Green Island Ice Arena
ROM Report

CITY OF LA CROSSE, WI
NOVEMBER 2019

FOR THE LIFE OF YOUR BUILDING

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A. Site Visits

McKinstry visited Green Island Ice Arena to identify possible Facility Improvement Measures (FIMs) and begin the inventory process of the various FIM components. The following summarizes the information acquired during the site visit and conversations with the facility staff.

B. Energy Consumption Overview

As part of the audit process, McKinstry reviewed available utility information from the facility. This data is an integral part of our preliminary energy audit as it provides the basis for determining the impact the FIMs will have within the facility. It also allows us to develop a realistic business model for the project.

It was discussed that the facility typically spends approximately $75,000 on electricity for the main operating months of August through May. More detailed analysis can be provided if additional utility data is received. The following utility summary is based on available data and estimates generated from comparable facilities:

Location	Square Footage	Electric (kWh)	Electric ($)	Gas (Therms)	Gas ($)	kBTU/ sq. ft.	Total ($)	Total $/sq.ft.
Green Island	40,000 (estimated)	778,996	$76,824	31,216	$19,986	144.5	$96,810	$2.42

Green Island EUI	EUI Range	Benchmark Category (Single Sheet Ice Arena)
144.5	**<100**	**High Performance Facility**
	100-125	**Satisfactory**
	125-150	**Fair**
	150-175	**Improvement Potential**
	175-200	***Investigation Recommended***
	>200	***Immediate Corrective Action Recommended***

Although the EUI for this facility is relatively high it is not considered uncommon. Ice arenas typically consume more energy per square foot than other building types, a large percentage of facility energy consumption is related to maintaining the ice sheet. Renovation and equipment replacement projects that focus on a holistic approach to arena operations can significantly reduce the EUI and subsequently lower the operating costs. Systems throughout the arena including refrigeration, climate control, and lighting are in a constant state of interaction; it is critical to understand these interactions and design accordingly.

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C. Facility Improvement Measures

Green Island Ice Arena has potential for both energy and operational improvements which will result in savings. Based on our site visits and facility staff feedback, the following preliminary FIMs are identified:

High Priority Measures:

1. Arena Refrigeration System & Floor Replacement
2. LED Retrofit
3. Roof Replacement

Additional Considerations:

4. Mechanical/HVAC
5. Building Automation System Retrofit
6. Dasher Boards, Glass, & Rubber Flooring Replacements
7. Exterior Door Replacements
8. Restroom & Locker Room Upgrades
9. REALice

Detailed descriptions of the existing conditions along with specific recommendations are provided on the following pages.

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FIM NO. 1: ARENA REFRIGERATION SYSTEM & FLOOR REPLACEMENT

EXISTING CONDITIONS

Ice rink refrigeration is provided by an R507 based plant using 4 compressors in an indirect configuration. The plant is approaching end of useful life, and it was discussed that the chiller plant may have been previously used when it was installed. A heat recovery system serves the snow melt pit and subfloor heating loops; snow melt pit operation is considered problematic as ice shavings build up after multiple resurfacing sessions. The exterior condensing unit was replaced in 2012 and appears to be in satisfactory condition. Winter operation typically requires 1-2 compressors while summer operation can require 3-4 compressors at times. It was discussed that the electrical circuit serving the chiller plant occasionally trips on over-current protection when 4 compressors are running; this indicates that electrical service upgrade may be required for proper and safe operation. The concrete arena floor and associated piping loops have not presented problems to this point; leaks have not been detected and a survey indicated that surfaces are generally level.

RECOMMENDATIONS

Replacement of the compressor plant should be considered within the next several years. R507 refrigerant is subject to the Montreal Protocol which may result in limited future supply and increased cost. After-market R507 supplies are expected to last for the foreseeable future, however price volatility remains unpredictable. The indirect configuration of the system means that refrigerant is generally contained within the mechanical room, thereby reducing the total amount of R507 to an estimated 600-1000 pounds. While significantly less than the amount of refrigerant contained in a direct system (6000+ pounds) there is still an unpredictable financial risk should the system suffer a leak. A well maintained R507 system can have a lifespan exceeding 20 years, however, planning for future replacement is recommended to ensure long term stability of the operation. Multiple options and considerations for plant replacement are listed below:

- Replacement with ammonia (R717) based system
    - Ammonia has been used as a refrigerant for over one hundred years and has no Ozone Depletion Potential (ODP) or Global Warming Potential (GWP) which excludes it from any manufacturing bans.
    - Retrofit options are available as skid mounted or stick built (constructed in place) and can be located in the existing mechanical room or on grade adjacent to the facility.
        - Safety modifications including a containment vestibule, leak detection, and purge fans would likely be required if constructed within the facility.
        - The existing condensing unit (2012 installation) must be evaluated for compatibility with an Ammonia refrigerant system. If the unit is not compatible it could be sold or re-purposed at another City facility. A replacement condenser would utilize either evaporative or adiabatic heat rejection.

