



## MEMORANDUM

**To:** Chris Johnson  
**From:** Ed Castle, PE  
**Date:** June 27, 2017  
**Re:** Biosolids Disposal Costs

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The KW Resort Utilities Corp. (KWRU) drying beds have a limited capacity. Based on historical operating records, the beds are capable of processing approximately 80 dry tons per year. As the flows at the WWTP increase, biosolids production has also increased. In 2016 and 2017, during peak loading periods, the drying beds were not able to process all of the biosolids, resulting in the need to haul liquid sludge.

As flows continue to increase, the quantity of biosolids that can't be processed on the drying beds will also increase. To determine the most economical method of disposal of the excess biosolids, I have used future flow projections to calculate future biosolids disposal needs. I then produced cost estimates for three different options for processing and disposal of the excess biosolids. The three methods are:

1. Haul liquid biosolids at 2% solids to a sludge disposal center
2. Purchase a centrifuge and haul biosolids cake at 20% solids to a landfill
3. Purchase a screw press and haul biosolids cake at 16% solids to a landfill

The table below summarizes the predicted biosolids hauling cost year by year.

Year	Excess Dry Tons	Drying Bed Hauling Cost	Additional Cost with Centrifuge	Additional Cost with Screw Press	Additional Cost with Liquid	Total Cost with Centrifuge	Total Cost with Screw Press	Total Cost with Liquid
2017	26.9	\$48,384.92	\$161,220.25	\$105,333.90	\$98,359.34	\$209,605.18	\$153,718.82	\$146,744.27
2018	30.2	\$52,917.75	\$168,751.13	\$113,060.90	\$111,941.73	\$221,668.88	\$165,978.65	\$164,859.48
2019	35.7	\$54,377.75	\$179,158.98	\$125,797.93	\$134,101.86	\$233,536.73	\$180,175.68	\$188,479.61
2020	41.5	\$56,320.46	\$191,285.68	\$139,730.87	\$158,564.66	\$247,606.14	\$196,051.33	\$214,885.12
2021	47.6	\$58,400.74	\$204,057.92	\$154,462.60	\$184,575.18	\$262,458.66	\$212,863.34	\$242,975.91
2022	53.9	\$60,577.19	\$217,497.40	\$170,020.18	\$212,186.99	\$278,074.59	\$230,597.37	\$272,764.18
2023	60.7	\$62,852.94	\$231,993.61	\$186,886.33	\$242,324.66	\$294,846.55	\$249,739.28	\$305,177.60
2024	67.7	\$65,279.03	\$247,965.13	\$204,647.82	\$274,201.26	\$313,244.16	\$269,926.85	\$339,480.29
2025	71.4	\$67,812.32	\$257,133.31	\$215,843.02	\$293,542.76	\$324,945.63	\$283,655.35	\$361,355.08
2026	75.3	\$69,667.52	\$266,898.99	\$227,258.55	\$314,312.03	\$336,566.51	\$296,926.06	\$383,979.54
2027	76.8	\$71,613.14	\$287,687.24	\$239,590.52	\$325,486.78	\$359,300.38	\$311,203.66	\$397,099.92
2028	77.5	\$73,042.82	\$291,188.65	\$243,650.39	\$333,179.22	\$364,231.48	\$316,693.21	\$406,222.04
2029	77.5	\$74,293.11	\$293,558.83	\$246,303.90	\$338,176.91	\$367,851.93	\$320,597.00	\$412,470.01
2030	77.5	\$75,407.50	\$295,964.56	\$248,997.21	\$343,249.56	\$371,372.06	\$324,404.71	\$418,657.06

In the near term, hauling liquid is the most cost effective means of disposal. In 2019, liquid hauling begins to be more costly than the centrifuge and screw press options, with the screw press being most cost effective.

Costs for the three options include hauling and disposal costs, capital equipment costs, labor costs, energy costs, chemical costs and equipment maintenance costs. Details are provided in the following pages.

