

TECHNICAL MEMORANDUM

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From:
Mary E. Sadler, PE

Date:
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Subject:
Review of Project Cost Estimates and Total Present Worth
Engineering Alternatives Analysis for Eastern Davie Sewer Project



1. Introduction

Hazen and Sawyer was commissioned by Grey Engineering to provide consulting services for the Eastern Davie Sewer Project. The project consists of the necessary infrastructure to support growth and development for 2 million gallons per day (mgd) of wastewater treatment capacity in the northeast portion of Davie County. The first Hazen and Sawyer task included a technical overview of the project and a review of the project cost estimates and total present worth of engineering alternatives as published in the *Eastern Davie Sewer Area Proposed Wastewater Treatment Facility Engineering Alternatives Analysis (EAA) / Environmental Information Document (EID)* (Grey Engineering, 2014). Pursuant to the State Environmental Policy Act (SEPA) General Statutes (GS) §113A-1 *et. seq.*, the EAA/EID was submitted for completeness review by the Department of Environmental and Natural Resources (DENR) Division of Water Resources (DWR); however, the document was not circulated for DENR agency review.

This Technical Memorandum (TM) provides documentation of the Hazen and Sawyer review of the project cost estimates and the total present worth as published in the EAA/EID. The technical basis for the total present worth of one of the evaluated alternatives has significantly changed since the EAA/EID was published. As such, this modification is documented in this TM.

2. Overview of Alternatives

Three alternatives were evaluated in the EAA/EID. The first alternative consists of conveyance improvements to pump raw wastewater to the Winston-Salem City/County Utility Commission (CCUC) Muddy Creek Wastewater Treatment Plant (WWTP). The second alternative consists of the construction of a new secondary treatment wastewater facility and effluent discharge via a land application system. The third alternative consists of a new tertiary treatment wastewater facility and a proposed National Pollutant Discharge Elimination System (NPDES) discharge to the Yadkin River downstream of Idols Dam. Table 1 provides a description of the necessary infrastructure components for each alternative.

Table 1: Summary of Infrastructure Components for Eastern Davie Sewer Project Engineering Alternatives

Alternative	Component 1 Description	Component 2 Description	Component 3 Description
Pump to CCUC	Collection system improvements in service area	Pump station and force main to Muddy Creek WWTP primary interceptor	N/A
Secondary Treatment with Land Application	Collection system improvements in service area	New secondary treatment WWTP	Land application system
Tertiary Treatment and Discharge to Yadkin River	Collection system improvements in service area	New tertiary treatment WWTP (treating to nutrient removal standards) and NPDES discharge to Yadkin River below Idols Dam	N/A

3. Review of Total Project Costs Based on a 20-year Present Worth

The total project cost for each alternative were assessed for two phases. The Phase 1 total project costs consist of the necessary infrastructure for a design capacity of 1 million gallons per day (mgd). Phase 1 improvements are anticipated to be adequate for a period of 10 years. The Phase 2 total project costs consist of the necessary infrastructure for an additional 1 mgd of wastewater treatment capacity for a total design capacity of 2 mgd. The Phase 2 improvements are anticipated to meet the project’s purpose and need between years 10 and 20 of the project life.

Hazen and Sawyer reviewed the total project costs prepared by Grey Engineering for infrastructure improvements for both Phases 1 and 2. Additionally, the operation and maintenance (O&M) costs for each of the three alternatives were reviewed. Tables 2, 3, and 4 provide a summary of the total project cost and total present worth as prepared by Grey Engineering and Hazen and Sawyer’s recommended revisions for the pump to CCUC, the secondary treatment with land application, and the tertiary treatment with NPDES discharge alternatives, respectively. Hazen and Sawyer does not have any comment on the cost opinions for O&M prepared by Grey Engineering. The detailed line item cost comparisons may be found in Attachment 1 of this TM.

The following is a summary of the differences between the Grey Engineering and Hazen and Sawyer total project cost opinions:

- Collection system improvements:
 - The cost per linear foot for the 8-inch Bermuda Run force main is slightly low compared to Hazen and Sawyer planning level estimates.
 - A line item should be added for mobilization, bonds, and insurance, typically

