41

FCRU's Response to Staff's 4th Interrogatories Nos. 28-36

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Application for water and wastewater service in Duval, Baker, and Nassau Counties, by First Coast Regional Utilities, Inc.	DOCKET NO. 20190168-WS DATED: November 30, 2020

FIRST COAST REGIONAL UTILITIES, INC.'S RESPONSE TO STAFF'S FOURTH SET OF INTERROGATORIES TO FIRST COAST REGIONAL UTILITIES, INC. (NOS. 28 - 36)

First Coast Regional Utilities, Inc. ("Applicant" or "FCRU"), pursuant to rule 1.340, Florida Rules of Civil Procedure, responds to Staff's Fourth Interrogatories to Applicant.

INTERROGATORIES

28. Is it First Coast's intention to continue to be the water and wastewater service provider to the customers in the requested service territory upon completion of the development? Please explain.

Response: Absolutely. FCRU commits to be the provider and is ready willing and able to provide water, wastewater and reuse services throughout the life of the development, and beyond. The project will be jeopardized if First Coast relies on a tenuous third-party provider. JEA's intention to remain in the water and wastewater business is seriously called in to question in light of press reports and the recent bidding process conducted by JEA to specifically sell the systems to private investors and/or water and wastewater holding companies.

JEA's unreliability includes its massive problems which it must first address within its existing service area, such as several hundred million dollars in capital that needs to be invested in order to be in compliance with its SJRWMD water use permit obligations on a going forward basis, several hundred million more dollars needed to eliminate wastewater discharges to the St. Johns River, and scores of millions more to address excessive sewer system overflows ("SSOs"), replacing crumbling infrastructure, etc. The JEA water and sewer system is a perfect candidate

for privatization given these capital needs and the reciprocal need to dramatically increase water and wastewater rates and charges. It would be irresponsible and shortsighted for First Coast to subject its customers to these financial perils.

At a meeting on February 14, 2020, JEA representative Zammataro described JEA's need for service in the Cecil Field area, and JEA's inability to provide such services for at least six years. In an effort to settle this matter, FCRU proposed to reserve capacity in its wastewater facilities to accommodate JEA's need in that area. Attached as Exhibit 1 to these interrogatory responses is a letter to JEA's counsel recounting the meeting and offering to reserve said capacity. In short, JEA cannot service its own area, let alone FCRU's.

29. Alternatively, does First Coast intend to dedicate the systems to JEA in the future, as the 2030 Comprehensive Plan directs? Please explain.

Response: Absolutely not. The City's 2030 Comprehensive Plan does not require dedication of the facilities and FCRU does not intend to dedicate the facilities to JEA. Early in this process FCRU attempted to negotiate with JEA for a future option for sale of the FCRU facilities in order to avoid the cost and delay occasioned by the JEA herein. JEA rebuffed those efforts to resolve the current conflict, and those options are now off the table. Moreover, JEA's tortured interpretation of the dedication language in the PUD Ordinance doesn't make any sense. If the City, in drafting the Ordinance, had intended for the facilities to be dedicated to JEA, the addition of the phrases "for operation and maintenance or contract operations" would not be necessary. If the owner were to turn over ownership of the facilities to JEA, as they claim, the language stated would be unnecessary and superfluous. It must be assumed that the City knew what it meant when it drafted the Ordinance. Accordingly, if the ownership of the facilities were to be transferred to JEA, the

City would have clearly said so instead of saying that the owners of the facilities would merely turn over some operational functions to JEA. JEA's suggested interpretation of the Ordinance renders the subject language vague and nonsensical. Under JEA's proposed tortured interpretation, FCRU would turn over ownership of the facilities and then enter into a contract with JEA for JEA to be the contract operator of those same facilities.

30. Please refer to witness Beaudet's rebuttal testimony, page 8, lines 2-5. Please provide the American Waterworks Association and the Water Environment Federation national benchmarks that were used for comparison.

Response: Please see Exhibit 2 hereto. Further, in witness Beaudet's rebuttal testimony, page 8, lines 2-5 a comparison was made between operational benchmarks published in JEA's December 12, 2019 Management Presentation (see Exhibit BAB 5, Rebuttal Testimony) to benchmarks presented in the 2019 publication: American Water Works Association ("AWWA") Utility Benchmarking, Performance Management for Water and Wastewater. This publication is the most recent and thorough benchmarking publication available in the industry. It contains aggregate data from over 150 water utilities including 80 combined water/wastewater utilities similar to JEA from 38 US states, 2 US Territories and 2 Canadian Provinces. Mr. Beaudet believed when writing his rebuttal that the Water Environment Federation was a joint sponsor of the above referenced publication; however, the AWWA is the sole sponsor.

Wastewater – Two of the three benchmarks presented in the JEA's Management Presentation can be compared to those published in the AWWA document, Wastewater Permit Exceedances by fiscal year and the number of SSOs occurring per year per 100 miles of pipe. In

reviewing these two benchmarks it was apparent to Mr. Beaudet that they were not presented in a manner that allowed them to be compared directly to AWWA's published benchmarks.

For example, the Environmental Compliance numbers presented on page 72 of the JEA Management Presentation showed an annual average of 45 days per year of National Pollution Discharge Elimination System ("NPDES") exceedances over a ten-year period. This is an appalling number of exceedances. The JEA presentation puts lipstick on a pig by comparing the number of exceedances to the number of tests run (compliance opportunities) and called that excellent. The number of tests run per year are irrelevant to the benchmark. An NPDES violation is a violation even if only one of many daily tests are exceeded on a given day and is to be avoided at all costs. Utilities generally set a goal of zero violations per year. Figure-1 in the attached Exhibit 2 shows a comparison of JEA's benchmark to the AWWA benchmark based on days per year of NPDES violations. Note that JEA, at only 81.7 percent compliance, is far below even the lowest 25th percentile of the 47 AWWA surveyed utilities.

Another example is the SSO benchmark reported by JEA, also on page 72 of the JEA Management Presentation, as an average over eight years of 0.72 SSOs per 100 miles of pipe. At first glance, this number appears to be reasonable. However, the number reported is only for SSOs that impacted Waters of the United States (WOTUS). These are the most serious of SSOs and in Mr. Beaudet's long experience usually make up about a third of total SSOs. The other two thirds consist of local overflows which occur during rainfall events due to infiltration and inflow within aging collection systems. These local overflows do not impact WOTUS but are an indication of the condition and reliability of the collection system and were not reported in the JEA Management Presentation. Furthermore, it is unclear whether or not the SSOs impacting WOTUS include the 56 SSOs documented in FDEP Consent Order 06-1796 (Fourth Amendment 2017) issued as a result of Hurricane Matthew and the 65 SSOs documented in FDEP Consent Order 17-210 (2018)

issued as a result of Hurricane Irma. Figure-2 of the attached Exhibit 2 compares JEA's SSOs as presented in its Management Presentation impacting WOTUS and an adjusted figure estimated by Mr. Beaudet to include non-WOTUS SSOs. As can be seen from Figure-2, the adjusted figure falls above (worse) than the 25th percentile of AWWA's benchmark of 66 combined water/wastewater systems surveyed.

The third benchmark presented by JEA in its Management Report is based on their TMDL permit level of 683 tons of Nitrogen per year discharged into the St. Johns River. The graph shown in page 72 of the JEA Management Presentation is difficult to read, but it appears that at least once or twice during the past ten years this permit level has been exceeded. AWWA does not publish benchmarks for comparison to a utility's individual TMDL permits.

Water - The water system benchmarks presented by JEA on page 73 of the JEA Management Presentation are not benchmarked by AWWA. Two of these are common parameters measured by utilities based on regulatory requirements, the Percent of Customers Affected by Unplanned Outages, and the Water Distribution System Average Minutes of Water Pressure Less Than 30 psi. Based on JEA's own goals reported in the Management Presentation for unplanned outages, JEA failed to meet their own goal of 2 percent in three of the eight years presented. JEA also failed to meet the regulatory goal of 30 psi water pressure in 2019. JEA also reported in its Management Presentation that JEA failed to meet their own goal of 65 minutes Customer Response Time in nine of the ten years reported.

