Memorandum

September 6, 2019

To:	Eli Naffah, City Manager	Ref. No.:	11198797
From:	Patrick Sullivan	Tel:	7074438326

Subject: City of Trinidad water demand and loss analysis

As the City of Trinidad considers its water supply needs, it is important to evaluate water losses within the existing system. Water losses are defined as water pumped and treated minus the water sold to clients. Identifying and eliminating system losses will have the effect of overall reducing water demand. This memorandum evaluates the amount of water the City produces and compares to the amount of water sold to quantify the amount of water lost in the system.

Water System Background

The City withdraws water from Luffenholtz Creek to meet the current demand from its customers. Raw water from Luffenholtz Creek is diverted through an infiltration gallery that feeds a wet well. The infiltration gallery allows water to flow into a wet well with intake pumps. Water is pumped from the wet well to a flocculator to reduces turbidity. The water is then pumped through a series of mixed media filters and then through a chlorine contact basin prior to entering the water storage and delivery system. The City has two water tanks that serve as a reservoir and supplies the water pressure for the City's piped delivery system. The City's delivery system has several miles of water pipes that convey the water from the treatment plant and storage tanks to the individual customers.

Water Loss

During the process of providing the City with potable water, some water is lost. To account for these losses, the City pumps more water than it provides to customers. Some of these losses are from expected uses and are typical for all water treatment and distribution systems. These include uses such as: backwashing the filters, backwashing gravel bed, flushing hydrants, firefighting and water quality instrument flushing. Water system losses due to expected factors typically accounts for 10% to 20% of the pumped water volume for most municipal water systems. There is also variability throughout the year as background raw water conditions vary. The primary factor is the raw water turbidity which is higher during storm events and higher flows in Luffenholtz Creek. Higher turbidity in the raw water requires more frequent backwashing of the filters. Operation conditions, like pumping at a higher rate or longer pumping duration may also necessitate more frequent backwashing of the filters. This may cause some variation in water loss that is due to seasonal variability of water use and stream conditions.

Water losses from other causes includes: metering errors, leaks in pipes and connections, and illicit connections. Water loss through leaks in pipes and connections is more common in older pipe systems and much of Trinidad's water system is in this category. If water losses are greater than 10% to 20%, identifying and eliminating these water losses could have the effect of decreasing the City's water demand.

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Water Pumping and Water Sales Records

The City records the amount of water pumped and the amount of water sold. The amount of water pumped is based upon the master flow meter that is located at the treatment plant. The amount of water sold is based upon totaling up the volume of all the water meters throughout the City. The water meters are totaled and recorded each month. To perform this comparative analysis, data from September 2012 to August 2019 were evaluated. The data is included in Appendix A (Figure A-1 and is graphically shown in Table A-1).

During this period, the monthly average water volume pumped was 2.1 million gallons and the monthly average water volume sold was 1.5 million gallons. The monthly average water loss was 0.6 million gallons with a monthly average water loss percent of 26.6%. There was a large amount of variability in the records with the lowest monthly water lost percent of 8.9% and the highest monthly water lost percent of 40.1%. These summary statistics are presented in Table 1.

Table 1. Monthly Water Pumped, Sold, and Lost Summary Statistics, September 2012 through August 2019

	Water Pumped (gallons)	Water Sold (gallons)	Water Lost (gallons)	Water Loss Percent
Minimum	1,354,490	1,040,922	123,795	8.9%
Maximum	3,314,731	2,434,805	1,117,590	40.1%
Average	2,105,045	1,542,084	562,960	26.6%

The City's water demand varies throughout the year with the highest demands in the months of July and August. The variation is apparent when the City's water pumping, sales and losses are averaged by each month, as shown in Figure 1 and Table 2.