- 5 percent.
- The project contingency should be increased to 20 percent for a planning level estimate.
- Pump station and force main to Muddy Creek WWTP interceptor:
 - A line item should be added for mobilization, bonds, and insurance, typically 5 percent.
 - Odor control should be included in the Phase 1 project cost.
 - Land acquisition for the pump station should be included in the Phase 1 project cost.
 - Hazen and Sawyer recommends that the pump station wet well and force main constructed in Phase 1 be utilized for the Phase 2 improvements project. It is recommended that a more detailed engineering evaluation be conducted to avoid the construction of a second wet well and force main for Phase 2 improvements.
 - The project contingency should be increased to 20 percent for a planning level estimate.
- New secondary treatment WWTP:
 - The electrical and instrumentation and control costs should be increased to 20 percent of the construction costs for Phases 1 and 2.
 - The cost per linear foot for the Phase 1 effluent force main is slightly low compared to Hazen and Sawyer planning level estimates.
 - A line item should be added for mobilization, bonds, and insurance, typically 5 percent.
 - Hazen and Sawyer recommends that \$9.5/gallon of secondary treatment be used in planning level estimates per 1 mgd of treatment capacity. This unit cost includes contingency.
- Land application system:
 - Grey Engineering did not include a Phase 2 opinion. A Phase 2 opinion should be included for a direct comparison to the other alternatives in the 20-year total present worth.
 - A line item should be added for mobilization, bonds, and insurance, typically 5 percent.
 - Hazen and Sawyer's recommendations for the land application system are based on previous bid tabs for spray irrigation infrastructure per acre and recent earthwork unit costs.
 - The project contingency should be increased to 20 percent for a planning level estimate.

- New tertiary treatment WWTP and NPDES discharge:
 - The electrical and instrumentation and control costs should be increased to 20 percent of the construction costs for Phase 1 and 2.
 - A line item should be added for mobilization, bonds, and insurance, typically 5 percent.
 - Hazen and Sawyer recommends that \$12/gallon of tertiary treatment be used in planning level estimates per 1 mgd of treatment capacity. This unit cost includes contingency. This unit cost also reflects Hazen and Sawyer's experience regarding the necessary infrastructure to reliably meet a total nitrogen of 4 mg/L (e.g., tertiary denitrification filters, etc.).

Table 2: Summary of Total Project Cost Evaluation for Pump to CCUC Alternative

Infrastructure	Grey Engineering Project Cost Estimate			Hazen and Sawyer Project Cost Estimate		
	Phase 1	Phase 2 ¹	Total Phases 1 and 2	Phase 1	Phase 2 ¹	Total Phases 1 and 2
Collection System Improvements	\$6,750,000	\$0	\$6,750,000	\$7,050,000	\$0	\$7,050,000
New Pump Station and Force Main	\$8,060,000	\$5,070,000	\$13,130,000	\$8,960,000	\$450,000	\$9,410,000
Total for Alternative	\$14,810,000	\$5,070,000	\$19,880,000	\$16,010,000	\$450,000	\$16,460,000
20-year Present Value of O&M ^{2,3}		\$76,051,914			\$76,051,914	
20-year Present Worth of Project Cost and O&M ²		\$95,931,914			\$92,511,914	

¹ Phase 2 costs are expressed as a 10-year present value of capital costs in 2014\$ (F/P, 4.75%, 10).

² Per data published in Eastern Davie Sewer Area Proposed Wastewater Treatment Facility Engineering Alternatives Analysis / Environmental Information Document (Grey Engineering, 2014).

³ The 20-year present value of O&M is representative of the outside-City CCUC rate structure.

Table 3: Summary of Total Project Cost Evaluation for Secondary Treatment and Land Application Alternative

Infrastructure	Grey Engineering Project Cost Estimate			Hazen and Sawyer Project Cost Estimate		
	Phase 1	Phase 2 ¹	Total Phases 1 and 2	Phase 1	Phase 2 ¹	Total Phases 1 and 2
Collection System Improvements	\$6,750,000	\$0	\$6,750,000	\$7,050,000	\$0	\$7,050,000
New Secondary WWTP	\$8,125,000	\$2,570,000	\$10,695,000	\$11,210,000	\$6,870,000	\$18,080,000
Land Application System	\$7,650,000	\$0	\$7,650,000	\$17,910,000	\$11,260,000	\$29,170,000
Total for Alternative	\$22,525,000	\$2,570,000	\$25,095,000	\$36,170,000	\$18,130,000	\$54,300,000
20-year Present Value of O&M ²		\$25,277,806			\$25,277,806	
20-year Present Worth of Project Cost and O&M ²		\$50,372,806			\$79,577,806	

¹ Phase 2 costs are expressed as a 10-year present value of capital costs in 2014\$ (F/P, 4.75%, 10).

² Per data published in Eastern Davie Sewer Area Proposed Wastewater Treatment Facility Engineering Alternatives Analysis / Environmental Information Document (Grey Engineering, 2014).