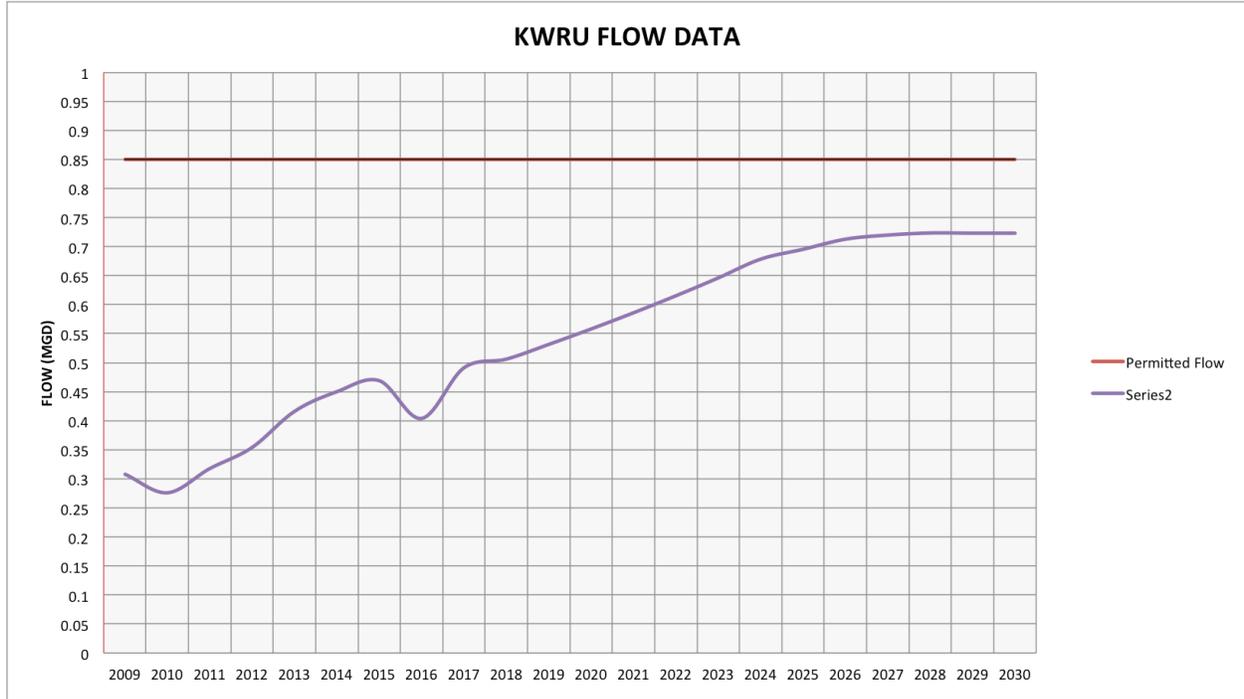
## BIOSOLIDS PRODUCTION AND HAULING COSTS

The table below presents estimates for the annual biosolids production based on the predicate WWTP flows and calculates the annual excess biosolids that cannot be processed on the drying beds. The excess mass of biosolids is then used to calculate the costs of processing and disposal for each of the three options under consideration.

