypass requirements are not the limiting factor for diversion during normal water years.

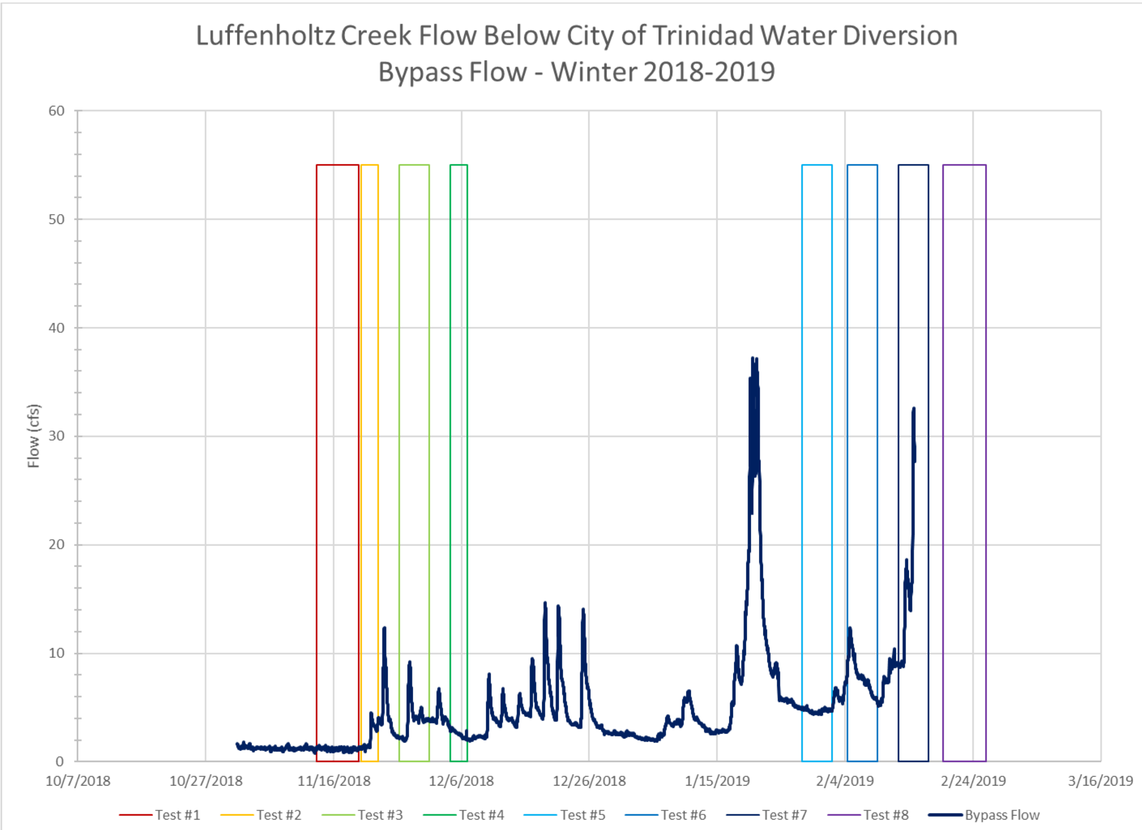

Figure 1. Luffenholtz Creek Bypass Flows below City of Trinidad Water Diversion, Winter 2018-2019

6.2 Wetwell Water Level Assessment

The wetwell for the water treatment plant is located adjacent to Luffenholtz Creek, just east of the Westhaven Drive culvert. Water for the treatment plant is pumped from the wetwell into the treatment plant. Water flows from Luffenholtz Creek and into the infiltration gallery made up of a series of perforated pipes and flows into the wetwell. The top of the wetwell is located above the bank full elevation of the creek at that location. There is depth gauge in the wetwell that records the water level and it is reported as a percent of the total wetwell height. Typically, the wetwell is recorded at roughly 47% to 50% capacity prior to starting the pumps for a production run after a period without pumping. The level of the wetwell is expected to typically decrease with increasing pumping rates and length of time that water is pumped into the treatment plant. The operators typically stop pumping when the water in the wet well decreases to 18% to 20%.

