BEMIDJI CITY COUNCIL

Work Session Agenda

Monday, August 11, 2014

City Hall
Council Chambers
5:30 P.M.

1. CALL TO ORDER / ROLL CALL

2. NEILSEN-REISE ARENA EVALUATION RESULTS - STEVENS

3. 2015 BUDGET DISCUSSION

4. ADJOURNMENT

NOTE: *All cellular telephones, pagers and BlackBerry devices to be switched to a non-audible function during Council and Committee meetings.*

COUNCIL AGENDA ITEM

Meeting Date: August 11, 2014

Action Requested: Evaluation of the Neilson Reise Arena

Prepared By: Marcia Larson, Parks and Recreation Director

Reviewed By: John Chattin, City Manager

Background

The Neilson Reise Arena is a community asset that is home to the Bemidji Figure Skaters and is also utilized by a variety of youth hockey organizations for games, practices, camps and tournaments. The facility also serves adult hockey and BSU Club and intermural programs, among many others. The facility hours are 6am to 12am and when not rented provides general skate, open hockey and pre-school parent skate. The majority of rentals/usage take place between 3:30pm and 11:30pm. In 2013 approximately 64 different groups rented a total of approximately 2535 hours of ice at the Arena (including general skate/open hockey). Ice rental ranges from several hours to over 400 annually. The most scheduled/rented groups:

General Skate/Open Hockey	909 hours
BFSC	430 hours
Bemidji Youth Hockey	186 hours
Private Rental (Figure Skater)	107 hours
BSU Intramurals	70 hours

The Neilson Reise Arena is the only year round ice arena in the Area – it is highly used and the single sheet of ice is needed by the community to continue to provide the current level of service. The plant, cooling tower, boards, dehumidifier and other equipment at the Neilson Reise Arena have extended past their useful life. Due to the phasing out of R-22 refrigerant, and the age of the facility, the City Council at the April 28, 2014 work session approved hiring Steven's Engineering to conduct an Evaluation of the Neilson Reise Arena to assist in the future planning for the facility. The Evaluation Report from Steven's Engineering is attached. An executive summary can be found at the beginning of the report.

The report outlines different options for the Neilson Reise Arena ranging from doing nothing to constructing a new indoor arena. Based on Steven's Engineering evaluation and costs – the recommended option outlined in the executive summary is to invest and repair the existing facility. Based on the age of the Nielson Reise Arena and in particular the plant, it is recommended repairs are completed within 5 years.

The highest priority is the replacement of the dehumidification system. The current dehumidifier is not functioning. The estimated cost is $329,072 and it is recommended this be considered for inclusion in the 2015 CIP.

The 2nd and 3rd phase would include Building and Ice System Improvements. The building improvements include roof replacement and wall repair. The existing framework of the building is still in good shape so would allow the improvements. The Ice System Improvements would include an ammonia system, news dashers, ventilation, required refrigeration room improvements. The estimated cost of both the building improvements and roof replacement is $ 3,078,290.00.

There are other improvements that were discussed when the Council toured the Arena in April – including renovating the locker rooms, adding showers and improving the lobby and access to the both ice sheet and the lobby.

The estimated cost for those improvements ranges from $1,062,000 to $1,416,000.

The City in order to continue operating the Neilson Riese Arena long term will need to invest between $3,407,362.00 (new dehumidification and building and ice system improvements) and $4,800,000 into the existing structure. This investment would provide the community a new Nielson Riese Arena for the next 25-30 years or more.

Evaluation Study

Neilson Reise Arena

For:

City of Bemidji
317 4th Street NW
Bemidji, MN 56601

August 7, 2014

Submitted By:

Stevens
2211 O'Neil Road
Hudson, WI 54016
800.822.7670

File No. 900.14.201

In Association With:
292 Design Group
Nelson Rudie & Associates

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Executive Summary

Neilson Reise Arena was constructed in 1967. The facility is well used and maintains the ice sheet year round. Over the years some significant improvements have been made to the ice arena including:

- 1967 - Original curling and skating facility constructed.
- 1979 - Locker room addition was added.
- 1981 - Ice Resurfacer room was added.
- 1986-1987 - Refrigeration system was replaced.
- 2005 – Ice rink floor replaced.
- 2005 - Lobby remodeled.

The facility has been well maintained, however, the 47 year old, pre-engineered metal building is showing signs of deterioration. The majority of the mechanical and building systems are original and have exceeded their expected life. The main concerns are the condition of the roof and mechanical systems. Some leaks in the roof are starting to occur and condensation is affecting the ice quality, wall and roof systems and energy use. Also, the existing refrigeration system was manufactured in 1972 (42 years-old) and was installed in the facility around 1987 and has well exceeded its 25-year expected life. The ice system uses R-22 refrigerant which is scheduled to be phased out by 2020 due to its adverse environmental affects. As the phase-out date approaches, the cost of R-22 increases.

Stevens was retained by the City of Bemidji to prepare an evaluation of the existing facility. The recommendations and costs are summarized in the tables that follow and are broken down in to phase priorities. The costs, presented in the tables, are estimated total project costs for 2015. They are intended to be used for budget purposes and are, therefore, higher than would be expected if the project was competitively bid.

Table A. Phase 1 – Recommended Mechanical System Improvements

Item	Cost
1. Dehumidification system	$329,072
Total estimated project cost	**$329,072**

Table B. Phase 2 or 3 – Recommended Building System Improvements

Item	Cost
Roof replacement Option 3 – Spray foam insulation	$419,482
Wall improvement Option 2 – Rigid foam metal panel	$520,030
Total estimated project cost	**$939,512**

Table C. Phase 2 or 3 – Ice System Replacement - Recommendations and Cost Estimates

Item	Cost
1. Ice system replacement (ammonia system, dashers, waste heat)	$1,981,220
2. Refrigeration room improvements	$93,100
3. Demand control ventilation	$16,963
4. Ice equipment room ventilation	$47,495
Total estimated project cost	**$2,138,778**

Table D. Phase 4 – Other Improvements or Considerations

Item	Cost
New lobby addition (6,000 SF)	$1,062,000 to $1,416,000
New Arena (32,000 SF)	$6,159,600 to $7,542,000

Implementing the recommendations in this study is, not only a necessity in some cases, but will provide a strong operational and structural foundation for the facility over the next 25 to 30 years or more.

Section 1
Project Information

Contact Information

Facility Address:
Neilson Reise Arena
1115 23rd St NW
Bemidji, Minnesota 56601

Type of Facility:	Ice Arena
Square Footage:	NA
Seating Capacity:	NA

Facility Manager:
Evan

P. 218.759.4861 (arena)

Client Contact:
Marcia Larson
Parks and Recreation Director
1351 5th St NW
Bemidji, Minnesota 56601
P. 218.333.1860
marcia.larson@ci.bemidji.mn.us

Consulting Engineering Firms:

Stevens
2211 O'Neil Road
Hudson, WI 54016
P. 651.436.2075
F. 715.386.5879
Scott A. Ward, P.E.
sward@stevensengineers.com

292 Design Group
3533 E Lake Street
Minneapolis, MN 55406
P. 763.533.3813
F. 763.367.7601
Tom Betti
tbetti@292designgroup.com

Nelson Rudie & Associates
9100 49th Avenue North
Minneapolis, MN 55428
P. 763.367.7600
F. 763.367.7601
Michael D. Woehrle, P.E.
Michael.Woehrle@nelsonrudie.com

Electric Utility:

Gas Utility:

Certification

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Minnesota.

Scott A. Ward, P.E.
STEVENS

40921
Registration Number

8.7.14
Date

Section 2
Project Overview

PROJECT OVERVIEW

Background

The Neilson Reise Arena began with the construction of the curling rink and skating rink in 1967. The ice arena includes an ice arena, team rooms, concessions and an office. The facility is has a long standing tradition of providing ice-related activities for the Bemidji Community and is home to Youth Hockey, Bemidji State University Practices, and Figure Skating. The facility also hosts open skating, hockey training and camps, along with a variety of youth and adult hockey events. The facility maintains the ice sheet year round.

Over the years some significant improvements have been made to the ice arena including:
- 1967 - Original curling and skating facility constructed.
- 1979 - Locker room addition was added.
- 1981 - Ice Resurfacer room was added.
- 1986-1987 - Refrigeration system was replaced.
- 2005 – Ice rink floor replaced.
- 2005 - Lobby remodeled.

The facility has been well maintained, however, the 47 year old, pre-engineered metal building is showing signs of deterioration. The majority of the mechanical and building systems are original and have exceeded their expected life. One main concern is the refrigeration system. The existing refrigeration system was manufactured by Holmsten Ice Rinks in 1972 (42 years-old) and was installed in the facility around 1987 and has well exceeded its 25-year expected life. Improvements to the refrigeration system were performed in 2005 when the sand-based ice rink floor was replaced. The dasher board system was also manufactured and installed by Holmsten Ice Rinks and has exceeded to expected life.

In addition, the ice system uses R-22 refrigerant which is scheduled to be phased out by 2020 due to its adverse environmental affects. As the phase-out date approaches, the cost of R-22 increases. A key part of this study will be evaluating possible refrigerant options and finding the best fit for this facility and the City. For example, CO2 has a long history as a refrigerant but not until 2000 has it gained momentum and popularity in the ice rink industry as a natural, environmentally friendly, alternative refrigerant. The analysis of the existing refrigeration room (both size and building material construction) will also be a key component of the study.

Neilson – Reise Ice Arena in one of four ice arenas that serve the Bemidji Community, the other three rinks are:
- Bemidji Community Arena
- Sanford Center
- Nymore Arena

Purpose

As part of a continued effort to: improve the operations and financial success of the Neilson Reise Arena; address concerns over the aging facility and systems; to plan for future improvements to the facility; and to continue to provide high quality ice for its user groups; Stevens and a specialized team of consultants were retained by the City of Bemidji to prepare an engineering study of the facility. The primary objectives of this study are as follows:

- To provide recommendations and a scope of work for future improvement project(s).
- Identify and evaluate the best system options for replacing the existing R-22 based ice system that will maximize performance and energy efficiency and provide superior ice quality for the next 25+ years.
- Provide accurate conceptual cost estimates to assist the City in making informed decisions on future project(s).
- Recommend improvements that maximize energy efficiency while incorporating sustainable design practices that reduce the use of fossil fuels, the production of greenhouse gas emissions, and reduce total energy use of the systems and facility.

It is recommended that the findings presented in this report be used to plan for improvements to the facility including the building and mechanical systems and future replacement of the ice system and related improvements. The information in this report should also be used to assist in identifying possible rebates or grant programs from utility or energy companies or departments, state and federal agencies, or other sources.

Scope of Services

The scope of the study included the following systems and areas of the ice arena facility. The curling rink was not part of this study.

- Evaluate existing refrigeration and dehumidification systems.
- Evaluate building systems, specifically the roof and walls. Evaluation will be a visual evaluation along with recommended replacement options. Evaluate restrooms, team rooms, existing ice equipment room upgrades and visual review of existing refrigeration room for code compliance.
- Identify potential building upgrades to allow the building to meet the needs of current users. Potential upgrades include new lobby, team rooms, repurpose existing lobby, concession stand, skate check area, community rooms, office space.
- Provide professional opinion of overall condition of existing facility, expected life span of structure if left in current condition.
- Provide cost to build a new ice arena at the existing site, or a new arena at a different site.
- Evaluate the existing facility's ability to support proposed refrigeration and mechanical improvements.

Report Organization

The report is organized starting with observations on the existing building, mechanical and ice systems followed by recommendation for improvements. Supporting documentation including cost estimates, schedules, etc. are provided in the Appendices.

Section 3
Building Systems

EXISTING BUILDING SYSTEMS

General

The existing ice arena consists of a major structure that houses the skating rink and curling club which is a pre-engineered steel roof framed building constructed in 1967.

Over the years improvements have been made to the facility including:

- Locker room addition was added in 1979
- Ice Resurfacer room was added in 1981
- Refrigeration system was replaced in 1986-1987
- Lobby was remodeled in 2005

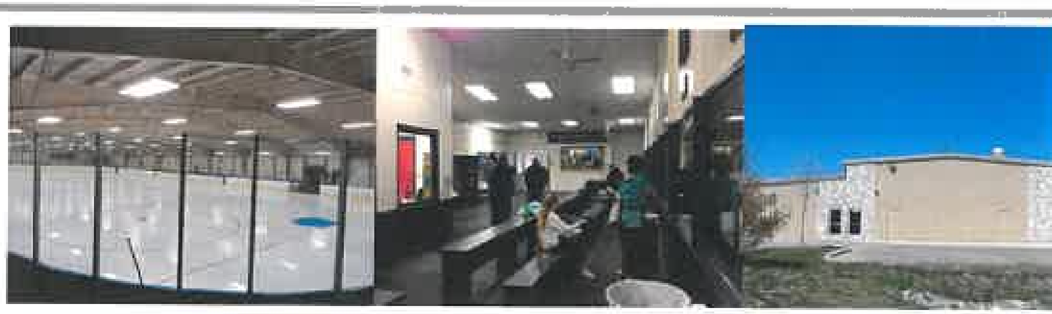
The facility is entered through a common entry that serves both the ice arena and curling club. The entry has a ramped surface to get up to the lobby level. Once inside the lobby there are wooded bleachers that allow for views of the ice rink to the south. The manager's office is located along the north wall of the lobby, along with restrooms, concessions, and coaches/skating club locker room. To enter into the ice arena from the lobby, there are stairs located on each end of the lobby that access bleachers and locker rooms on the east side of the arena. The west side stairs provide access to the ice resurfacer, refrigeration room, and ice rink.