Year	Flow, AADF MGD	Dry Solid, Ton	Drying Bed Dry Tons	Excess Dry Tons	Drying Bed Wet Tons	Centrifuge Wet Tons	Screw Press Wet Tons	Liquid Gallons	Centrifuge Hauling Cost	Screw Press Hauling Cost	Liquid Hauling cost	Drying Bed Hauling Cost
2016	0.404	88.0	80.0	8.0	166.7	40.0	50.0	95,923	\$11,612.80	\$14,516.00	\$28,776.98	\$48,384.92
2017	0.491	106.9	80.0	26.9	179.6	134.7	168.4	323,019	\$39,692.40	\$49,615.50	\$98,359.34	\$52,917.75
2018	0.506	110.2	80.0	30.2	181.8	151.0	188.8	362,192	\$45,173.50	\$56,466.88	\$111,941.73	\$54,377.75
2019	0.531	115.7	80.0	35.7	185.5	178.3	222.8	427,480	\$54,116.11	\$67,645.13	\$134,101.86	\$56,320.46
2020	0.558	121.5	80.0	41.5	189.5	207.7	259.6	497,990	\$63,987.94	\$79,984.93	\$158,564.66	\$58,400.74
2021	0.586	127.6	80.0	47.6	193.7	238.2	297.7	571,113	\$74,484.35	\$93,105.44	\$184,575.18	\$60,577.19
2022	0.615	133.9	80.0	53.9	198.0	269.7	337.2	646,847	\$85,626.96	\$107,033.70	\$212,186.99	\$62,852.94
2023	0.646	140.7	80.0	60.7	202.6	303.5	379.4	727,803	\$97,788.85	\$122,236.07	\$242,324.66	\$65,279.03
2024	0.678	147.7	80.0	67.7	207.3	338.3	422.9	811,372	\$110,652.49	\$138,315.62	\$274,201.26	\$67,812.32
2025	0.695	151.4	80.0	71.4	209.9	356.9	446.1	855,767	\$118,457.65	\$148,072.07	\$293,542.76	\$69,667.52
2026	0.713	155.3	80.0	75.3	212.5	376.5	470.6	902,775	\$126,838.98	\$158,548.73	\$314,312.03	\$71,613.14
2027	0.720	156.8	80.0	76.8	213.6	384.1	480.1	921,055	\$131,348.50	\$164,185.62	\$325,486.78	\$73,042.82
2028	0.723	157.5	80.0	77.5	214.0	387.3	484.2	928,890	\$134,452.74	\$168,065.93	\$333,179.22	\$74,293.11
2029	0.723	157.5	80.0	77.5	214.0	387.3	484.2	928,890	\$136,469.53	\$170,586.91	\$338,176.91	\$75,407.50
2030	0.723	157.5	80.0	77.5	214.0	387.3	484.2	928,890	\$138,516.57	\$173,145.72	\$343,249.56	\$76,538.61

# FUTURE FLOW ESTIMATES

Future flows were predicted by updating the flow projections previously submitted to the Public Services Commission. It is noted that some specific anticipated property redevelopment projects did not occur as quickly as previously anticipated. To correct for this, the time of connection of the various projects has been extended, resulting in the data below. These Annual Average Daily Flow projections were used to calculate the increasing quantities of biosolids as the WWTP flow increases.



	Year	AADF	Permitted Flow
Recorded Flow	2009	0.308	0.850
Recorded Flow	2010	0.276	0.850
Recorded Flow	2011	0.318	0.850
Recorded Flow	2012	0.354	0.850
Recorded Flow	2013	0.416	0.850
Recorded Flow	2014	0.450	0.850
Recorded Flow	2015	0.469	0.850
Recorded Flow	2016	0.404	0.850
Add .026 for Oceanside & .0303 for SIMV	2017	0.491	0.850
Add .015 for Sunset Marina	2018	0.506	0.850
Add 5% for misc redevelopment, infill	2019	0.531	0.850
Add 5% for misc redevelopment, infill	2020	0.558	0.850
Add 5% for misc redevelopment, infill	2021	0.586	0.850
Add 5% for misc redevelopment, infill	2022	0.615	0.850
Add 5% for misc redevelopment, infill	2023	0.646	0.850
Add 5% for misc redevelopment, infill	2024	0.678	0.850
Add 2.5% for misc redevelopment, infill	2025	0.695	0.850
Add 2.5% for misc redevelopment, infill	2026	0.713	0.850
Add 1% for misc redevelopment, infill	2027	0.720	0.850
Add 0.5% for misc redevelopment, infill	2028	0.723	0.850
Buildout achieved	2029	0.723	0.850
Buildout achieved	2030	0.723	0.850

## CENTRIFUGE COST ESTIMATES

A trailer-mounted centrifuge was selected for this estimate since it will be a lower cost option than constructing a permanent mounting and enclosure system.

The capital cost was estimated using the 2010 purchase price of an appropriately sized unit that was purchased by the City of Marathon, using competitive bidding. Sales tax was added to the 2010 purchase price. Then the cost was increased by applying the annual CPI for South Florida for each year as follows.

2010 Cost, pre-tax	\$622,000.00
Sales Tax	\$37,395.00
Total Cost 2010	\$659,395.00
2011 cost (CPI 3.0)	\$679,176.85
2012 Cost (CPI 1.7)	\$690,722.86
2013 Cost (CPI 1.5)	\$701,083.70
2014 Cost (CPI 0.8)	\$706,692.37
2015 Cost (CPI 0.7)	\$711,639.22
2016 Cost (CPI 2.1)	\$726,583.64
<b>2017 Cost (CPI 2.8 as of April)</b>	<b>\$746,927.98</b>

The centrifuge has an expected life of 10 years. The cost projections for the centrifuge option include purchasing a new centrifuge in 2027. The cost of the centrifuge in 2027 was estimated by assuming a 1.5% per year increase. This cost was also amortized over 10 years, with the annual payments being included in the centrifuge costs.