The observed drawdown in water level of the wetwell varied for each test. During the limited test runs, the drawdown does not appear to be correlated with pumping rates. The lowest wetwell water level observed was not coincident with the highest pumping rate. The water levels did not appear to decrease with the increase in duration of the pumping test either. The lower pumping rates required a longer pump run time to generate the daily water demand and resulted in lower wetwell level. The variability in wetwell drawdown is likely due to the cumulative effect of pumping at higher rates from previous tests. Test #4 had the lowest recorded percent wetwell level and was recorded during a pump run lasting 14 hours. However, previous pumping test were performed at higher pumping rates. The previous tests coincided with storm events when turbidity in the stream (raw water) was elevated and pumping at the higher rates may have introduced additional fine sediments into the subsurface gravels, reducing subsurface flow in the creek bed to the wetwell. When the creek sediments become clogged or fouled with creek sediments the system may be back flushed with water and air to flush the fine sediments out of the gravels. The creek gravels are backwashed only when needed. Typically, backwashing is needed more frequently during the winter wet period when the turbidity in the creek is naturally higher. In future analysis a flushing of the creek sediments should occur prior to each test.

A summary of the average decrease in percent of wetwell volume and the minimum percent of wetwell volume is presented in Table 3.

Table 3. Percentage of Wetwell Drawdown per Pumping Rate Test.

Test #	Flow Rate (gpm)	Average Decrease (% of Total Wetwell Volume)	Minimum % of Wetwell Level
Test #1	120	4.94	41.31
Test #2	115	4.80	41.7
Test #3	110	6.34	26.26
Test #4	105	13.15	19.9
Test #5	100	5.65	40.15
Test #6	95	9.13	34.11
Test #7	90	5.60	32.92
Test #8	85	11.37	24.75

The apparent lack of correlation between the pumping rate and wet well level suggests there may be an instrumentation problem resulting in faulty elevation readings. There may also be other factors affecting headloss in the creek bed, but such headloss is not expected to change in such a sporadic way to result in the wet well readings recorded during the tests. The cause of these apparent characteristics should be investigated further by the City.

6.3 Flocculent and Chlorine Assessment

One of the factors to consider when evaluating the capacity of the system is how flow rate affects the need for dosing of treatment chemicals to achieve the required finished water standards. This is primarily chlorine for disinfection and polymer added as a flocculants for turbidity reduction.

The chlorine contact time is defined by the amount of time it takes for a volume of water to pass through the chlorine contact pipe. The higher the pumping rate the lower the chlorine contact time. The existing chlorine contact pipe was designed to provide 30 minutes of contact time at flow of 175 gpm. The maximum testing rate of 120 gpm is much less than the 175 gpm maximum design, therefore, chlorine contact time is not a limiting factor for any of the evaluated pumping rates.

The amount of chlorine and polymer required is dependent on the quality of the raw water and flow rate. These conditions will vary based on weather patterns and flow conditions in the creek. In general, the higher the flow, the more organic matter and particulates contributing to the raw water turbidity. This requires more polymer and chlorine during treatment. It is also possible that higher pumping rates could increase the water velocity of the water entering the wetwell. Higher velocities could mobilize sediments in the gravels and increase turbidity in the raw water, thus increasing the chemical demand.

To assess the potential effects on chemical demand, the amount of chlorine and polymer used per 1,000 gallons of water produced was calculated for each test. The resulting rate of chemical usage varies by test run, but there does not appear to be a correlation with production rates. The usage is more likely affected by the turbidity of the raw water from the conditions in the creek. The results are graphically depicted in Figure 2.