Observations of Existing Conditions – Building Systems

The design team toured the facility with the facility's management personnel and have the following observations and comments.

- The facility is visually in good condition and has been well maintained considering the age and the heavy use the facility receives.
- The ice arena has a very low roof/ceiling compared to new community ice arenas.
- The exterior walls are in good shape on the exterior skin, the interior skin is dented and in need of some upgrades.
- Concessions area is undersized, and in a location that causes congestion with access to the restrooms.
- The Manager's Office and office space in general is undersized.
- The locker rooms don't appear to have any sort of ventilation. Also, there are no showers available for users.
- The existing roof system is starting to leak in a few areas.
- The metal wall panels at the exterior walls have condensation and/or leaking issues.

- The ice-resurfacer room and refrigeration room utilize a large amount of structural wood sheathing, wood sheathing and framing is not allowed by today's building codes.
- The refrigeration room is not separated from the ice arena by a fire wall/smoke barrier.
- A description and evaluation of the mechanical, electrical, and ice systems are included in the following sections.



Picture Window 1: (left to right): Interior of arena, interior of lobby, exterior entry.

Evaluation and Recommendations – Existing Building Systems

General

The evaluation process consisted of a kick-off meeting on May 23, 2014 with representatives from the City of Bemidji to discuss overall project goals that are listed at the beginning of the study. We recommend the City plan and budget for the capital improvements for the existing building systems at the facility as outlined in this Section.

Rink Roof

The east rink roof system is the original roof system that was installed in 1967 and is getting to the end of its useful life. Given the age of the roof it has held up fairly well. Over the years advances and understanding of arena roof and wall systems has evolved in how to deal with temperature, humidity, and seasons of operation. Rinks today are running all year long without removing the ice, or if the ice is removed for only a brief period of time. Even if they are not running year around the ice is going in earlier in the season and coming out later. This extension of the ice season has increased the thermal and moisture stresses on an ice arena. Because of this better roof and wall systems and approaches have been developed.

For reroofing the project a variety of options exist.

First Option:

Remove the existing metal roof panels and insulation and provide a new mechanically seamed metal roof system. Install new 10" fiberglass insulation with a perforated Low-E barrier.

Picture Window 2 (left to right): Interior photo showing insulation damage at ceiling, overall interior

Pros:
Provides a new watertight roof system.

Cons:
Condensation will develop within this system and cause dripping onto the ice surface. The reason condensation will form is the inside surface of the metal deck, which acts like a vapor barrier, will be very close to the outside air temperature. So when the arena dew point temperature exceeds the outside air temperature condensation will form.

The Stevens Design Team does not recommend this system because of the condensation issues. This system is being replaced in ice arenas constantly. It is a good system if the arena was only operational in the winter seasons from late November to mid March. Even running during these times there could be periods of times when condensation forms because of unseasonably warm weather.

Second Option:
Leave the existing roof and insulation system in place and provide an adhesive applied EPDM or TPO roof membrane over the existing metal roof. There are also some spray applied membrane systems that could be utilized for this application. Install a Low-E barrier just below the new insulation system to protect it from flying pucks and help create a more energy efficient arena by reflecting heat away from the ice surface.

Pros:
Inexpensive solution. This system will seal the roof from leaks.

Cons:
Similar to Option One this solution will not prevent condensation from forming on the underside of the metal deck because it does not solve the issue of roof deck temperature.

Third Option:
Leave the existing metal roof deck in place and remove the existing fiberglass. Spray apply foam insulation to the underside of the metal deck and apply a thermal barrier top coat over the foam to protect it from fire. Install a Low-E barrier just below the new insulation system to protect it from flying pucks and help create a more energy efficient arena by reflecting heat away from the ice surface. Note,

the existing fiberglass insulation must be removed in order for the metal deck temperature to stay at a temperature that will minimize the chance of condensation forming on the deck.

Pros:
Maintains the temperature of the underside of the metal deck above freezing, therefore eliminating the chance for condensation to develop do to outside temperature variations. Also, this approach eliminates areas and pockets that can harbor mold growth. The amount of maintenance required on the ice surface is minimized by eliminating the time required to take out the bumps and ridges formed from condensation dripping on the ice surface. The existing roof structure is protected from deterioration and rust do to condensation within the roof structure. The dehumidification system can work more efficiently because it is not also trying to remove the moisture in the facility caused by condensation.

Cons:
This roof system is expensive. Also, the existing roof structure will need to be analyzed to verify that it can support the additional load of the new roof materials. Based on past experience the weight of saturated fiberglass insulation exceeds the weight of the spray foam system, so most code officials approve this approach.

Based on the site visit and preliminary analysis, the Stevens Team would recommend Option Three. But given the unknowns with the structural capacity of the existing roof structure and given the potential cost of this system, detailed plans and specifications need to be developed to help in determining the most appropriate solution for the arena. Based on the systems outlined above the following budgets have been established for each system.

<u>Exterior walls</u>
The exterior walls of the ice arena consist of steel girt framing with metal panels on the exterior, fiberglass insulation in the cavity space and a metal liner on the interior face. The existing wall has frost buildup on the exterior face of the walls during some of the winter months and condensation within the panels in the summer months. This is common with this type of system.

The moisture in the wall is typically a result of condensation from the warm moist summer air penetrating through the gaps, cracks, and holes in the metal panel and condensing when it hits a cold surface (dew point) within the wall. The opposite occurs in the winter months where warmer moist air from within the arena condenses in the wall when it hits a colder surface in the interior of the wall cavity. So depending on the season the point of condensation within the wall changes, or to put it another way the vapor barrier needs to be on the exterior of the wall in the summer and in the interior in the winter.

To solve this problem an insulation system is required that has an integral vapor barrier, rigid insulation has this property.

Picture Window 3 (left to right): Interior of metal panel liner, interior of resurfacer room (2 pictures)

Wall Solution

First Option:
Remove the existing metal interior wall panels and insulation and provide new interior perforated metal wall panels with fiberglass insulation.

Pros:
Provides a new interior finish and is the least expensive option.

Cons:
Condensation and frost will develop within this system. The reason condensation will form is the inside surface of the metal panel, which acts like a vapor barrier, will be very close to the outside air temperature. So when the arena dew point temperature exceeds the outside air temperature condensation and frost will form depending on the time of year. A perforated metal wall panel is recommended to allow the dehumidification system to dry out the insulation when it gets wet from condensation during the winter months.

The Stevens Design Team does not recommend this system because of the condensation issues. This system is being replaced in ice arenas constantly. It is a good system if the arena was only operational in the winter seasons from late November to mid March. Even running during these times there could be periods of times when condensation forms because of unseasonably warm weather.

Second Option:
The most appropriate way to remedy the wall condensation and frost issue is to install a rigid foam metal panel system on the exterior face of the existing wall construction. This new panel would be clipped to the existing steel girts. The bottom edge of the panel will need to be sealed against the floor or stem wall. By placing the foamed panel at the exterior it prevents moisture and water vapor from migrating into the wall assembly.

Pros:
Maintains the temperature at the inside face of the metal panel above the dew point, therefore eliminating the chance for condensation to develop do to outside temperature variations. Also, this approach eliminates areas and pockets that can harbor mold growth. The existing wall structure is

protected from deterioration and rust by eliminating condensation within the wall system. The dehumidification system can work more efficiently because it is not also trying to remove the moisture in the facility caused by condensation.

Cons:
This wall system is expensive. Sound can be an issue because of the hard interior metal finish causes the interior to echo. This can be controlled by installed an interior perforated metal panel liner with mineral wool insulation to act as a sound absorber.

Based on the site visit and preliminary analysis, the Stevens Team would recommend Option Two. Based on the systems outlined above the following budgets have been established for each system.

<u>Existing Refrigeration Room</u>
With the introduction of a new refrigeration system utilizing ammonia as the primary refrigerant the existing refrigeration room that serves the current ice arena will need code upgrades. If an ammonia based system is not used, the vestibule construction can be eliminated from the budget outlined below. The upgrades include a 1-hour rated wall and roof construction, along with an interior vestibule for the interior entry to the room. Also, additional electrical and mechanical items will be required; refer to the respective section for a description of the upgrades required for the electrical and mechanical systems.

Picture Window 4 (left to right): interior of refrigeration room

<u>New Lobby Addition</u>
The existing lobby, concessions area, and bathrooms lack adequate space and compliant ADA access. The existing ramp that accesses the ice arena is to long without intermediate landings as required by ADA. An opportunity exists to add a new lobby along with associated support spaces; this upgrade will better serve the existing users of the ice arena. The proposed addition would include the following:

- Lobby Space
- Concessions
- Concession Storage
- Referee Room
- 2 Locker Rooms with Showers and Toilet Facilities
- Restrooms
- Managers Office
- Skate rental area

This addition could be added onto the east side of the existing arena and would create a new entry identity to the facility. The concept design of this addition is beyond the scope of this study but for planning purposes an addition that includes the above spaces would be approximately 6,000 square feet.

Picture Window 5 (left to right): non-compliant ice arena access, non-compliant access arena from lobby

New Ice Arena

When putting together a study such as this a question is always asked: How much is it to build a new ice arena? This is a difficult question to answer because of the many variables that come into play. These variables include ice arena size, seating capacity, type of refrigeration system, mechanical systems, and site parameters just to name a few. The best way is to provide a cost per square foot estimate based on historical low and high ranges of construction cost. The costs per square foot are based on traditional community ice arenas and the following assumptions and building program:

- Assumes site is pad ready
- Utilities are readily available
- 32,000 SF Precast building shell with long span joists, clear height of 24' minimum
- Quality mechanical and electrical systems
- Ammonia Refrigeration
- Concrete block interior partitions
- Seating for 400
- 4 Team Rooms
- Lobby Space
- Concessions
- Concession Storage
- Referee Room
- Restrooms
- Managers Office
- Skate rental area

If this is a direction the City is interested in pursuing, The Stevens Design Team highly recommends a more detailed study be performed to refine a building program, identify a site and size for the arena, and to refine the cost estimate.

Cost Estimates – Existing Building Systems and New Arena

The costs of the recommended improvements are summarized below and are total project costs. A more detailed description of the cost estimate is located in the Appendix.

Table 1. Building System Improvements Cost Estimate Summary

Item	Cost
Roof Options	
Option 1	$276,640
Option 2	$225,834
Option 3	$419,482
Wall Improvement Options	
Option 1	$165,186
Option 2	$520,030
Refrigeration Room Improvements	$93,100
New lobby addition (6,000 SF)	$1,062,000 to $1,416,000
New Arena (32,000 SF)	$6,159,600 to $7,542,000

Section 4

Mechanical and Electrical Systems

EXISTING MECHANICAL AND ELECTRICAL SYSTEMS

General

In general, the existing mechanical (HVAC and dehumidification systems) and electrical systems are original to the building construction and have exceeded their useful and expected life. The electrical systems were not included in the scope of this study but are discussed in relation to the mechanical and ice systems.

Observations of Existing Conditions – Mechanical Systems

The design team toured the facility with the facility's management personnel and have the following observations and comments.

- The arena is operated with year round ice.
- The arena uses a natural gas powered ice resurfacer which off gasses the products of combustion into the arena.
- The arena envelope has numerous cracks in the envelope which allow humidity to infiltrate into the building.
- The arena is heated with gravity vented gas fired unit heaters. The heaters have flues which are open to the exterior of the building. This allows a path for humid outside air to infiltrate into the building. It also allows moisture to condense and accumulate on the inside of the unit heater causing issues with the life and operation of the unit heaters.
- The ice arena portion of the building is dehumidified with a Rink-Drier brand dehumidifier manufactured by Holmsten Ice Rinks. The dehumidification unit is nearly 50 years old and no longer functions properly.
- The arena is ventilated with a wall mounted exhaust fan and intake louvers with manual volume dampers. This ventilation system allows hot, humid air to be directly introduced into the arena during the summer and untreated cold winter air to enter the arena during the winter. Both conditions are undesirable and can lead to poor arena conditions.

<u>Existing Arena Dehumidification System</u>

The ice arena portion of the building is dehumidified with a Rink-Drier brand dehumidifier manufactured by Holmsten Ice Rinks. The dehumidification unit is nearly 50 years old and no longer functions properly. The unit uses low temperature refrigerant from the ice plant to dehumidify the arena. The system is not designed to dehumidify the outside air and it does not have heating components for heating the arena. The unit has well exceeded its expected service life and should be scheduled for replacement.