31. Please refer to witness Beaudet's rebuttal testimony, page 9, lines 16-17. Witness Beaudet testified that the "cost of connecting the reclaimed water lines to the plant's major line is a cost to be paid for by the third-party developers, not a cost incurred by FCRU, as is common practice." Please describe any instances that the witness has knowledge of where

the cost of connecting reclaimed water lines to a plant's major line was paid for by third-party developers.

Response: Most large Florida water/wastewater/reuse utilities have line extension policies which dictate both the utility's and the developer's responsibility for connecting to the utility and receiving service. The line extension policy is the prerogative of the utility, set by the governing board or management of the utility. As Mr. Beaudet stated in his Rebuttal Testimony, in his long experience as both a consulting engineer and a utility director in Florida, the most common policy is that the utility constructs only the major transmission lines through corridors planned or zoned for development. In the case of reuse transmission lines, the utility will often construct these major transmission lines along major arterial roads external to the developments that currently, or in the future, have an anticipated need for reuse water. It is typically the responsibility of the developer or existing homeowner's association to construct the lines that connect to the major reuse transmission lines and to construct the internal irrigation infrastructure within their developments.

Some examples of this common policy, among the many in Florida, include: Palm Beach County Water Utilities; Broward County Utilities; Orange County Utilities; and The TOHO Water Authority. Examples of private or non-profit cooperative utilities which adhere to this policy include Ave Maria Utility Company in Collier County and Bonita Springs Utilities in Lee County. It is Mr. Beaudet's understanding that the JEA also adheres to this common policy, although there are examples where they have constructed reuse lines directly into developed areas or areas planned to be developed. In at least one case, JEA has entered into specific agreements with the developers to do so. Nocatee is an example of an exception where JEA agreed to construct, at JEA's sole cost, the reuse lines on all arterial and collector roads internal to the Nocatee development in addition to all reuse facilities external to the development. The majority of the

Nocatee development was remote to the JEA service area at the time of the agreement, being located in St. Johns County. Similarly, the 301 Capital Partners' development is remote to JEA facilities, but JEA has never offered to provide facilities or the associated infrastructure at its cost to the proposed service territory.

The St. Johns River Water Management District requires that new and existing developments connect to a utility's major reuse transmission line at the developer's expense when such connection is economically feasible, per the District's sole determination.

The City of Jacksonville 2030 Comprehensive Plan, Natural Groundwater Aquifer Recharge Sub-Element Goals, Objectives and Policies, Objective 1.2, paragraph 1.2.9 states that the City shall support the development of reuse water and other alternative supplies. Additionally, it is stated among other practices that the City shall require where economically feasible the connection of new development or substantial redevelopment to a reuse system to supply uses that do not require potable water, unless the use of a lower quality source is otherwise authorized by SJRWMD (specific verbiage in 1.2.9 has been intentionally omitted for the sake of brevity). FCRU will have the capacity and is ready, willing and able to economically provide reuse water to the 301 Capital Partners' development.

FCRU plans to adopt a line extension policy requiring that third-party developers connect to the reuse transmission line which terminates at the boundary of the wastewater treatment facility. Provision of reuse water to the 301 Capital Partners' development is without question economically feasible because the first two phases of the 301 Capital Partners' development are compact and close to the point of connection (POC).

32. Please refer to witness Beaudet's rebuttal testimony, page 11, lines 1-14, and Exhibit BAB-6. Please describe how these cost estimates were developed and what materials were relied upon.

Response: The cost estimates referred to in Mr. Beaudet's Rebuttal Testimony page 11, lines 1-14 and detailed in Exhibit BAB-6 were developed under Mr. Beaudet's direct supervision by an experienced cost estimation engineer with whom he sub-contracted. The first step was to determine the exact location and line size of the JEA water and wastewater pipelines point of connection ("POC") which are on Normandy Boulevard and closest to the 301 Project. Mr. Beaudet personally verified that this POC has not changed since the Engineering Assessment Report was written and submitted. The second step was to choose the most direct and feasible pipeline route for the connecting water and wastewater lines to the POC, utilizing public rights-of-way wherever possible. Given that this cost estimate is a planning level estimate, no costs for purchasing what would be small lengths of private rights-of-way were included in the estimate. A hydraulic analysis, which Mr. Beaudet reviewed, was performed to determine pipe sizes as well as any pumping stations and/or storage tanks needed to convey FCRU's buildout capacity of 4.0 MGD along the 7.2-mile route. The cost estimates presented in BAB-6 detail all the materials, specialized equipment and labor for each task required to construct this large and lengthy conveyance project. The costs presented are based on standard engineering cost estimation practice which considers current material prices, labor and specialized equipment needed to perform the project as compared to similar projects completed in Florida within a recent timeframe. In personally reviewing these costs Mr. Beaudet took into consideration his long and extensive experience in overseeing similar projects performed by Palm Beach County Water Utilities. It is important to note that JEA's proposed conveyance facilities, which are the subject of the cost

estimate shown in Exhibit BAB-6, are only for water distribution and wastewater force main pipelines.

JEA's closest reuse water POC is over 20 miles away from the proposed FCRU facilities at JEA's Southwest Regional Wastewater Treatment Plant. Therefore, the Engineering Assessment Report, when comparing JEA's conveyance project to on-site water/wastewater/reuse facilities constructed by FCRU is not truly an apples to apples comparison. The JEA option does not provide for reuse water, the provision of which would add much higher costs. Preliminary estimates exceed $20 million to construct the reuse transmission line from the Southwest Regional Wastewater Treatment Plant to a point of connection at the 301 Capital Partners' development. The preliminary estimates did not, however, include the necessary multi-million dollars onsite improvements at the Southwest Regional Wastewater Treatment Plant which would be needed to produce acceptable quality reuse water. The Engineering Assessment Report cost estimate for FCRU's on-site facilities includes the provision of reuse water. 301 Capital Partners and their advisors have concluded that reuse will be required in the development for a number of reasons, including a commitment to conserve water and preserve the water supply for future generations. 301 Capital Partners also recognizes that the provision of reuse water is a requirement of the SJRWMD in the consumptive use permitting process. 301 Capital Partners wholeheartedly supports this requirement.

33. Please refer to witness Beaudet's rebuttal testimony, page 12, lines 6-10, and Exhibit BAB-7. Please describe how these cost estimates were developed and what materials were relied upon.

Response: Mr. Beaudet's rebuttal testimony on page 12, lines 6-10, and Exhibit BAB-7 is a Life Cycle Cost (LCC) analysis of JEA's proposed interconnection from their POC on Normandy Blvd. to the FCRU plant site. The Engineering Assessment Report only compared the capital cost ("Capex") of JEA's interconnection project to the Capex of FCRU constructing its own on-site water/wastewater/reuse facilities. A more accurate comparison would include the Life Cycle Costs of operating the conveyance system for a 30-year period. The 30-year period is commonly used in an LCC analysis because 30 years is generally the life of the bonds issued to finance a large project, or otherwise, the cost of money to the owner. Note that the amortized operational costs within the LCC analysis are only applicable to JEA's conveyance project. FCRU, by constructing its facilities on-site, completely avoids conveyance costs. The LCC analysis in question was performed in accordance with ASTM Standard F1675. This Standard considers the cost of money to the owner of a project, the future operational costs over time adjusted for inflation, as well as the cost of any replacement materials or equipment needed over the 30 years. The relevant assumptions used in the subject analysis are clearly stated in Exhibit BAB-7. The largest LCC cost is the cost of electricity needed for pumping the water and wastewater 7.2 miles for 30 years. The method of calculation can be found in the attached Exhibit 3, which is a peer reviewed paper of which Mr. Beaudet was the primary author: **LIFE CYCLE COST ANALYSIS FOR DECISION MAKING IN COLLECTION SYSTEM REHABILITATION,** presented at the 2019 ASCE Pipelines Convention in Nashville, TN .

34. Please refer to witness Beaudet's rebuttal testimony, page 15, lines 4-15.

a. Please describe any developments plans that are underway which would necessitate construction of the treatment facilities be completed in the estimated 30-month

timeframe, opposed to the five-year projection for access to treatment facilities provided by JEA.