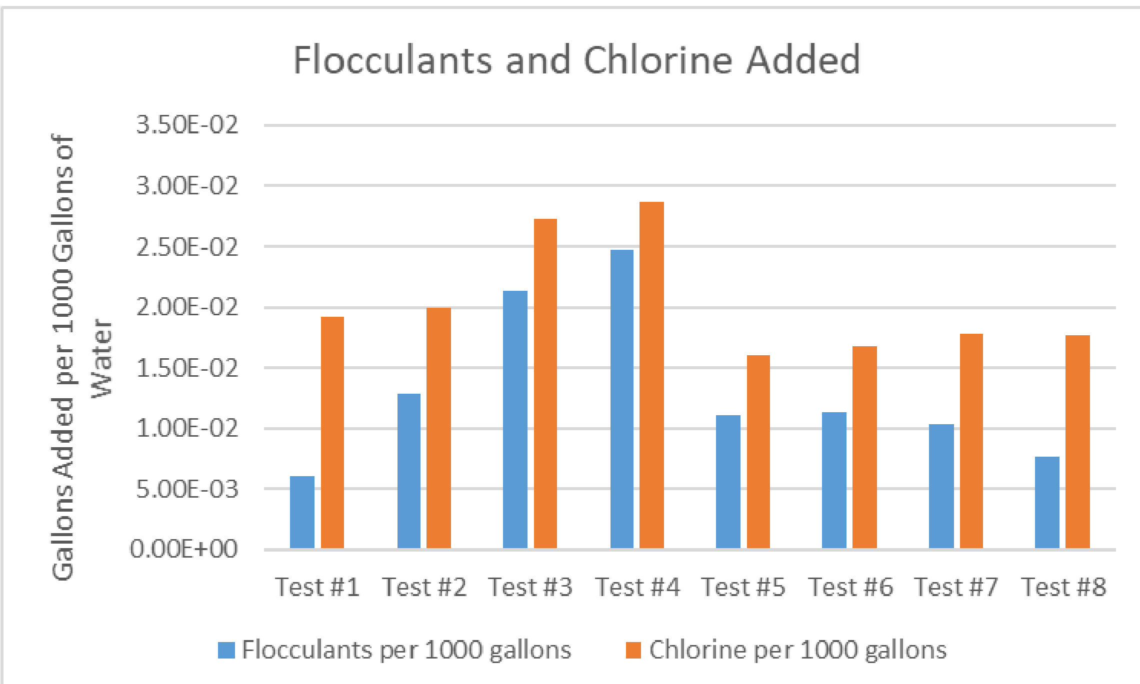

Figure 2. Flocculent and Chlorine Usage per Volume of Water Produced.

6.4 Pressure Drop

As stated above, during the processing of potable water, the raw water is pumped through mixed media filters. The filters are container vessels that are filled with sand, gravel and anthracitic carbon. Particulates are trapped in the filter as the water passes through the filter. The more particulates in the water (measured as higher turbidity), the faster the filters will become clogged. As the filters become clogged the pressure drop across the filter will increase. A filter train is comprised of two filter vessels aligned in series. The treatment plant has three filter trains that are run in parallel. The pressure on the inlet and outlet of each filter train was periodically recorded for each filter train during each pumping rate test.

If the pressure drop across a filter train is too great, the filter will not function correctly and will need to be backwashed to remove the accumulated sediment in the filter. The maximum pressure drop per 1,000 gallons of water produced was calculated and the results are graphically presented in Figure 3.