Picture Window 6: Dehumidification unit to be removed

Arena Ventilation System

The arena is ventilated with a wall mounted exhaust fan and intake louvers with manual volume dampers. This ventilation system allows hot, humid air to be directly introduced into the arena during the summer and untreated cold winter air to enter the arena during the winter. Both conditions are undesirable and can lead to poor arena conditions.

Our initial review of the system produced the following concerns.

1. The amount of outdoor air introduced into the facility is determined by the building operators. If the outdoor air damper is accidently left open the arena can easily be overwhelmed with humidity or the arena can become extremely cold in the winter season.
2. The arena does not have carbon monoxide or other toxic gas sensors. The levels of carbon monoxide are regulated by the state with required documentation logs. This is currently being completed using hand sensors. Adding building mounted sensors with associated alarms would help protect the facility from high contaminant levels.
3. The system is a refrigerant based system. The effectiveness of the system decreases as the arena temperature drops. We recommend that a desiccant based dehumidification be considered for the facility.

Picture Window 7 (l to r): Intake louver & gas fired heater, vapor barrier penetration, mold & rust

Existing Arena Unit Heaters

The arena is heated with gas fired unit heaters which are suspended in the arena. We have the following concerns about the heaters.

- The heaters are natural draft heaters which have flues extending up through the roof. The flues are an open penetration of the building envelope with outdoor air conditions inside the flue. During summer use of the arena the temperature of the flue inside the arena is often colder than the dew point temperature of the outside air. When this condition occurs water will condense out of the outside air and collect in the flue system. Over the course of a summer this continually occurs and can greatly reduce the life of the unit heater. It also adds increased humidity load on the arena dehumidification system. We recommend that the facility consider adding a heating section to the new dehumidification system which would eliminate the gas fired heaters.

- Some of the heaters are pointed out over the ice surface. This adds cooling demand on the ice plant reducing the quality of the ice and increasing energy bills.

Existing Arena Envelope Issues

During our survey of the ice arena facility we noted numerous areas where the building vapor barrier has been compromised. This leads to condensation in the building insulation system, mold growth in the insulation system, deterioration of the building deck and structural steel, water dripping on the ice and other humidity related issues. We recommend that the arena envelope be closely reviewed and any penetrations of the building vapor barrier be repaired.

Arena Team and Locker Rooms Mechanical Systems

- The Arena team rooms are being heated with a high efficiency gas fired furnace coupled with an air to air energy recovery unit. The unit appears to be in good working order and was recently replaced. (Don't know age of unit.)

Picture Window 8 (l to r): team room furnace, team room energy recovery unit

Existing Refrigeration Machine Room
The refrigeration machinery room is ventilated with a wall mounted exhaust fan and an intake louver open to the room. The existing installation does not comply with new refrigeration room ventilation requirements. The system will need to be replaced with a new ventilation system when the refrigeration plant is upgraded.

Current building codes require a one hour fire separation between the refrigeration room and other occupancies. During our survey we noticed several penetrations of the enclosure that should be properly fire rated

Existing Building Fire Protection System
The existing building is not protected with an automatic fire protection system. Discussions will need to occur with the Building Officials to determine if the existing building will need to be upgraded with a new fire protection system.

Recommendations – Existing Mechanical Systems

General
We recommend the City plan and budget for the capital improvements for the existing mechanical systems at the facility as outlined in this Section.

Recommendation 1:
Mechanical Recommendation 1 – Disconnect the Existing Dehumidification System and replace with a new gas fired Dehumidification system.

The existing gas fired, desiccant based dehumidification unit is improperly sized to dehumidify and ventilate the Arena on a year round basis. We recommend that the unit be replaced with a new gas fired, desiccant based dehumidification unit that is sized to dehumidify and ventilate the rink on a year round basis. The system should be designed to provide current code mandated ventilation air to the facility. This new unit will properly maintain the humidity levels in the building. The new Rink dehumidification system will include a gas fired heating section and 100% outside air capabilities. The existing desiccant dehumidification unit and gas-fired unit heaters will be removed from the building.
During the design process of the arena we will investigate the use of several energy saving technologies

that can be applied to the system including using waste heat from the ice plant to regenerate the desiccant wheel, using waste heat from the ice plant to heat the building, and using air to air energy recovery wheels to reduce the energy use of the facility. We will also review the use of CO_2 monitoring to reduce the amount of outside air introduced into the building. This dramatically reduces the heating and dehumidification needs of the building. Preliminary design concepts for the system include locating the unit on grade outside the building. New ductwork will be run down one side of the arena to distribute warm dry air throughout the arena.

A letter was provided prior to the completion of this report to assist the City is replacing this unit in the summer of 2014. This letter is included in Appendix A.

Recommendation 2

Mechanical Recommendation 2 – Add Demand Control Ventilation Controls to the Arena Ventilation System.

The second item that we recommend considering is demand control ventilation for the arena ventilation systems. Demand control ventilation actively controls the amount of outside air introduced into the arena based on the level of carbon dioxide, CO_2, and carbon monoxide, CO, in the arena. CO_2 is given off when people exhale. As the occupant load in the building increases the level of CO_2 increases. When the level of CO_2 reaches a first set point the outside air damper on the make-up air unit will modulate open to flush the contaminates from the building. Carbon monoxide is given off when internal combustion engines are operated in the facility. We recommend that new CO sensors be integrated into the control sequence to flush CO from the building. The sequence of operation will be similar to the CO_2 control system with outside air systems sequencing on to flush contaminants from the building.

Cost Estimates – Existing Mechanical Systems

The costs of the recommended improvements are summarized below and are total project costs. A more detailed description of the cost estimate is located in the Appendix. The control system recommended under Recommendation #2 has a typical pay back of less than three years.

Table 2. Mechanical System Improvements Cost Estimate Summary

Item	Cost
Recommendation 1	$329,072
Recommendation 2	$16,963
Ice Equipment Room Ventilation System	$47,495

Section 5
Ice Systems

EXISTING ICE SYSTEM

General

The existing ice arena is served by a *direct-type* ice system that includes a refrigeration system, NHL sized ice sheet and dasher board system. R-22 refrigerant is used as the primary refrigerant that is circulated through the ice rink floor. The existing refrigeration system was manufactured by Holmsten Ice Rinks in 1972 (42-years old) and was installed in the facility around 1987 (27-years ago) and has reached its original expected life. This study includes an in-depth evaluation for the improvement or replacement of the existing ice system.

This section of the study discusses the existing ice systems, general design parameters to consider, options available, and recommendations for improving or replacing the existing ice system. Estimated costs for each recommendation are also provided in this section and the Appendix.

Definitions for the two types of ice systems used in ice rink facilities and several other common terms discussed throughout the study are provided below:

Ice System: A term that collectively refers to the refrigeration system, ice rink floor system, waste heat recovery systems and dasher board systems.

Direct System: A *direct* refrigeration system circulates the primary refrigerant (e.g. R-22) directly through the ice rink floor. There is no secondary solution or refrigerant. **This is the type of system installed at Neilson Reise Arena.**

Indirect System: An *indirect* refrigeration system uses two refrigerants. A primary refrigerant (e.g. R-22) remains confined in the refrigeration room and a secondary refrigerant (e.g. glycol or calcium chloride) is circulated in the rink floor. The heat exchange between the primary and secondary refrigerants takes place in the refrigeration room.

HCFC: Hydrochlorofluorocarbon (e.g. R-22, etc.). **Neilson Reise Arena's refrigerant.**

HFC: Hyrdrofluorocarbon (e.g. R134a, R404A, R407C, R410, R507, etc.)

Natural Refrigerants: Natural occurring refrigerants such as ammonia (R717), carbon dioxide (CO_2, R744) and hydrocarbons.

Synthetic Refrigerants: Artificial refrigerants such as HCFC and HFC type refrigerants.

Ice Systems - Observations of Existing Conditions

The design team toured the facility with the facility's management personnel and have the following observations and comments.

- This refrigeration system was installed in 1987 (27-years ago) but was manufactured in 1972 (42-years old). The ice rink floor was replaced in 2005. The dasher boards are at least 27 years old if not older.

- Ice operational season: 12 months. The ice was removed this summer for the first time in 12 years.

- Overall, the systems related to the ice system have been very well maintained by the facility's operational and maintenance personnel.

- *Refrigeration System.* The arena is served by a *direct* refrigeration system manufactured by Holmsten Ice Rinks. The majority of the components include two (2) York compressors, one (1) low pressure receiver, two (2) pumper drum vessels, and one (1) motor control center. The 42-year old (27 years in operation) refrigeration system is at the end of its expected life of 25 years. The system is in fair condition for its age. It is becoming more difficult to maintain with its outdated electrical and control systems, discontinued compressors units, etc. Some improvements have been performed on the refrigeration package over the years like reinsulating sections of the piping systems, etc.

  The existing cooling tower is an evaporative condenser type system, manufactured by Evapco and original to the system. This system uses air and water to dissipate heat for the refrigeration processes.

- *Waste heat recovery system(s).* The facility does an excellent job (more than many ice arenas) at recovering waste heat from the refrigeration system and reusing it throughout the facility. The waste heat recovery systems serve the existing subfloor heating (front prevention system) beneath the ice rink floor, snow melt pit, air handling unit and preheating domestic hot water (the old water heaters are used as storage tanks).

  The subfloor heating system is reportedly in good working order eliminating the concern of frost heave or build-up beneath the ice rink floor. This piping system beneath the rink floor was replaced in 2005 when the rink floor was replaced. Frost heave, due to frost build-up beneath the ice rink floor, is a common concern and problem with the older Holmsten *direct* systems. There are no visible or reported signs of frost heave, such as cracked perimeter concrete or building walls.

- *Ice rink floor.* The rink floor was replaced in 2005 (9-years old) with the same type of sand floor design as the original floor. The existing floor is standard NHL size (200'x85'x28' radii) and the standard Holmsten Ice Rink design consisting of: 6 inch subfloor sand layer and heating system; 3 inches of floor insulation; ½ schedule 40 steel tubing installed at 4 inches on-center with welded connections; and 5 inches of reinforced concrete. It is very typical for the rink floors in a Holmsten Ice Rink System to be the first components to fail as was the case at this facility and led to its replacement in 2005.

- *Ice equipment room.* The existing ice equipment room is located in the northwest corner of the facility and is approximately (18'x40') 720 square feet in size. The two exterior walls allow for the use of various types of refrigerants. There are electrical components and systems located in the room that are unrelated to the ice system such as a distribution panel, junction boxes, transformers, etc.

- *Life safety systems.* The refrigeration room is equipped with an R-22 leak detection system. We did not recall seeing an emergency power shunt trip for the refrigeration system or an energizer switch for the emergency ventilation system on the exterior of the mechanical room door(s) as required per code. It was not noted when pressure relief valves on the systems were last replaced. Replacement is required every 5 years. There is an existing mechanical ventilation system in the refrigeration room as required by code.

- *Dasher board system.* The existing dasher board system was manufactured and installed at the time the building was constructed. The 24-year old system was manufactured by Holmsten Ice Rinks and is a steel frame system with acrylic shielding. The life expectancy of a typical dasher board system like this is approximately 20-25 years.

Picture Window 9 (left to right): Existing direct refrigeration system; water tank and electrical gear, waste heat recovery system.

Recommendations – Ice System

General

In addition to evaluating the feasibility of expanding the facility, one of the main focuses of this study is the planning and budgeting for the replacement of the 42-year old (27-years of use) refrigeration system, the 27-year old dasher board system and possibly the rink floor. Holmsten Ice Rink's *direct*-type ice system is one of the most efficient systems designed for ice rink applications. However, because of the following factors, this type of system is no longer a viable type of system to use in today's ice arena facilities:

- Requires a large quantity of refrigerant (6,000 pounds vs. 400 to 1,000 pounds on a modern *indirect* system).
- Refrigerant is circulated through the ice rink floor, potentially exposing spectators to refrigerant if a leak occurs.
- R-22 is currently on a phase out schedule mandated by the EPA and will no longer be produced after 2020.

- The rink floor already failed and was replaced so the condition of the floor is not a concern.

Outlined below are several improvement options ranging from doing nothing and operating as-is to a total replacement of the ice system. Options 3-87 require changing from a *direct* system to an *indirect* system with the exception of using CO2 refrigerant. *Indirect* systems require a secondary heat exchange process making them less energy efficient than *direct* systems.

The following options will be discussed in this section:

Option 1: Do nothing. Continue to maintain existing systems.

Option 2: Make improvements to the existing *direct* system(s).

Option 3: Convert to an *indirect*, industrial grade, R-22 or other hydrofluorocarbons (HFCs) based system using the existing refrigeration equipment.

Option 4: New *indirect*, commercial grade, HFC based system.

Option 5: New *indirect*, industrial grade, HFC based system.

Option 6: New *indirect*, industrial grade, ammonia based system.