Response: The PUD Ordinance grants the developers the necessary entitlements to develop the property as more fully described in the certificate application, and the developers have begun various preliminary earthwork plans and preparations necessary for the future construction of homes and commercial development within the property. The developers have conferred and negotiated with several national and statewide developers and homebuilders that would ultimately construct the homes and commercial parcels. However, while these developers and homebuilders are fairly comfortable with knowing that facilities will be available from FCRU within the 30 month planning horizon, the JEA's nebulous 5-year estimate, JEA's current management uncertainty, and potential for change in capital planning direction has kept the homebuilders and developers from committing to the takedown of all of the Phase I lots under consideration until the utility provider and timing issue is resolved. Until homebuilders see water and wastewater facilities coming out of the ground, or are confident that construction is imminent, they will not commit.

35. Please describe other benefits or need, if any, for constructing the treatment facilities in the estimated 30-month timeframe, rather than the five-year projection.

Response: Construction by FCRU within the 30-month timeframe provides a level of certainty and a planning horizon required by the large statewide and national homebuilders that have expressed a high level of interest in the 2,500 units comprising Phase I of the proposed development. FCRU commits, without qualification or equivocation, to provide the service it has

proposed to provide. To the contrary, there is no certainty that the JEA will ever provide service to this development or if it does upon what terms, cost, or conditions. The 5-year projection is merely a back-of-the-envelope estimate by JEA. In stark contrast to FCRU, absolutely no affirmative steps have been taken by JEA to either design, engineer or plan for the building of the facilities, nor has JEA even begun the process to budget for such a project. On the contrary, as Ms. West testified in her pre-filed testimony, JEA is prohibited under the City's 2030 Comprehensive Plan from investing in water and wastewater facilities in the area encompassing the proposed development. JEA's plan, such as it is, is to have FCRU, and ultimately FCRU's customers, pay for and build infrastructure off-site, in violation of the PUD Ordinance, that will serve as the backbone of systems JEA will then use to serve other future developments.

In addition to certainty, FRCU's construction of facilities on-site in 30 months to serve the proposed development will help fulfill the need for new housing in Jacksonville to meet the growing need, and alleviate the current shortage, of housing in Jacksonville. Development of the property will also provide jobs and economic energy to Jacksonville as well as in Baker and Nassau Counties. The Duval County portion of the development is located relatively near to Cecil Field and all the land within the proposed territory is located near Interstate 10 and SR 301 which will allow a mobile workforce to efficiently reach different parts of Jacksonville, Baker and Nassau Counties. In fact, the Florida Department of Transportation, in recognition of the importance of the future growth of this area, has committed significant resources to complete the ongoing construction of improvements to the I-10/SR 301 interchange located near the NE corner of the service area.

36. Please refer to JEA's Response in Opposition to First Coast Regional Utilities' Motion for Partial Summary Final Order, Exhibit A – Application for Minor Modification to a PUD, Application No. MM-20-08. The document assigns a Planning Commission Hearing Date of September 3, 2020. Please describe the outcome of that hearing and provide the current status of the application.

Response: The Application for Minor Modification to a PUD ("Application") was originally scheduled to be heard by the Planning Commission on September 3, 2020. However, JEA intervened and had the Application pulled from consideration. As of this submission, the matter has not been heard.

Respectfully submitted this 30th day of November, 2020, by:

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AFFIDAVIT

STATE OF FLORIDA)

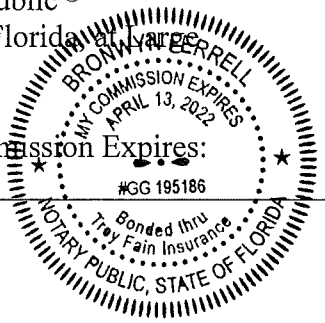
COUNTY OF LEON)

I hereby certify that on this 30th day of November, 2020, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, appeared Robert Kennelly, who is personally known to me, and he acknowledged before me that he provided the answers to interrogatory number(s) 28, 29 and 34-36 from STAFF'S FOURTH SET OF INTERROGATORIES TO FIRST COAST REGIONAL UTILITIES, INC. (NOS. 28 - 36) in Docket No. 20190168-WS, and that the responses are true and correct based on his personal knowledge.

In Witness Whereof, I have hereunto set my hand and seal in the State and County aforesaid as of this 30th day of November, 2020.

Bronwyn Kennelly

Notary Public
State of Florida at Large



My Commission Expires:

AFFIDAVIT

STATE OF FLORIDA)

COUNTY OF LEON)

I hereby certify that on this 30th day of November, 2020, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, appeared Bevin A. Beaudet, who is personally known to me, and he acknowledged before me that he provided the answers to interrogatory number(s) 30-33 from STAFF'S FOURTH SET OF INTERROGATORIES TO FIRST COAST REGIONAL UTILITIES, INC. (NOS. 28 - 36) in Docket No. 20190168-WS, and that the responses are true and correct based on his/her personal knowledge.

In Witness Whereof, I have hereunto set my hand and seal in the State and County aforesaid as of this 30th day of November, 2020.

Bronwyn Ferrell

Notary Public
State of Florida, at Large

My Commission Expires:

BRONWYN FERRELL MY COMMISSION EXPIRES APRIL 21, 2022 #GG 195186 Bonded thru Troy Fain Insurance NOTARY PUBLIC, STATE OF FLORIDA

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March 16, 2020

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Re: Offer of Settlement by First Coast to the JEA

Dear Tom, Susan and Miriam,

On February 14th, a meeting took place at the JEA headquarters. In attendance on behalf of the JEA were Robert Zammataro, Director of Water and Wastewater Planning and Development, and Susan West, its consulting engineer; on behalf of First Coast Regional Utilities, Inc. ("First Coast") were Bob Kennelly, its President, and Bevin Beaudet, P.E., its chief engineer.

The thrust of that meeting was that the JEA has a need for wastewater service near Cecil Field and is under some pressure from the Chamber of Commerce, the building industry and others to assemble wastewater capacity so as to allow for additional development in that area. Additionally, Mr. Zammataro made it clear that it will be at least six years before the JEA will be in a position to build wastewater capacity to serve that area. Under the current JEA fee structure, the projected plant would cost about $30 million, however, the JEA would only be able to recover about $10 million thereof. The JEA officials also indicated that other portions of Duval County are a higher priority for wastewater plant investment than Cecil Field, such as the property in and around the Jacksonville International Airport. The JEA representatives were hopeful that, somehow, First Coast could provide a solution to the JEA's problem.

As can be determined by a review of the attached map, the entirety of the First Coast certificate application involves lands on the west side of US 301 and at the western extremities of Duval County. First Coast has the option of building its utility facilities in Baker County should it elect to do so.

In an effort to forge a "win-win" solution for both parties, First Coast hereby offers to build its wastewater plant in Duval County and to reserve 25% of the treatment plant capacity in its Phase I wastewater facility for the use and benefit of the JEA. First Coast is further willing to discuss reservation of additional capacity in its Phase II wastewater plant expansion if the JEA so desires. First Coast can have that wastewater plant capacity on-line and ready to serve customers within 24 months from the time that the parties execute the appropriate bulk service agreement.