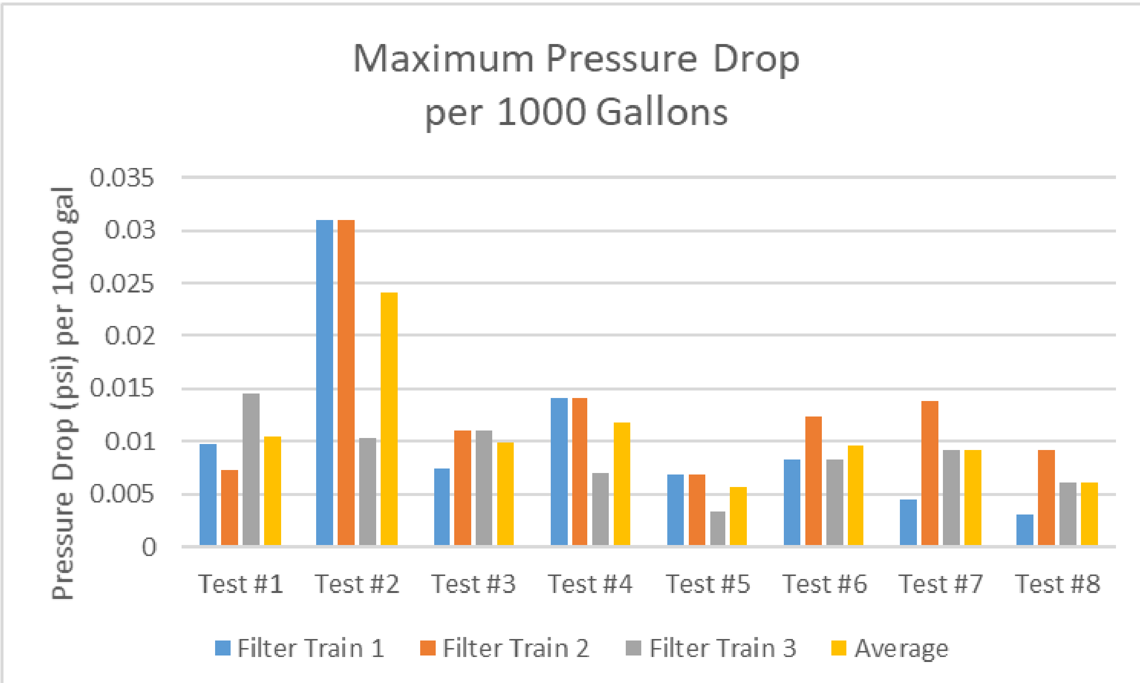

Figure 3. Maximum Pressure Drop across the Filter Trains.

6.5 Turbidity Assessment

The turbidity of water is a measure of the amount of suspended particles or sediment and is reported in Nephelometric Turbidity Unit (NTU). An NTU is a measure of light scattered through a liquid. At the City's treatment plant, the turbidity is measured at various location throughout the treatment process, but of primary concern is the raw water turbidity and the finished water turbidity. The City is required to produce water that is less than 0.3 NTU. The more turbidity in the raw water the faster the filters either clog or fail to produce water that meets their requirements.

The raw water turbidity observed during the pumping rate tests ranged from 0.38 NTU to 50 NTU. The highest turbidity measurements coincided with storm events where runoff into the creek increases the amount of suspended solids in the water. The turbidity of the processed water is also monitored. When the turbidity of the processed water is greater than 0.3 NTU the processing of potable water is stopped and the filter trains are back washed and flushed prior to restarting potable water production. Each of the pumping rate tests were ended due to processed water turbidity being greater than 0.3 NTU.

The observed turbidity during the test period is shown in Figure 4. The raw water turbidity is represented with the green dots and references the scale on the left. The finished water turbidity is represented with the blue dots and references the scale on the right.

The filter run time is determined by the amount of water filtered between a backwash of the filters and when the turbidity of the finished (filtered) water reaches 0.3 NTU, which triggers another backwash cycle. The turbidity of the finished water gradually increases as the volume of water filtered increases during a filter run. There was variability in the filter run times during the tests. Two trends were observed during the tests: the higher the turbidity of the raw water the shorter the run times, and the higher pump rates the shorter the run times.

