SUBJECT: District Cooling System and Chiller Selection (PW08109) - (City Wide)

RECOMMENDATION:

(a) That the concept of a District Cooling system be supported by Council;
(b) That Johnson Controls-York chillers be approved as the City of Hamilton’s base product for chiller renewal;
(c) That Smardt chillers be approved as the City of Hamilton’s unit of choice for smaller specialized applications for chiller renewal;
(d) That the products, consisting of a combination of the two manufacturer’s chillers be pre-purchased in order to meet our construction timelines within 2008;
(e) That stages 2 and 3 of the project costs up to $6 million be funded from a combination of the following:

2009 Block Funding $0.5 million
Energy Conservation Reserve 112272 $0.6 million
Capital reserve 108020 $4.9 million - to be repaid over ten years according to the Current Borrowing from Reserve policy.

John Mater, C.E.T.
Acting General Manager
Public Works

EXECUTIVE SUMMARY:
The City of Hamilton’s corporate facilities, located in the City’s downtown core, are faced with the challenge of needing to replace fourteen chillers and related cooling
systems within the next three years due to the age of equipment (30+ years), and the “New” CFC Refrigerant Regulation that comes into effect in 2011. This new CFC regulation will require that all R11 and R12 refrigerants currently used in many of today’s chillers/cooling systems be eliminated or replaced. Given that the City’s chillers/cooling systems are beyond their rated life cycles, the option to retrofit this equipment with approved refrigerants is not feasible, due to cost and reliability risks.

Driven by the City’s “New” Corporate Energy Policy, which calls for targeted reductions in energy intensity in City-owned facilities and operations (20% by 2020), the City’s Public Works, Corporate Buildings & Technical Services and Office of Energy Initiatives teamed up to examine new and innovative approaches for improving the cost, energy and environmental efficiency of this major capital replacement project. Several energy efficient alternatives were compared to the traditional retrofit or base case option of replacing these chillers and related cooling systems on a one-for-one basis. Various options were compared, to examine overall benefits including Life Cycle basis, (as outlined in the Corporate Energy Policy, Section 2.2.1, item 3) versus a first cost or simple payback method.

The end result was the evolution to a district cooling concept. The district cooling system would reduce the number of chillers required from fourteen to eleven machines. The district cooling system would meet with all legislative and safety code requirements and provide added redundancy so that if a chiller fails, the district cooling system will still be able to provide adequate cooling capabilities. Detailed engineering/ feasibility studies concluded that the District Cooling System offers many benefits to the City, including greater energy efficiency by reducing the chiller/cooling system energy use by 41%; reducing environmental or greenhouse gas (GHG) emissions by 556 metric tons of CO₂ annually; energy cost savings of $181,000 (from $445,000 annual utility costs) and the best life cycle cost benefit of approximately $2.5 million over the 30-year life of the equipment.

All downtown core City-owned buildings would be further connected through a cold water piping system to two main chiller or cooling plants located at the City’s Central Utility Plant (CUP) and Copps Coliseum. The downtown buildings impacted by this retrofit project include: the CUP, Copps Coliseum (CC), Hamilton Convention Centre (HCC), Hamilton Place (HP), Hamilton Public Library and Market (HPL), and Hamilton City Hall (HCH). In addition to City-owned facilities, the City also currently provides chilled water from our CUP to the Ellen Fairclough Building (EFB), Hamilton Art Gallery (AG) and the Hamilton Wentworth District School Board office (HWDSB). A smaller Smardt chiller will also be installed at the Library to replace an existing unit. Appendix “A” provides a comparison between the City’s existing cooling systems and the proposed District Cooling System for City-owned facilities.

The CUP will be the first of three stages of the project retrofit and will take place in the fall of 2008 with completion in the spring of 2009. The work will be funded through Corporate Buildings & Technical Services 2008 capital budget ($2.5 million). This stage and its timing are critical to ensure that the CUP is available for the 2009 summer cooling season. There is some concern about the reliability of the current chillers and cooling system at the CUP and its capability of meeting another summers cooling needs. The CUP is also the cornerstone for of the overall district cooling system concept.
The first phase (three stages) of the district cooling project is to supply cooling to City-owned facilities in the downtown core. A future second phase would be to further expand the district cooling system to other core customers who are not currently supplied by the City. The second phase of the project could offer chilled water supply to existing and new core customers subject to proper due diligence and business case(s). Potential customers may include the new district school board building, Lister Block and future hotels in the core.