The centrifuge operating cost was estimated using the biosolids quantities for each year as shown in the following table.

Year	Centrifuge Run Time, Hours	Batches Per Year	Labor Time, 10 hours per batch	Electricity	Polymer	Loaded Labor Cost	Annual Centrifuge Operating Cost
2016	16.0	3	30.0	\$349.16	\$600.00	\$1,875.15	\$2,824.31
2017	53.8	9	90.0	\$1,047.47	\$2,020.49	\$5,723.90	\$8,791.85
2018	60.4	11	110.0	\$1,280.24	\$2,265.51	\$6,995.87	\$10,541.63
2019	71.2	12	120.0	\$1,396.63	\$2,673.89	\$7,631.86	\$11,702.37
2020	83.0	14	140.0	\$1,629.40	\$3,114.93	\$8,903.84	\$13,648.17
2021	95.2	16	160.0	\$1,862.17	\$3,572.31	\$10,175.81	\$15,610.30
2022	107.8	18	180.0	\$2,094.94	\$4,046.03	\$11,447.79	\$17,588.76
2023	121.3	20	200.0	\$2,327.72	\$4,552.41	\$12,719.77	\$19,599.89
2024	135.2	23	230.0	\$2,676.87	\$5,075.13	\$14,627.73	\$22,379.73
2025	142.6	24	240.0	\$2,793.26	\$5,352.83	\$15,263.72	\$23,409.80
2026	150.5	25	250.0	\$2,909.64	\$5,646.86	\$15,899.71	\$24,456.21
2027	153.5	26	260.0	\$3,026.03	\$5,761.20	\$16,535.70	\$25,322.93
2028	154.8	26	260.0	\$3,026.03	\$5,810.21	\$16,535.70	\$25,371.93
2029	154.8	26	260.0	\$3,026.03	\$5,810.21	\$16,535.70	\$25,371.93
2030	154.8	26	260.0	\$3,026.03	\$5,810.21	\$16,535.70	\$25,371.93

The total annual cost for the centrifuge options was estimated assuming a 4% interest rate and an annual CPI increase of 1.75%. The table below summarizes the costs.

Year	Loan Payment	Operating Cost	Maintenance Cost	Hauling Cost	Total Annual Cost
2017	\$92,736.00	\$8,791.85	\$20,000.00	\$39,692.40	<b>\$161,220.25</b>
2018	\$92,736.00	\$10,541.63	\$20,300.00	\$45,173.50	<b>\$168,751.13</b>
2019	\$92,736.00	\$11,702.37	\$20,604.50	\$54,116.11	<b>\$179,158.98</b>
2020	\$92,736.00	\$13,648.17	\$20,913.57	\$63,987.94	<b>\$191,285.68</b>
2021	\$92,736.00	\$15,610.30	\$21,227.27	\$74,484.35	<b>\$204,057.92</b>
2022	\$92,736.00	\$17,588.76	\$21,545.68	\$85,626.96	<b>\$217,497.40</b>
2023	\$92,736.00	\$19,599.89	\$21,868.87	\$97,788.85	<b>\$231,993.61</b>
2024	\$92,736.00	\$22,379.73	\$22,196.90	\$110,652.49	<b>\$247,965.13</b>
2025	\$92,736.00	\$23,409.80	\$22,529.85	\$118,457.65	<b>\$257,133.31</b>
2026	\$92,736.00	\$24,456.21	\$22,867.80	\$126,838.98	<b>\$266,898.99</b>
2027	\$107,805.00	\$25,322.93	\$23,210.82	\$131,348.50	<b>\$287,687.24</b>
2028	\$107,805.00	\$25,371.93	\$23,558.98	\$134,452.74	<b>\$291,188.65</b>
2029	\$107,805.00	\$25,371.93	\$23,912.36	\$136,469.53	<b>\$293,558.83</b>
2030	\$107,805.00	\$25,371.93	\$24,271.05	\$138,516.57	<b>\$295,964.56</b>

## SCREW PRESS COST ESTIMATES

A skid-mounted screw press was selected for this estimate since it will be a lower cost option than constructing a permanent mounting and enclosure system.