Option 7: New *indirect*, carbon dioxide (CO2) based system.

Option 8: New *direct*, carbon dioxide (CO2) based system.

One option that is not discussed in this report but may be an option in the future is installing a common refrigeration system serve both the skating and curling facilities. A common refrigeration has the least capital costs overall and operates with the greatest efficiency. A new refrigeration system for the skating rink could be sized to accommodate the curling rink in the future.

Before the system options are discussed in more detail, a general discussion of seven (7) major factors or design considerations that the design team feels are most important to consider when evaluating ice system options is presented below. A general understanding of these factors, we believe, will aid the City in making the best possible selection for improving or replacing the existing ice systems. In a historically slow-changing industry, the somewhat recent updated environmental regulations and increasing energy costs have brought new innovations and technology to the ice rink industry.

1. *Selection of Primary Refrigerant:* **R-22** has been the most popular refrigerant used in ice rink applications in recent history. However, with the signing of the Montreal Protocol, the United States Environmental Protection Agency (EPA) implemented the final rule of Section 604 of the Clean Air Act in July 1992, limiting the production and consumption of a set of chemicals known to deplete the stratospheric ozone layer as measured by their ozone depleting potential (ODP). R-22, which also has a high global warming potential (GWP), is one of these targeted chemicals.

   Regulations on R-22 started taking effect in 2010 and will continue to significantly reduce the allowances to produce and import R-22 through 2020 when production and importation in the U.S. will be halted all together. The U.S. EPA has proposed to significantly reduce allowances by 11-17% per year through 2014.

In addition to the current regulations on refrigerants that affect the ozone, there is now pressure to consider phasing-out refrigerants that contribute to global warming, as measured by their global warming potential (GWP). This affects mainly hydrofluorocarbons (HFCs) like those used in blended refrigerants such as R-507A, R407C, R-404A etc. The European Union has been on the leading edge of this change. The European Parliament passed legislation called the "F Gas Directive" that became effective in 2007, that requires very strict inspection of systems for leakage, rigorous record keeping, and mandatory training and certification on systems using HFCs. Most recently, the European Union has tightened these restrictions with an informal agreement in December, 2013. The changes include increasing taxes on HFC's and providing incentives for using natural refrigerants.

Currently, the ice rink industry is caught in a transition period for refrigerants as new environmental regulations are implemented. Careful consideration and evaluation of the current refrigerant options should be made. The replacement refrigerants for HCFC refrigerants (i.e. **R-22**, etc.) are fairly new with a limited history and performance data in this application. The almost certain future regulations of HFC refrigerants (i.e. **R-507, R407C**, etc.), which are used in many of the R-22 replacement refrigerants, should be considered.

Large global companies, such as Coca Cola, are leading the charge to ban HFCs and use natural refrigerants such as **CO2**, hydrocarbons and **ammonia**. Between 2004 and 2012, twenty four ice skating facilities in Europe have switched over to using CO2 as the secondary refrigerant with ammonia as the primary. The first CO2-based ice system in North America, and the first *direct* CO2-based system in the world, opened in 2011 in Quebec, Canada with a second rink opening in Montreal in 2012.

Some other factors that should be considered when comparing primary refrigerants are listed below.

<u>Location:</u> it is important to consider local temperatures and weather patterns when selecting refrigerants. For example, CO2 is more likely to be affected by ambient conditions than other refrigerants. CO2 is most efficient in colder climates. The following is a partial list of CO2 ice rinks that are currently in operation or under construction world-wide. Note that most if not all are located north of Montreal or Quebec, Canada:

<u>Indirect CO2 Systems</u>
Dollard-des-Ormeaux Civic Centre, Canada, 2012
Stade de la Cite des Jeunes – Riviere-du-Loup, Qc, Canada. Complete Nov. 2013
Lacroix-Dutil Sport Complex – St-Georges, Qc, Canada. Complete Nov. 2013
Curling Roberval – Roberval, Qc, Canada. 3 sheets. Complete Nov. 2013
Rosaire-Belanger Sports Center – Riviere-Bleue, Qc, Canada. Complete Nov 2013
Cynthia-Coull Arena – Longueuil, Qc, Canada. Complete Nov. 2013

Direct CO2 Systems
Arena Marcel Dutil, Les Costeaux, Qc, Canada. 1 Sheet. 2010.
Concordia College, Montreal, Canada. 1 sheet, 600 seats. Recently completed.
St-Gedeon-de-Beauce Arena, Canada.
Isatis Sport Chambly, Chambly, Qc, Canada. 3 sheets, Completed July 2012.
McDonald Center, Eagle River, Alaska – start-up in fall of 2014

30+ direct CO2 or Ammonia/CO2 systems in Europe
CO2 ice rink systems started in the year 2000 in Europe.

Efficiency: Compared to HFCs, ammonia and CO2 refrigerants are significantly more efficient, providing greater capacity at less horsepower. The winner between ammonia and CO2 is less clear. It has been shown that CO2 is most efficient in colder climates. As the ambient temperature rises above CO2's critical temperature of 86 F, the capacity and performance of the system drops mainly due to the change from subcritical operation (condensing with gas cooler) to transcritical (no condensing takes place). It has been determined that, in general, the efficiency of CO2 based ice systems is greater than HCFC-based systems.

A technical paper presented at the 2013 Industrial Refrigeration Conference and Exhibition presented by the International Institute of Ammonia Refrigeration (IIAR) concluded that an indirect ammonia/glycol ice system with waste heat recovery is the best solution from an energy perspective when compared to a transcritical CO2 system and an ammonia/glycol system without waste heat recovery systems.

In contrast, a September 2012 Master of Science Thesis paper on "Carbon Dioxide in Ice Rink Refrigeration" by Tuyet Nguyen at the KTH School of Industrial Engineering and Management, Stockholm, Sweden showed through simulation that *direct* CO2 systems in ice rink applications is 30% lower in energy consumption than an *indirect* ammonia/brine system and 46% lower than and *indirect* CO2/brine system. CO2 systems also had the highest energy savings in regards to waste heat recovery potential. The study also concluded that the overall life cycle of a direct CO2 system is approximately 13% lower than an *indirect* ammonia/brine system. Finally, it was noted that a direct CO2 system has the high potential to be the next generation refrigeration system in ice rink applications but the transcritical working may restrict it to cooler climates.

In both cases, significant modeling was performed with numerous scenarios. It is likely that, as the rapid development of CO2 in the supermarket industry continues and further development of CO2 transcritical (both subcritical and supercritical states of operation) technology progress, greater system efficiencies will be realized in the near future.

Environment: Both ammonia and CO2 are naturally occurring refrigerants with zero ozone depleting potentials (ODP). The global warming potential (GWP) is zero for ammonia and one for CO2.

System Charge: The following table lists approximate system charges for the proposed ice systems with various refrigerants. One main restriction when using CO2 direct systems is current industry codes restrict the amount of refrigerant in a system based on arena volume or space. Depending on the size of the facility, a direct CO2 system may not meet code requirements.

Table 3. Typical System Charge for Single Ice Sheet

Refrigerant	Charge (pounds)
Ammonia (indirect)	400-600
HFC (indirect)	600-1,200
CO2 (indirect)	500-600
CO2 (direct)	4,000–5,000

<u>Composition:</u> While ammonia and CO2 are natural or "pure" refrigerants, the HFC refrigerants replacing R-22 are "blended" refrigerants, meaning they are a mixture of several different, individual refrigerants. Since refrigerants have different properties, each one reacts differently to changes in its properties, such as pressure and velocity. When a leak occurs, varying amounts of each refrigerant may leak out, throwing the original mixture out of balance and potentially forcing the replacement of the entire charge, rather than simply adding the amount that was lost.

<u>Safety:</u> HFC refrigerants have the least safety concerns of the refrigerants that are discussed in this report, although they can be difficult to detect without a leak detection system. Ammonia on the other hand, is considered a high health hazard because it is corrosive to the skin, eyes and lungs. Exposure of 300 parts per million (ppm) is immediately dangerous to life and health. It can be explosive if released in an enclosed space with a source of ignition or if the vessel is exposed to fire. It is fortunate that ammonia has a low odor threshold (20 ppm) forcing people to seek relief at much lower concentrations, and because if its efficient composition, the system charge can be significantly reduced. Ammonia has mild flammability. There are also safety devices and systems available to help detect, signal, and prevent dangerous situations.

CO2 is a non-toxic, non-flammable and non-explosive gas. The one disadvantage of using CO2 in ice rink applications is the operating pressures are between pressures of 300 and 1800 psi compared to ammonia and HFC-based systems that operate at maximum pressures of 300-350 psi. The following is table comparing CO2 and ammonia safety limitations.

Table 4. Refrigerant Safety Limitations

Parameter	Ammonia	CO2
TLV (Threshold Limit Value)	25 ppm	5,000 ppm
STEL (Short Term Exposure Limit)	35 ppm	30,000 ppm
Revised IDLH (Immediate Dangerous to Life and Health)	500 ppm	40,000 ppm
LFL (Lower Flammability Limits)	15%	Non-flammable
GROUP (ASHRAE, 1992)	B2 Toxic	A1 Non-Toxic

<u>Cost:</u> The increasing environmental regulations are certainly impacting the price of R-22. As the industry experienced in March of 2012 when the price suddenly jumped overnight from $7 per pound to $13 per pound. Replacement or "drop-in" refrigerants for R-22 are currently on the market and becoming more available at a cost of approximately $15 to $18 per pound. Ammonia and CO2 are currently $1.50 per pound.

<u>Additional Regulations:</u>
Regulations on HFC refrigerants would be similar to the existing R-22 system. Ammonia is probably among the most regulated refrigerants. For example:

- Facilities containing 500 pounds of ammonia or more must be reported to the local emergency planning committee. **A new system at Neilson Reise will operate with less than 500 pounds.**

- Facilities containing over a threshold quantity (TQ) must submit a risk management plan to the U.S. Environmental Protection Agency. Typically TQ around 10,000 pounds.
- Losses of over 100 pounds must be reported to the National Response Center within 15 minutes.

Since CO2 is very new to the ice rink industry in North America, it will likely be regulated similar to an ammonia-based system. This assumption was used in this evaluation and in determining cost estimates.

<u>Reporting a Release of R-22</u>

With the existing aging R-22 direct refrigeration system at the facility it is important to understand the reporting requirement if a release occurs. There are requirements for governments, local authorities and facilities to report hazardous and toxic chemicals. For accidental releases of refrigerant a report must be filed under the Emergency Planning and Community Right-To-Know Act (EPCRA). For an ice system, the reporting trigger leak for CFC (e.g. R-12) or HCFC (e.g. R-22) type refrigerant is 35 percent annually. The Environmental Protection Agency, under the Clean Air Act (Section 608), also requires a report for the release of HCFC type refrigerants.

There are government regulations for repairing leaks in a refrigeration system. If during the course of a 12-month period, an appliance is leaking refrigerants beyond the trigger rate, the owner must take action to repair it. In general, the owner needs to make suitable repairs to the appliance within 30 days of finding out about the leak. Or, make plans to retrofit or retire the appliance within 30 days, and act on the plan within a year of the plan date.

<u>Other Considerations</u>

It is recommended that prior to making a change in the type of refrigerant that is used, that the proposed changes be reviewed in detail with the Owner's insurance carrier, the fire marshal, fire department and other interested parties.

2. *Selection of Secondary Refrigerants:* There are two main secondary refrigerants that are used for ice arena applications, **calcium chloride** (often referred to as "brine") and **ethylene glycol**. In some cases, although fairly rare, **propylene glycol** is used. A diluted **ammonia** solution is being used in Europe with increased frequency. A comparison of the secondary refrigerants provided below.

   <u>Efficiency:</u> The efficiency of the secondary refrigerant is determined by a number of factors including thermal conductivity, specific heat, fluid flow characteristics, surface area, etc. Calcium chloride is a salt and water mixture. The chemical properties of the calcium chloride solution allow it to be pumped easier and to transfer heat at a higher rate than glycol. Therefore, the refrigeration equipment can be reduced in size. This leads to an overall system efficiency of 8% of 12% greater than ethylene glycol. Propylene glycol is less efficient than ethylene.

   <u>Environment:</u> Since calcium chloride is a mixture of salt and water it poses little harm to the environment if a leak or spill occurs.

   Ethylene glycol on the other hand will remain in high concentrations in the soils for long periods of time. Propylene glycol is less toxic than ethylene glycol. It is a food-based glycol that is much more environmentally friendly than ethylene glycol.

Corrosiveness: The disadvantage of using calcium chloride is that it can become corrosive when exposed to air. Systems using calcium chloride require more monitoring and maintenance. Once mixed with ammonia refrigerant, the corrosiveness increases substantially and potentially turns into a hazardous chemical. There are inhibitors that are mixed with the solution to aid in corrosion prevention and many rinks in North America have used this solution for 50+ years. Glycol on the other hand is not corrosive.