Table 4: Summary of Total Project Cost Evaluation for Tertiary Treatment and NPDES Discharge Alternative

Infrastructure	Grey Engineering Project Cost Estimate			Hazen and Sawyer Project Cost Estimate		
	Phase 1	Phase 2 ¹	Total Phases 1 and 2	Phase 1	Phase 2 ¹	Total Phases 1 and 2
Collection System Improvements	\$6,750,000	\$0	\$6,750,000	\$7,050,000	\$0	\$7,050,000
New Tertiary WWTP and NPDES Discharge	\$9,100,000	\$2,700,000	\$11,800,000	\$14,090,000	\$8,680,000	\$22,770,000
Total for Alternative	\$15,850,000	\$2,700,000	\$18,550,000	\$21,140,000	\$8,680,000	\$29,820,000
20-year Present Value of O&M ²		\$26,262,656			\$26,262,656	
20-year Present Worth of Project Cost and O&M ²		\$44,812,656			\$56,082,656	

¹ Phase 2 costs are expressed as a 10-year present value of capital costs in 2014\$ (F/P, 4.75%, 10).

² Per data published in Eastern Davie Sewer Area Proposed Wastewater Treatment Facility Engineering Alternatives Analysis / Environmental Information Document (Grey Engineering, 2014).

4. Review of Total Project Costs Based on a 10-year Present Worth

The technical basis for the total present worth for the pump to CCUC alternative has changed significantly since the EAA/EID was published. The County currently pays the outside-City rate for CCUC to treat the County's raw wastewater at the Tanglewood Pump Station. Recently, the County has negotiated charges representative of the inside-City rate if raw wastewater is delivered to the main interceptor serving the Muddy Creek WWTP in lieu of the current wastewater delivery to the headwaters of the CCUC collection system. Therefore, the present value of O&M for the pump to CCUC alternative has been modified to reflect this change. Additionally, a 10-year present value of project and O&M costs were prepared for the evaluation of alternatives as requested by the Board of Commissioners.

Table 5 provides a summary of the updated total present worth for each of the three alternatives. Phase 1 and 2 project costs were included in the 10-year present worth of project cost and O&M. The total project cost must be represented per the stated purpose and need. The 10-year present worth of project cost and O&M for the pump to CCUC alternative is approximately \$10 million less than the tertiary treatment and NPDES discharge alternative.

Table 5: Summary of Total Project Cost Evaluation for Alternatives with Recent Revisions

Alternative	Total Construction Cost Phases 1 and 2 ¹	10-Year Present Value of O&M ²	10-Year Present Worth of Project Cost and O&M
Pump to CCUC	\$16,460,000	\$8,456,288 ³	\$24,916,288
Secondary Treatment and Land Application	\$54,300,000	\$10,832,424	\$65,132,424
Tertiary Treatment and NPDES Discharge	\$29,820,000	\$6,065,330	\$35,885,330

¹ Per Hazen and Sawyer's cost evaluation.

² A 10-year present value of capital and O&M costs as requested by Davie County Board of Commissioners.

³ Revised based on Davie County's recent discussions with CCUC. Davie County has negotiated surcharges as representative of the inside-City rate in lieu of the outside-City rate.

5. Summary and Recommendations

Grey Engineering and Hazen and Sawyer differ on the project cost opinions for each of the three alternatives. For the pump to CCUC alternative, significant Phase 2 savings could be realized with utilization of the wet well and force main constructed in Phase 1. It is recommended that a more detailed engineering evaluation be conducted to assess the technical feasibility of this approach. For the secondary treatment WWTP with land application alternative, Hazen and Sawyer's planning level estimate for the 20-year present worth is 37 percent greater than the cost opinion prepared by Grey Engineering. For the tertiary treatment WWTP with NPDES discharge alternative, Hazen and Sawyer's planning level estimates for the 20-year present worth is 20 percent greater than the cost opinion prepared by Grey Engineering. The biggest difference in the cost opinions for these two alternatives is Hazen and Sawyer's experience with unit cost per gallon of treatment for activated sludge facilities of similar size.

Hazen and Sawyer does not have any comment on the cost opinions for O&M prepared by Grey Engineering. If the county wishes to evaluate alternatives using a 10-year present worth basis versus a 20-year present worth basis, the salvage value should also be considered in the analysis. It should also be noted that DENR requires that projects be evaluated on a 20-year present worth basis in SEPA environmental documentation. Regardless of the alternative selected by Davie County, all the alternatives in this evaluation will be required to comply with NC SEPA pursuant to GS §113A-1 *et. seq.* Specifically for the pump to CCUC alternative, Hazen and Sawyer recommends that the County investigate the fraction of the debt service and O&M cost associated with the CCUC inside-City rate as a direct comparison to the O&M cost associated with the tertiary treatment WWTP and NPDES discharge alternative.