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- Replacement with a synthetic refrigerant (R410a or similar) based system
    - A newer generation of refrigerants with low Ozone Depletion Potential (ODP) was developed in response to the Montreal Protocol. These refrigerants were found to have high Global Warming Potential (GWP) and have since been subject to restrictions of their own. Supply of these refrigerant types is not expected to be an issue in the foreseeable future, however long term stability of pricing and availability is unclear at this point
- Replacement with an HFO refrigerant (R449a, R513a, or similar) based system
    - Several refrigerants that feature low Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP) have entered the market recently. While these refrigerants are not yet widely used they are gaining popularity in the ice arena sector. Ammonia (R717) remains the most popular choice for modern ice arena refrigeration, however HFO refrigerants represent a potential alternative in cases where Ammonia systems are not feasible.
- Replacement with a CO2 (R744) based system
    - Carbon Dioxide has also been used as a refrigerant for many years and represents another option free from ODP or GWP restrictions. CO2 systems typically cost more to install, operate at relatively high pressures, and suffer from poor energy efficiency in warmer climates. While feasible, this option is not recommended for Green Island Ice Arena.

ADDITIONAL CONSIDERATIONS

- The typical lifespan for a concrete arena floor with steel piping is approximately 20 to 25 years. While rink floors can be operated satisfactorily beyond their expected lifespan, replacement is strongly recommended in conjunction with refrigeration system replacement. By replacing the entire ice-making system at once project costs can be minimized and system design can be optimized for long term operation. Further inspection and analysis can be performed in order to determine the feasibility of utilizing the existing floor with a new refrigeration system.
- Electrical system upgrades will be dependent on final equipment selection.

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PRELIMINARY SCOPE OF WORK:

- Demolish existing refrigeration skid
    - Recover and process R507 refrigerant charge
    - Demolish electrical back to nearest junction box or disconnect
    - Cut or disassemble existing skid for transport out of mechanical room and removal from site
    - Cap condenser piping at mechanical room walls (if condenser is to be re-used)
        - If condenser cannot be re-used:
            - Remove existing condenser for repurpose or resale
            - Demolish all condenser piping
    - Demolish heat recovery exchangers and all associated pumps and piping within mechanical room
- Demolish existing rink floor & associated piping systems
    - Disassemble & palletize existing dasher board system including glass, player benches, penalty boxes, and scorer's table
        - Storage of dasher board system is assumed to be on site; locker rooms, lobby areas, and concourse may be utilized. Off-site storage options can also be considered.
            - Dasher board system must be stored away from extreme heat to prevent warping. Parking lot, storage container, or facilities without temperature control are to be avoided.
        - Dasher board system may also be removed and sold if desired. Budgetary pricing for a replacement system is included in this report. Estimated resale/salvage value of the existing system has been included in this report.
    - Saw-cut concrete floor and remove in sections for disposal
    - Demolish coolant piping, subfloor heat piping, and headers
- Provide and install new Ammonia (R717) based refrigeration system in existing mechanical room
    - Refrigeration system shall be either skid mounted or "stick built"
    - Two (2) direct drive Vilter (or equivalent) compressors
    - Two (2) glycol circulation pumps
    - Heat exchanger assembly to serve subfloor heat and snow melt pit
        - One (1) subfloor circulation pump & one (1) snow melt circulation pump
    - Chiller barrel or flat plate heat exchanger to serve secondary coolant loop

