

Appendix D

Tanglewood Pump Station Capacity Allocation Evaluation

Highfill Engineering



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TECHNICAL MEMORANDUM

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Subject: Tanglewood Wastewater Pump Station Capacity Evaluation



1 Background

Tanglewood Pump Station is located in the southwestern part of the City/County Utility Commission (CCUC) collection system in the Yadkin River drainage basin. Pump controls, switchgear, and other electrical equipment are located remotely from the pump wet well on higher ground to protect against flooding. Tanglewood Pump Station receives flow from gravity systems and two pump station force mains. One force main comes from CCUC's Fair Oaks Pump Station, and the other comes from the Davie County Yadkin River Pump Station.

Tanglewood Pump Station is equipped with two submersible pumps, each with a rated capacity of approximately 2,700 gpm (3.9 MGD). Approximately 15,000 feet of 18-inch force main delivers pumped wastewater to a manhole located near the intersection of Hampton Burg Road and Hampton Road. From there, it flows by gravity to the Muddy Creek interceptor and wastewater treatment plant. CCUC does not have a flow meter on the Tanglewood pump station, but staff does track pump run times and average pumping rates.

In 2008, CCUC hired a consultant to perform an evaluation of how to expand Tanglewood Pump Station. Results from that evaluation were included in a report called "Study of Tanglewood Wastewater Pump Station" prepared by Diehl & Phillips, dated May 2008. However, that evaluation did not contemplate when Tanglewood Pump Station would need to be expanded or if additional capacity is available for allocation.

CCUC currently has an agreement with Davie County for 550,000 GPD (average daily flow) of capacity through Tanglewood Pump Station until 2030. A copy of the agreement is included in Appendix A. Current flows from Davie County account for 47% of their allotment; however, they appear to have committed all of their allocated capacity. Additionally, the Town of Bermuda Run is growing, and they are considering options to either expand their wastewater treatment plant or pump their wastewater to

CCUC. In a memorandum dated August 25, 2010, Bermuda Run's Town Manager outlined their future wastewater plans and made an initial request for an addition 200,000 GPD (average daily flow) capacity through the Tanglewood Pump Station system. A copy of the flow request Memorandum is also included in Appendix A.

The purpose of the capacity evaluation described in this Technical Memorandum is to:

1. estimate when the Tanglewood pumping system will need to be expanded, and
2. determine if the station's capacity will allow an increased allocation to Davie County.

2 Existing Pump Station Capacity and Flows

2.1 Existing Pump Station Capacity

To assure adequate on-line redundancy, pump stations are rated according to their pumping capacity with the largest pumping unit out of service. This condition is commonly referred to as the "firm capacity". Based on field testing by CCUC, the firm capacity of the pump station is reported as 2,700 gpm (3.9 MGD). CCUC staff performs draw-down tests at least once per year to keep these flow rates updated to account for impeller wear that can reduce pump performance over time. When new, the pumps are rated for about 2,800 gpm as documented in "Study of Tanglewood Wastewater Pump Station" prepared by Diehl & Phillips, dated May 2008. For the purpose of this evaluation, a firm capacity of 2,700 gpm (3.9 MGD) was used to reflect the most current test data.

2.2 Existing Pump Station Influent Flows

Tanglewood Pump Station is not equipped with a flow meter to capture historical flow information. Current average daily flow (ADF) was estimated by CCUC staff using pump draw-down test data and 12 months of recorded pump run-times. There are some simplifications and assumptions to consider when estimating flow rates in this manner. Listed below are limitations of this simplified flow estimating method:

- This method assumes that the pumping rate measured in the draw-down test is constant any time the pumps are running. Since the pumps are centrifugal-type pumps, the flow rate actually changes somewhat depending on the wet well water depth.
- This method assumes that only one pump runs at any given time. It is our understanding that on a typical day, only one pump runs at any given time at this pump station.