ATTACHMENTS

Detailed Cost Comparison of Alternatives

Grey Engineering Cost Estimate: Collection System Improvements (all alternatives)

Description	Unit	Unit Cost (Calculated)	Total Construction Cost	Total Construction Cost w/H&S		H&S Assumptions
				Additions		
18" gravity sewer (6 to 10 feet, manholes)	8,595	\$99.20	\$852,663	\$852,663		20" DIP Sewer at \$103/LF per Westside bid tab, 0 to 12 feet deep
24" gravity sewer (12 to 20 feet, manholes)	13,173	\$149.32	\$1,967,048	\$1,967,048		
Subtotal			\$2,820,000	\$2,820,000		
Yadkin River PS and 5,000 ft 8" FM			\$625,000	\$625,000		
Bermuda Run PS and WWTP decommission			\$700,000	\$700,000		
Bermuda Run force main, 8"	7,000	\$35.00	\$245,000	\$280,000	\$40	\$56 \$5 to \$7 per/inch-diameter foot DIP force main
Easements			\$100,000	\$100,000		
Rock			\$200,000	\$200,000		
Road bores			\$300,000	\$300,000		
Erosion Control			\$200,000	\$200,000		
Subtotal			\$2,370,000	\$2,405,000		
Mobilization, Bonds, Insurance (5%)				\$118,500		
Total Construction Cost			\$5,190,000	\$5,225,000		
Professional (15%)			\$778,500	\$783,750		
Contingency (15%)			\$778,500	\$1,045,000	20%	
Total Project Cost			\$6,750,000	\$7,050,000		

Grey Engineering Cost Estimate: Pump station and Force main to Muddy Creek WWTP Interceptor

Description	Unit	Unit Cost (Calculated)	Total Construction Cost		Total Construction Cost w/H&S Additions, Phase 1	Total Construction Cost w/H&S Additions, Phase 2	H&S Assumptions		
			Construction Cost Phase 1	Construction Cost Phase 2					
18" dia. Force main	26,000	\$130	\$3,380,000		\$3,380,000		\$90	\$126	\$5 to \$7 per/inch-diameter foot DIP force m
Road bores			\$300,000		\$300,000				
River crossing rock bore	1,100	\$950	\$1,045,000		\$1,045,000				
Additional FM rock			\$200,000		\$200,000				
Pump Station (1 mgd with PF 3.5):									
Wet well			\$200,000	19.5%	\$200,000				Westside Pump Station bid tab, GUC, 2012
pumps and screening			\$400,000	39.0%	\$400,000	\$400,000	47%		Westside Pump Station bid tab, GUC, 2012
electrical and controls			\$250,000	24.4%	\$250,000	\$100,000	14%		Westside Pump Station bid tab, GUC, 2012
site work			\$175,000	17.1%	\$175,000		18%		Westside Pump Station bid tab, GUC, 2012
Easements			\$100,000		\$100,000				
Erosion control			\$150,000		\$150,000				
Mobilization, Bonds, Insurance (5%)					\$310,000	\$25,000			
Odor Control					\$100,000				
Total Construction Cost			\$6,200,000		\$6,610,000	\$525,000			
Land Acquisition (5 acres at \$7,000/ac)					\$35,000	\$0			
Professional (15%)			\$930,000		\$991,500	\$78,750			
Contingency (15%)			\$930,000		\$1,322,000	\$105,000	20%		
Total Project Cost			\$8,060,000	\$8,060,000	\$8,960,000	\$710,000			