  - Provide new electrical disconnects and motor starters/Variable Frequency Drives (VFDs) and connect to new refrigeration plant and associated pumps
  - Connect piping from existing condenser sump to new refrigeration plant
  - Provide BACnet control interface on new refrigeration plant and pumps
  - Provide leak detection, monitoring, and alarming system
  - Provide purge ventilation system interlocked with leak alarm system
  - Provide eye wash and shower station(s) for code compliance
  - Verify code compliance of mechanical room door panic hardware and upgrade if necessary
- Provide and install new rink piping and concrete slab
  - Connect new refrigeration plant to existing coolant mains if applicable
    - Trench and install new coolant mains if required
  - Grade and compact sand base to a depth of 14" below top of proposed concrete slab
  - Install new glycol supply and return headers
  - Install new subfloor heat system headers
  - Install subfloor heating system using fusion welded HDPE (or similar)
  - Install rigid insulation and vapor barrier(s) where necessary
  - Install glycol cooling loops using fusion welded HDPE (or similar)
  - Install steel chairs to support in floor piping
  - Pour and level new 5" concrete slab over piping
  - Install existing or new dasher board system using concrete anchors (where applicable)
  - Install new goal post bases
  - Install new ice temperature sensor array
  - Pressure test all piping loops
  - Fill subfloor heat and coolant piping with glycol (some existing glycol may be recovered, filtered, and reused)
  - Startup, Test Adjust & Balance (TAB), and Commission (Cx) new system

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FIM NO. 2: LED RETROFIT

EXISTING CONDITIONS

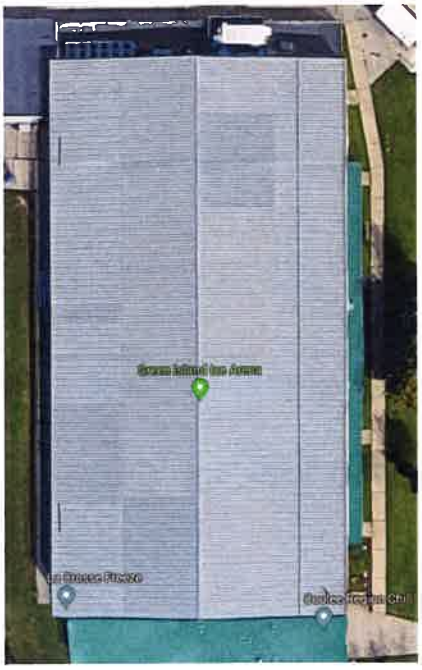
Fluorescent fixtures are present throughout the facility. 12 lamp T5 fixtures provide lighting for the ice arena with limited switching control. Remaining areas are a mix of linear fluorescent and compact fluorescent fixtures. One row of LED linear fixtures are present near the north end of the facility.

RECOMMENDATIONS

It was discussed that a two phased lighting retrofit may be desired in order to quickly improve aesthetics and occupant experience in the facility. Based on information provided to the City by local vendors the following approach can be pursued:

- Retrofit "non-ice sheet" fixtures including entryway, lobby, concessions, restrooms, locker rooms, and spectator areas. This work could be accelerated for completion in 2019. Energy savings could be captured and utilized for subsequent facility enhancements.
- Retrofit remaining "ice sheet" fixtures in conjunction with subsequent project. Fixtures can be replaced on a "one for one" basis in accordance with current proposals or evaluated further for increased fixture density.
- Lighting controls, including switch locations, can be improved in conjunction with retrofits.

FIM NO. 3: ROOF REPLACEMENT



EXISTING CONDITIONS

Several areas of the building exterior were replaced/repaired after a tornado in 2012. The steel roof was left in place and is now approaching end of useful life.

RECOMMENDATIONS

Infill and overlay of the existing steel roof is recommended to provide a cost-effective and long lasting solution for the facility. Two inches of flute fill insulation and two inches of rigid polyisocyanurate insulation will be fastened on top of the existing steel roof and covered with a fully adhered 60 mil EPDM membrane. The new insulation layers will provide an approximate R value of 22. Analysis of the original building drawings indicate that existing insulation values could be as high as R15; actual insulation values can be determined by removing minor sections or accessing through vent penetrations.

This solution will provide significantly improved insulation values and vapor barrier characteristics with a life expectancy exceeding 20 years.

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FIM NO. 4: MECHANICAL/HVAC

EXISTING CONDITIONS

HVAC equipment throughout the facility appears to operate in fair to poor condition; equipment is generally functional however most units are approaching end of expected useful life. Replacement of major HVAC equipment should be considered in the near future.

RECOMMENDATIONS

Assessment of HVAC equipment is provided according to areas served as follows:

North End – Chill Locker Room: (Sketch Zone 1)

The Chill locker room, figure skating office, and several adjacent areas are served by a Lennox Pulse gas-fired furnace. The furnace provides heat and air movement to these spaces; cooling, dehumidification, or fresh air ventilation are not provided. The furnace also provides supply air to adjacent public restrooms, however air from the restrooms is exhausted by a separate fan; this provides a potential shortfall of return air to the furnace unit.