The screw press operating cost was estimated using the biosolids quantities for each year as shown in the following table.

Year	Screw Press Run Time, Hours	Batches Per Year	Labor Time, 8 hours per batch	Electricity	Polymer	Loaded Labor Cost	Annual Screw Press Operating Cost
2016	32.0	5.0	40.0	\$46.55	\$600.00	\$2,500.20	\$3,146.75
2017	53.8	9.0	72.0	\$83.80	\$2,020.49	\$4,579.12	\$6,683.40
2018	60.4	10.0	80.0	\$93.11	\$2,265.51	\$5,087.91	\$7,446.53
2019	71.2	12.0	96.0	\$111.73	\$2,673.89	\$6,105.49	\$8,891.10
2020	83.0	14.0	112.0	\$130.35	\$3,114.93	\$7,123.07	\$10,368.35
2021	95.2	16.0	128.0	\$148.97	\$3,572.31	\$8,140.65	\$11,861.93
2022	107.8	18.0	144.0	\$167.60	\$4,046.03	\$9,158.23	\$13,371.85
2023	121.3	20.0	160.0	\$186.22	\$4,552.41	\$10,175.81	\$14,914.44
2024	135.2	22.0	176.0	\$204.84	\$5,075.13	\$11,193.40	\$16,473.36
2025	142.6	24.0	192.0	\$223.46	\$5,352.83	\$12,210.98	\$17,787.26
2026	150.5	25.0	200.0	\$232.77	\$5,646.86	\$12,719.77	\$18,599.39
2027	153.5	26.0	208.0	\$242.08	\$5,761.20	\$13,228.56	\$19,231.84
2028	154.8	26.0	208.0	\$242.08	\$5,810.21	\$13,228.56	\$19,280.85
2029	154.8	26.0	208.0	\$242.08	\$5,810.21	\$13,228.56	\$19,280.85
2030	154.8	26.0	208.0	\$242.08	\$5,810.21	\$13,228.56	\$19,280.85

The total annual cost for the screw press option was estimated assuming a 4% interest rate and an annual CPI increase of 1.75%. The initial capital cost was based on an budgetary estimate provided by a vendor in 2017. The table below summarizes the costs.

<b>Year</b>	<b>Loan Payment</b>	<b>Operating Cost</b>	<b>Maintenance Cost</b>	<b>Hauling Cost</b>	<b>Total Annual Cost</b>
2017	\$41,535.00	\$6,683.40	\$7,500.00	\$49,615.50	<b>\$105,333.90</b>
2018	\$41,535.00	\$7,446.53	\$7,612.50	\$56,466.88	<b>\$113,060.90</b>
2019	\$41,535.00	\$8,891.10	\$7,726.69	\$67,645.13	<b>\$125,797.93</b>
2020	\$41,535.00	\$10,368.35	\$7,842.59	\$79,984.93	<b>\$139,730.87</b>
2021	\$41,535.00	\$11,861.93	\$7,960.23	\$93,105.44	<b>\$154,462.60</b>
2022	\$41,535.00	\$13,371.85	\$8,079.63	\$107,033.70	<b>\$170,020.18</b>
2023	\$41,535.00	\$14,914.44	\$8,200.82	\$122,236.07	<b>\$186,886.33</b>
2024	\$41,535.00	\$16,473.36	\$8,323.84	\$138,315.62	<b>\$204,647.82</b>
2025	\$41,535.00	\$17,787.26	\$8,448.69	\$148,072.07	<b>\$215,843.02</b>
2026	\$41,535.00	\$18,599.39	\$8,575.42	\$158,548.73	<b>\$227,258.55</b>
2027	\$47,469.00	\$19,231.84	\$8,704.06	\$164,185.62	<b>\$239,590.52</b>
2028	\$47,469.00	\$19,280.85	\$8,834.62	\$168,065.93	<b>\$243,650.39</b>
2029	\$47,469.00	\$19,280.85	\$8,967.14	\$170,586.91	<b>\$246,303.90</b>
2030	\$47,469.00	\$19,280.85	\$9,101.64	\$173,145.72	<b>\$248,997.21</b>