Typically, the types of heat exchangers available for use with CO2 systems are limited because of the higher operating pressures and usually require a glycol solution.
Cost: At a mixture of 21% concentration, calcium chloride is approximately $1.00 per gallon compared to glycol, 35% concentration at $9.00 per gallon. A new indirect ice system for this facility will require approximately 4,000 gallons of a secondary refrigerant.

Monitoring: A more extensive monitoring program will be required with calcium chloride than with glycol and generally requires sampling and testing once or twice a year.

3. *Quality of Materials and Equipment:* Balancing the initial cost of materials and equipment with energy savings can be difficult during the budgeting process of the project. For example, the phrases "commercial grade" and "industrial grade" systems, used throughout the report, refer to quality and operational efficiency differences in the refrigeration system.

   Commercial grade systems are similar to supermarket type refrigeration systems, built on a rack package, and have a lower life expectancy (15-20 years). These systems typically use copper and PVC pipe in place of steel; disposable type compressors in place of rebuildable ones; direct expansion type heat exchangers in place of flooded type systems; etc.

   Industrial grade systems are typically stick built on site, have a longer life expectancy (25-35 years), and are generally more efficient to operate.

   For the **ice rink floor**, there are several different types of piping arrangements and designs to consider. For example, the traditional design of rink floor piping systems used clamped connections using hose clamps to connect the poly rink piping to a steel header system. Around 1995, the industry replaced the hose clamp connections with heat fused connections, similar to what the natural gas companies' use for their pipelines. Fusion weld technology has eliminated the need or use of corrosive materials in the rink floor and provided the opportunity for a virtually seamless piping system that can extend the life of the rink floor from 25 years to over 40 years.

   Another important choice is the selection between the use of steel pipe or polyethylene pipe. Polyethylene pipe is significantly less cost but does not transfer heat as efficiently. For most community based rinks, polyethylene pipe is the most cost effective pipe material. For larger venues, steel pipe systems are preferred.

4. *System Design:* A thorough design of the ice system is critical in maximizing its efficiency. Examples of design elements that should be thoroughly evaluated during the design phase include:

- *Lowering condensing temperatures.* Lowering the condensing temperature of the refrigeration system increases its efficiency but decreases the amount of waste heat that is generated.

- *Liquid cooler.* A liquid cooler is a large cooling system that is installed outside the ice arena and takes advantage of cold air temperatures and is most applicable in colder climates. Brine is circulated through the unit when the air temperature is lower than the ice temperature set point.

- *Compressor options.* Depending on the refrigerant selection, there is typically more than one option for the type of compressor that could be used including semi-hermetic, open drive or reciprocating, screw, etc. Continuous advances in technology are increasing the number of options available for ice rink applications.
- *Floating head pressure.* Allowing the head pressure of the system to vary based on ambient temperatures can provide a significant energy savings over a fixed setting. However, this results in less waste heat being available from the system and, in one recent study, has been shown to have an overall negative effect on energy savings. *Variable frequency drives.* The use of variable frequency drives on pumps and compressors can be beneficial not only for energy savings but control of ice temperatures as well.

- *Variable frequency drives.* The use of variable frequency drives on pumps and compressors can be beneficial not only for energy savings but control of ice temperatures as well.

- *Controls.* System control options range from very basic to a complete integrated building or energy management system.

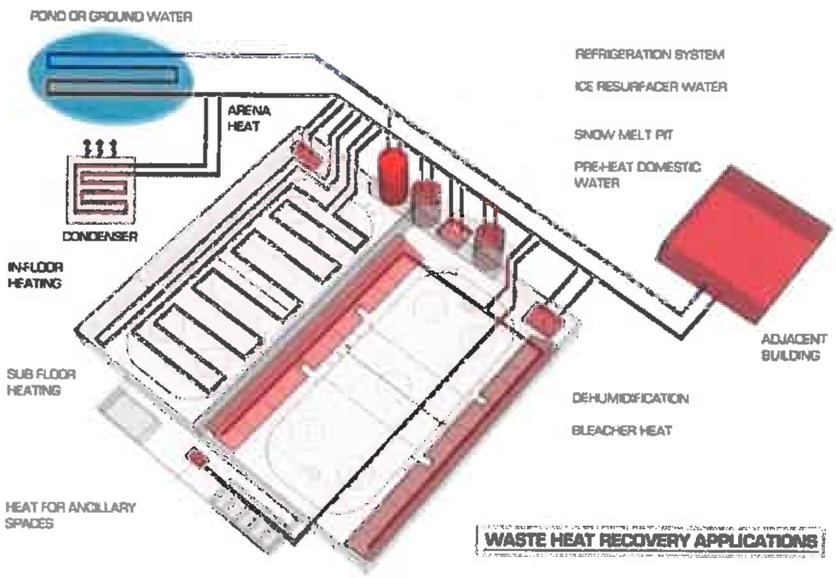
Finding the balance between system and equipment options is key to a successful and efficient design.

5. *Energy Source:* As energy costs rise, alternative sources of energy, such as geothermal, natural gas, or co-generation, may look more attractive. Electricity still remains the most practical energy source for these types of systems. Stevens has designed several geothermal systems and can provide information on these systems if desired.

6. *Waste Heat Recovery:* Refrigeration systems generate a large amount of heat that is typically wasted into the atmosphere. A refrigeration system for a single ice sheet can typically generate enough waste heat to serve the subfloor heating system, snowmelt pit, the dehumidification system, and potentially preheat domestic water source or in-coming air. Historically, ice rink facilities have only captured and reused approximately 25% of the waste heat generated. It has now become normal design practice in the ice rink industry to capture 90% or more of the waste heat and reuse this "free energy" throughout the facility. While all ice rinks have a demand for heat during most, if not all of the season; the heat recovery systems are especially beneficial for arenas where the greatest heat is required for the longest period of time (e.g. northern U.S. and Canada). At least one recent major study shows that systems that recover waste heat and use it throughout the facility will operate much more efficiently than systems that do not.

Table 5. Estimated of Total Waste Heat Available

Units - MBH	Winter	Spring/Fall	Summer
1 sheet	410	550	700
2 sheets	800	1100	1500



Some uses for waste heat include:

Snow Melt Pit Operations (basic heat recovery): This is a very common use of the waste heat. In this option, waste heat is captured from the refrigeration process through the use of a heat exchanger which will reject the heat into a solution of glycol and water. The glycol solution is then pumped to a coil located in the snow melt pit. This process will eliminate or greatly reduce the use of other sources of heat such as natural gas or electric boiler systems.

This system will also eliminate the need to melt snow with hot water from the domestic water system which is often installed as a band-aid for an underperforming or broken system. A boiler can be connected to the waste heat system to provide snow melting when the ice plant is turned off.

Subfloor Heating System (basic heat recovery - frost prevention system): This is another very common use of waste heat. In this option, waste heat is captured from the refrigeration process through the use of a heat exchanger which will reject the heat into a solution of glycol and water. The glycol solution is then pumped through a system of pipes located beneath the ice sheet and insulation system. The subfloor heating system prevents the ground from freezing below the ice rink floor. Frost heave is a common problem with the *direct* Holmsten Ice Rink systems, especially for the earlier installations where the piping systems used thin walled pipe and hose clamps and had a high failure rate.

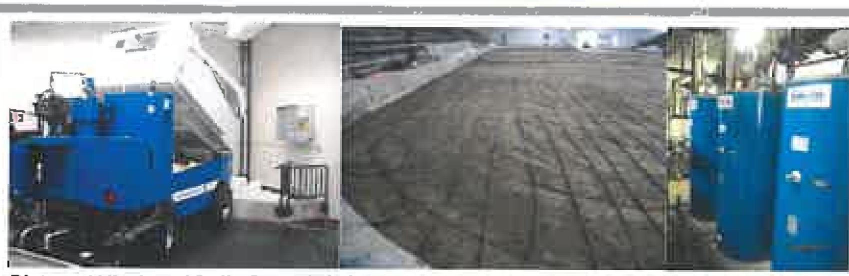
Domestic Hot Water Preheat (enhanced heat recovery): In this option high temperature waste heat is captured from the refrigeration process through the use of heat recovery water heaters. The water heaters are specifically designed to capture heat from the refrigeration systems. The system has proven to greatly reduce the domestic water heating needs of the facility.

Resurfacer Water Preheat (enhanced heat recovery): Most ice arena facilities have water heaters dedicated to providing the ice resurfacers with hot water for flooding and resurfacing the ice sheet. A waste heat recovery system could be installed that is similar to the domestic hot water preheat system described above.

Building Heat (enhanced heat recovery): Waste heat can be used to offset the heating needs of the building. Ice arenas require heat on nearly a constant basis. In this option waste heat is captured from the refrigeration process through the use of a heat exchanger which will reject the heat into a solution of glycol and water. The glycol solution is then pumped over to a heating coil located in an air handler unit. The air handler can run whenever the refrigeration system is operational. This process is attractive because it presents a nearly constant use for the waste heat.

This option is viable for most refrigerant systems and becomes even more viable for the CO2-based refrigeration system. The CO2-based refrigeration system operates at very high pressures and the heat rejected from the system will be at correspondingly higher temperatures. It is much less expensive to use the waste heat when it is at the higher temperatures provided by the CO2-based refrigeration system. However, waste heat from CO2 systems can be limiting when ambient air temperatures are higher.

Exterior Snow Melting System: Waste heat can also be used for exterior snow melting use. Piping can be installed in sidewalks or ramps and waste heat from the ice plant can be used to keep the surfaces clean of snow and dry. This can be a good use of the waste heat but its use is limited to a small percentage of the total hours available in a year.



Picture Window 10. (Left to right): snow melt pit, subflooring heating, preheating water

During the design phases of each project; the facility's layout and potential use for waste heat from the refrigeration system should be evaluated in depth to determine the benefit of each system.

7. *Sustainability:* Sustainability goes hand-in-hand with all the items in this list of considerations. Energy savings, through smart design practices, translates directly into the reduction of green house gas emissions such as carbon dioxide. There is an opportunity for the City to lower the carbon

footprint of the ice arena by reducing or eliminating the use of HCFC refrigerants and increasing the use of waste heat from the refrigeration system.

Other recommended improvements to the existing ice and refrigeration system.

- *Install waste heat recovery systems.* See previous discussion on options.

- *Replace dasher board system.* The useful life of a dasher board system depends on the quality of construction, maintenance, timeliness of the repairs, and the amount of moisture in the ice arena, and therefore, can be difficult to determine. Generally, the useful and safe life ranges between 15-20 years. In some cases, dasher board systems are replaced because of new technology and options that are available such as:
  - Seamless or supportless glass systems. These systems are installed in most NHL rinks and many college and community rinks. However, these systems are more rigid than the traditional supported or posted systems;
  - Framing systems. Options include steel or aluminum framing systems. Steel is the traditional material and is considered to be more durable. However, aluminum systems have improved tremendously providing a corrosion resistant and lighter weight system. Aluminum is the preferred system when frequent assembling and disassembling is required;
  - Tempered glass shielding providing clearer viewing and reducing maintenance over acrylic shielding. Tempered glass shielding is currently about the same cost as acrylic shielding; and
  - Lift out panels for indoor soccer nets on the ends of the rink or for access to the rink floor during dry floor activities.

  Many advancements have been made in dasher board system technology over the past 10 years. Not only should the new system be designed to improve spectator viewing and installation and take-down efforts, but more importantly, to improve player safety.
  - Acrylic shielding system. The new acrylic shielding systems have been designed to better resist scratching and discoloring and provide the greatest flexibility of all the shielding systems. These systems are currently being installed in most NHL rinks and will eventually be installed in many college facilities. Framing systems. Since the dasher board system in this facility will remain in place, either steel or aluminum framed system will work well.
  - Flexible glass or frame systems should be considered to aid in reducing injuries especially at the ends and radii of the rink.
  - Soft caprail. This is fairly new product that was recently introduced by one manufacturer and is marketed to reduce head injuries. The product has a life span of approximately 5 years.
  - Recessed kickplate in place of the traditional kick plate that protrudes out ½ inch from the face of the dasher panel.

Picture Window 11(left to right): flexible frame and glass system, seamless tempered glass, acrylic shielding

- *Flood water systems for resurfacing:*
  - *Water Quality.* Water quality has a direct relationship with energy use, performance and aesthetics. Purer water takes less energy to freeze, is more dense and therefore, provides greater structural integrity. The denser the ice, the faster it plays. The players want to be on the surface and not in the ice so ice density is very important. It's possible to lessen the thickness of the ice by a quarter inch or more with using clean water. This in turn saves energy. The Department of Energy found that for every 1-inch of ice thickness required, the refrigeration system demand increases by 8 to 15 percent. Typical ice thickness is 1.5 inches.
  - *Water Temperature.* There is a general rule of thumb that states for every one degree (F) rise in ice surface temperature, there is an energy savings of 4 to 6 percent on the refrigeration system. Ice temperatures can typically be raised by 2 to 4 F higher using treated water over untreated water for a total overall energy savings of 8 to 12 percent depending on programming, weather, length of season, etc. The traditional standard temperature for flood water is 120-165 F. However, some facilities use temperatures as low as 80-90 F.
  - *Water Treatment.* A common water treatment system that is used in ice arena facilities today (mainly collegiate and NHL facilities) is based on a reverse osmosis (RO) process. Typical water hardness readings between 50-80 ppm (3 to 5 grains) are desired. For water with readings higher than this, treatment is recommended. The City's water quality reports should be reviewed for a possible application at Sullivan Arena.