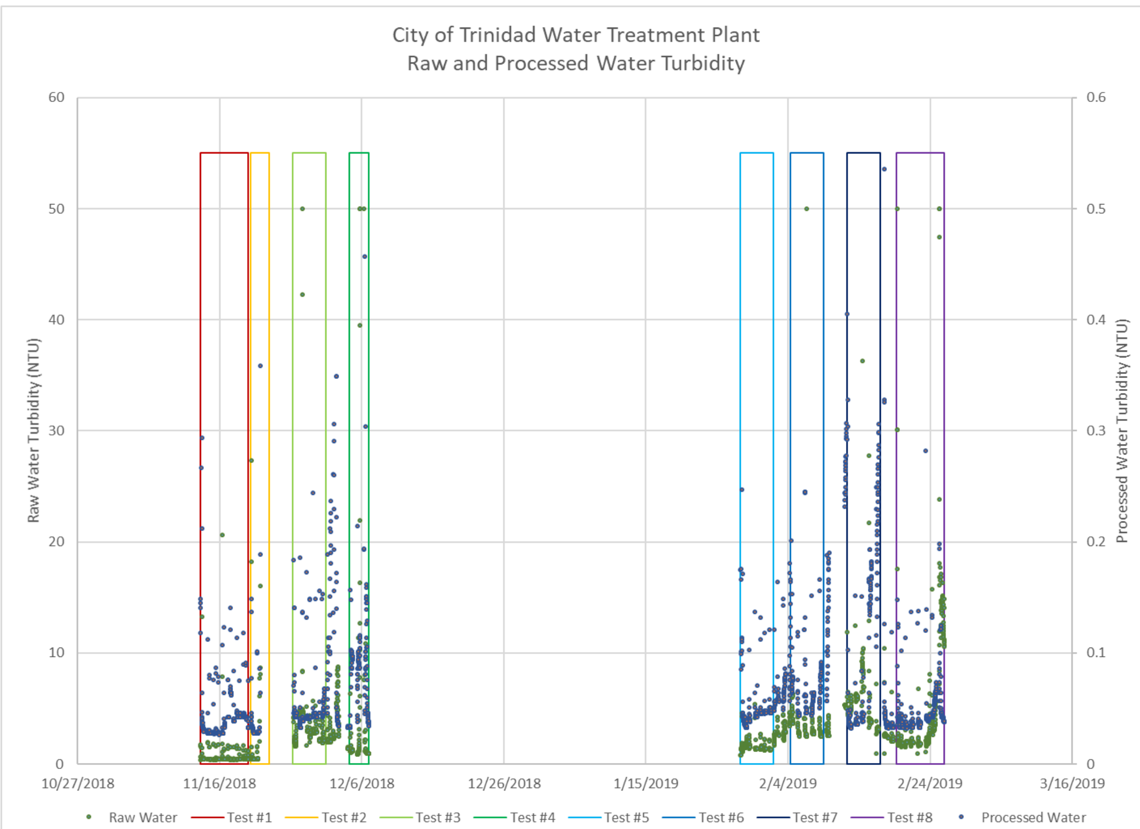

Figure 4. Raw Water and Processed Water Turbidity at the City of Trinidad Water Treatment Plant.

6.6 Filter Train Backwash

When processed water fails to meet the required levels of turbidity or the pressure drop across the filters is too great, the filter trains need to be backwashed to remove the trapped suspended solids and flocculants. This process requires the treatment plant to stop producing water. Potable water that is already in the distribution system is fed back through the filters at a rate of 300 gpm. Each filter is back flushed for 15 minutes (4500 gallons) with the backwash water routed to a 20,000 gallon backwash holding tank. After the backwash, raw water is then processed until it meets the 0.3 NTU requirement. This process water is also discharged to the backwash holding tank. The backwashing of all three filter trains produces between 15,000 and 18,000 gallons of backwash water. This water is allowed to settle and is then decanted off the top of the tank. The decanted water is then re-introduced into the raw water filter process or appropriately land applied. Alternatively, the decanted backwash water may be disposed of on the surface and allowed to infiltrate. The surface disposal is not allowed to cause erosion or runoff from the disposal area which prohibits surface disposal during the wet season when the ground is saturated. The backwash tank can be discharged at maximum rate of approximately 10 gpm. At this rate, the disposal of the backwash water requires between 25 and 30 hours of water plant operation.

With the treatment plant operating for 16 hours per day it would require approximately two days of operations to dispose of the backwash water between filter backwash processes.

Another factor to consider with the backwash process is the accumulation of sediments, or sludge, in the backwash tank. Periodically the sediment needs to be removed from the backwash tank, which is completed by washing down with a hose and pumping the solids to a truck and hauling off for drying.

7. Maximum Production Rate Estimate

In determining the current maximum water treatment plant production rate, the factors presented and discussed in Section 6 need to be considered. Based upon the eight pumping rate tests the limiting factors are daily pumping times and the turbidity of the processed water.

The City currently produces enough water to meet the daily demand for existing customers. The demand fluctuates from day to day and is typically higher in the summer and fall months. The staff at the treatment plant adjust water production to meet the demand by lengthening or shortening the time when the pumps are running. Staff have found that the overall treatment process operates most effectively when operated at the lowest flow rate that meets the overall system demand. Therefore, the operators pump at the lowest rate possible and adjust the pumping time to meet the demand. They typically will produce water for the longest period possible that allows time for backwashing the filters and infiltration gallery in creek bed. The required time for backwashing the filters and the infiltration gallery varies with the raw water quality, and more time is required when the turbidity in the raw water is higher (i.e. during the winter storms). When the turbidity in the creek is higher the operators need to backwash more frequently. Based on operational experience, City staff have found that the plant can produce water for approximately up to 18 hours per day November through April, up to 20 hours per day May through June, and up to 22 hours per day July through October.

