CITY OF CHARLOTTESVILLE, VIRGINIA
CITY COUNCIL AGENDA

Agenda Date:	June 15, 2015
Action Required:	Adoption of Resolution Approving Transfer of Funds
Presenters:	Brian Daly, Director, Parks & Recreation Lance Stewart, Division Manager, Facilities Maintenance
Staff Contacts:	Leslie Beauregard, Director, Budget and Performance Management Brian Daly, Director, Parks & Recreation Lance Stewart, Division Manager, Facilities Maintenance
Title:	**Transfer of Funds – From Capital Improvement Program Contingency Account to the Smith Aquatic & Fitness Center Project Account - $150,000**

Background:

On April 6, 2015, Council approved reallocation of $231,547 to complete improvements to the Smith Aquatic & Fitness Center Natatorium, an amount based on consultants' opinion of probable cost. The project will address ongoing concerns regarding air quality, staff and visitor health, and corrosion.

Since that date, the project design has been completed and contractor procurement attempted. Due to a combination of factors further explained in the Discussion section of this document, staff received only one firm proposal to complete this project within the targeted timeframe, a proposal exceeding previously allocated funds.

To move forward with this critical project, additional funding is required. The attached resolution requests that funds be transferred from CIP Contingency. The total amount of the transfer is $150,000.

Discussion:

In an effort to counter on-going concerns regarding indoor air quality in the Natatorium (swimming pool area), and to arrest associated corrosion of the building's structural members, hardware and equipment, the City engaged the services of a team of consulting electrical/mechanical engineers and aquatics engineers. The resulting recommendations focused on air flow and ventilation, but also include detailed analyses of the existing pool water chemistry and the pool's water treatment systems. Upon the recommendation of the consultant team, an architectural firm was also engaged to perform an independent assessment of the facility's building envelope, as related to outside air infiltration, as well as the integrity of the vapor barrier separating the Natatorium from the remainder of the building.

A detailed summary of their findings and recommendations, as well as further explanation of the basic principles and best practices for indoor pool water treatment and ventilation, is included as a separate Technical Memorandum.

Following the completion of design documents, contractor and subcontractor interest proved extremely limited, despite extensive efforts to engage every relevant commercial contractor in the area. This fact is attributed to a booming commercial construction/renovation market, the abbreviated opportunity to bid on and mobilize for the project, and most critically the timing of the project. Summers are this region's peak construction period, placing the project in competition with others in this area's many schools and universities. The great majority of contractors were already committed, even over-committed, to other projects. Utilizing the job order contracting process – a mechanism established by a Commonwealth of Virginia contract – staff received only one firm proposal. That contractor is ready to start the work in July, provisional to the City's ability to fully fund the project and expedite the contract execution process.

The summer season is the optimal time of the year to perform this work at Smith. Visitation is generally lower in the summer months and fewer instructional programs are held in the natatorium. Full instructional programming begins anew in September and the Charlottesville High School swimming & diving season begins November 9, running through the end of February. Pass sales also increase in the fall and winter months, our months of highest visitation at the facility. Revenue impacts of a closure at this time of year will be significant (estimated above $75,000 for a 2 month closure).

Any significant delay in performing this work that pushes construction later this year or even into 2016 is not advisable.

Over the past four years we have had numerous complaints from our lifeguards indicating nausea, watering eyes, sore throat and heavy lungs. On rare occasions life guards have become physically ill supposedly due to the Smith AFC air and their physicians have recommended another work location. The symptoms seem to affect each guard and patron differently but nonetheless there is a negative effect from the chloramines. Patrons have also left our facility and joined other fitness centers.

In 2013 we addressed a complaint to the NoVA Region Safety Director, Virginia Department of Labor and Industry indicating: "Employees are exposed to chemical vapors from the chlorine used in the Smith pool areas due to inadequate ventilation". Despite the subsequent implementation of several ventilation and air flow improvements (detailed in the Technical Memorandum), which helped to reduce the frequency and severity of air quality problems, building system design deficiencies continue to cause adverse health reactions for staff and patrons.

To date, staff continues to receive complaints from employees, lifeguards and patrons. For example, a patron complained that he could not breathe while our features were on when he visited Smith AFC after work. A new policy was then implemented to only operate the slides and water playground during birthday parties. Employees on the fitness side of the facility also can smell and feel the effects of the chloramines.