Ice System Replacement Options - Recommendations

The following improvement and replacement options were evaluated in this study.

Option 1: *Do Nothing – Maintain Existing Systems.* The City may elect to keep operating the existing refrigeration system. The existing *direct* refrigeration ice system, manufactured and installed by Holmsten Ice Rinks; was commonly installed in arenas during the 1970's and 80's. The design of this *direct* ice system is unique and has proven to perform very well and operate very efficiently. However, this type of system is outdated and numerous concerns exist with the basic system design and current code regulations. These concerns include:

Some of the potential downsides, or risks, involved in continuing to operate the existing system for too much longer are as follows:

- *On-going Maintenance and Equipment Costs:* The equipment and parts on the refrigeration system will continue to require replacement in the near term. It's similar to driving a vehicle with high miles; the longer it runs, the more costly it becomes to repair and the lower the return on investment. Parts for the existing York compressors are no longer manufactured and becoming extremely difficult to find and costly to purchase. Some valve manufacturers (like Sporlan) no longer manufacture some of the valves used on the system. Major improvements to the existing refrigeration system will soon be required to extend its safe and useful life.

- *Safety:* The *direct* ice system circulates R-22 refrigerant in the ice rink floor, which is located in the occupied space of the facility, potentially exposing hundreds of spectators, skaters, and workers to leaking refrigerant as the floor system ages. However, the rink floor is fairly new so leaks are less of a concern at this time.

- *Dependability:* The risk of problems occurring with the refrigeration system, and therefore, the risk of losing the ice sheet, increases as the system ages.

- *Cost and future availability of refrigerant:* As the system ages, the risk of a major release of refrigerant increases. A single *direct* system contains approximately 6,000 pounds of R-22 refrigerant with a replacement costs (refrigerant only) currently ranging from $60,000 to $120,000. As the phase-out date for R-22 approaches, the cost will continue to increase. Since 2005, the cost of R-22 refrigerant has risen 850%. Depending on the availability of R-22 when this occurs, the City may be forced to install a new blended refrigerant which will require additional modifications to the system.

- *Environmental:* The existing system uses a large volume of R-22 refrigerant (approximately 6,000 lbs) with a high global warming potential (GWP) rating. R-22 refrigerant is scheduled to be phased out of production in the near future.

Option 2: *Make Improvements to the Existing Systems.* Holmsten Ice Rinks provided good quality vessels (e.g. high pressure receiver, pumper drums, etc.) with their systems. This opens up the option of renovating the existing refrigeration system to extend its useful, dependable, and safe life. This option has successfully been performed at several facilities such as Gustavus Adolphus College, University of Minnesota-Duluth and others.

If the existing refrigeration system(s) is going to remain in place, whether in its current operation as a *direct* system, or converted into an *indirect* ice system, we recommend the following improvements be performed on the existing refrigeration system.

- *Replace relief valves on all vessels:* Relief valves are required on all high pressure vessels and should be replaced every five years. These are important safety devices and should be maintained on a regular basis. This work will include installing pressure reliefs on the pumper drums which were not typically installed.

- *Replace and install monitoring devices on the refrigeration system:* Quality monitoring devices such as pressure, temperature and pressure gauges are extremely important in monitoring and troubleshooting the system. These devices will allow the facility's staff to more accurately assess and adjust the performance of various systems and to pinpoint problem areas.

- *Investigate the integrity of the existing steel vessels and piping systems:* Corrosion along the bottom of the low pressure receiver is common in these systems and is visible by staining on the jacket or covering of the insulation systems. The extent of any corrosion cannot be determined without removing the insulation. The recommended repair includes: removing several sections of the existing insulation on the system; conducting a visual inspection of the vessels and piping; and conducting a non-destructive ultra sound tests of the steel. If high levels of corrosion are found, the entire insulation system should be removed; the surface of the vessels and piping should be sanded, primed, painted; and then the entire system should be re-insulated.

  If the steel vessels and piping systems are found to be in good shape, this system could last another 15 or more years with the other recommended improvements completed and with continued proper maintenance.

If extensive corrosion is found, the vessels should be repaired and recertified and/or replaced and piping should be replaced before reinsulating. Poor insulation can aid in pre-mature corrosion and loss of efficiency.

- *Replace dump solenoids on each pumper:* The coils in the existing solenoid valves (typically Sporlan) have a tendency to dry out. Solenoid valves manufactured by Hanson or Parker seem to work better for this application and reportedly have fewer problems. Replace one valve on each pumper drum.

- *Replace vent solenoids on each pumper with same materials:* Inspect and replace the existing valve (typically a Sporlan MA50) with same model. This valve cannot be replaced with a higher quality valve as manufactured by Hanson due to the inadequate space.

- *Replace compressors:* Parts for the existing York compressor can be difficult to find since they are no longer in production. These compressors can be rebuilt and reused for well over 30 years. However, if the compressors need replacement, they should be replaced by compressors that can be used in a future refrigeration system.

Option 3: *Convert existing direct system to an indirect, industrial grade, R-22 or other hydrofluorocarbons (HFCs) based system using the existing refrigeration equipment.* Only recently has this option proven feasible for converting Holmsten refrigeration packages from *direct* to *indirect* systems while using the existing refrigeration equipment.

The option includes converting the existing refrigeration system to an *indirect* system by installing a new heat exchanger and rink pumps. This option includes reusing the existing low pressure receiver, pumper drums and piping, and main motor control center. The existing system would be updated as recommended in Option 1. The existing ice rink floor would require replacement under this option.

This option will substantially reduce the charge of R-22 in the system to approximately 1,000 pounds. A reduction from 6,000 to 10,000 pounds of R-22 down to 1,000 pounds of R-22 will noticeably reduce the facility's carbon footprint. The City could store the extra R-22 refrigerant for future use.

Option 4: New *indirect*, <u>commercial</u> grade, HFC based system. Replace all ice system components with a new commercial grade, direct expansion chiller, blended HFC refrigerant, semi-hermetic compressors, pumps, and concrete rink floor.

Option 5: *New indirect, <u>industrial grade</u>, HFC system.* This option includes replacing the entire refrigeration system and concrete ice rink floor with an industrial grade flooded chiller, new blended HFC refrigerant, reciprocating compressors, pumps, and concrete rink floor. This system is similar the construction of the existing ice system for Rink 2 at Dempsey-Anderson Ice Arena.

Option 6: New *indirect*, <u>industrial</u> grade, ammonia based system. This option is the same as Option 5 but replaces the use of a new blended HFC type refrigerant with ammonia refrigerant. This option typically requires more extensive modifications to the refrigeration room to meet safety and code requirements.

Picture Window 12(left to right):
Option 3 – Convert to indirect using existing equipment – University of Minnesota-Duluth
Option 4 – Commercial grade refrigeration system.
Options 5 & 6 – Industrial grade, "stick-built", refrigeration system.

Options 7 and 8: *New indirect or direct, carbon dioxide (CO2) based system.* Continuing the discussion from the refrigerant discussion earlier in the report, the use of CO2 refrigerant will likely be the next substantial "innovation" in the ice rink industry. Currently European countries are using CO2 as a secondary refrigerant in twenty four ice rink applications. Several rinks in Canada just recently installed *direct* CO2 system. CO2 applications in the U.S are rapidly increasing mainly in the supermarket industry. However the selection of equipment is limited and the regulatory codes are still under development.

The use of carbon dioxide as the primary refrigerant changes the type of refrigeration equipment presented in previous options. CO2 systems will be provided on equipment or skid packages as shown in the photographs in this section. The existing ice equipment room will likely be able to accommodate a system with the required capacity for this facility but space requirements need to be confirmed.

Because this is a new technology and application, there is fairly limited information on the systems. The cost estimates should be updated as the desired project date approaches.

The most efficient CO2 system is the *direct* system where CO2 is circulated throughout the rink floor. This type of system has been successfully installed, in the past year, in a facility in Montreal, Canada. The rink floor is constructed with stainless steel tubing with mechanical connections at 4 inches on center. The main concern and relatively unknown is the cost and durability of the rink floor materials. The alternate stainless steel pipe is poly coated copper piping as is used in many of Europe's CO2 based ice rinks.

In addition to its efficiency, the waste heat that is generated from these systems ranges from 140-170 F as compared to an HFC or ammonia system where the majority of the useable waste heat is at temperatures of 80-85 F. The higher temperature waste heat allows the heat recovery systems to be sized up to 20% smaller than standard systems.

It is recommended that a CO2 refrigerant based ice systems be seriously considered. If the City is interested in pursuing the use of CO2 refrigerant, we encourage a site visit to at least one facility that is currently using this type of system along with in-depth discussion with the facility's management and operation personnel and manufacturer's representatives. Possible locations include:

- Quebec and Montreal Canada – CO2 based ice systems
- Sweden – direct Ammonia/CO2 ice systems and CO2 equipment manufacturers.
- Eagle River, Alaska – First CO2 ice system to be in operation November, 2014.

Presented in the table at the end of this section are cost estimates for a *direct* CO2 system for a single rink application Option 7.

Ice Rink Floor - Recommendations

The ice rink floor is only 9-years old. In Options 3-7 the ice system would be converted from a direct to an indirect system. This requires the rink floor to be replaced. Option 8 (CO2 direct) may allow the rink floor to be reused. Stevens is currently exploring this as an option for rink owners that have newer direct rink floors like the City of Bemidji.

Cost Estimates – Existing Ice System

The costs of the recommended improvements are summarized below and are total project costs. A more detailed description of the cost estimate is located in the Appendix.

Table 6. Ice System Improvements/Replacement Options Cost Estimate Summary

Item	Cost
Option 2 – Improve existing system	$366,000
Option 3 – Convert existing R-22 to indirect system	$1,521,000
Option 4 – New HFC commercial grade indirect system	$1,737,000
Option 5 – New HFC industrial grade indirect system	$1,845,500
Option 6 – New ammonia industrial grade indirect syst	$1,981,000
Option 7 – New CO2 indirect system	$2,015,000
Option 8 – New CO2 direct system	$2,237,000

Section 6
Site

SITE

General

The Neilson – Reise Ice Arena is located at 1115 23rd Street Northwest in Bemidji, MN.

Observations

We walked the site to get an understanding of the existing site conditions. The ice arena and curling club shares a parking lot with the City Park located to the East and South of the existing ice arena. Currently the curling club and ice arena share an entry between the two facilities. The parking lot is relatively new and in excellent condition. The City Park includes a community building with restrooms and concessions and also provides access to an outdoor hockey rink located just to the east.

Arial Photo of Site

The site is relatively flat and is not very conducive to water drainage away from the facility. The exterior should be visually expected periodically for any excessive settlement or drainage compromises to minimize the chance of water migrating back into the building. If this happens the soils below the refrigerated ice slab could become saturated. If the soils get saturated the potential for movement of the ice slab and building structure is greatly increase do to potential frost heaving.

Overall, the site is well maintained and utilizes the available site very well by sharing the parking infrastructure. No immediate improvements to the site are anticipated.

Appendix A

Dehumidification Replacement Letter

Nelson-Rudie & Associates, Inc.
Structural - Mechanical – Electrical
Consulting Engineers

July 7, 2014

Mr. Scott Ward, P.E.
Stevens
2211 O'Neil Road
Hudson, WI 54016

Re: Neilson-Reise Arena Ice and Curling Rink
Bemidji, Minnesota
Condition Study
NRA Project No.: 14-056

Dear Scott:

We recently toured the Neilson-Reise Arena Ice and Curling Rink located in Bemidji Minnesota to review the condition of the existing mechanical systems. During our site visit we were requested to prepare preliminary recommendations for the ice rink dehumidification systems. The following items were noted pertaining to the existing arena dehumidification system:

1. Existing Conditions
    a. The arena is operated with year round ice.
    b. The arena uses a natural gas powered ice resurfacer which off gasses the products of combustion into the arena.
    c. The arena envelope has numerous cracks in the envelope which allow humidity to infiltrate into the building.
    d. The arena is heated with gravity vented gas fired unit heaters. The heaters have flues which are open to the exterior of the building. This allows a path for humid outside air to infiltrate into the building. It also allows moisture to condense and accumulate on the inside of the unit heater causing issues with the life and operation of the unit heaters.
    e. The ice arena portion of the building is dehumidified with a Rink-Drier brand dehumidifier manufactured by Holmsten Ice Rinks. The dehumidification unit is nearly 50 years old and no longer functions properly. It has well exceeded it's expected service life and should be scheduled for replacement.