The turbidity is the primary limiting factor and it is associated with the required time to perform filter train backwashes and then process the backwash water. The results of Test #4, at a pumping rate of 105 gpm, and when the turbidity of the raw water was the highest, allowed for over 30 hours of pumping (which occurred over 3 consecutive days of operation) between filter train backwashes. At this rate there is adequate capacity to process and dispose of backwash water during the normal process runs.

With a pumping rate of 105 gpm and the pumping hours as specified above the maximum daily water production is: 113,400 gallons per day November through April, 126,000 gallons per day May through June, and 138,600 gallons per day July through October.

The average daily production between 2013 and 2018 is estimated at 68,600 gallons per day. However, it is important to consider that this is averaged for the whole year and water demand varies through the year. The highest average water demand by month is 85,300 gallons per day and occurs in August. A summary of production by month is presented in Figure 5.

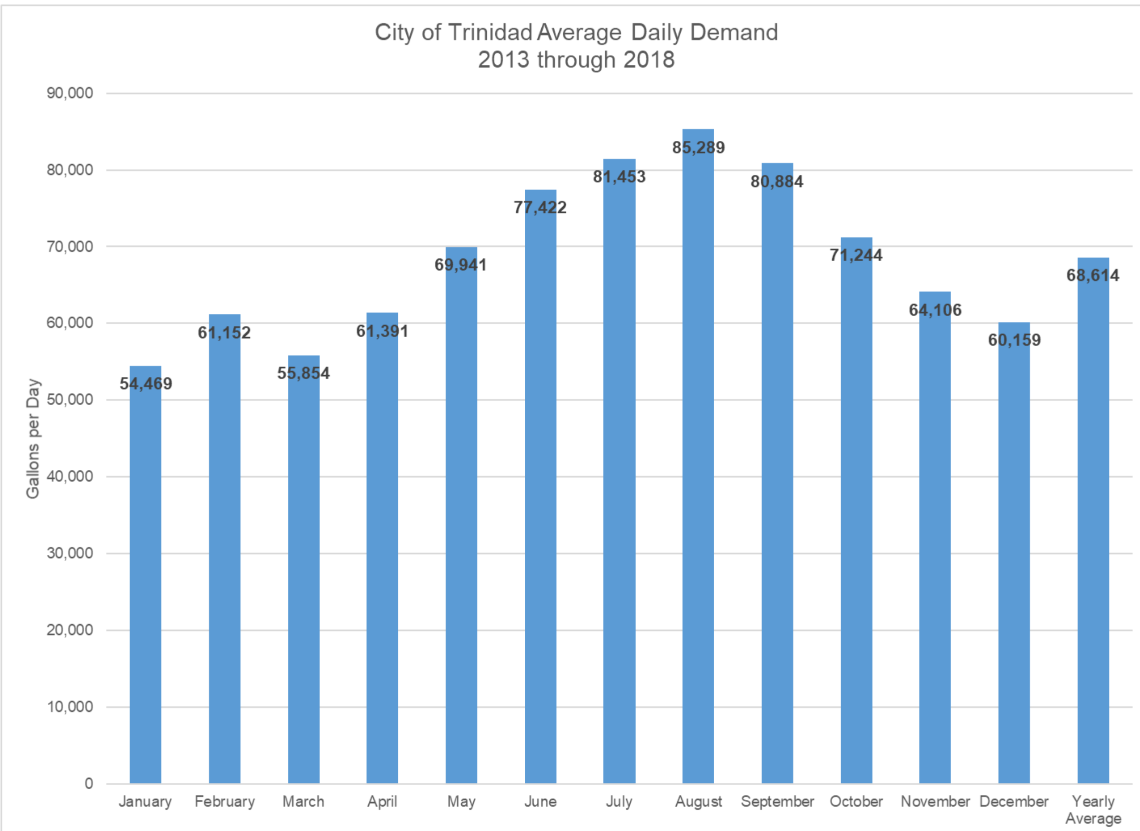

Figure 5. Average Daily Water Production 2013 through 2018.

The surplus water supply may be estimated by subtracting average daily water production from the maximum daily water production rate. The surplus water amount will vary by month based upon the expected demand and daily pumping run time. A summary of the theoretical water production surplus by month is shown in Figure 6. The smallest surplus daily production was estimated to be 48,578 gallons per day and occurred in June. The largest surplus daily production was estimated to be 67,356 gallons per day and occurred in October.