Due to this critical timing of the first project stage, the retrofit of the CUP chiller plant; staff is seeking Council approval to sole source two types of chillers. The selection of this equipment will ensure consistency and functionality for the complete project. For the project there are two types of high efficiency electric chiller’s needed to manage the specialized requirements of the different facilities (larger centrifugal chillers and smaller quiet chillers). These types of chiller and systems will also ensure that the project maximizes energy efficiency and operational control. The chillers recommended in this report are the Johnson Controls-York for the larger capacity chillers machines and Smardt Inc. for the smaller, quieter, extremely efficient chiller(s) for the library which have no vibration.

Staff conducted an informal request for information with five manufactures who supply commonly available commercial chillers. Manufactures were asked to respond with information regarding a variety of aspects of the Chiller’s operational characteristics. Energy efficiency and price were key components of this evaluation. Manufactures were also asked to including details on: energy efficiency; integrated part load values; non-standard part load value (operation); equipment maintenance; control options; warranties; experience/ references; safety features; code compliance; the type of cooling system refrigerant used and a detailed life cycle analysis. The York and Smardt chiller were the best of the evaluation process in terms of costs and energy efficiency.

**BACKGROUND:**

The information/recommendations contained within this report have City wide implications.

The City’s corporate facilities, located in the City’s downtown core, are faced with the challenge of needing to replace fourteen chillers and related cooling systems within the next three years, due to the age of equipment (30+ years) and “New” CFC Refrigerant Regulation that comes into effect in 2011. Driven by the City’s “New” Corporate Energy Policy, Corporate Buildings & Technical Services and Office of Energy Initiatives teamed up to examine new and innovative approaches for improving the cost, energy and environmental efficiency of this major capital replacement project. The end result is the recommendation to a district cooling system in the City’s downtown core.

The first stage of the district cooling project would be the redesign, retrofit and renewal of CUP’s chiller plant in 2008/2009. The CUP is the catalyst or cornerstone for the success of the district cooling project and several other energy initiatives being evaluated in the core. Other projects beyond the district cooling project include major renovations/building renewal of Hamilton’s City Hall, the Library & Market and potentially the Lister Block.

Overall, the District Cooling System (all three phases) versus the standard one for one replacement of chillers is far superior in several areas including:
Most energy efficient - Cooling system energy reductions of 41% or 1,828,000 kilowatt-hours (kWh) annually;
- Reductions in environmental emissions of GHG emissions by 556 tons per year;
- Reduced maintenance costs - fewer central plants with fewer chillers - installed chiller capacity reduction of approximately 1,000 cooling tons;
- Best Life Cycle benefits by $2.5M over thirty years compared to the traditional or base case option of a one-for-one replacement;
- Job Creation - fifty person years locally over the 24 month construction period;
- Improved reliability and reduced supply risk. Up to two chillers can fail and still provide system cooling;
- Improved operation - variable supply capabilities (as required) versus a constant volume system;
- Opportunity for expansion to other downtown core customer facilities not owned or currently supplied by the City of Hamilton (this could support the City’s downtown renewal/retention strategy);
- Code compliant and improvements in health and safety practices;
- Full system renewal - including cooling system pumps and controls;
- Highest level of incentive funding (est. $300,000 to $500,000)
- Assists in reduced project capital costs for the City Hall renovation and potentially the Lister Block redevelopment, by reducing the capital costs associated with installing chillers and cooling systems at the site(s).