Scott F. Rudie, P.E
John R. Brison, P.E.
Joseph M. Pearce, P.E.
Frederic A. Decourt, P.E.
Andrew N. Erdmann, P.E.
Jeffrey A. Piehl, P.E., P.Eng., LEED AP BD+C
Michael D. Woehrle, P.E., P.Eng., LEED AP BD+C

9100 49th Avenue North, New Hope, MN 55428
Tel: 763.367.7600 ■ Fax: 763.367.7601
www.nelsonrudie.com

f. The arena is ventilated with a wall mounted exhaust fan and intake louvers with manual volume dampers. This ventilation system allows hot, humid air to be directly introduced into the arena during the summer and untreated cold winter to enter the arena during the winter. Both conditions are undesirable and can lead to poor arena conditions.

2. We recommend the following improvements be considered for the Ice Arena portion of the building.

   a. Remove the existing dehumidification unit and replace it with a new high temperature, desiccant based dehumidification unit. The unit should be sized to adequately dehumidify the arena on a year round basis. The least expensive dehumidification option would include a dehumidification system with minimal outside air and no building heating system. We estimate the cost for this type of system to be approximately $175,000.

   b. Consider removing the arena exhaust fan and intake louvers and properly sealing the existing openings. Arena ventilation air for occupant breathing and contaminant removal should be introduced into the building through the new dehumidification system. This will allow the outside air to be heated and dehumidified before it is introduced into the arena. This will increase the cost of the first cost of the project but it will improve conditions in the arena. All outside air will be introduced through the dehumidification unit. The humidity will be removed from the air before it ever enters the building. This is highly preferable to the current installation which uses wall intake air louvers for the ventilation air. We estimate that adding the ventilation system with controls to the unit will increase the cost by approximately $20,000. We strongly suggest this option be implemented.

   c. Consider removing the gas fired unit heaters and replacing them with a gas heating section designed into the new dehumidification system. This option will remove the flue opening through the roof. It will also result in warmer air being distributed into the arena which will feel less drafty than untreated air being introduced into the arena. We estimate that this option will increase the cost by approximately $25,000.

   d. Provide new controls that will allow the dehumidification to automatically dehumidify the arena, heat the arena, and modulate the outside air to prevent contaminants from accumulating in the building. This option will increase the project cost by approximately $5,000.

   e. Consider tightening up the envelope of the building. This would include adding weather stripping to doors, sealing cracks, replacing dampers and other issues that may be identified in the building envelope. Tom suggested we carry $10,000 for thjis item.

Please review the above data with the arena staff and let us know if any additional data is needed. Lead time on the equipment is normally 10 to 12 weeks so getting a system installed for this summer will be difficult. We understand that the arena is having humidity problems and will be happy to work with the Owner to get a solution implemented as soon as possible.

Yours very truly,

Michael D. Woehrle, P.E., P.Eng., LEED AP

Enclosure

Appendix B

Investigation Methods, Documentation, Codes and References

Investigation Methods and Documents

Various methods were used to evaluate the existing facility including:

Visual Observations and Meetings: Site visits and meetings were conducted on the following dates: May 23, 2014. Stevens has previously designed improvements to the facility and has been on-site numerous times prior.

Interviews: During the on-site visit, in-depth discussions were conducted with the facility's management and operational staff to document existing issues with the facility and discuss historical problems with its systems.

Research: Where applicable, additional research was conducted to provide accurate and detailed information regarding improvements or systems recommendations.

Documents: The following documents were received and reviewed for the evaluation:

Existing Drawings:

- Partial Original Drawings – 1967
- 1972 ice rink floor plans
- 1981 addition plans
- 1986 – Refrigeration and rink floor plans
- 1987 addition – plumbing plans
- 2005 remodel plans
- 2005 ice rink floor replacement

Reports, Studies, Memos:

- None

Codes, Standards, and Guidelines Applicable to the Project

The following Codes generally apply to projects of this scope and may or may not be enforced by the City:

- 2006 Life Safety Code, as amended
- 2011 NRFA 70 National Electric Code, as amended
- 2009 Minnesota State Building Code, including Chapter 1341 Accessibility Code
- 2007 Minnesota State Fire Code (2009 International Fire Code)
- 2009 Minnesota State Mechanical Code (2006 International Mechanical Code)
- 2009 Minnesota State Plumbing Code
- 2007 NFPA 13 -Sprinkler Systems
- 2007 NFPA 72 – National Fire Alarm Code
- ASHRAE 90.1 – 2007 Energy Standard
- 2010 ADA Standards for Accessible Design as Required to Comply with Section 504 of US Rehabilitation Act of 1973 title II of Americas with Disability Act of 1990, Updated September 15, 2010
- Department of Labor & Industry – High Pressure Piping and Code for Power Piping Systems, Chapters 326 (MN Statues 1999) and Chapter 5230 (MN Rules 2001)
- ANSI/ASHRAE Standard 15-2013
- ANSI/IIAR 2-2008 (Includes Addendum A1)
- The City's CODE OF ORDINANCES were not reviewed or referenced for this evaluation.

Appendix C
Cost Estimates

Estimated Project Costs

The proposed cost estimates presented throughout this report were developed by estimating the probable construction costs based on similar types of construction projects and work performed and bid in 2009-2014 and updated for 2015 costs unless otherwise noted. The estimated costs include all materials and labor for a complete installation unless otherwise noted. Costs will vary depending on the time of year the projects are bid, the current economic climate and the size of project.

In addition to the probable construction costs of the proposed work, other associated project costs are included to provide a total estimate cost for the project. The Estimate, Design and Construction Contingency line item in each cost table is included during the preliminary phase of design projects because the exact scope of the project has not yet been determined. This percentage is typically reduced from 10% to 5% during the final design phase of the project.

The Engineering, Legal, Financial and Administrative line item in each cost table is provided to cover all work performed by the design team, geotechnical services and other material testing services, and all legal, financial and administrative responsibilities required by the City for projects of this type. These costs will vary based on project scope. A proposal will be provided to the City for all architectural and engineering services.

Escalation Factor and Method of Application

Where costs are projected beyond 2015, an escalation factor of 4% is applied. The escalation factor is based on current economic conditions and location, and is applied to midpoint of construction which is estimated to be July 1st of the applicable year.

Estimated Energy Savings

Estimated savings presented in this report are computed from the equipment and manufacturer's information provided to us and on Stevens experience with similar systems. The actual energy savings will depend on many factors including: conservation measures implemented, seasonal weather variations, energy price increases, and energy use practices of the facility's staff and users.

Building System Evaluation

The following are cost estimates for the building improvements discussed in Section 3 of the report.

Roof Options

Option One (20,800 SF of Roof Area)	Cost*
Demolition	$62,400
Standing Seam Metal Roof System and Insulation	$145,600
Estimate/Design/Construction Contingency (15%)*	$31,200
Engineering/Legal/Administrative Contingency (18%)*	$37,440
Total	$276,640

* These contingencies are added to provide a complete project budget picture.

Option Two (20,800 SF of Roof Area)	Cost*
Preparation Work	$20,800
Fully Adhered Membrane Roof	$104,000
Low-E Barrier	$45,000
Estimate/Design/Construction Contingency (15%)*	$25,470
Engineering/Legal/Administrative Contingency (18%)*	$30,564
Total	$225,834

* These contingencies are added to provide a complete project budget picture.

Option Three (20,800 SF of Roof Area)	Cost*
Demolition	$41,600
Spray Foam Insulation and Top Coat	$228,800
Low-E Barrier	$45,000
Estimate/Design/Construction Contingency (15%)*	$47,310
Engineering/Legal/Administrative Contingency (18%)*	$56,772
Total	$419,482

* These contingencies are added to provide a complete project budget picture.

Wall Solutions

Option One (9,200 SF of Wall Area)	Cost*
Metal Panel Demolition (9,200 SF)	$23,000
Insulation	$27,600
Interior Liner Panel	$73,600
Estimate/Design/Construction Contingency (15%)*	$18,630
Engineering/Legal/Administrative Contingency (18%)*	$22,356
Total	$165,186

* These contingencies are added to provide a complete project budget picture.

Option Two (9,200 SF of Wall Area)	Cost*
Metal Panel Demolition (9,200 SF)	$23,000
Insulated Rigid Foam Metal Panel	$276,000
Interior Liner Panel and Sound Insulation	$92,000
Estimate/Design/Construction Contingency (15%)*	$58,650
Engineering/Legal/Administrative Contingency (18%)*	$70,380
Total	$520,030

* These contingencies are added to provide a complete project budget picture.

Existing Refrigeration Room

Item	Cost*
Demolition	$5,000
New vestibule	$15,000
1 hour rating upgrade to wall and roof	$20,000
Estimate/Design/Construction Contingency (15%)*	$10,500
Engineering/Legal/Administrative Contingency (18%)*	$12,600
Total	$93,100

* These contingencies are added to provide a complete project budget picture.

Lobby Addition

New Lobby Addition (6,000)	Low Cost*	High Cost*
New Construction	$900,000	$1,200,000
Engineering/Legal/Administrative Contingency (18%)*	$162,000	$216,000
Total	$1,062,000	$1,416,000

* These contingencies are added to provide a complete project budget picture.

New Arena

New Ice Arena (32,000)	Low Cost*	High Cost*
New Construction	$5,120,000	$6,240,000
Allowance for repurposing existing lobby	$100,000	$150,000
Engineering/Legal/Administrative Contingency (18%)*	$939,600	$1,152,000
Total	$6,159,600	$7,542,000

Mechanical System Improvements

The following are cost estimates for the mechanical systems improvements discussed in Section 4 of the report.

Item	Cost
Mechanical Recommendation #1 – new gas fired desiccant dehumidification system.	$240,000
Mechanical Recommendation #2 – Add Demand Control Ventilation Controls to the Arena Ventilation System.	$10,000
Demolition	$5,000
Ice Equipment Room Ventilation System	$35,000
Subtotal Estimated Construction Costs	$290,000
Estimate, Design, and Construction Contingency (15%)[1]	$43,500
Total Estimated Construction Costs	$333,500
Engineering, Legal, and Administrative (18%)[1]	$60,030
Total Estimated Project Costs	$393,530

Ice System Improvements

The following cost estimates are based on the existing facility continuing the current programming and include improvements recommended in this study.

Option 2 – Improve the existing ice system. The following table provides cost estimates for the recommended improvements to the existing ice system. See explanation of each line in the description for Option 2 in the study narrative.

Ice System Option 2 - Minimum Improvements to Existing System

Item	Cost[1]
Replace refrigerant relief valves	$7,000
Replace monitoring devices (temp. and press.)	$4,000
Investigate integrity of vessels and piping systems	$4,000
Replace dump solenoid valves (3 total)	$7,000
Replace vent solenoid valves (3 total)	$7,000
Overhaul compressors typ maintenance (2 total)	$7,000
Replace dryer cores - typical maintenance	$3,000
Replace compressors and motors (2 total)	$95,000
Replace evaporative condenser	$60,000
R-22 refrigerant to top off system (1,000 lbs x $22)	$22,000
New life safety systems - emergency shutoff for refrig syst.	$5,000
Subtotal of estimated construction costs	$221,000
Cost adjustment for location (20%)	$44,200
Subtotal of estimated construction costs	$265,200
Estimate, design and constr. Contingency (15%)[1]	$39,780
Total estimated construction costs	$304,980
Engineering, legal, financial and administrative (20%)[1]	$60,996
Total estimated project costs	**$365,976**

Footnotes:

1. See cost estimate narrative in report.

Ice System Options - Cost Estimate Summary

Item	Cost Estimate[1]					
	Single System					
	Option 3 Conversion	Option 4 New	Option 5 New	Option 6 New	Option 7 New	Option 8 New[3]
Refrigerant type	Ex R-22	New HFC	New HFC	Ammonia	CO2 indirect	CO2 direct
Grade of system	Industrial	Commercial	Industrial	Industrial	Industrial	Industrial
Removal and dispose of dasher boards	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
Demolition of existing refrigeration system	$5,000	$15,000	$15,000	$15,000	$15,000	$15,000
Demolition of existing conc. rink floor (NHL + 5" thick)	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000
Repairs to existing direct system (see Option 2 table)	$221,000	N/A	N/A	N/A	N/A	N/A
New refrigeration system or equipment	$225,000	$400,000	$475,000	$575,000	$600,000	$650,000
New concrete rink floor w/poly pipe +subfloor (NHL +5" thick)	$420,000	$420,000	$420,000	$420,000	$420,000	$600,000
Basic waste heat recovery system (subfloor + snowmelt pit)	N/A	$75,000	$75,000	$75,000	$75,000	$75,000
Enhanced waste heat recovery system (preheat zam water, etc	N/A	$100,000	$100,000	$100,000	$100,000	$100,000
New life safety systems	Incl above	Incl above	Incl above	Incl above	Incl above	Incl above
Ventilation system improvements or replacement in room	see mech	see mech	see mech	see mech	see mech	see mech
Miscellaneous plumbing improvements in ice equip room	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Electric service upgrade	N/A	$20,000	$25,000	$25,000	$25,000	$25,000
Lighting modifications and misc. electrical	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Dewatering allowance	$0	$0	$0	$0	$0	$0
New dasher board system (NHL size)	$165,000	$165,000	$165,000	$165,000	$165,000	$165,000
New interior vestibule and doors	N/A	N/A	N/A	$0	$0	$0
Water treatment system for resurfacer water	$0	$0	$0	$0	$0	$0
Subtotal of estimated construction costs	$1,121,000	$1,280,000	$1,360,000	$1,460,000	$1,485,000	$1,715,000
Cost adjustment for location (0%)	$0	$0	$0	$0	$0	$0
Subtotal of estimated construction costs	$1,121,000	$1,280,000	$1,360,000	$1,460,000	$1,485,000	$1,715,000
Estimate, design and constr. Contingency (15%)[1]	$168,150	$192,000	$204,000	$219,000	$222,750	$257,250
Total estimated construction costs	$1,289,150	$1,472,000	$1,564,000	$1,679,000	$1,707,750	$1,972,250
Engineering, legal, financial and administrative (18%)[1]	$232,047	$264,960	$281,520	$302,220	$307,395	$355,005
Total estimated project costs	**$1,521,197**	**$1,736,960**	**$1,845,520**	**$1,981,220**	**$2,015,145**	**$2,327,255**
Expected useful life - refrigeration system (yrs)	15-25	15-20	25-30	25-30	20-25	20-25
Expected useful life - rink floor (yrs)	40-50	40-50	40-50	40-50	40-50	20-25
Adjusted Costs for 2016[2]	$1,582,045	$1,806,438	$1,919,341	$2,060,469	$2,095,751	$2,420,345
Adjusted Costs for 2017[2]	$1,645,327	$1,878,696	$1,996,114	$2,142,888	$2,179,581	$2,517,159
Adjusted Costs for 2018[2]	$1,711,140	$1,953,844	$2,075,959	$2,228,603	$2,266,764	$2,617,845

Footnotes:

1. See cost estimate narrative in report.
2. Applied escalation costs of 4% per year.
3. Cost savings of 994,000 to reuse existing direct floor (total project costs

Appendix D

Financial Assistance Programs

FINACIAL ASSISTANCE PROGRAMS

There are several financial programs that Energy utilities may have available that the City may wish it take advantage of. They include:

1. Engineering Assistance Study Program. The purpose of this program is to provide the City with the necessary business case justification to implement energy-saving opportunities. This evaluation report can be expanded to identify energy conservation opportunities, energy modeling, etc. to meet the programs requirements. Utilities companies may reimburse the City up to fund up to 75% of the cost of this study. One example where the City would benefit from this additional energy analysis is in selecting a refrigerant (ammonia, CO_2, etc.) or refrigeration system to replacing the existing R-22 refrigerant or system. It is typically required that these programs be pre-approved prior to starting any work on the study.

2. Rebate Programs. Rebate programs are available through utility companies for many energy improvement measures that can be performed such as lighting replacement, motor replacement, installation of variable frequency drives, improving insulation systems, etc. Custom rebate programs are also available and may apply to the refrigeration system replacement depending on the type of system selected. Utility companies should be contacted to identify possible rebates prior to starting any improvement project relating to energy savings. Some rebates require preapproval prior to purchasing and installation.

State Appropriation Board
Programs should be reviewed for potential funding opportunities.

Sports Commission
Programs should be reviewed for potential funding opportunities.

Mighty Ducks Legislation
The Mighty Ducks legislation from the mid 1990's was revived in 2013 to include funding for air quality (ventilation, testing and resurfacers) initial program deadlines have pasted. The legislation failed by four votes. It appears that some funding will be included in the 2014 bonding bill but will likely be very limited. Stevens was intimately involved in this process and providing information to the Minnesota Amateur Sports Association to aid in their lobbying efforts.

Alternate Project Delivery Method

Another delivery and funding option the City may consider for this project is through guaranteed-savings contracts. Stevens has teamed with several Energy Service Organizations to successfully complete ice rink projects for the City of Brooklyn Park, Northfield, Eden Prairie, and New Hope. We are currently working with the Minneapolis Park and Recreation Department on a guaranteed-energy savings contract project at Parade Ice Gardens.

If the City is interested in learning more about this delivery method we would be happy to discuss it in more detail with you.

City of Bemidji

Finance Office

Memorandum

To:	**Honorable Mayor and City Council**
From:	**Ron Eischens, Finance Director**
Reviewed by:	**John Chattin, City Manager**
Date:	**August 11, 2014**
RE:	**2015 Budget**

At the two previous budget work sessions, staff presented fifteen issues for consideration during the 2015 budget process. Based on discussion at the June 9th work session, the following items were added to the proposed 2015 budget:

- Traffic calming measure local grant match costs of $80,000 to the Capital Improvement Plan
- Grant matching costs of $28,000 for one police officer funded through COPS grant
- Use of $50,000 of liquor profits to subsidize General Fund budget, effectively reducing property taxes

Several issues need council direction as summarized below:

Annexation of Northern Township

There was limited discussion at the June 9th work session on this topic. Staff raised the need for increased street improvement funding as well as the possible addition of two new employees to service the annexation area. In addition, new franchise fee revenue of $15,000 is projected.

If Phase II annexation of Northern Township takes place in 2015, staff recommend an effective date of July 1 to avoid snow plowing confusion. The City would not receive any property tax benefit from annexation until 2016.

Long Term Considerations

Staff's goal for this budget was to approach it as a long term process. Looking beyond the upcoming year is important as several items listed below can or will impact future budgets. Planning for these issues now can minimize future financial challenges. As the Council considers short term issues discussed later in the memo, be aware of the following items:

- **South Shore Land Bond Payments** – Based on land sale proceeds received to date, there is sufficient cash to make bond payments through the end of 2015. If no land sales occur before December 2015, the City will need funding of $239,000 to meet 2016 bond requirements.
- **Neilson Reise Arena** – the building and ice plant are in need of significant upgrades with costs in the $3 to $6 million range. The Council must decide what policy direction to take regarding this facility.
- **South Shore Park and Beach Cleanup** - Depending on the results of the City's recent grant application for lake bed cleanup, there remains a significant financial obligation if the Council still desires to complete a park on the South Shore.
- **The Sanford Center** – while it is unknown at this point what, if any, financial ramifications there is for the water leaks, legal and other costs for resolving this matter could be significant.
- **Birchmont Drive Assessments** – The outcome of this legal case may remain unresolved until 2015 or beyond. City funds could be required to resolve this matter.
- **Capital maintenance of City buildings and infrastructure** – Funding to keep City buildings, streets and infrastructure in good condition requires adequate on-going funding. The situation the City faces with the Arena is an example of what can happen when funding for infrastructure is ignored. Funding for the Sanford Center is <u>first</u> on the list for optional 2015 budget items.
- **Annexation** - Since none of Phase II Bemidji Township can be annexed until 2018, the new staff positions may not be required in 2015, but will be in 2018. Phasing in the costs of new positions over three years would minimize levy increases for 2018.

None of the above items are included in the 2015 budget but will impact future City financial well-being. Staff don't want anyone to be surprised about the impact these projects/items may have. Before deciding on any priorities, consideration should be given to the above. Funding options include reduced services, increased property taxes and/or user fees, higher utility rates or development of new revenue sources such as the hospitality tax.

Optional Budget Items

Other budget considerations for 2015 are:

- **Sanford Center Capital Replacement** – Funding for future major capital repairs at the Sanford Center was discussed at the June meeting but clear direction was not provided. Deferring the decision on this issue only compounds the problem. $1 per square foot, or $185,000 annually is the amount discussed in June.
- **Fire Marshall/Inspector** - The goal of the Fire Department is to reduce the impact of fire on the community. Two strategies are implemented to do so; emergency response and fire prevention. A well balanced fire prevention program includes public education, code enforcement and fire protection engineering. Currently these functions are performed on a minimal basis, if at all. This position would allow implementation of a more effective fire prevention program with an approximate $88,000 total cost. The City portion would be $51,000 with the Rural Fire Association paying the balance of $37,000.
- **Building Maintenance/Inspector** – currently several City staff fill the role of building maintenance, most of which do not have the technical experience or background for the position. For example, the administrative secretary at Public Works manages the HVAC system and Mike Miller, Building Official does routine maintenance tasks at City Hall. Building department staff generated $50,000 of revenue in 2014 to review plans for state projects. This revenue stream should average $35,000 annually in the future. Hiring a full-time person to handle both building inspection as well as maintenance duties would be an effective utilization of resources. Total cost of $65,000 less $35,000 funded through building plan review fees.
- **Community Service Officer** – during 2013 this officer responded to nearly 1,000 animal calls and handles animal impound, adoptions and maintains the impound facility. In addition they handle code enforcement regarding dirty yards, deceased animals, rental parking and other neighborhood complaints. These duties reduce the officer's ability to perform community oriented policing functions. Cost of $65,000.
- **Neilson Reise Arena** – Immediate short term needs include a dehumidifier with costs of $300,000.
- **Emergency Outdoor notification system** – In May the Fire Chief brought to the Council's attention the current outdoor warning sirens are unreliable. Replacement costs are approximately $30,000 per siren, or $180,000 total. An option would be to hire a consultant to study the need for and placement of sirens, estimated cost of $5,000 to $10,000.
- **Upstream TV** – request for funding was withdrawn at their request.
- **Railroad Corridor Development** – does the City want to contribute any funding to encourage development in this area?

Potential Funding Sources

Property Tax Levy

A 1% levy increase generates approximately $42,000 in additional tax revenue. The owner of a $100,000 average home pays $345 in City taxes. The City assessor estimated new construction value will add 1.4% to the City tax base, which means raising the levy by 1.4% will not increase property owner's taxes. The estimated City tax impact on the average home and business is provided at the bottom of the attachment.

If the City is to benefit from the annexation area tax base, it will require a levy increase of 5% in 2016. Keep in mind this levy increase will **not** increase a property owner's taxes. One of the primary reasons for annexation was increasing the City tax base. If the levy is not increased, there would effectively be a tax decrease for property owners. However, annexation does increase our costs and additional revenue is needed.

Gas/Electric Franchise Fees

A source of additional revenue is the gas/electric franchise fee. The City is authorized up to 5% and are currently at 4.5%. The remaining .5% would generate $98,000 in new revenue. This increase can be implemented at any time.

Service Reductions

The Council can reduce services in one area to increase in another.

Hospitality Tax

New revenue sources are important because they add stability to City finances, not to mention provide opportunity for reduced property taxes. This revenue source could provide substantial property tax relief. The City should make it a priority to develop community support for this revenue prior to the start of the next legislative session.

SUMMARY

Items needing Council direction are as follows:

- Review the attachment and provide direction on the 2015 General Fund Budget. In particular, review the optional budget items and direct staff on which items to include in the 2015 budget.
- Determine annexation effective date for 2015

CITY OF BEMIDJI
2015 BUDGET

Revenue Adjustments	Amount	Levy Impact
Tax revenue sharing reduction with townships - Phase I	50,500	
Additional Liquor Profits	50,000	
Liquor License increase	14,000	
MSA increase	6,000	
LGA increase	605	
Misc	(6,000)	
Gas/Electric Franchise Fees	(57,000)	
Net revenue increases	58,105	**-1.4%**

Required Expense Adjustments		
Personnel Cost changes which include:	106,626	
2% Cost of living, payroll taxes, finance staff reduction		
PTO - Legal, COPS Grant Match, Auto theft grant phase out		
Liability/Property Insurance - Various Depts	13,300	
Motor Fuels - Various Depts	17,000	
Water/Sewer/Refuse - Parks	5,000	
Storm Water - Parks	2,000	
Other - Police	1,000	
30th Street Trail project	50,000	
CIP increase including Traffic Calming measures	42,571	
Net expense increases	237,497	5.7%
BUDGET/LEVY INCREASE	179,392	**4.3%**
Less new construction		(1.4)
Effective Tax Increase		2.9%

Optional Budget Items

Annexation Impacts		
Annexation related Franchise Fee increases (7/1 date)	(15,000)	-0.4%
Street Dept Employee	60,000	1.4%
Street Maintenance Program	25,000	0.6%
Bldg Inspector/Bldg Maintenance	30,000	0.7%
Other Options		
Sanford Center Capital Replacement	185,000	4.4%
Fire Marshall	51,000	1.2%
Community Service Officer	65,000	1.6%
Neilson Reise Arena ???? (Dehumidifier)	300,000	7.2%
Emergency Outdoor notification system replacement	180,000	4.3%
Railroad Corridor Development	???	???
Gas/Electric Franchise Fee increase from 4.5% to 5%	(98,000)	-2.4%
Total Optional Items	798,000	19.1%

Annual Impact on Average Valued Home/Business	Home $100K	Business $300K
5% levy increase	12	92
10% levy increase	30	220
15% levy increase	47	348