Using the procedure described, the current average daily flow at the Tanglewood pump station is estimated at 1,116,500 GPD (based on January – September, 2010 flow data). Table 1 below provides a breakdown of flows by jurisdiction:

Wastewater Source	Average Daily Flow (GPD)
Davie County	258,500
Clemmons	858,000
Total (2010)	1,116,500

Table 1 – Tabulation of Current Wastewater Flows

Peak hourly flows were estimated by applying peaking factors to average daily flows. Since historical peak flow rates were not available for this station, industry-accepted planning factors were applied based on “Recommended Standards for Wastewater Facilities” prepared by the Great Lakes–Upper Mississippi Board of States and Provincial Public Health and Environmental Managers, commonly referred to as the “10-State Standards”. The published peaking factors are a function of average daily flow, and assume that wet weather flows are maintained within normal industry inflow and infiltration standards.

The Diehl & Phillips “Study of Tanglewood Wastewater Pump Station” documents temporary pump station flow monitoring performed in May 2008. Although their monitoring was performed for a short period, the average-day-to-peak-hourly-flow factors from two storms (2.8 and 3.3) were similar to the industry standard 10-State Standards recommended planning factor (2.92) for the average daily flow recorded at that time.

Table 2 below tabulates the average daily flow, peak hourly flow, and remaining pump station capacity.

Average Daily Flow	1,116,500 GPD (1.12 MGD)
AD:PH Peaking Factor	2.91
Estimated Peak Hourly Flow	3,240,000 GPD (3.24 MGD)
Pump Station Firm Capacity	3,888,000 GPD (3.89 MGD)
Unused Peak Capacity	648,000 GPD (0.648 MGD)

Table 2 – 2010 Comparison of Flows to PS Capacity

3 Future Pump Station Expansion and Projected Future Flows

3.1 Future Pump Station Capacity

The 2008 Diehl & Phillips "Study of Tanglewood Wastewater Pump Station" indicates that the most logical Tanglewood Pump Station capacity expansion is an increase to 3,500 gpm (5.0 MGD). Improvements required to get the system to this capacity are significant and include the installation of a new pump station and force main to reduce the discharge pressure on the Tanglewood pumps. Accommodating peak flows higher than 5.0 MGD would require significantly larger improvements to the pump station electrical systems, mechanical systems, and downstream sewers.

3.2 Future Service Area Flows

Future planning data was not readily available for the Tanglewood service area. To refine future flow projections, meetings were held with key staff familiar with the served jurisdictions.

On October 19, 2010 we met with Lee Rollins, Town Manager of Bermuda Run; Terry Bralley, Davie County Economic Development Commission President; and representatives of Grey Engineering, Inc., the Town and County's Engineer. The Town is being contacted by developers wanting wastewater capacity, but the Town has no capacity left to offer within the current 550,000 GPD allotment from CCUC. The proposed regional hospital/healthplex and surrounding parcel development, area retailers, and service to an existing residential neighborhood with failing septic tanks require the Town to find additional capacity. Town staff was not able to provide a projected timeline for when wastewater flow generators would be operational; however, they indicated that they need more capacity immediately to serve their constituents. In addition, they are working on a comprehensive wastewater plan that will address their future wastewater capacity needs.

On October 28, 2010 we met with Bill Shookman, Senior Engineering Technician with CCUC, to discuss projected growth in the Clemmons jurisdiction. Mr. Shookman tracks flow allocation requests and has extensive knowledge of proposed developments within the Tanglewood service area. Discussions revealed that the areas upstream of the Fair Oaks pump station are built-out. Tanglewood also serves two sub-basins by gravity: Village Point and East Gravity.

Currently, the Village Point area is undeveloped; however, there is now a school under construction within this sub-basin. The Village Point area has been through a master planning process by a private development group and has been allocated an average daily flow of 342,100 GPD.

The East Gravity area is about 70% developed with existing flows of 561,900 GPD and estimated undeveloped flows of approximately 234,000 GPD. The undeveloped area flows were based on zoning, so actual post-development flows could vary.

