AECOM

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# Memorandum

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| To | Terry Desmarais, City Engineer | Page 1 of 2 |
| CC | Peter Rice, Director; Brian Goetz, Deputy Director; and Paula Anania, Chief Operator | |
| Subject | Electrical Feed Justification<br>Peirce Island WWTF Upgrade Design | |
| From | Erik Meserve and Jon Pearson | |
| Date | October 28, 2013 | |

This memorandum summarizes the reasons why the change from construction of a secondary WWTF upgrade to a larger facility providing nitrogen removal significantly impacts the work required on the plant electrical feed, distribution, and standby power systems. AECOM, in concert with its subconsultant Carlin Contracting, has prepared this memorandum in support of the City's request for an extension of the current Consent Decree schedule. The impacts of the change from construction of a secondary WWTF to a larger facility designed for nitrogen removal are described below:

- When designed for secondary treatment only, the BAF was small enough to fit inside the existing Filter Building. Under this situation, the Filter Building would be retrofit for the BAF and the existing electrical switchgear and generator would have remained in service.

- When the flows and loads increased and the treatment objective changed to include total nitrogen, the BAF grew significantly larger and exceeded the footprint of the existing Filter Building. Additionally, the electrical load increased to greater than the capacity of the existing electrical service. The increase in flows and loads and change in treatment objective requires that the Filter Building be completely demolished and thus the main electrical switchgear and generator be moved and replaced.

- However, the main electrical switchgear and generator must remain operational until the new switchgear and generator are completed in order to maintain the operation of the existing treatment process. Therefore, demolition of the existing Filter Building and construction of the BAF would not begin until this work is completed.

- The timeline for installing a new electrical service and generator is extended because this equipment is large enough and of custom sizing and configuration that manufacturers only fabricate it on an as-needed basis. The typical timeline for obtaining this type of equipment is shown below. The subsequent bullet point summarizes why this timeline is difficult to accelerate.

    - Contractor submittal preparation, Engineer review and approval: 4 months

- Vendor fabrication and delivery: 6 months
- Contractor installation: 2 months
- Contractor transfer facility to new electrical: 2 months

- The potential for acceleration of this schedule is limited. Because of the size and complexity of the equipment, the several hundred page submittals are lengthy to prepare and take time to review. The fabrication period is determined by the manufacturers and offers limited opportunities for acceleration. Installation and transferring the facility to the new electrical service is also difficult to accelerate because the existing facilities must be closely coordinated with plant operations, transferred one at a time, and tested before the next facility is transferred. As an example of how long this process takes, the Warwick Sewer Authority's treatment facility in Warwick, RI was flooded on March 30, 2010. The existing switchgear and generator were destroyed during the flood. Despite having only to replace these two pieces of equipment in kind and an expedited shop drawing review and approval process, the new switchgear and generator did not arrive on-site until November 17, 2010. Following installation and testing, the new components were put into service in March 2011.

- Relocation of the electrical switchgear and generator will necessitate reconfiguration of the underground electrical distribution system to re-feed existing facilities from the new switchgear and generator. Temporary wiring and careful sequencing will be needed to maintain the plant in operation.

- Because of the time required for the relocation and replacement of the switchgear and generator, which was not needed when the plant was to be upgraded only for secondary treatment, demolition of the Filter Building and construction of the BAF would not begin until approximately 14 months after the construction contract is executed.

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# Memorandum

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| To | Terry Desmarais, City Engineer | Page 1 of 3 |
| CC | Peter Rice, Director; Brian Goetz, Deputy Director; and Paula Anania, Chief Operator | |
| Subject | Design Extension Justification<br>Peirce Island WWTF Upgrade Design | |
| From | Erik Meserve and Jon Pearson | |
| Date | October 28, 2013 | |

This memorandum briefly outlines the reasons why AECOM believes that the change from construction of a secondary WWTF upgrade with an estimated construction cost of $25 million to a larger facility providing nitrogen removal with an estimated construction cost of $45 million will require more time and effort to design. The original Consent Decree schedule allowed 14 months for design and 6 months between design completion and the startup of construction. The proposed schedule includes an additional 6 months for design and maintains 6 months between design completion and construction. This memorandum has been prepared in support of the City's request for an extension of the current Consent Decree schedule. AECOM believes that an extension of the design schedule is warranted for the following reasons:

- The design process is a linear, iterative, sequential process in which subsequent steps build on the results of the previous steps. The following is a simplistic summary of the design process. First, the treatment process sizing and flow diagram is determined by process engineers, followed by preliminary equipment selections, conceptual building and structure layouts and a preliminary site plan. The process engineers then work with the architects to refine the building and structure layouts, which typically revises the initial concepts. After the building layouts are further advanced, the structural engineers begin work to define the building envelopes. Once the structure and building envelopes are sufficiently defined, the HVAC, plumbing and fire protection engineers can begin their work. As work by the different disciplines progresses, revisions to the initial layouts and concepts are made. When equipment layouts and selections are finalized at approximately 60% complete, the electrical and instrumentation engineers can begin their work in earnest. Typically 70% of the electrical design budget is expended after the 60% design point. Because information developed by one discipline is relied upon by another discipline, it is not possible to have the entire design team begin at the same time. As a result, to design the significantly larger and more complex upgrade project, more time is needed.

- The design of the larger upgrade will require significant changes to the plant electrical system that were not required with the smaller project (see separate explanation).

- The constricted site of the treatment facility will increase the design effort when more facilities are required within the same site area. There is little available room on the existing site to

locate the new facilities required as part of the upgrade. In many cases, relocation and reconstruction of existing facilities will be required to accommodate the new structures, with additional design effort and careful coordination needed. For example, the second stage BAF is to be located where the existing recycle pump station is located, requiring that this pump station be relocated. Not only does this result in additional design effort for reconstructed facilities such as the recycle pump station, but it also requires careful thought during the design process as to how current plant operations will be maintained during construction. For example, thought must be given as to when processes can be taken off line for rehabilitation or replacement at the same time and what time of year they can be taken off line so that the plant operators have the best chance of continuing to meet their discharge limits during construction.

- Attempting to complete the design of the larger upgrade project within the current Consent Decree schedule for design will unacceptably compromise the City's and NHDES's ability to comment and have input into the design process. Typically, the design team will pause after a progress submittal while the City reviews and comments on the design. If the current schedule is maintained, the design team will need to continue moving during the City's review time and large aspects of the design will need to be "frozen" much earlier than normal. Similar to the City, NHDES would typically have several chances to review and comment on a project of this magnitude during the design process. The current schedule allows for only one review at the conclusion of design activities.

- In Portsmouth's case, the design process is reliant upon the equipment vendors to a larger degree than normal because the BAF process is proprietary. Detailed elements of the design cannot be determined until information is received from the process vendor, Kruger. Just as the design process within AECOM is iterative, AECOM's interaction with Kruger is also iterative to customize their process to the site specific situation. For example, Kruger's preferred layout places the mudwell in an attached structure to the BAF cells. There is not enough space on the Peirce Island site for this to occur so AECOM and Kruger have had to iterate to develop a way in which the mudwell can be located underneath the BAF cells. With two BAF stages required for the larger project, additional time is needed to complete the design effort.

- The proposed schedule includes two Value Engineering reviews, which are recommended by EPA's *Value Engineering For Wastewater Treatment Works* (EPA 430/9-84-009) for large, complex projects as these reviews typically result in an excellent ratio of capital savings to cost. Value engineering is also required by the NH DES for projects with an estimated construction cost of over $10 million (Env.-wq 508.01). However, the typical time period for each of these exercises is 3 to 4 months (EPA 430/9-84-009, p.2-5). Maintaining the current Consent Decree schedule will result in the elimination of one, if not both, VE reviews. This is unacceptable to the City, as the use of value engineering on past projects has yielded significant cost savings.

- Maintaining the current Consent Decree design schedule results in less design time than is typically required for projects of this size. The following list of recent AECOM projects is shown as an example:

    - Cheshire, CT WPCP Upgrade - $30M construction - design period: 24 months
    - Meriden, CT WPCP Upgrade - $35M construction - design period: 21 months
    - Westborough, MA WWTF Upgrade - $46M construction – design period: 20 months

- Proposed Peirce Island WWTF Upgrade – approx. $45M construction – design period: 20 months

The proposed design schedule of 20 months for the Peirce Island WWTF Upgrade is aggressive given the complexities of this project.

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# Memorandum

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|---|---|---|
| To | Terry Desmarais, City Engineer | Page 1 of 4 |
| CC | Peter Rice, Director; Brian Goetz, Deputy Director; and Paula Anania, Chief Operator | |
| Subject | Construction Extension Justification<br>Peirce Island WWTF Upgrade Design | |
| From | Erik Meserve and Jon Pearson | |
| Date | October 28, 2013 | |

This memorandum briefly outlines the reasons why AECOM believes that the change from construction of a secondary WWTF upgrade with an estimated construction cost of $25 million to a larger facility providing nitrogen removal with an estimated construction cost of $45 million will require more time and effort to construct. AECOM, in concert with its subconsultant Carlin Contracting, has prepared this memorandum in support of the City's request for an extension of the current Consent Decree schedule.