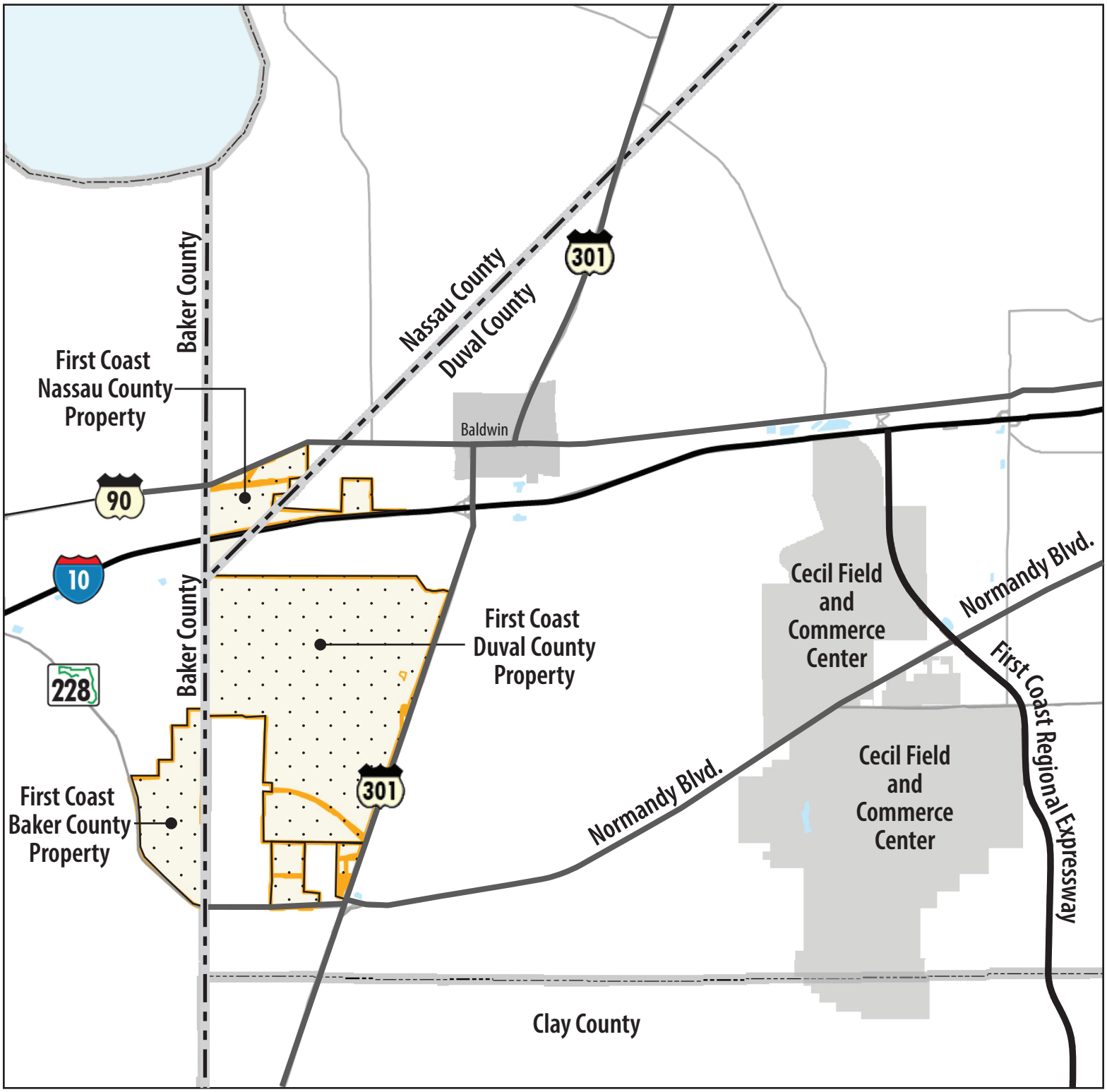
We look forward to working with you towards a mutually acceptable resolution of this matter.