We have a legal and ethical obligation to our users and employees to do everything within our means to provide the best recreational experience and safe work environment possible. We have a solution that will solve the problem which cannot wait another season.

Alignment with Council Vision Areas and Strategic Plan:

This project supports City Council's "Smart, Citizen-Focus Government" vision.

It contributes to Goal 4 of the Strategic Plan, to "be a well-managed and successful organization", and objective 4.1, to "align resources with City's strategic plan".

Community Engagement:

N/A

Budgetary Impact:

The funds to be transferred and consolidated all were previously appropriated by City Council as CIP Contingency.

Recommendation:

Staff recommends approval of this resolution.

Alternatives:

Defer project until market is favorable. Deferral would result in continued visitor and staff exposure to a potentially unhealthy environment, as well as prolonged corrosion of equipment and building structural elements; and the impact of lost revenue and the lack of adequate aquatic programming opportunities and potential loss of pass holders.

Attachments:

Technical Memorandum – Smith AFC Natatorium Improvements

RESOLUTION

Transfer of Funds – From Capital Improvement Program Contingency Account to the Smith Aquatic & Fitness Center Project Account
$150,000

NOW, THEREFORE BE IT RESOLVED by the Council of the City of Charlottesville, Virginia that the following is hereby transferred in the following manner:

Transfer From
$150,000 Fund: 426 WBS: CP-080 (P-00684) G/L Account: 599999

Transfer To
$150,000 Fund: 426 WBS: P-00858 G/L Account: 599999

TECHNICAL MEMORANDUM
Smith AFC Natatorium Improvements
June 8, 2015

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Pool Chemistry, Air Quality Basics

"Pool and Spa Operator Handbook", National Swimming Pool Foundation – 2014

> *Combined chlorine (CC) forms when free chlorine (FC) reacts with contaminants in the water. When free chlorine reacts with ammonia, inorganic chloramines (not containing carbon) are produced. When FC reacts with organic nitrogen compounds, organic chloramines are formed. Both inorganic and organic chloramines show up in pool water tests as combined chlorine (CC) and are generally called chloramines. Urine, sweat and the environment are sources of ammonia and organic nitrogen-containing compounds. It is important to know how much of total chlorine is comprised of CC as CC is not an effective disinfectant. The presence of combined chlorine poses several challenges that the facility staff must work to address. Chloramines evaporate and are the cause of chlorine-like smell often witnessed in indoor pools. Chloramines are also irritating to skin and mucous membranes. Thus the removal or destruction of combined chlorine is a common problem pool operators must work to solve.*

In an indoor pool, when one smells 'chlorine', what one is actually sensing is the presence of chloramines. **Chloramines are a by-product of the work the chlorine does as a sanitizer**, generated by the chemical reaction between the chlorine and that which it sanitizes. They enter the air as water is evaporated or migrates on skin or in swimsuits, as a result of splashing, or through general agitation of the water. It should be noted that play features – such as slides and sprayers – agitate water and lead to accelerated evaporation of chloramines.

While it is somewhat counter-intuitive, the smell of chloramines does not mean there is too much chlorine in the water. It may in fact mean that there isn't enough chlorine, or that present chloramines are not being efficiently evacuated from the pool area. The reduction of chloramines in the air is accomplished through air return and exhaust systems.

Chloramines atoms are "heavier than air". Undisturbed, they seek the lowest level, typically no more than inches above the pool surface. This is a central fact engineers and pool operators must consider when managing air quality.

Numerous factors can contribute to the levels of chloramine in the air and water in indoor pools. Water temperature, turnover (the rate that the pool water cycles through the filtration system), clean water makeup, and evaporation all have an effect on chloramine levels. However, the biggest factor is bather load. **The higher the bather load (people in the water), the more chlorine is required to neutralize elements added to the water by humans (sweat, hair, skin, etc.), resulting in a proportional increase in the chloramine byproduct**. In an indoor facility these impacts on air quality are multiplied due to the closed environment.