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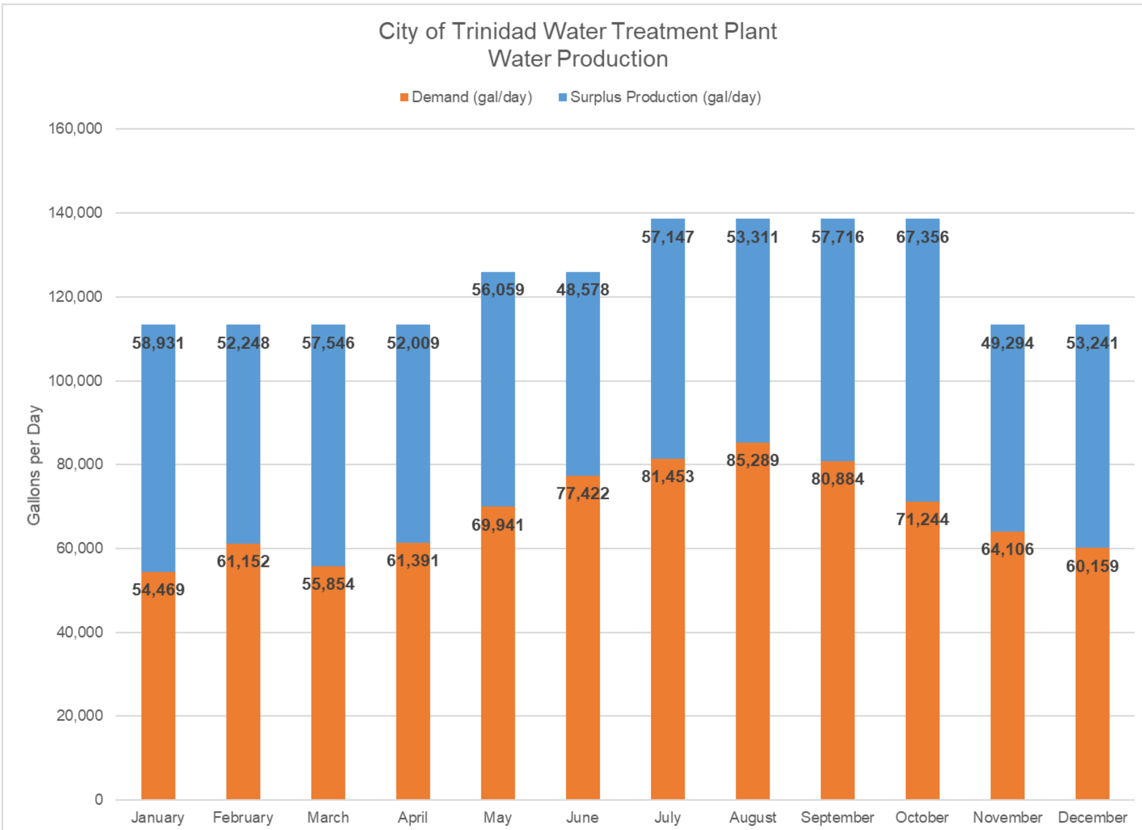

Figure 6. Theoretical Daily Production Surplus by Month.

It is important to keep in mind that these projected surplus capacities are approximate averages over typical months. Actual available surplus on any given day will depend on the actual characteristics at the time. The other factors evaluated (water right allocation, pump theoretical maximum rates, bypass flow rates, chlorine contact time, additive requirements, and pressure drop across the filter trains) do not appear to be limiting factors to water production rates.

8. Conclusions

The Trinidad Water Treatment Plant and treatment process was evaluated under multiple production rates to identify factors limiting production and to determine the theoretical effective maximum water production capacity of Trinidad's drinking water production facility under current conditions. Of all the factors evaluated, turbidity breakthrough in the filters (and associated filter backwash) and decreases in the wetwell water elevations were limiting factors. Turbidity breakthrough on the filters stops the production of water and necessitates the backwashing of the filters. This condition is most noticible during the winter storm period when the turbidity of the raw water from the creek is higher. Faster pumping rates cause the filter trains to foul quicker and shorten the runtimes of the filters before they need to be backwashed. The flow rate of 105 gpm allowed for sufficient runtime on the filter trains and allowed enough time between backwash cycles to process and discard the backwash water.