While these meetings produced guidance on build-out future flow needs for the Tanglewood Pump Station service area, there was no reliable information available about the pace at which the growth would occur. As such, the following methodologies were used to develop growth rates for the service area:

- **Davie County future flow estimates:** Historical flows from Davie County were evaluated over a seven-year. From October 2003 to October 2010, the Davie County flow rates grew at a compounding rate of 21.1% per year. From October 2007 to October 2010, an economically depressed time for most of North Carolina, the Davie County flow rates grew at a compounding rate of 8.6% per year. Future flow rates were projected from 2010 through 2015 at the historical depressed rate of 8.6% per year. From 2015 through 2030, future flow rates were projected at the seven-year average rate of 21.1% per year. The projected flow rates reached the flow allocation limit prior to 2020. Flow rates were capped and held constant thereafter.
- **Clemmons area future flow estimates:** Future flows were projected to be consistent with planning figures used by CCUC in water system planning. The 2008 "Water System Master Plan" developed by Hazen and Sawyer used Traffic Analysis Zones (TAZ) to develop projected growth across the CCUC water distribution system. The 982-foot pressure zone includes Clemmons and the Tanglewood pump station service area. Growth with this pressure zone from 2010 to 2020 was projected at an annual rate of 4.75%. Growth from 2020 to 2030 was projected at an annual rate of 3.84%. The projected flow reached theoretical build-out prior to 2030. Flow rates were capped and held constant thereafter.

Table 3 below outlines the projected peak flow rates with the current 550,000 GPD allocation to Davie County in five-year increments. More detailed flow tabulations are included in Appendix B. Figure 1, imbedded below the table, shows how the projected peak flows compare to the current pump station capacity and the readily expandable pump station capacity of 5.0 MGD.

Year	Average Daily Flow (MGD)	Peaking Factor	Peak Hourly Flow (MGD)
2010	1.12	2.91	3.24
2015	1.47	2.79	4.10
2020	1.91	2.67	5.11
2025	2.20	2.61	5.74
2030	2.25	2.60	5.85

Table 3 – Projected Flows *excluding* Town of Bermuda Run 200,000 GPD Request

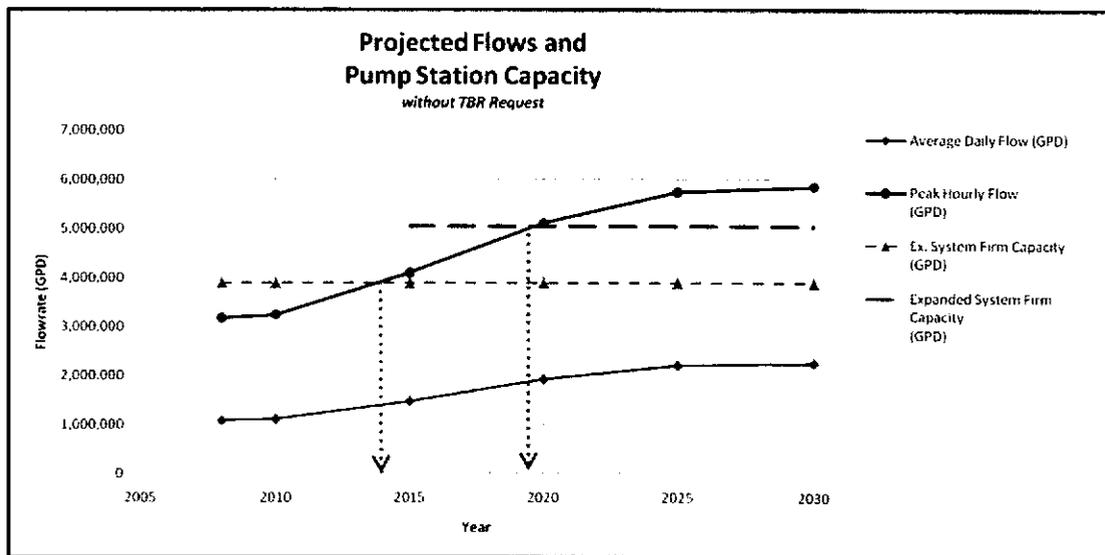


Figure 1 – Projected Flows *excluding* Town of Bermuda Run 200,000 GPD Request

Table 4 outlines the same information but includes the 200,000 GPD additional allocation requested by the Town of Bermuda Run. Figure 2, imbedded below the table, shows how the projected peak flows compare to the current pump station capacity and the readily expandable pump station capacity of 5.0 MGD.