Sincerely,

SUNDSTROM & MINDLIN, LLP

William E. Sundstrom, P.A.
For the Firm

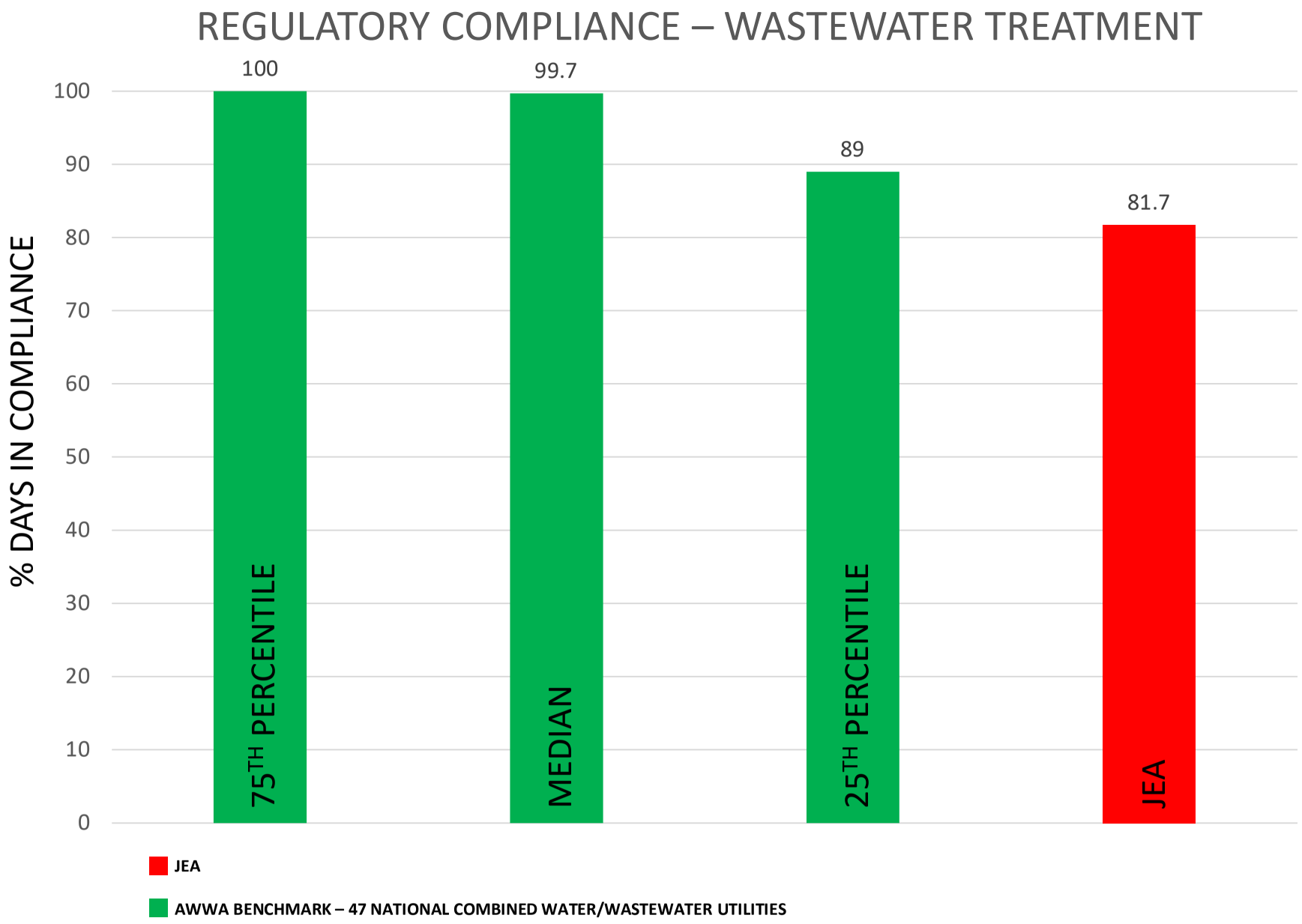
WES/brf

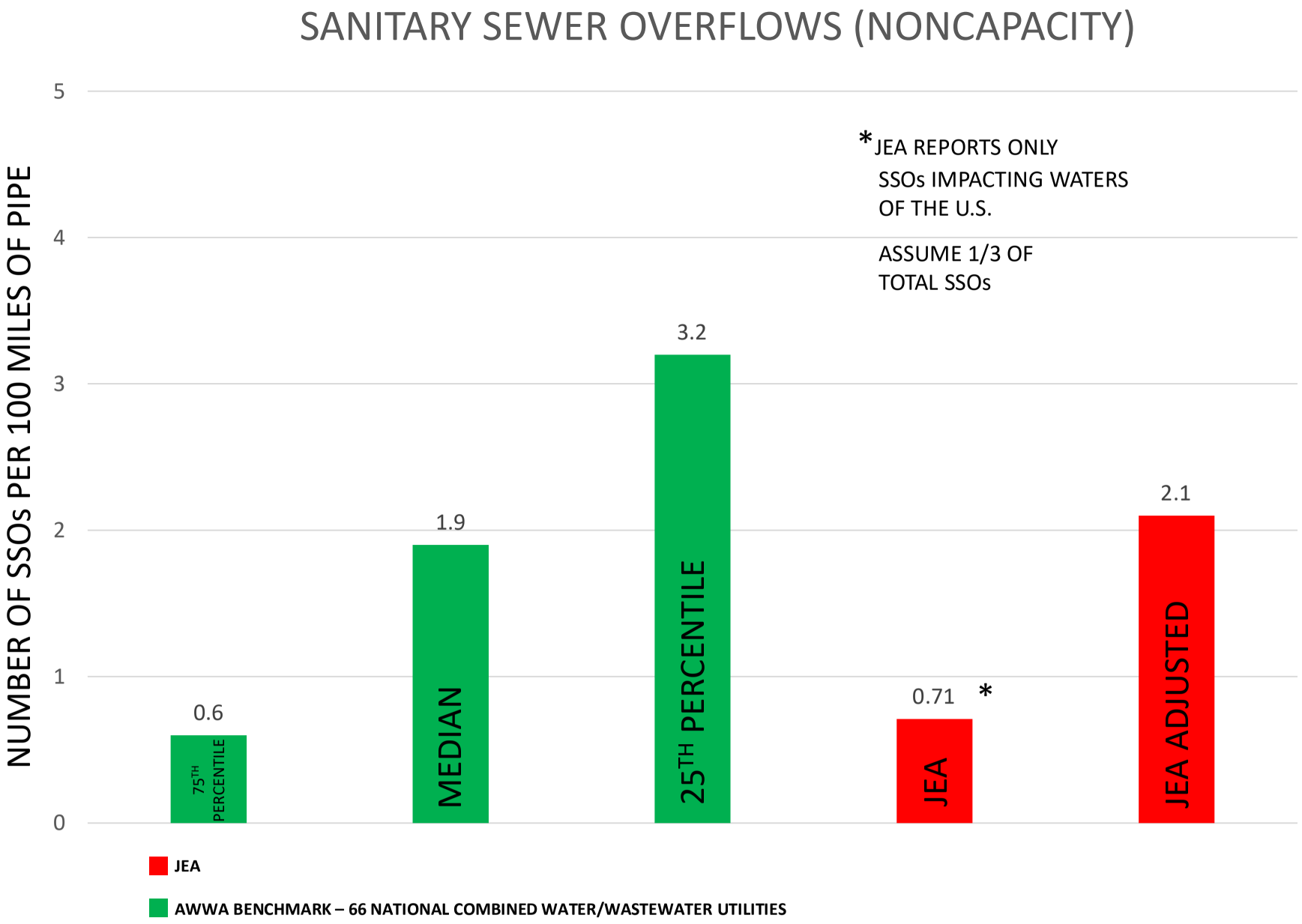


First Coast Regional Utilities

Location Map

NORTH





ASCE 2019 PIPELINES CONFERENCE
Nashville, Tennessee
July 21-24, 2019

LIFE CYCLE COST ANALYSIS FOR DECISION MAKING IN COLLECTION SYSTEM REHABILITATION

Bevin A. Beaudet, P.E. M.ASCE[1], Bruce Tobey, Esq.[2], and Scott E. Harder, P.E.[3]

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1. ABSTRACT

Life Cycle Cost analysis (LCC) is a tool allowing utility owners to make sound project decisions, considering both capital and operating costs over a long-term analysis period. Capital projects prioritized by rigorous LCC analyses facilitate strongly supportable business case decisions. More often performed for projects such as treatment plants or pumping stations, rarely is LCC used to make decisions on collection system rehabilitation. This is unfortunate because rehabilitation projects are consuming a greater percentage of utilities' capital budgets. This paper presents a detailed description of the LCC methodology as it pertains to collection system rehabilitation decisions. A simple spreadsheet-based case study is presented for collection system rehabilitation of lateral liners using Cured In Place Plastic (CIPP) lining. During the presentation many often overlooked variables influencing life cycle rehabilitation costs will be identified and methods to incorporate them into the LCC will be described. These include not only initial capital and long-term operating costs, but also a broad range of other evidence including job site tests, published reports, manufacturer product data as well as historical local experience. The broader the range of evidence incorporated into the analysis, the more accurate is the LCC and corresponding business case.

2. INTRODUCTION

The American Society of Civil Engineers has assigned a D+ to the condition of U.S. wastewater infrastructure. In the U.S., there are over 800,000 miles of public sewers and 500,000 miles of private lateral sewers connecting private property to public sewer lines (1). Each of these conveyance systems is susceptible to structural failure, blockages, and overflows. The EPA estimates that $271 billion is needed for wastewater infrastructure over the next 25 years. Of that amount, $51 billion is needed for conveyance system repair (2). Clearly, this expenditure, however financed, will ultimately be passed on to rate payers / utility customers. Maximizing the benefit of every dollar spent on collection system repair and rehabilitation should be the goal

of every utility decision maker. Too often, only initial investment (least cost) is the main priority in the process of capital planning for collection system rehabilitation.

Fortunately, there is an analytical tool, Life Cycle Cost analysis (LCC), which provides the decision maker a tool to determine the cost of rehabilitation alternatives based on the full life cycle (service life) of each alternative. LCC takes into consideration operation and maintenance costs, performance and service life of each alternative, and other considerations. LCC is such an important tool in maximizing cost effectiveness that the Water Resources Reform and Development Act of 2014 (WRRDA) amended the Clean Water Act to include section 602(b)(13) mandating LCC for federally funded projects.

3. WHAT IS LCC?

ASTM International defines LCC analysis in its Standard F1675 – 13, *Standard Practice for Life-Cycle Cost Analysis of Plastic Pipe Used for Culverts, Storm Sewers and Other Buried Conduits* (3) as:

> Section 1.2: The LCC technique measures the present value of all relevant costs to install, operate and maintain alternative drainage systems such as engineering, construction, maintenance, rehabilitation, or replacement over a specified period of time.
> Section 1.3: The decision maker, using the results of the LCC analysis, can then identify the alternative(s) with the lowest estimated total cost based on the present value of all costs.

For the LCC to be as useful as possible, it should follow the procedures detailed in F1675. After carefully defining independent, mutually exclusive alternatives that satisfy the same functional requirements and provide the same benefit, the following data should be compiled:

- Initial installed cost
- Material service life
- Operating costs
- Maintenance costs
- Rehabilitation cost
- Replacement cost
- Terminal value (commonly called salvage or estimated value of an asset in the future)

In compiling these costs, F1675 recommends that use of job site reports, published reports, manufacturer product data, and local experience with the alternatives to be considered. The broader the range of information assessed by the LCC analysis the more accurate the analysis will be.

4. EXAMPLE LCC ANALYSIS

A common method of trenchless rehabilitation of gravity sewer pipes is CIPP lining. CIPP lining provides a structurally sound pipe-within-a pipe that significantly reduces infiltration from the old, deteriorated mainline pipe. However, lining only the mainline pipe is not a complete solution.

The laterals (pipes from residences and other buildings that drain into the mainline) also need to be lined as leaking laterals can contribute from 25-75% of the total I&I depending on environmental conditions. Figure – 1 depicts a typical lateral after lining and sealing.

Figure – 1 Typical CIPP-Lined Lateral Showing Seals at Mainline Pipe and Within the Lined Lateral

CIPP methods are also commonly used to line the laterals, which must be sealed tightly to both the mainline and the upper portion of the old lateral. The main difference between the various CIPP lateral lining methods is the type of seal used. There are two generic type of seals: seals which use a hydrophilic paste or adhesive and seals which use pre-engineered, molded rubber hydrophilic gaskets. The only type of seal with specific standards are the rubber seals: ASTM F2561 (4) and ASTM F3240 (5).