Managing and controlling these factors is a complex and multi-faceted challenge. This challenge begins with properly designed and constructed building and water treatment systems, and continues with the vigilant attention application of water management best practices. Those most essential best practices include:

HVAC/Building Systems

- Must control humidity within the space
- Must minimally disturb the air, **allowing chloramines to remain near the pool surface**, rather than being dispersed through the space
- Must direct air currents in the direction of exhaust systems to facilitate chloramine removal
- **Must exhaust pool air outside the building sufficient to eliminate chloramine buildup, and must do so as close to and on level with the pool surface as possible**
- Barriers between swimming areas and other portions of the building must be vapor retardant, to avoid corrosion

Pool Water Treatment/Management

- Utilize chemicals and appropriate levels to control water hH (potential hydrogen), Free and Total Chlorine and Alkalinity
- Routinely and consistently measure water temperature and chemistry makeup throughout the day, and respond with water treatment as necessary
- Utilize advanced systems, such as ultraviolet light system, to break down chloramines in the water before they are evaporated into the surrounding air
- Utilize and maintain simple and advanced water filtration systems

Design Intent of Smith AFC Natatorium
Water Treatment and Ventilation Systems

The Smith AFC Natatorium contains two pools: a competitive pool and a leisure pool with two water slides, in-water play structure, and a lazy river. These pools function very differently from each other. The competitive pool is a large body of relatively stable water in terms of chemistry and temperature. The leisure pool's much lower total volume greater ratio mass-to-surface ratio is volatile by comparison. Its temperature fluctuates at a much greater rate, as does water chemistry. 10 patrons utilizing the competitive pool will have very little impact on water chemistry. 10 patrons in the leisure pool for an hour will measurable alter that pool's water chemistry. The relative instability of the leisure pool triggers reactions in pool water treatment and heating systems. To accommodate the variance between these bodies, each pool as a completely separate water treatment and heating systems.

Those systems are considered state of the art. The water is heated efficiently by borrowing energy from the pool air dehumidification system, and further by secondary high efficiency boilers. Pool water is scrubbed by modern large and fine filtering systems. Ultraviolet systems help to destroy biological contaminants and to break down chloramine atoms prior to evaporation. Precision control systems monitor chlorine levels, automatically adjusting chlorine introduction rates to ensure health, balanced pool water.

Collectively, the pool water treatment systems are appropriately and professionally monitored and maintained. Staff consider that there are no design deficiencies, though equipment has been stressed by corrosive airborne chloramine particles, resulting in instances of premature equipment failure and pool downtime.

All elements of the building were designed to meet or exceed Leadership in Energy and Environmental Design (LEED) standards for energy efficiency and minimal environmental impact both during construction and for the life of the building. Smith AFC received a LEED Platinum from the U.S. Green Building Council, the highest available designation.

This is a remarkable fact, both as a reflection of the City's commitment to sustainability and of the fine line that must be walked between, for instance, building systems' efficiency and their effectiveness.

As earlier noted, it is considered an industry best practice to exhaust pool air outside the building sufficient to eliminate chloramine buildup, and to do so as close to and on level with the pool surface as possible. From the standpoint of energy efficiency, this is a wasteful practice. The act of expelling conditioned, humidity-controlled air directly outdoor, requires that a corresponding amount of outside air must be drawn into the building, cleaned, conditioned and dehumidified. For this reason, project designers specified the ventilation system to return air to central air handling units. There units exhaust a portion of that "return air", then scrub and dehumidify remaining air to the space. This avoids energy loss and reduces the amount of energy required to condition outdoor air.