Year	Average Daily Flow (MGD)	Peaking Factor	Peak Hourly Flow (MGD)
2010	1.12	2.91	3.24
2015	1.47	2.79	4.10
2020	2.11	2.63	5.56
2025	2.40	2.57	6.17
2030	2.45	2.56	6.28

Table 4 – Projected Flows *including* Town of Bermuda Run 200,000 GPD Request

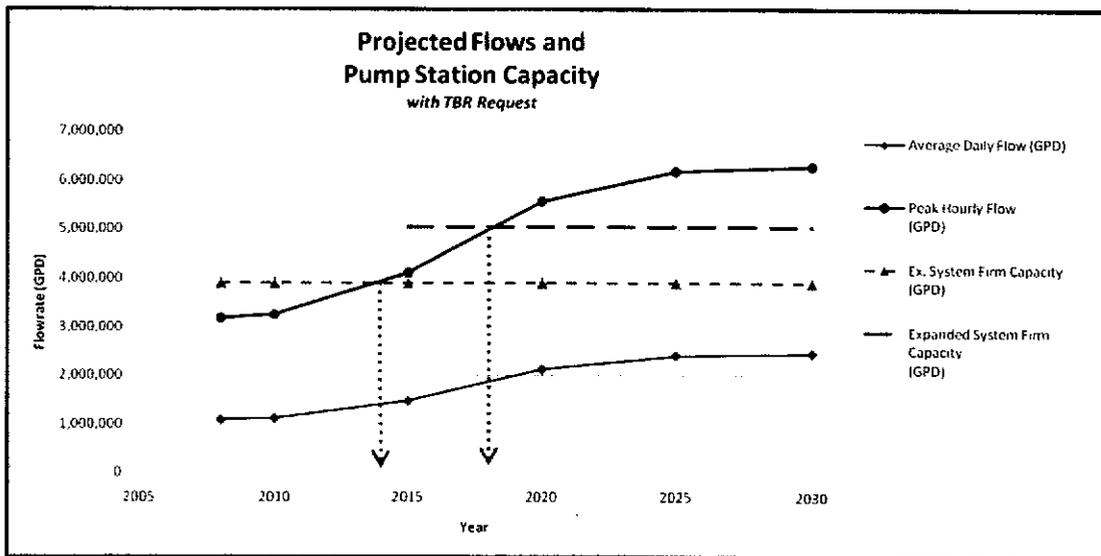


Figure 2 – Projected Flows *including* Town of Bermuda Run 200,000 GPD Request

Figure 3 below shows the projected cumulative contribution of peak hourly flow by jurisdiction including the Town of Bermuda Run additional 200,000 GPD request.