In order to demonstrate an LCC analysis, a theoretical example is shown below. This example compares a "Do Nothing" alternative with two different CIPP lateral lining alternatives. The example analysis is conducted over a 50-year period, which is the projected service life of a CIPP lined mainline pipe. The three alternatives are:

1. "Do Nothing" and leaving in service an old, leaking lateral and controlling the resultant leakage by scheduled maintenance activities including inspection, cleaning and grouting. Grouting is a short-term maintenance activity where a resin or other sealing material is injected into a leaking lateral to minimize leakage
2. CIPP lining using hydrophilic adhesive or paste-based seals
3. CIPP lining using pre-engineered, molded Neoprene rubber gaskets in compliance with ASTM F3240

Costs considered in the example analysis include initial installation and periodic replacement costs (if applicable), and two specific annual recurrent costs: conveyance and treatment of leakage flow volumes; and periodic maintenance by CCTV inspection, cleaning and grouting (if applicable) of the lateral.

5. COST ASSUMPTIONS USED IN THE ANALYSIS

- **Leakage –** the volume of leakage from a failed lateral was estimated using data from the paper given at the April 2014 NASTT No-Dig Conference: Rehabilitation of the Coral Gables Wastewater Collection System (6). In this paper the measured flow within a basin after the mainline pipe and laterals were fully lined by CIPP was reduced from 65 to 13 gpm. This indicates that 80% of the unlined flow resulted from I&I, assuming a generally accepted sewerage flow of 220 gpd from an equivalent residential connection. Fifty (50) percent of the I&I was assumed to come from the unrehabilitated mainline and 50% from the laterals, again a generally accepted figure. The cost of conveyance and treatment in 2018 dollars was assumed to be $2.50 per 1000 gallons.

- **CCTV Inspection and Grouting** – These costs were obtained from the authors' personal experience and that of several other utilities and contractors. The per lateral costs were based on the number of laterals that can be serviced by a single crew in one shift and the costs of labor and equipment for that shift.

- **Initial Installation Costs –** These costs were obtained from 2018 competitive bids for each type of lateral, without the installation of cleanouts. These bids were for lining 3-feet into the lateral connection from the sewer main.

6. DATA USED TO DETERMINE MATERIAL SERVICE LIFE

As previously reported, F1675 allows use of job site reports, published reports, manufacturer product data and local experience for each of the alternatives to be considered. This analysis makes use of such data to develop the assumptions on leakage, operating costs, and service life contained in the example LCC analysis. Review of the data in the spreadsheets shows that the leakage in the Do Nothing alternative can be mitigated for a number of years by inspection, cleaning and grouting, a practice conducted by many utilities. Such mitigation rarely results in eliminating leakage, only reducing it for a number of years until the process must be repeated to be of any value. It is also assumed that old, crumbling laterals can deteriorate to a stage that eventually grouting will have little to no effect. The example spreadsheets assumes that after 25 years, grouting will reach that stage, so no further leakage mitigation is assigned.

There are a number of reports and technical studies, which show limitations in material service life of the CIPP lining using the hydrophilic, adhesive or paste seals alternative. Recent tests conducted by an independent laboratory (7) (8) summarize the amount of expansion when submerged of both a commonly used paste seal (Adeka P-201A) compared to an ASTM F3240 compliant, molded neoprene rubber seal. Figure-2 demonstrates the results of this test. The hydrophilic paste seal expands to approximately 100% of its original volume, while the ASTM F3240 seal expands to approximately 800%.

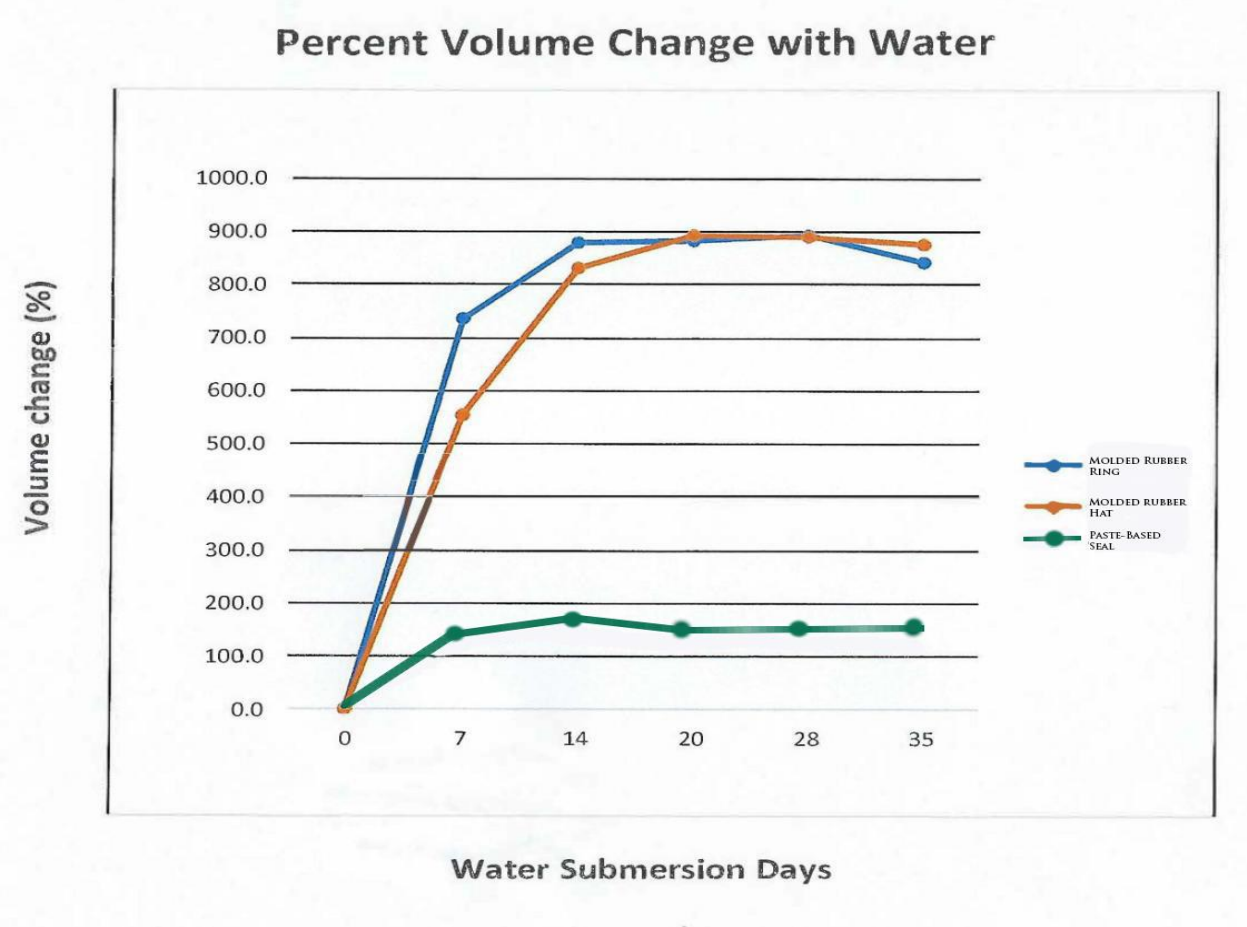

Figure – 2 Submersion/Expansion Test Results

Even in a best case, when the installers faithfully adhere to the controlled cool-down process which keeps the paste-based lateral CIPP liner full wrap barrel tight to the host's wall surface, there remains to be considered the issue of dimensional shrinkage from long-term creep. Creep is defined as the movement of the host pipe away from the liner due to external perpendicular forces, particularly the hydrodynamic head of surrounding groundwater. The gap formed after analyzing a standard barrel wrap under just 5.0 feet of groundwater after 8 years exceeds .012 inches, and that is equivalent to what has been proposed to be the maximum swelling capability of the caulk. The gap over 50-years is approximately 0.050 inches (a U.S. quarter is 0.07 inches thick), and this distance is well beyond the capabilities of the "squashed paste" at its thickest assuming that it still possesses the ability to grow 100% volumetrically. Figure – 3 demonstrates the effect of creep on the long-term performance of both sealing alternatives. This figure is derived from calculations using published material data and Thépot's creep analysis (9) (10).