A Heat Recovery Ventilator (HRV) provides fresh air ventilation to the Chill locker room, however the control system and ductwork configuration likely limit the overall effectiveness of the unit. Furthermore, while the unit can recover heat from its exhaust stream it is not able to provide control of humidity levels; under certain conditions it is believed that the unit may actually increase humidity in the locker room area.

Replacement Options:

- (1) Replace furnace and HRV with a single Energy Recovery Ventilator (ERV) capable of providing heat and fresh air ventilation. ERV will provide up to 100% fresh air ventilation to ensure odors are controlled effectively and efficiently. An enthalpy wheel will reduce heating and cooling costs associated with introduction of outside air to the spaces. It should be noted that control of indoor humidity will be limited during summer months and/or periods of high ambient humidity unless the new unit is equipped with dehumidification capability.
    - Cooling and dehumidification capability could be provided on new ERV in order to provide maximum control of humidity levels regardless of outside air conditions.
    - Return air louvers will be installed in the adjacent office spaces to ensure proper airflow.
- (2) Improve control system and ductwork configuration of existing equipment. Adding "enthalpy-based control" to the existing HRV would allow for automatic ventilation cycles to occur based on comparison of interior and exterior conditions. The existing HRV would function only when outdoor temperature and humidity levels are considered favorable; introduction of additional humidity to the locker room spaces will be prevented. This approach will not entirely eliminate humidity issues in the locker room, however it is considered an improvement from current conditions.
    - Return air louvers will be installed in the adjacent office spaces to ensure proper airflow.
    - Restroom Exhaust Fan will be controlled by occupancy sensor(s)

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North End – Offices & Locker Room: (Sketch Zone 2)

An office area, locker room, and laundry area on the north end of the building are served by a Ducane gas-fired furnace. The furnace provides heat and air movement to the spaces; cooling, dehumidification, or fresh air ventilation are not provided. The furnace appears functional although it is believed to be approaching end of expected useful life.

Replacement Options:

- (1) Replace furnace with a new unit equipped with fresh air ventilation capability. Fresh air ventilation modes can be interlocked with occupancy sensors to ensure high overall system efficiency.
- (2) Continue operating Ducane furnace until failure; replace with similar type of unit or upgraded system at that time.

East End – Locker Rooms: (Sketch Zone 3)

The locker rooms underneath the spectator seating area are served by a gas-fired Reznor Make-Up Air Unit (MAU) and a dedicated Exhaust Fan (EF). The Reznor MAU provides continuous 100% fresh air ventilation to the locker rooms; the Exhaust Fan is interlocked to remove an identical quantity of air.

Replacement Options:

- (1) Replace Reznor MAU and associated Exhaust Fan with a single Energy Recovery Ventilator (ERV). Ventilation rates will be fully modulated from 0% to 100% (depending on occupancy levels) to meet code requirements and provide control of odors. Energy recovery functionality will minimize heating and cooling costs associated with fresh air ventilation. ERV will provide heat to the spaces via indirect gas-fired furnace unit; optional cooling and dehumidification capability can be included to provide maximum control of humidity levels if desired.
    - Existing exhaust ductwork will be routed back to new ERV to serve as return air path.
    - ERV can be installed in the same location as the existing Reznor unit, or on grade next to the facility, or on the adjacent roof.
        - Exterior wall/roof penetrations will be made to accommodate supply, return, exhaust, and fresh air intake louvers (depending on location).

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South End – Spectator Viewing Area: (Sketch Zone 4)

An enclosed spectator viewing area is served by a ceiling mounted Reznor heating unit and a section of gas-fired radiant heaters. The Reznor unit is not ducted throughout the space; supply and return air locations are within close proximity of the unit, therefore air and heat circulation are limited. Radiant heaters are used to provide temperature control in areas where the Reznor unit has limited effect.

Replacement Options:

- (1) Extend supply air ductwork from the Reznor unit throughout the entire viewing area to provide even heating distribution, thereby reducing the need to operate both the Reznor unit and the radiant heaters at the same time. Return air ductwork is not required given the relatively small area and open configuration.
    - The Reznor unit could be replaced with a new high-efficiency unit or allowed to operate until failure.
    - Supply air ductwork can be extended to the upper level Chill office area to provide heat and ventilation in those spaces (as described in the following section).
        - In this scenario, a transfer grill will be installed to provide a return air path back to the spectator viewing area.