Grey Engineering Cost Estimate: Secondary WWTP

Description	Unit	Unit Cost (Calculated)	Total	Total		Total	Total	H&S Assumptions		
			Construction Cost Phase 1	Construction Cost Phase 2		Construction Cost w/H&S Additions, Phase 1	Construction Cost w/H&S Additions, Phase 2			
Electrical			\$600,000	\$200,000	10.4%	\$900,000	\$472,500			
Wet well			\$600,000	\$0	10.4%	\$600,000	\$0			
Influent pumps, controls, screening			\$500,000	\$200,000	8.7%	\$500,000	\$200,000			
Biological Treatment, Settling, and Aerobic Digestion			\$1,500,000	\$1,500,000	26.1%	\$1,500,000	\$1,500,000			
Effluent UV			\$300,000	\$200,000	5.2%	\$300,000	\$200,000			
Effluent Pumping			\$250,000	\$250,000	4.3%	\$250,000				
Effluent Piping Phase 1, 18"	14,000	\$100	\$1,400,000	\$700,000	24.3%	\$1,764,000		\$90	\$126	\$5 to \$7 per/inch-dia
Site work, office, Misc. Chem			\$450,000	\$50,000	7.8%	\$450,000				
Erosion Control			\$150,000	\$50,000	2.6%	\$150,000				
Mobilization, Bonds, Insurance (5%)						\$641,400	\$237,250			
Subtotal			\$6,000,000	\$3,150,000		\$7,060,000	\$2,610,000			
Revised Subtotal						\$9,500,000	\$9,500,000			
Land Acquisition			\$250,000	\$0		\$250,000	\$0			
Total Construction Cost			\$6,250,000	\$3,150,000		\$9,750,000	\$9,500,000	Using \$9.5/gal construction (incl. cont.)		
Professional (15%)			\$937,500	\$472,500		\$1,460,000	\$1,430,000			
Contingency (15%)			\$937,500	\$472,500						
Total Project Cost			\$8,125,000	\$4,095,000		\$11,210,000	\$10,930,000			

Grey Engineering Cost Estimate: Land Application

Description	Unit	Unit Cost (Calculated)	Total Construction Cost Phase 1	Total Construction Cost Phase 2	Total Construction Cost w/H&S Additions, Phase 1	Total Construction Cost w/H&S Additions, Phase 2	H&S Assumptions
Effluent Lagoon			\$1,522,430		\$4,105,000	\$4,105,000	
Spray System			\$530,000		\$5,210,000	\$5,210,000	
Misc. Sitework			\$540,000		\$509,000	\$509,000	access roads, wells
Mobilization, Bonds, Insurance (5%)					\$491,200	\$491,200	
Subtotal			\$2,590,000	\$0	\$10,320,000	\$10,320,000	
Land Acquisition			\$3,300,000		\$2,950,000	\$2,950,000	
Total Construction Cost			\$5,890,000	\$0	\$13,270,000	\$13,270,000	
Professional (15%)			\$880,000	\$0	\$1,990,000	\$1,990,000	
Contingency (15%)			\$880,000	\$0	\$2,650,000	\$2,650,000	20%
Total Project Cost			\$7,650,000	\$0	\$17,910,000	\$17,910,000	

Grey Engineering Cost Estimate: Tertiary Treatment with BNR and NPDES Discharge

Description	Unit	Unit Cost (Calculated)	Total Construction			Total Construction Cost w/H&S Additions, Phase 1	Total Construction Cost w/H&S Additions, Phase 2	H&S Assumptions
			Construction Cost Phase 1	Construction Cost Phase 2				
Electrical			\$600,000	\$200,000	8.9%	\$1,055,250	\$598,500	15 - 20% for electrical
Wet well			\$600,000	\$0	8.9%	\$600,000	\$0	
Influent pumps, controls, screening Biological Treatment, Settling, and Aerobic Digestion			\$500,000	\$200,000	7.4%	\$500,000	\$200,000	
			\$2,600,000	\$2,400,000	38.5%	\$2,600,000	\$2,400,000	
Effluent filters			\$350,000	\$200,000	5.2%	\$900,000	\$900,000	Deep bed filters needed for TN Removal
Effluent UV			\$300,000	\$200,000	4.4%	\$300,000	\$200,000	
Effluent Pumping			\$250,000	\$0	3.7%	\$250,000	\$0	
Effluent Piping			\$950,000	\$0	14.1%	\$950,000	\$0	
Site work, office, Misc. Chem			\$450,000	\$50,000	6.7%	\$450,000	\$50,000	
Erosion Control			\$150,000	\$50,000	2.2%	\$150,000	\$50,000	
Mobilization, Bonds, Insurance (5%)						\$335,000	\$190,000	
Subtotal			\$6,750,000	\$3,300,000		\$8,090,000	\$4,590,000	
Revised Subtotal						\$12,000,000	\$12,000,000	
Land Acquisition			\$250,000	\$0		\$250,000	\$0	
Total Construction Cost			\$7,000,000	\$3,300,000		\$12,250,000	\$12,000,000	Using \$12/gal construction (incl. contingency
Professional (15%)			\$1,050,000	\$495,000		\$1,837,500	\$1,800,000	
Contingency (15%)			\$1,050,000	\$495,000				20%
Total Project Cost			\$9,100,000	\$4,290,000		\$14,090,000	\$13,800,000	