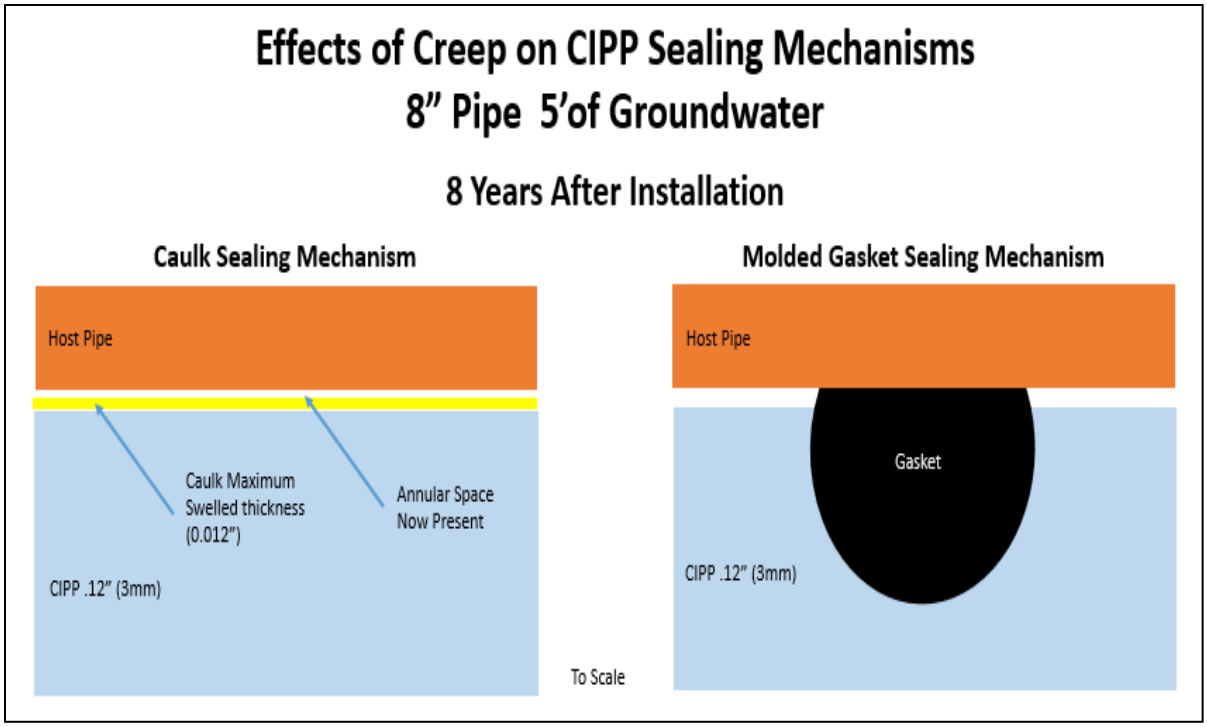

Figure – 3 Effects of Creep on CIPP Sealing Mechanisms

7. LCC METHOD OF CALCULATION

As previously discussed, Life Cycle Costs are overall costs spent by the owner during the entire life cycle of the project. The costs are incurred during the investment phase (installation), the operating phase, and the end-of-life phase. The alternative with the lowest net present value (NPV) over the analysis period is then considered the most cost-effective. To consider both the time value of money using the discount rate and the effect of annual inflation, future costs are adjusted for inflation prior to discounting.

Equation [1] is the standard equation for determining inflated costs:

$$InflC = C * (1 + ir)^t \qquad [1]$$

where: InflC = the cost after inflation at time = t
C = initial cost at time t = 0
t = time in years
ir = annual inflation rate

The next step is to discount all inflated annual costs to present costs and then add these discounted costs together to derive a single NPV result for each alternative. In order to calculate the NPV a discount rate is necessary. This discount rate represents the time value of money and is normally set to the utility's long-term cost of borrowing.

Equation [2] is the equation used for determining NPV (11):

$$NPV = \sum_{t=0}^{T} \frac{C_t}{(1+dr)^t} \qquad [2]$$

where: NPV = the net present value of the stream of costs considered over the analysis period
C_t = all relevant costs during year t
dr = the discount rate expressed as a percentage
t = the time in years (t=0……T) (years)
T = the selected analysis period

An Annual Inflation Rate of 2.25% and a Discount Rate of 5.00% have been assumed for the example given below, The analysis period has been defined to be 50 years, the generally accepted service life for CIPP mainline lining. Salvage (Terminal) values have been defined based on straight-line depreciation. For instance, if an asset with a useful life of 20 years were only 10 years into its service life at the end of the analysis period, then 50% of its installation cost would be credited at the end of the analysis period

8. RESULTS

Tables – 1, 2 and 3 are spreadsheets which use the above equations to calculate the NPV of each alternative.

The NPV results for each of the three alternatives are:

1. Do Nothing Alternative - $9494.85
2. CIPP lining using hydrophilic adhesive or paste-based seals - $6185.37
3. CIPP lining using pre-engineered, molded rubber gaskets, ASTM F3240 compliant - $3192.42

TABLE 1
No Action Alternative
Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect/ Grout	Total Annual Cost	Present Value
0	$0.00				$0.00
1		$400.00		$400.00	$380.95
2		$409.00		$409.00	$370.98
3		$418.20		$418.20	$361.26
4		$427.61		$427.61	$351.80
5		$437.23	$524.68	$961.91	$753.68
6		$55.88		$55.88	$41.70
7		$114.28		$114.28	$81.22
8		$233.71		$233.71	$158.18
9		$358.45		$358.45	$231.06
10		$488.69	$586.42	$1,075.11	$660.02
11		$62.46		$62.46	$36.52
12		$127.73		$127.73	$71.13
13		$261.21		$261.21	$138.53
14		$400.63		$400.63	$202.35
15		$546.19	$655.43	$1,201.63	$578.00
16		$69.81		$69.81	$31.98
17		$142.76		$142.76	$62.29
18		$291.95		$291.95	$121.31
19		$447.78		$447.78	$177.20
20		$610.47	$732.56	$1,343.03	$506.17
21		$78.03		$78.03	$28.01
22		$159.56		$159.56	$54.55
23		$326.30		$326.30	$106.24
24		$500.47		$500.47	$155.18
25		$682.31		$682.31	$201.49
26		$697.66		$697.66	$196.21
27		$713.36		$713.36	$191.07
28		$729.41		$729.41	$186.07
29		$745.82		$745.82	$181.19
30		$762.60		$762.60	$176.45
31		$779.76		$779.76	$171.83
32		$797.30		$797.30	$167.33
33		$815.24		$815.24	$162.94
34		$833.58		$833.58	$158.68
35		$852.34		$852.34	$154.52
36		$871.52		$871.52	$150.47
37		$891.13		$891.13	$146.53
38		$911.18		$911.18	$142.70
39		$931.68		$931.68	$138.96
40		$952.64		$952.64	$135.32
41		$974.08		$974.08	$131.77
42		$995.99		$995.99	$128.32
43		$1,018.40		$1,018.40	$124.96
44		$1,041.32		$1,041.32	$121.69
45		$1,064.75		$1,064.75	$118.50
46		$1,088.70		$1,088.70	$115.40
47		$1,113.20		$1,113.20	$112.38
48		$1,138.25		$1,138.25	$109.43
49		$1,163.86		$1,163.86	$106.57
50		$1,190.04		$1,190.04	$103.78
NPV					$9,494.85