West End – Upper Level Chill Offices: (Sketch Zone 5)

An enclosed, upper level office area is not equipped with heating or ventilation equipment at this time.

Replacement Options:

- (1) Extend supply air ductwork from adjacent Reznor unit to provide heating and ventilation to the spaces.
    - A dedicated thermostat and associated modulating air damper could be used to provide specific temperature control of the office area.
        - A manual balancing damper could be installed to provide a lower cost temperature control option in lieu of thermostat and modulating damper. Precise temperature control will not be possible; this option is still considered an improvement from existing conditions.
    - A transfer grill will be installed to provide a return air path back to the spectator viewing area.
- (2) Install a dedicated heating unit to serve the area; the following options can be considered based on future expected use of the space:
    - Electric ceiling mounted or baseboard heating units.
    - Wall mounted heat pump unit with optional fresh air ventilation capability.

Additional Considerations:

Gas-fired radiant heaters are present at several locations throughout the arena including spectator seating and entrance lobby areas. The majority of these units are considered beyond expected useful life and should be considered for replacement in the near future. 1 for 1 replacement is considered appropriate provided that current coverage is considered satisfactory. Control of the units can be evaluated if improvement is desired.

A re-commissioning exercise could help troubleshoot issues with the Innovent dehumidification unit resulting in more reliable and consistent operation. Perimeter areas of the arena (locker rooms, restrooms, offices, etc.) may be able to operate satisfactorily without supplemental cooling/dehumidification provided that the Innovent unit can achieve full and consistent functionality.

Several exhaust fans in the arena appear to operate without appropriate make-up air sources; this results in unbalanced airflow and a slightly negative building pressure. It is believed that unconditioned air is being drawn into the building through gaps in the envelope; during summer months this can lead to increased humidity throughout the facility. Outside air dampers on the west side of the facility are an example of this phenomenon. Since the dampers do not seal perfectly (typical of most dampers) moisture is drawn into the facility; the moisture condenses upon contact with cool interior surfaces and results in pooling water. The measures described in the sections above are intended to mitigate the effects of air infiltration by providing a slightly positive building pressure. Regardless of the retrofit options selected it is important to maintain a holistic approach in order to reduce or eliminate unbalanced airflows.

FIM NO. 5: BUILDING AUTOMATION SYSTEM IMPROVEMENTS

EXISTING CONDITIONS

Mechanical and HVAC components throughout the facility are controlled by standalone systems. A central Building Automation System (BAS) is not present.

RECOMMENDATIONS

Installation of a Direct Digital Control (DDC) system has the potential to greatly improve energy efficiency of the facility HVAC systems while also improving occupant comfort, reducing maintenance burden, and extending equipment life. Enhanced scheduling and unoccupied setback control will reduce equipment run times and energy consumption. Remote monitoring, alarming, and control would allow operators to manage the building without a need to be on site. Integration of the existing or replacement ice plants could also allow for greater control of ice conditions and simplified troubleshooting.

Final scope of equipment to be included on a new BAS system will depend on the HVAC/mechanical upgrades that are performed on the building. The BAS budget and savings estimates are intended to cover the range of possible scenarios.

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FIM NO. 6: DASHER BOARDS, GLASS, & RUBBER FLOORING REPLACEMENTS

EXISTING CONDITIONS

The dasher board & glass system contains a mix of components from several different manufacturers including Becker, Athetlica, and possibly Cascadia. Stanchions in several locations protrude into the playing area more than typical arenas resulting in unpredictable puck deflections. Overall condition of components is considered fair to poor.

Rubber flooring is present throughout the arena. Flooring components are approaching end of expected useful life in most locations.

RECOMMENDATIONS

Dasher Boards & Glass:

- (1) Replace entire dasher board & glass system with Becker Signature Series (or similar), scope of work to include:
    - Galvanized steel frame dasher boards with high-density polyethylene dasher facing and kick plates.
    - 8' high tempered glass on the ends and radius corners with two-piece round anodized aluminum shield supports
    - 6' high "Vision" support-less tempered glass for the spectator side of the rink.
    - 15' high puck control netting for the office end and radius corners of the rink.
    - Player benches: 5' deep by 30' long with gates, elevated flooring and coach's walkway, new benches, new gates.
    - Penalty boxes: (2) 5' deep by 7' long with new benches and gates.
    - Timekeeper box: 5' deep by 8' long with new timekeeper table (18" by 96") and new gate.
- (2) Replace glass system only
    - 8' high tempered glass on the ends and radius corners with Becker Arena Products Signature Series (or similar) posts.
    - 6' high tempered glass on the sides of the rink with Becker Arena Products Signature Series (or similar) posts.