The attached three schedules were prepared to support this evaluation. The schedules were developed with the current Consent Decree construction time frame of 24 months and the proposed construction timeframe of 33 months (excludes startup and compliance). The schedules have been prepared by Carlin Contracting and represent one contractor's opinion of how these projects would be constructed. Each contractor will approach the job slightly differently so the schedules should be interpreted as conceptual rather than final. The schedules show the following three scenarios:

- Schedule 1 – Secondary, 4.3 MGD, 24 months - Upgrading the current WWTF to meet secondary treatment standards with a BAF within the current Consent Decree schedule. The design average daily flow is 4.3 mgd and the estimated construction cost was approximately $25 million. Figure 1 shows the site layout for the work proposed under this schedule.

- Schedule 2 – TN8, 6.13 MGD, 33 months - Upgrading the current WWTF to meet a total nitrogen of 8 mg/L with a two-stage BAF process within the proposed Consent Decree schedule. The design average daily flow is 6.13 mgd and the estimated construction cost is approximately $45 million. Figure 2 shows the site layout for the work proposed under this schedule

- Schedule 3 – TN8, 6.13 MGD, 24 months - Upgrading the current WWTF to meet a total nitrogen of 8 mg/L with a two-stage BAF process within the current Consent Decree schedule. The design average daily flow is 6.13 mgd and the estimated construction cost is approximately $45 million. Figure 2 shows the site layout for the work proposed under this schedule

Each schedule has been annotated with the estimated average number of construction employees and estimated average number of heavy construction vehicle one-way trips per month. Using these

estimates, the average number of one-way trips per day, the peak number of one-way trips per day, and the peak trip frequency has been estimated in the following manner:

- In order to take into account weekends, holidays, and days lost to weather, the average number of one-way trips per day has been estimated based on 18 working days per month between November and April and 20 working days between May and October.
- The peak number of one way trips on any given day within the month has been estimated by assuming that the peak day is roughly 40% greater than the average.
- The peak trip frequency displays the frequency in minutes of a truck either entering or exiting the site on the peak day of the month. It was calculated assuming that trucks entered and exited the site throughout 7 hours of an 8 hour shift in recognition that work does not commence promptly at the beginning of the shift nor continue right up to the end. When double shifts are required, the peak truck frequency was calculated assuming that 67% of the truck traffic occurred during the day.

It is important to note that the manpower estimates do not include staff that are not on-site for the entire shift, such as delivery truck drivers, but does include full-time construction labor force. Additionally, the estimates of one-way trips does not include pick-ups and vans that many subcontractors will have for tools, deliveries to the contractor and City, City staff vehicles, engineering staff vehicles, and other visitors. Lastly, the vehicular weight limit of 80,000 lbs on the Peirce Island Road bridge has been taken into account in estimating the truck traffic.

Based on these assumptions and estimates, the tables below display comparisons of manpower and truck traffic between the schedules prepared.

**Table 1. Estimated Construction Manpower Comparisons**

| Schedule Number | Average Manpower Per Day | Peak Manpower Per Day | Sum of Average Monthly Manpower |
|---|---|---|---|
| Schedule 1 – 4.3 mgd, Secondary Treatment BAF, current CD schedule | 44 | 65 | 1,060 |
| Schedule 2 – 6.13 mgd, TN8 BAF, proposed CD schedule | 51 | 76 | 1,699 |
| Schedule 3 – 6.13 mgd, TN8 BAF, current CD schedule | 77 | 119 | 1,857 |

**Table 2. Estimated Truck Traffic Comparisons**

| Schedule Number | Total One-Way Trips | Average Trips per Day | Peak Trips per Day | Peak Trip Frequency Range (minutes) |
|---|---|---|---|---|
| Schedule 1 – 4.3 mgd, Secondary Treatment BAF, current CD schedule | | | | |
| 7:00 AM – 3:30 PM | 9,869 | 11 – 39 | 15 – 55 | 8 - 28 |
| 3:30 PM – 12:00 AM | - | - | - | - |
| Schedule 2 – 6.13 mgd, TN8 BAF, proposed CD schedule | | | | |
| 7:00 AM – 3:30 PM | 21,392 | 18 – 56 | 26 – 79 | 5 - 16 |
| 3:30 PM – 12:00 AM | - | - | - | - |
| Schedule 3 – 6.13 mgd, TN8 BAF, current CD schedule | | | | |
| 7:00 AM – 3:30 PM | 20,261 | 19 – 51 | 27 – 71 | 6 – 15 |
| 3:30 PM – 12:00 AM | | 10 - 25 | 14 - 35 | 12 - 30 |