TABLE 2
CIPP Lined with Adhesive Seals Alternative
Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect/ Grout	Lining Replacement	Total Annual Cost	Present Value
0	$1,290.00					$1,290.00
1		$0.00			$0.00	$0.00
2		$0.00			$0.00	$0.00
3		$0.00			$0.00	$0.00
4		$0.00			$0.00	$0.00
5		$0.00			$0.00	$0.00
6		$55.88			$55.88	$41.70
7		$85.71			$85.71	$60.91
8		$116.85			$116.85	$79.09
9		$179.22			$179.22	$115.53
10		$305.43	$586.42		$891.85	$547.52
11		$62.46			$62.46	$36.52
12		$95.80			$95.80	$53.34
13		$130.60			$130.60	$69.26
14		$200.32			$200.32	$101.17
15		$273.10			$273.10	$131.36
16		$349.05			$349.05	$159.90
17		$428.29			$428.29	$186.86
18		$510.91			$510.91	$212.29
19		$597.03			$597.03	$236.27
20		$610.47		$1,968.76	$2,579.23	$972.08
21		$0.00			$0.00	$0.00
22		$0.00			$0.00	$0.00
23		$0.00			$0.00	$0.00
24		$0.00			$0.00	$0.00
25		$0.00			$0.00	$0.00
26		$87.21			$87.21	$24.53
27		$133.75			$133.75	$35.83
28		$182.35			$182.35	$46.52
29		$279.68			$279.68	$67.95
30		$476.62	$915.12		$1,391.74	$322.02
31		$97.47			$97.47	$21.48
32		$149.49			$149.49	$31.37
33		$203.81			$203.81	$40.74
34		$312.59			$312.59	$59.50
35		$426.17			$426.17	$77.26
36		$544.70			$544.70	$94.05
37		$668.34			$668.34	$109.90
38		$797.28			$797.28	$124.86
39		$931.68			$931.68	$138.96
40		$952.64		$3,072.27	$4,024.91	$571.72
41		$0.00			$0.00	$0.00
42		$0.00			$0.00	$0.00
43		$0.00			$0.00	$0.00
44		$0.00			$0.00	$0.00
45		$0.00			$0.00	$0.00
46		$136.09			$136.09	$14.42
47		$208.72			$208.72	$21.07
48		$284.56			$284.56	$27.36
49		$436.45			$436.45	$39.96
50		$743.78	$1,428.05	($1,918.94)	$252.88	$22.05
NPV						$6,185.37

TABLE 3
CIPP Lined with ASTM 3240 Compliant Seals
Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect	Lining Replacement	Total Annual Cost	Present Value
0	$2,440.00					$2,440.00
1		$0.00			$0.00	$0.00
2		$0.00			$0.00	$0.00
3		$0.00			$0.00	$0.00
4		$0.00			$0.00	$0.00
5		$0.00			$0.00	$0.00
6		$0.00			$0.00	$0.00
7		$0.00			$0.00	$0.00
8		$0.00			$0.00	$0.00
9		$0.00			$0.00	$0.00
10		$0.00	$277.94		$277.94	$170.63
11		$9.37			$9.37	$5.48
12		$9.58			$9.58	$5.33
13		$9.80			$9.80	$5.19
14		$10.02			$10.02	$5.06
15		$10.24			$10.24	$4.93
16		$10.47			$10.47	$4.80
17		$10.71			$10.71	$4.67
18		$10.95			$10.95	$4.55
19		$11.19			$11.19	$4.43
20		$11.45	$347.20		$358.65	$135.17
21		$15.61			$15.61	$5.60
22		$15.96			$15.96	$5.45
23		$16.32			$16.32	$5.31
24		$16.68			$16.68	$5.17
25		$17.06			$17.06	$5.04
26		$17.44			$17.44	$4.91
27		$17.83			$17.83	$4.78
28		$18.24			$18.24	$4.65
29		$18.65			$18.65	$4.53
30		$19.06	$433.73		$452.79	$104.77
31		$29.24			$29.24	$6.44
32		$29.90			$29.90	$6.27
33		$30.57			$30.57	$6.11
34		$31.26			$31.26	$5.95
35		$31.96			$31.96	$5.79
36		$32.68			$32.68	$5.64
37		$33.42			$33.42	$5.49
38		$34.17			$34.17	$5.35
39		$34.94			$34.94	$5.21
40		$35.72	$541.81		$577.54	$82.04
41		$48.70			$48.70	$6.59
42		$49.80			$49.80	$6.42
43		$50.92			$50.92	$6.25
44		$52.07			$52.07	$6.08
45		$53.24			$53.24	$5.93
46		$54.44			$54.44	$5.77
47		$55.66			$55.66	$5.62
48		$56.91			$56.91	$5.47
49		$58.19			$58.19	$5.33
50		$59.50	$676.84		$736.34	$64.21
NPV						$3,192.42

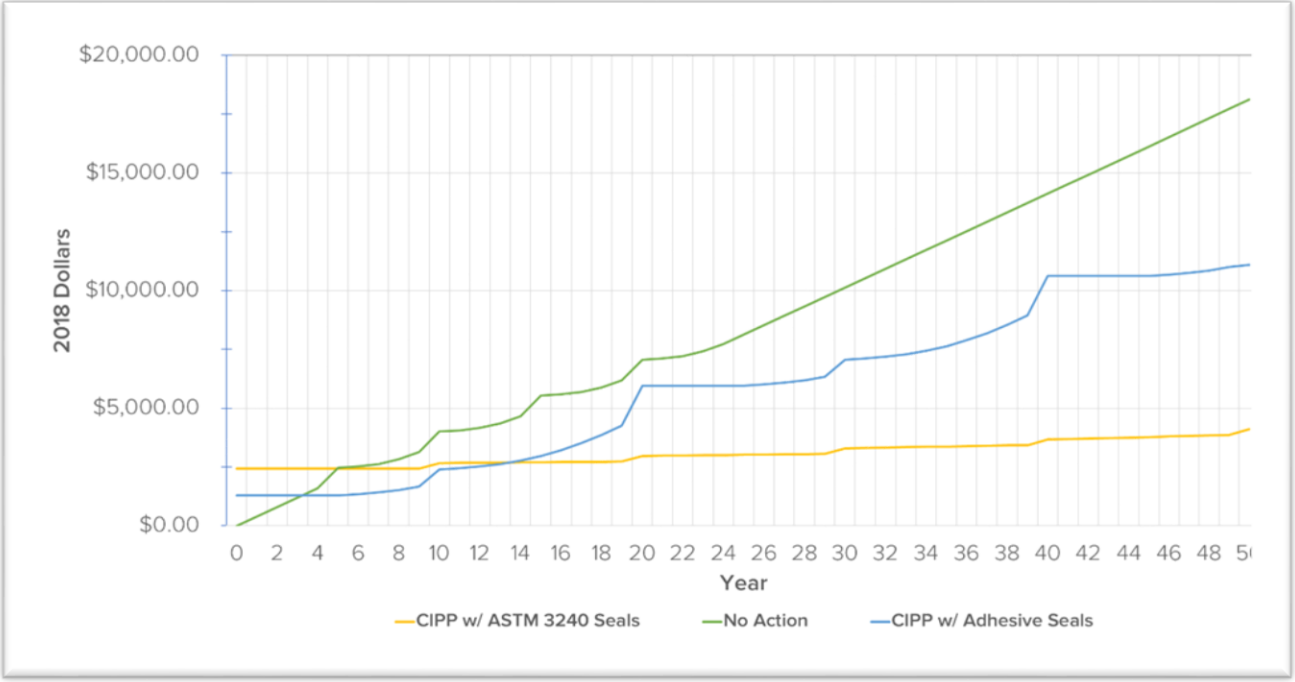

Figure 4 Cumulative Annual Costs (Uninflated)

9. CONCLUSIONS

The results of the example analysis demonstrate the value of the LCC analysis to a utility considering alternatives for rehabilitation of laterals in a collection system. In this example, the higher initial cost alternative is shown to be the most cost effective long-term alternative to the utility and its customers. Not only is the 50-year NPV much less, but according to Figure – 4, the cumulative annual costs of the ASTM F3240 compliant alternative are achieved and begin to benefit the utility in year 15 following installation. Further, since the ASTM F3240 alternative has lower annual costs, its economic advantage is much less sensitive to inflation.

The same method of LCC analysis, described in this paper, can be used to compare alternatives for other collection system projects, including conveyance system projects such as pumping stations. Treatment plant projects can also be analyzed for NPV using this method as long as the alternatives analyzed provide the same project benefits and that time-related variable costs can be reasonably estimated.

Perhaps one of the most important benefits of LCC to a utility decision maker is the solid documentation of a business case for the most cost effective alternative. Utility managers are under tremendous pressure to stretch capital budgets as much as possible, given all the pressing needs for infrastructure rehabilitation throughout the utility. An LCC analysis can be used to insure decision makers that they are making the best decision for their customers in the long-term.

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