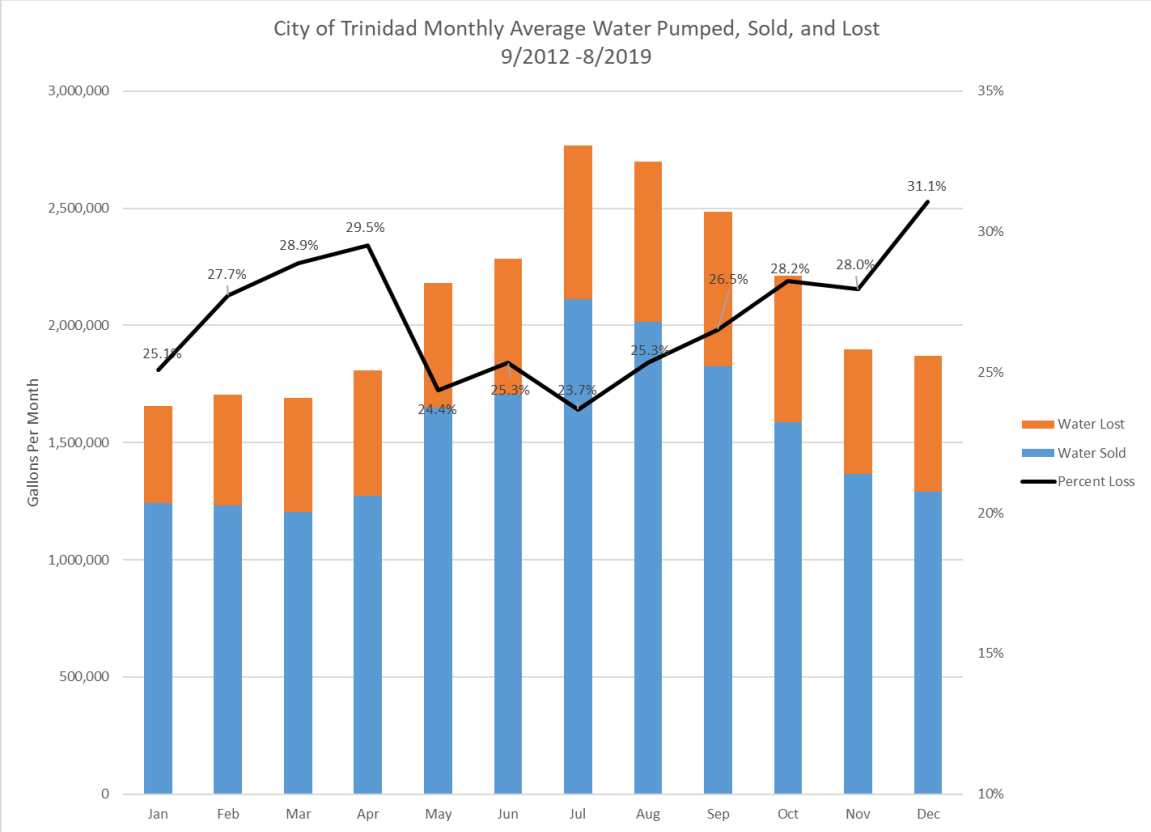

Figure 1. Monthly Water Pumped, Sold, and Lost, September 2012 through August 2019

Table 2. Water Production, Sales, and Loss by Month, September 2012 to August 2019

	Water Pumped (gallons)	Water Sold (gallons)	Water Lost (gallons)	Daily Average Water Pumped (gallons)	Daily Average Water Sold (gallons)	Daily Average Water Lost (gallons)	Percent Loss
Jan	1,657,941	1,242,005	415,936	53,482	40,065	13,417	25.1%
Feb	1,704,689	1,231,878	472,811	60,882	43,996	16,886	27.7%
Mar	1,691,881	1,203,217	488,664	54,577	38,813	15,763	28.9%
Apr	1,807,590	1,274,157	533,433	60,253	42,472	17,781	29.5%
May	2,182,550	1,650,742	531,807	70,405	53,250	17,155	24.4%
Jun	2,285,232	1,706,123	579,109	76,174	56,871	19,304	25.3%
Jul	2,766,948	2,111,838	655,110	89,256	68,124	21,133	23.7%
Aug	2,699,988	2,016,109	683,879	87,096	65,036	22,061	25.3%
Sep	2,485,415	1,826,054	659,361	82,847	60,868	21,979	26.5%
Oct	2,211,611	1,587,153	624,459	71,342	51,198	20,144	28.2%
Nov	1,897,107	1,366,799	530,308	63,237	45,560	17,677	28.0%
Dec	1,869,584	1,288,937	580,647	60,309	41,579	18,731	31.1%