When turbid water from the creek is drawn into the creek bed the suspended sediments clog the void spaces between the gravels and causes a restriction to subsurface flow. The restriction of creek water migrating through the creek bed gravels and subsequently flowing into the wetwell leads to the lower water levels in the wetwell. This condition is exacerbated during the higher pumping rates. Restrictions on the flow into the wetwell is exacerbated by higher raw water turbidity from the creek, especially during storm events.

With a treatment plant production rate of 105 gpm and a maximum daily production run time that varied from 18 to 22 hours per day the daily maximum treatment plant production is between 48,578 and 67,356 gallons per day. This is much less than the City's annual allocation of water under the two appropriative permits of 337 acre-feet per year (just under 110 million gallons per year). Based upon a demand and production analysis, there is a theoretical surplus of up to approximately 48,000 gallons per day of supply to meet future service requests. How many and what type of service request can be accommodated will depend on how many and what type of requests there are as well as long term raw water supply characteristics, City water facilities characteristics, and operational practices.

It should be noted that current water demand are met with the existing water treatment plant staff and facilities. Increasing the pumping rates and total amounts of water produced will certainly require additional efforts in treatment plant staff time, pumping electrical costs, maintenance costs, monitoring costs, and chemical costs. While the increased water production rates are possible the increased costs associated with the increase should be considered. These impacts were not evaluated in this analysis.

The current City water system includes two water tanks. These tanks provide storage that allow the plant to be operated with minimal staffing and does not require multiple daily or night shifts to meet the daily demand. In the event of a break down at the plant or a break in a water line, there is typically capacity in the tanks to meet the existing daily demand while the problem is resolved. The existing surplus capacity may then be used to "catch up" and refill the storage tanks. This ability to handle emergency situations is decreased when the surplus supply is allocated to other customers and may make recovery difficult or limit service until the problem is resolved.

Future supply allocations should also consider the need for firefighting demand. The existing water tanks and supply lines currently serve the City's fire demand needs. It is not known if the existing system meets today's standards for fire protection flows. Any future supply allocations should include an analysis of storage and pipe system capacity to meet the fire demands of the new allocation.

Increased supply and demand through the existing system may impact the disinfection process of the water supply system. While the chlorine contact basin will certainly meet the chlorine contact time requirements, this evaluation did not consider the potential impacts on the chlorine residual or chlorine byproducts throughout the entire water delivery system. The operation of the water delivery system is very dynamic and City staff quite artfully operate the system to ensure a safe chlorine residual throughout the delivery system while minimizing the formation of chlorine byproducts. Any changes to the production, storage, and delivery of new water services should include an evaluation of the delivery and storage system with regards to disinfection and disinfection byproducts.

9. Recommendations

During the process of performing the pumping tests and evaluating the results there were a couple of performance items that should be evaluated.

The fluctuations in the wetwell water levels does not appear to be consistent with our understanding of how water enters the wetwell. This may indicate that subsurface conditions in the creek may vary with stream flow or the water level transducer or volume calculation are not functioning as expected. Erroneous reading from the wetwell level can cause the treatment plant to shut down prematurely. It is recommended that an evaluation of the wetwell water level transducer and volume calculation be verified.

It is also recommended that the flocculator be evaluated. In discussions with City staff it is clear that the flocculator does reduce sediment in the raw water as designed but it is not clear that it is functioning as indicated in the manufacturer's equipment specifications. Therefore an evaluation of how the flocculator is functioning should be performed to see if there are any modifications that could be made to increase its performance. Increased performance from the flocculator should decrease the turbidity of the raw water entering the filter trains. Less sediment entering the filters will allow longer runtimes between filter backwash cycles. Making changes to increase the performance of the flocculator could decrease operation costs and may increase production rates.

The findings and operational issues presented in this memorandum should be discussed and confirmed with the operators and engineers. This analysis and recommendations were limited to considering the theoretical effective maximum water production capacity of Trinidad's drinking water production facility under current conditions. This memo does not address policy issues related to providing additional connections or obligating the City to provide additional water. This analysis did not consider or address potential water storage needs, distribution network needs, nor any risk analysis of different system components. It is recommended that the City evaluate their policy for considering additional service requests. Additional evaluations are needed before making obligations for additional water supply to meet future service requests.