Rubber Flooring:

- (1) Replace rubber flooring throughout the arena, scope of work to included:
    - Approximately 9,200 square feet of 10mm 4' by 6' SportFloor Stamina rubber flooring with speckle finish in "public" areas. (includes 7% overage for stock).
    - Approximately 5,376 square feet of 10mm 4' by 6' SportFloor Stamina rubber flooring with basic finish in locker rooms and other miscellaneous spaces. (includes 7% overage for stock).

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Additional Considerations:

McKinstry can facilitate the purchase of all above components through the Sourcewell Cooperative Purchasing Program on behalf of the City in order to obtain favorable pricing.

The existing dasher board and glass system has an estimated resale value of $10k - $15k.

FIM NO. 7: EXTERIOR DOOR REPLACEMENTS

EXISTING CONDITIONS

Exterior doors throughout the arena are in varied conditions. Weatherstripping appears degraded at most locations. Air and pest infiltration is likely occurring throughout the facility.

RECOMMENDATIONS

Replacement of exterior doors can be performed throughout the entire facility or at select locations. The following options exist at each location:

- SL17 Fiber Reinforced Polymer
    - Aluminum chassis with closed-cell, high-density polyurethane foam core
    - Scratch, dent, and graffiti resistant
    - Best choice for durability, longevity, and thermal insulation properties
- AF100 Fiberglass
    - Closed cell foam core wrapped in 4 layers of glass fiber
    - Good overall combination of durability and thermal insulation properties at moderate cost
- Standard Hollow Metal
    - Aluminum frame construction with standard insulation fill
    - Lowest cost option

Cut sheets of door options are provided as an attachment.

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FIM NO. 8: RESTROOM & LOCKER ROOM UPGRADES

EXISTING CONDITIONS

Restrooms are located on the south end of the building near the main entrance and on the north end of the building. Several additional restroom and/or shower areas are present within the locker rooms. A shower area was added to one of the locker rooms on the east side of the building; the shower does not appear to meet current codes.

Four locker rooms are located beneath the spectator seating area on the east side of the building. Two locker rooms, including one dedicated to the Chill, are located on the north side of the building.

RECOMMENDATIONS

Restrooms and locker rooms will be upgraded in part by other measures recommended in this study. Lighting and rubber flooring will be replaced which will improve the aesthetics of these areas. Additional measures described below can be pursued further if desired:

- The "makeshift" shower in the east locker room requires additional modifications to meet codes. Since the locker room was not designed to have a shower area, it is recommended that the modifications be removed and the area restored to is previous configuration. If the shower area is desired/needed, the following modifications are recommended:
    - Add floor drain in the area directly adjacent to existing showerheads. A trough style drain could be installed near the wall directly beneath the showerheads for optimal drainage; re-grading of the floor would be required. Alternatively, a single floor drain could be added several feet west of the showerheads; minor re-grading of the floor is likely required for this approach as well.
    - Ventilation upgrades are required if the shower is to remain. This could be incorporated into the HVAC replacement measures described earlier in this report; otherwise a dedicated exhaust fan and make-up air source will be required.
- Fixtures (sinks, toilets, urinals) could be replaced at restroom locations throughout the rest of the arena. Existing fixtures appear to be in satisfactory condition, replacements for aesthetic, maintenance, or functionality reasons can be pursued if desired.
- Restroom stall enclosures, doors, and/or partitions can be replaced if desired. Sanding and/or painting of existing components could provide a lower cost option to improve aesthetics.

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FIM NO. 9: REALICE

EXISTING CONDITIONS

Domestic hot water is currently used to fill the resurfacer tank.

RECOMMENDATIONS

REALice is a device installed at the resurfacer fill station that enables operators to use cold water to resurface the ice. Energy savings are realized from the elimination of natural gas previously used to heat resurfacing water and from the reduced load on the compressor plant during resurfacing operations. Energy savings are dependent on the frequency of resurfacing, the facility operating season, and the efficiency of previously used water heating equipment.