Conclusion

The evaluation of the City's water production and sales records indicate that system water losses are in the range of 24% to 31% of the total water produced. These values are higher than typically expected for water systems of this type and indicate that there is a potential to reduce water demand by identifying and eliminating system losses. Possible causes for the water losses include the following and are further described below:

- Metering errors,
- Illicit connections
- Bulk water sales
- Leaks in pipes and connections

Water meters are installed at each service connection. Water meters have moving parts that wear with time and use. These meters were installed at various times and the usage for each varies. Therefore, errors in recording the quantities may vary slightly. The City regularly replaces old and worn meters when needed and meters are periodically tested to verify accuracy. Based upon discussions with the City's public works staff, it is estimated that the amount of error due to water meter accuracy is very low and not expected to be above

1%-2%. Errors with meters may cause an under reading or an over reading and with the number of meters in the system, these errors typically cancel out.

Illicit connections are unmetered connections made to the system without the knowledge or consent of the City. The City's public works staff regularly inspect the system while reading water meters. They do not suspect that any illicit connections have been made. When evidence of an illicit connection is discovered it is quickly resolved by City staff.

Another type of illicit connection is taking water from unmetered fire hydrants. This has not been observed in the Trinidad area but is a common problem in other areas. It typically occurs at night with a water truck hooking up to an unmetered hydrant to fill a water truck. This has become a problem in drought years when illegal marijuana grows and households on wells are in need of water. The higher loss rates during the summer months may be an indication of this type of water loss.

The City does sell water to a bulk water delivery company and sales are typically in the summer and fall months. This company fills water trucks from unmetered hydrants and delivers the water to people with water tanks for domestic use. The company pays the City based on the number of truck loads delivered and the City reports that water usage on an annual basis. Because the trucks are filled from unmetered hydrants, the amount of water sold appears as a water loss. The amount of water sold to bulk delivery ranges from 40 to 50 thousand gallons per year. This is about one days' worth of product or less than 0.3% of the total water produced.

The most likely cause for the high water loss rate is leaks in old pipes and connections. The City has made several efforts to locate leaks from connections. They have hired independent leak detection services to isolate individual leaks. While minor leaks were identified and resolved these leaks would have had only minor effect upon the overall losses in the system. The City's conveyance system of pipes is aging and much of it is constructed of AC (asbestos concrete) pipe. As this type of pipe ages it may become brittle and may form small leaks. When this occurs throughout the system the leaks can add up to a significant loss of water. The solution to this type of problem is to replace the old pipe. Leaks can be detected and sections prioritized for replacement by isolating sections of the system and measuring pressure loss over time.