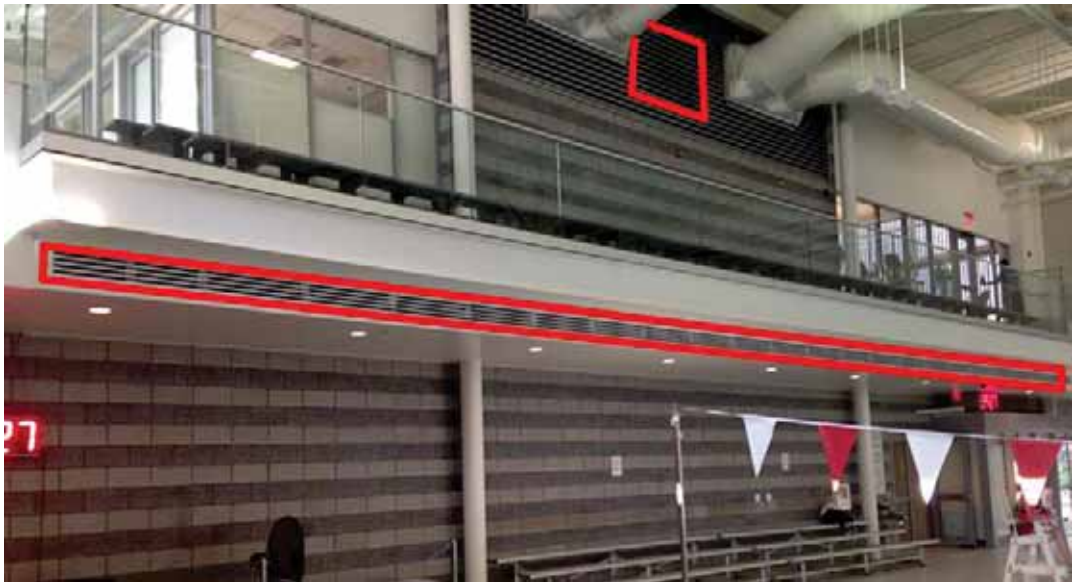

Figure 1: HVAC Air Returns

With indoor pools, appropriate and thoughtful air flow throughout the space is essentially to maintaining consistent temperatures, humidity and air quality. Conditioned supply air was designed to be distributed throughout the Smith AFC Natatorium via two large, ceiling mounted duct systems originating from the 2nd floor mechanical room. Additionally, and in-ground air supply register was designed to 'wash' the window curtain walls on the west and northwest sides of the space, to forestall condensation. Collectively these ducts distribute air through the space, directing it to create a vortex effect within the space to mix air.

This strategy is considered a best practice for large indoor spaces *in general*, though indoor pools present special challenges.

Mixed air is then drawn back to the air handling units in two locations, as shown in Figure 1, partially exhausted, and ultimately cycled back into the space.

The Smith AFC As-Built Environment

The Smith Aquatic and Fitness center opened to the public with great enthusiasm. The building is undoubtedly beautiful, and was designed to meet the recreational needs of our citizens to a degree that no other Charlottesville facility had before. Inevitable "bugs" were worked out of building systems with little impact on the building. Water treatment systems were as effective as advertised, and Aquatics program staff soon mastered their management.

Very shortly after opening, however, problems with mechanical systems arose. Open-loop geothermal wells required constant attention due to unexpected large quantities of silt in the underground water table. The large amount of heat from the building exchanged with the water table gradually increased the temperature of that large body of water, ultimately resulting in repeated failures of difficult-to-replace well pumps, impacting comfort and humidity levels within the building. Elements of that system were re-designed and replaced, after great effort and at no small expense.

Those problems proved to be, by comparison, much less difficult to resolve than the air quality problems that were immediately apparent. Building and pool systems were working as designed, but collectively were not effective in their first mission: to ensure a healthy environment for staff, lifeguards and patrons. Elevated chloramine levels were routine. Complaints of adverse health effects were persistent and real. Metal fixtures – such as door hardware and restroom hand dryers – began to quickly show rust. HVAC system's impacted ability to consistently control humidity, due to the aforementioned problems with the geothermal wells, were a contributing factor, but could not be considered the sole source. Most impacted were pool lifeguards, who must remain in the space for extended periods to ensure patron safety.

Aquatics staff consulted their industry peers to try to find a solution. It was discovered that the UVA Aquatic & Fitness Center had experienced similar problems after its opening, a problem that was effectively resolved by install high-volume fans to wash lifeguard stations and other areas with the cleaner air of the space's upper reaches.

City Aquatics and Facilities staff worked together to duplicate this system, improving the experience of lifeguards greatly.

It did not, however, resolve the larger problem with elevated chloramine levels. Complaints of adverse health effects continued.

After extensive consultation with project engineers, it was determined that the primary cause of elevated chloramine levels was a ventilation system design deficiency. Heavier-than-air chloramine particles were not mixing with higher air pockets to the extent that they could be effectively drawn from the space via the lowest of the two air returns. As shown in **Figure 1** on page 5, the lowest return duct in the space is located approximately 10' above the pool surface. Smoke tests performed after-hours confirmed that air at lower elevations was overly inert, and that air flow in the across the space from north-to-south toward that register was poor.