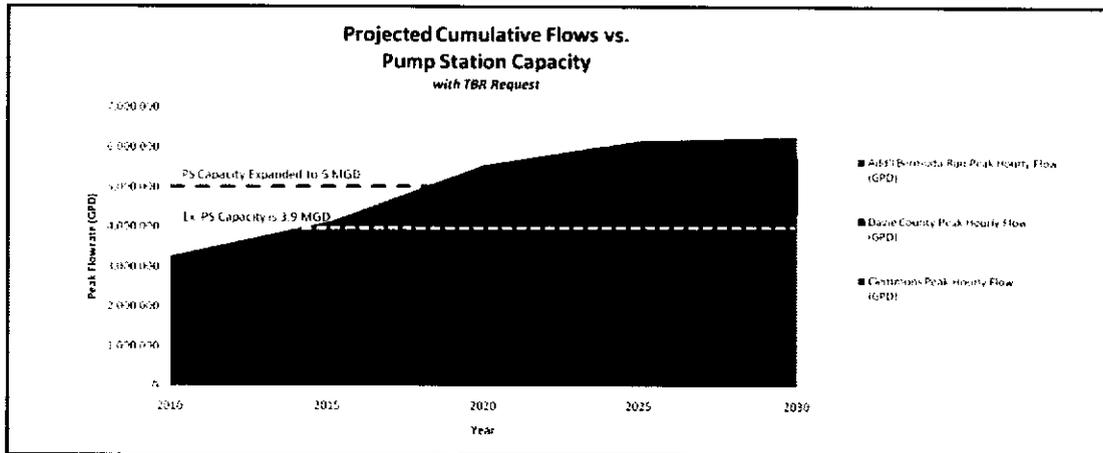


Figure 3 – Projected Peak Hour Flows By Jurisdiction

4 CCUC Options

Tanglewood Pump Station is not adequately sized for the projected service area build-out. Furthermore, the readily expandable capacity of 5.0 MGD also does not meet the projected service area build-out. Several options are identified below.

When planning the timing of pump station expansions, several factors should be considered and factored into the capital planning:

1. Flow estimates are approximate. They are based on projected needs, which will change with the pace of development and volume of wastewater generated.
2. Extended abnormal wet or dry periods will affect influent flows. For example, if an abnormally wet period occurs prior to the pump station expansion, there may be capacity issues earlier than expected.

4.1 Option 1 - No new allocations to Davie County

If no new allocations are extended to Davie County, we expect the existing Tanglewood Pump Station to reach capacity by 2014. Once expanded to a 5.0 MGD station, the expanded station is expected to reach capacity by 2019. Based on prior work, it appears that major facility modifications or rerouting of flows will be required to meet the 2030 flows (projected build-out).

This option does not appear to be a desirable long-term plan for CCUC. However, if this option is selected, CCUC should pursue a solid understanding of the Davie County flow agreement clause related to reductions of capacity prior to 2030 in case growth continues at the rates projected.

4.2 Option 2 - Accept new allocations on a temporary basis

If the 200,000 GPD allocation request is granted on a temporary basis (i.e. until about 2018) and then reduced back to the current 550,000 GPD allocation, we would expect Tanglewood Pump Station to reach capacity by 2014. Although there is more allocation, the projected growth rate of actual flows delivered to the sewers is not expected to exceed the current allocation until sometime between 2015 and 2020.

Once Tanglewood Pump Station is expanded to a 5.0 MGD station, the expanded station is expected to reach capacity by 2018 (about one year earlier than without accepting the additional allocation amount). If the 200,000 GPD allocation is removed at that time, we would expect the 5.0 MGD Tanglewood Pump Station to reach capacity in about 2019. Based on prior work, it appears that major facility modifications or rerouting of flows will be required to meet the 2030 flows (projected build-out).

This option does not appear to be a desirable long-term plan for CCUC; however, it does provide a temporary solution to the Town of Bermuda Run's current sewer capacity concern and would give them a few years to devise an alternate plan for ultimate disposal of their 200,000 GPD flows.

As mentioned in Option 1 above, if this option is selected, CCUC should pursue a solid understanding of the Davie County flow agreement clause related to reductions of capacity prior to 2030 in case growth continues at the rates projected.

4.3 Option 3 - Accept new allocation on a temporary basis and renegotiate long-term allocation to Davie County

Under this option, CCUC would accept the 200,000 GPD flow on a temporary basis and renegotiate the Davie County wastewater flow agreement to a reduced total allocation of 180,000 GPD by about 2018.

We expect the existing Tanglewood Pump Station will reach capacity by 2014. Once expanded to a 5.0 MGD station, the expanded station is expected to reach capacity by 2018. At that time the Davie County contribution would be reduced to 180,000 GPD, eliminating the need to make the more major facility modifications that would otherwise be required to meet the 2030 flows (projected build-out). With Davie County's flows capped at 180,000 GPD, the projected 2030 peak hourly flows to the Tanglewood pump station are 5.0 MGD, which matches the expanded pump station capacity of 5.0 MGD.

This option provides a temporary solution to the Town of Bermuda Run's current sewer capacity concern and would give them a few years to devise an alternate plan for ultimate disposal of their 200,000 GPD flows. It also provides CCUC a long-term plan whereby the 5.0 MGD Tanglewood Pump Station expansion would serve the area through build-out.