Appendix A

Memorandum

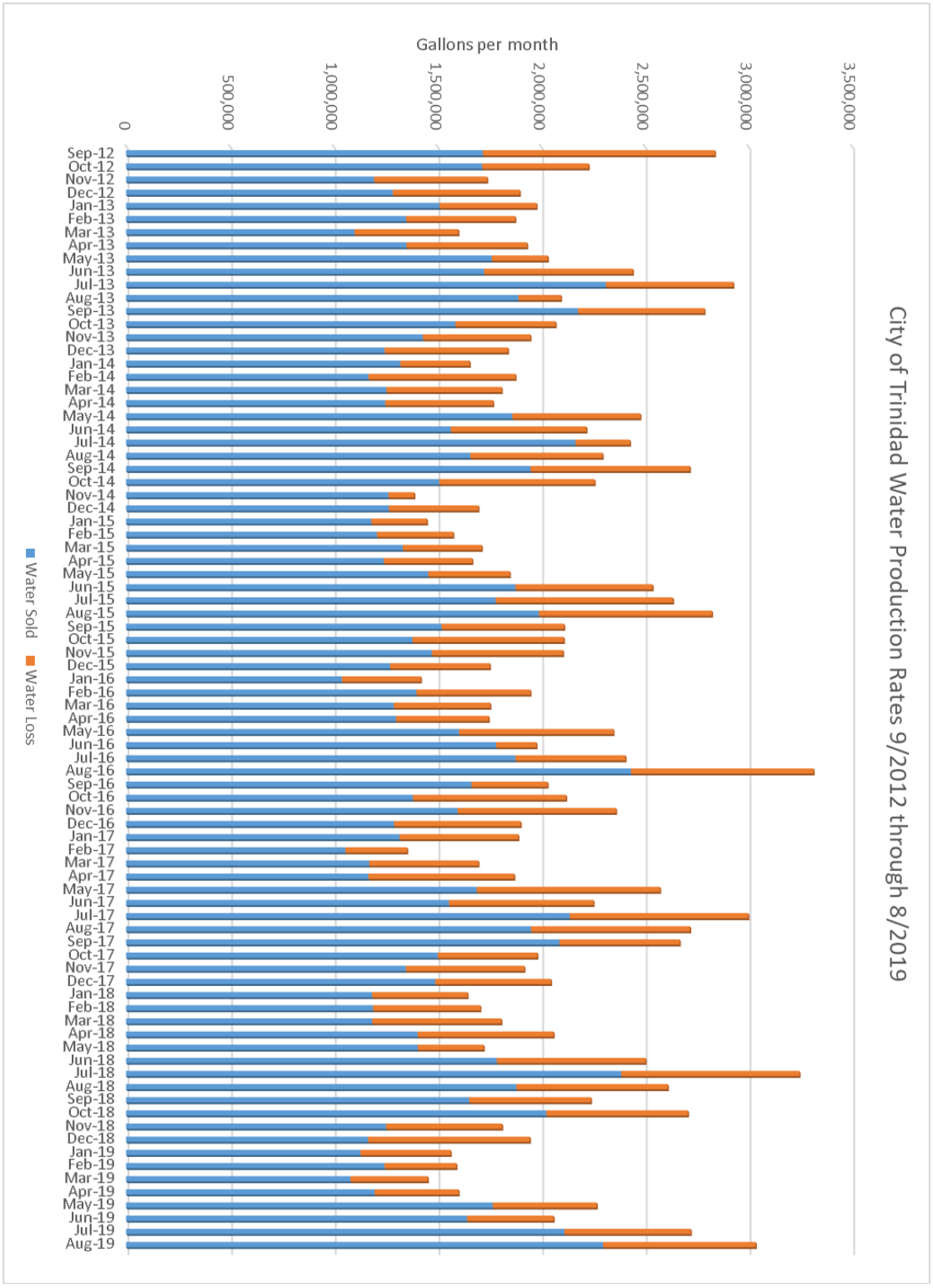

Figure A-1 Monthly Water Production Rates, September 2012 to August 2019

Appendix A

Table A-1. Water Production Data September 2012 to August 2019

Date	Water Pumped (gallons)	Water Sold (Gallons)	Water Lost (Gallons)	Percent Loss
Sep-12	2,838,790	1,721,200	1,117,590	39.37%
Oct-12	2,229,861	1,717,901	511,959	22.96%
Nov-12	1,740,724	1,195,522	545,203	31.32%
Dec-12	1,897,531	1,285,834	611,697	32.24%
Jan-13	1,978,336	1,511,918	466,418	23.58%
Feb-13	1,875,927	1,349,965	525,963	28.04%
Mar-13	1,601,811	1,101,536	500,275	31.23%
Apr-13	1,933,034	1,351,760	581,274	30.07%
May-13	2,032,944	1,763,353	269,590	13.26%
Jun-13	2,443,168	1,726,205	716,963	29.35%
Jul-13	2,927,000	2,314,114	612,886	20.94%
Aug-13	2,096,543	1,891,958	204,585	9.76%
Sep-13	2,788,297	2,179,105	609,191	21.85%
Oct-13	2,070,743	1,588,122	482,621	23.31%
Nov-13	1,949,132	1,431,128	518,004	26.58%
Dec-13	1,840,732	1,246,352	594,380	32.29%
Jan-14	1,656,217	1,322,556	333,661	20.15%
Feb-14	1,877,229	1,169,400	707,829	37.71%
Mar-14	1,810,323	1,255,209	555,114	30.66%
Apr-14	1,769,225	1,250,040	519,185	29.35%
May-14	2,479,373	1,862,358	617,016	24.89%
Jun-14	2,219,051	1,565,561	653,491	29.45%
Jul-14	2,429,269	2,167,189	262,080	10.79%
Aug-14	2,296,961	1,660,354	636,607	27.72%
Sep-14	2,717,793	1,950,164	767,629	28.24%
Oct-14	2,258,661	1,509,973	748,688	33.15%
Nov-14	1,388,998	1,265,203	123,795	8.91%
Dec-14	1,698,115	1,267,200	430,915	25.38%
Jan-15	1,449,702	1,182,648	267,055	18.42%
Feb-15	1,576,707	1,209,839	366,867	23.27%
Mar-15	1,714,318	1,334,166	380,153	22.18%
Apr-15	1,668,119	1,242,836	425,283	25.49%
May-15	1,849,431	1,456,951	392,480	21.22%