A plan was then developed to re-purpose the in-ground supply registers running along with west and northwest walls of the space. The theory was simple. Rather than providing conditioned air to wash the windows, it would draw air off the pool deck along the length of the pool, where heavier-than-air chloramines should be most concentrated. That air would be directly exhausted outside, not mixed with air returned to the space. The existing exhaust air system would be modified, to ensure air pressure between the two sides of the building remained under control, without which too much outside air would be drawn into the building, negatively impacted humidity levels, comfort and energy efficiency. Staff were optimistic that this strategy – easily implemented without disturbing programming and at a reasonable cost – would resolve both air quality and corrosion problems.

As an interim measure while project design and procurement were underway, an exit door on the north side of the Natatorium was replaced with a temporary plywood panel, into which were installed two variable, high speed fans. The placement of these fans had an immediate positive impact on air quality.

Once the completion of the exhaust system modification project, there was a noticeable improvement in air quality in the space. The frequency and severity of what staff have called "air quality spikes" diminished greatly. It remained necessary, however, to leave the "interim" door fans in place, for use when conditions worsened. This provides immediate relief in most instances, but sometimes results in elevated humidity levels; as overly-humid air is capable of holding more chloramine particles, their use can create an unfortunate cycle that results in intolerable building conditions.

Corrosion of building elements, throughout the entire facility, continued unabated. It's not possible to say whether the reduced chloramine content of the air on most days slowed the corrosion process. Once rust "sets in", it is not easily arrested.

Some months after the completion of the ventilation modifications, it became unavoidably apparent that air quality problems would continue to cause problems for staff and patrons. A second after-hours smoke test was performed, this time supplemented with dry ice. The dry ice fog, also heavier-than-air, visibly mimicked the movement of air at the pool deck level. For the first time, staff could see exactly how the ventilation air distribution and ventilation systems impacted chloramine-laden air at the deck. This test revealed that air throughout the space was not behaving as designed, or as re-designed. It was, in effect, time to go back to the drawing board if a permanent solution was to be found.

Recent Study Recommendations, Planned Improvements

Past efforts having fallen short of achieving full resolution of air quality and corrosion problems in the Natatorium, as well as corrosion occurring in the Fitness areas of the building. Seeking fresh, expert ideas from the industry's best, the staff engaged the services of consulting engineers Lawrence Perry & Associates (LPA), partnered with aquatics engineers Counsilman-Hunsaker (C-H). This team completed conducted evaluation a thorough investigation of design documents, the built environment, the operational practices of Aquatics and Facilities Maintenance caregivers, as well as daily logs of pool chemistry tests.

The resulting recommendations are generally focused on air flow and ventilation, but also include detailed analyses of the existing pool water chemistry and the pool's water treatment systems. The central element of their assessment was analysis of the interaction between the pool water chemistry and the Natatorium's ventilation air distribution system. Upon the recommendation of the consultant team, the architectural firm Virginia A&E was also engaged to perform an independent assessment of the facility's building envelope, as related to outside air infiltration, as well as the integrity of the vapor barrier separating the Natatorium from the remainder of the building. Collectively, the recommendations and resulting project scope is summarized as follows.

1. Install a new primary exhaust from the pool deck, incorporated in a factory fabricated plenum box (exhaust bench), which would be mounted down low on the pool deck.
2. Install a 'spot' exhaust system, located on and beneath the slide tower to facilitate air movement from the de-stratification fans.
3. Relocate and redirect the eight existing de-stratification fans to improve air movement.
4. Add a humidity control alarm to alert staff when humidity has exceeded recommended limits.
5. Test, recalibrate and/or replace the existing room pressure sensors for the Fitness Room and the Natatorium, to ensure pool air is not forced into adjacent spaces.
6. Insulate and seal all voids in the Natatorium building envelope, and all wall penetrations separating the Natatorium from the rest of the building.

For items 1 and 2, the project team selected a product lined manufactured by Paddock Evacuator, who make systems intended to be installed as an element of new construction and as retrofits for indoor pools with air quality problems. A photo of the selected exhaust bench is shown. Paddock has a series of highly illustrative videos, as well, including:

http://paddockevacuator.com/media-gallery/videos/paddock-evacuator-bench-system/

This project is planned to occur July – August, 2015, and will require closure of the facility for the duration of the project.

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