This option could be further refined, if desirable, for a stepped reduction in flows from Davie County to parallel the projected increases in flows from Clemmons, in lieu of the immediate one-step reduction to 180,000 GPD.

4.4 Option 4 – Expand the Tanglewood pumping system to a capacity greater than 5.0 MGD

Feedback from CCUC staff indicated that renegotiation of the existing agreements with Davie County may not be feasible or desirable, so a fourth option was developed. This option considers what would be required to expand Tanglewood Pump Station to a capacity greater than 5.0 MGD to accommodate projected build-out flows of the service area. If this option is selected, a thorough alternatives analysis and project cost opinion should be completed to determine if there is a more efficient way to accomplish the goal of providing adequate collection system capacity to serve the Tanglewood Pump Station service area, including flows from Davie County.

To add capacity to the Tanglewood pump station, a conceptual plan was developed that includes a pump station and force main, which would be installed to operate in parallel with the existing Tanglewood pumping system. The proposed parallel system was sized to meet capacity needs based on continued operation of the existing Tanglewood Pump Station at a capacity of 2,700 gpm (3.9 MGD). To meet build-out projected flows, an expansion to 6.0 MGD would be required without considering the additional flow request from the Town of Bermuda Run. A station capacity of 6.5 MGD would be required to include the additional flow request from the Town of Bermuda Run.

Recommended project budgets for these two expansions were developed based on a conceptual pump station layout and the assumption that the new force main traverses the same route as the existing force main and Hampton Road gravity sewer. The force main would end at the Muddy Creek interceptor. Details are included in Appendix C and summarized below:

Item	Estimated Cost without TBR Flow Request	Estimated Cost with TBR Flow Request
C-900 PVC Force Main	\$2,400,000 (16-inch)	\$2,700,000 (18-inch)
Pump Station Additions	\$960,000 (add 2.1 MGD)	\$1,032,000 (add 2.6 MGD)
Contingency (20%)	\$672,000	\$746,000
Easements	\$100,000	\$100,000
Professional Services	\$504,000	\$560,000
Total Recommended Project Budget (in 2011 dollars)	\$4,636,000	\$5,138,000
Cost Difference	--	+\$502,000

Table 5 – Recommended Project Budget

Implementation of the expansion project could be phased. Phase 1 would include the installation of a parallel force main from the pump station to the Hampton Road interceptor, a distance of approximately 15,000 linear feet. The parallel force main would reduce the head on the existing pumps to a point that they could operate at a 5 MGD capacity. This phase would need to be completed by 2014. Phase 2 would include pump station improvements and an extension of the force main approximately 5,000 linear feet to the Muddy Creek interceptor. This phase would need to be completed by 2018 or 2019, depending on growth in the basin and flow allocations to Davie County.

5 Summary

Based on the expected service area growth, Tanglewood Pump Station will need to be expanded to meet the future flow projections. Previous studies indicated that Tanglewood Pump Station can be readily expanded to a capacity of 5.0 MGD but that expansions beyond that limit will create more extensive downstream impacts.

Currently, the pump station is operating below its reliable capacity, and there is room for temporary allocations to Davie County. However, regardless of whether the additional flow allocation is granted to Davie County, Tanglewood Pump Station either needs to be expanded significantly in capacity or a portion of the service area needs to be diverted away from the pump station.

If the long-term agreement with Davie County can be renegotiated with a flow reduction beyond 2018 (Option 3 above), then we recommend that CCUC budget funds for expansion of Tanglewood Pump Station to a capacity of 5.0 MGD by 2014. This expansion is projected to meet the service area capacity needs through build-out. The project budget recommended in the 2008 Diehl & Phillips report (adjusted to 2011 dollars) for this option is \$1,140,000.

If the long term agreement with Davie County cannot be modified, then CCUC should begin budgeting for a major expansion of the Tanglewood pumping system. Phase 1 of the expansion to 5.0 MGD capacity would need to be online by 2014. Phase 2 would need to be online by 2018 or 2019 depending on growth within the basin and whether additional allocation is provided to Davie County. The recommended project budget for this option is \$5,138,000, including costs to cover the flow allocation request from the Town of Bermuda Run. This option can be constructed in phases.