Date	Water Pumped (gallons)	Water Sold (Gallons)	Water Lost (Gallons)	Percent Loss
Jun-15	2,538,275	1,877,842	660,433	26.02%
Jul-15	2,636,382	1,782,503	853,879	32.39%
Aug-15	2,824,697	1,991,038	833,659	29.51%
Sep-15	2,111,646	1,521,321	590,325	27.96%
Oct-15	2,110,045	1,381,465	728,580	34.53%
Nov-15	2,106,447	1,475,024	631,423	29.98%
Dec-15	1,753,726	1,273,461	480,264	27.39%
Jan-16	1,420,775	1,040,922	379,853	26.74%
Feb-16	1,949,035	1,400,084	548,950	28.17%
Mar-16	1,755,424	1,290,539	464,884	26.48%
Apr-16	1,748,123	1,301,543	446,580	25.55%
May-16	2,349,265	1,605,761	743,504	31.65%
Jun-16	1,978,037	1,784,545	193,491	9.78%
Jul-16	2,407,665	1,877,700	529,965	22.01%
Aug-16	3,314,731	2,434,805	879,926	26.55%
Sep-16	2,031,335	1,665,478	365,857	18.01%
Oct-16	2,120,944	1,383,096	737,849	34.79%
Nov-16	2,361,862	1,598,325	763,537	32.33%
Dec-16	1,901,930	1,291,991	609,939	32.07%
Jan-17	1,890,634	1,319,541	571,093	30.21%
Feb-17	1,354,490	1,057,701	296,790	21.91%
Mar-17	1,698,265	1,172,183	526,083	30.98%
Apr-17	1,870,871	1,168,779	702,092	37.53%
May-17	2,574,481	1,690,919	883,562	34.32%
Jun-17	2,253,252	1,556,838	696,414	30.91%
Jul-17	2,999,509	2,139,743	859,766	28.66%
Aug-17	2,719,491	1,952,326	767,165	28.21%
Sep-17	2,669,289	2,090,027	579,262	21.70%
Oct-17	1,982,241	1,503,053	479,187	24.17%
Nov-17	1,919,958	1,348,887	571,070	29.74%
Dec-17	2,048,316	1,491,137	557,179	27.20%
Jan-18	1,645,812	1,186,523	459,289	27.91%
Feb-18	1,707,421	1,190,166	517,256	30.29%
Mar-18	1,808,722	1,187,173	621,549	34.36%

Date	Water Pumped (gallons)	Water Sold (Gallons)	Water Lost (Gallons)	Percent Loss
Apr-18	2,060,943	1,405,874	655,069	31.78%
May-18	1,723,497	1,407,131	316,366	18.36%
Jun-18	2,504,097	1,787,919	716,178	28.60%
Jul-18	3,246,523	2,387,984	858,539	26.44%
Aug-18	2,611,382	1,882,024	729,358	27.93%
Sep-18	2,240,752	1,655,080	585,672	26.14%
Oct-18	2,708,786	2,026,458	682,328	25.19%
Nov-18	1,812,627	1,253,503	559,124	30.85%
Dec-18	1,946,738	1,166,587	780,151	40.07%
Jan-19	1,564,109	1,129,925	434,184	27.76%
Feb-19	1,592,012	1,245,993	346,019	21.73%
Mar-19	1,454,303	1,081,713	372,590	25.62%
Apr-19	1,602,814	1,198,267	404,547	25.24%
May-19	2,268,857	1,768,724	500,133	22.04%
Jun-19	2,060,741	1,643,949	416,792	20.23%
Jul-19	2,722,288	2,113,636	608,653	22.36%
Aug-19	3,036,111	2,300,260	735,851	24.24%