Table 1 shows that there is a roughly 15% increase in the average number of construction workers on-site per day between Schedule 1 – Secondary, 4.3 MGD, 24 months and Schedule 2 – TN8, 6.13 MGD, 33 months. On the constricted site of the WWTF, this level of staffing may, at times, make effective operation and maintenance of the existing plant challenging. Under Schedule 3 – TN8, 6.13 MGD, 24 months, the levels of staffing are similar, except that instead of the negative impacts of construction such as noise, light, traffic and dust are being spread over the 8 hour workday, they are spread over 16 hours of the day.

Table 1 also shows a significant increase in the number of construction workers between Schedules 2 – TN8, 6.13 MGD, 33 months and 3 – TN8, 6.13 MGD, 24 months, although the scope of work between Schedules 2 – TN8, 6.13 MGD, 33 months and 3 – TN8, 6.13 MGD, 24 months is the same. This increase is due to the fact that the shortened schedule results in double shifts being required for approximately 21 of the 24 months of construction, as shown in red on the attached Schedule 3 – TN8, 6.13 MGD, 24 months. Multiple shift operation results in a loss of production efficiency, which results in an increase in the overall number of construction workers and will increase the cost of the project to the City. Loss in construction efficiency is well documented in publications from RS Means and the American Society of Civil Engineers. Under this scenario, construction would take place daily from 7 AM until midnight, 5 days a week. This will result in extensive site lighting during the night hours to allow work to be conducted. Nighttime construction work is inherently less safe than daytime construction work because of the limited lighting and the fact that people are naturally tired. Additionally, preliminary conversations with the United Stated Coast Guard and Harbormaster have indicated that site lighting at night will need to be turned off or turned away from the adjacent Piscataqua River shipping channel while the Harbor Pilots are guiding a large deep draft vessel into or out of the harbor.

The estimated truck traffic in Table 2 shows that the proposed project to remove nitrogen to 8 mg/L more than doubles the amount of truck traffic associated with the project as compared to the traffic associated with the secondary treatment upgrade. The frequency of trucks entering or exiting the site may be as frequent as every 5 minutes. Total truck traffic decreases slightly in Schedule 3 – TN8, 6.13 MGD, 24 months as compared to Schedule 2 – TN8, 6.13 MGD, 33 months because many trucks, such as the fuel trucks and dumpster trucks, are regularly scheduled and will not change significantly if construction takes place over one shift or two. However, under Schedule 3 – TN8, 6.13 MGD, 24 months, trucks will continue to enter and exit the site after 3:30 PM extending to midnight five days per week. On the peak days, it is estimated that a truck will enter or exit the site as frequently as every 12 minutes during that period.

Based on the information contained in these schedules, AECOM believes that an extension of the construction schedule is warranted for the following reasons:

- Completing the upgrade for total nitrogen of 8 mg/L within the current Consent Decree schedule will result in nearly two continuous years of double-shift construction which will degrade the quality of life in the City. Double shift construction will result in extensive heavy construction during the evening and night hours adjacent to the heart of downtown Portsmouth for nearly two years. The noise, traffic, light and dust impacts will significantly impact the residential, recreational and commercial activities that surround the project site and are the foundation of daily life in the City.

- Completing the upgrade for total nitrogen of 8 mg/L within the current Consent Decree schedule with double shift work will require the City to maintain a skeleton operations staff at Peirce Island for an extra shift, adding cost to the project and risk that if construction activities mistakenly cause a malfunction in the plant the skeleton crew may not be large enough to avoid affecting treatment performance.

- Completing the upgrade for total nitrogen of 8 mg/L within the current Consent Decree schedule with double shift work will increase the risk of a construction accident because it will require nearly two years of nighttime construction, which is inherently less safe than daytime construction.

- Completing the upgrade for total nitrogen of 8 mg/L within the current Consent Decree schedule with double shift work may cause delays and increased costs due to the added need to coordinate nighttime work with the USCG and Harbormaster in order to maintain a safe shipping channel.

- Completing the upgrade for total nitrogen of 8 mg/L within the current Consent Decree schedule with double shift work will result in a loss of production which translates into an increase in cost to the City. In addition, the expedited schedule increases the potential for construction coordination and execution errors which would also increase the project cost.