Table 1 below provides a further comparison between the standard or base case replacement and the proposed district cooling system.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Standard or “Base Case” Replacement</th>
<th>District Cooling System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Chillers</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Estimated Capital Cost</td>
<td>$7.0 M</td>
<td>$8.5 M</td>
</tr>
<tr>
<td>Potential Incentive Funding</td>
<td>$50-$100,000</td>
<td>$300-$500,000</td>
</tr>
<tr>
<td>Net Cost</td>
<td>$6.9-$6.95 M</td>
<td>$8.0-$8.2 M</td>
</tr>
<tr>
<td>Incremental Cost</td>
<td>-</td>
<td>$1.1-$1.25 M</td>
</tr>
<tr>
<td>Estimated Annual Energy Savings vs. Current System</td>
<td>$98,000</td>
<td>$181,000</td>
</tr>
<tr>
<td>*Payback on Incremental Cost</td>
<td>-</td>
<td>5 to 6 years</td>
</tr>
<tr>
<td>Total Life Cycle Costs Benefit</td>
<td>-</td>
<td>$2.5 M</td>
</tr>
</tbody>
</table>

*Note: There will be additional incremental efficiency gains maintenance over the life of the project, due to reduced number of chillers and modernization of equipment. These efficiency gains were not shown in this table since they vary from year-to-year over the life of the project.

The district cooling system will eliminate the existing cooling plants at HCH and the HPL. The project will include a new district cooling loop that will interconnect all of the individual sites. The project will replace the existing cooling plants at CUP and Copps Coliseum with new modern high efficiency cooling plants, including increased equipment capacities; increased equipment quantities at each site; modified cooling plant layouts; additional components and advanced chiller control strategies.
The project will also allow for additional future expansion of the district cooling loop as a
downtown renewal/ retention strategy, as well as the addition of other cooling plants
onto the loop, should they be required to meet new capacity needs. The cooling loop
will serve as a decentralized central cooling plant or district cooling loop.

The following is a list of the new equipment and technologies that will be used in the
district cooling project:

1) High efficiency chillers and equipment;
2) Variable Speed Drives (VSD): Variable speed drives will be utilized on chillers,
chilled water loop pumps, condenser pumps, and cooling tower fans;
3) Magnetic Bearing Chillers: Some of the smaller chillers within the district cooling
loop will utilize magnetic bearing drives, avoiding the requirement for oil within
the refrigerant circuit;
4) Injection Pumps and Piping;
5) Chiller Series Configuration: In order to maximize the heat rejection capacities of
existing installed cooling towers, additional piping and control valves will be
installed for the CUP chillers;
6) Advanced Controls: The cooling plants will be controlled by specialized cooling
plant control systems, allowing for optimal operation of all equipment in
consideration of the total cooling plant efficiency.

The following is a list of studies and assessments completed to date in preparation for
the project. Please note that an environmental assessment is NOT required for this type
of retrofit/ replacement project.

- CUP - Condition Assessment Report (includes CUP, AG, HCC, HP, EFB),
  Building Innovation Inc., July 2007
- Downtown Core Buildings - Core Cooling Plant Renewal Plan, Building
  Innovation Inc., July 2007
- Downtown Core Buildings - Core Cooling Plant Renewal Plan - District Cooling
  Loop Expansion, Building Innovation Inc., December 2007
- HCH - Central Plant Renewal Plan, Building Innovation Inc., December 2007

Public Works met with Purchasing in April to establish the guidelines for purchasing the
chillers. An informal RFQ process was suggested, with the condition that the process
would be reviewed by Purchasing and a Report to Council outlining the rationale and
results.

The five chiller manufacturers (Johnson Controls-York, Carrier, McQuay, Trane and
Smardt) were contacted and each gave presentations to a panel of four to six persons
from Corporate Buildings & Technical Services and the Office of Energy Initiatives. A
document outlining the process and the information upon which they would be
evaluated was provided prior to the presentation.

Further, each participant had an additional opportunity to formally respond with answers
to these same items which were submitted one week after the presentation.
Four of the five firms responded, Carrier being the firm that did not participate after the initial meeting.

Staff proposes that the District Cooling System be implemented in three stages:

1) Renewal of Central Utility Plant’s chiller plant;
2) Renewal of the Copps Coliseum’s chiller plant;
3) Removal of remaining old redundant chillers and systems, along with the installation and interconnection of piping between City-owned buildings. *Note:* all piping will be sized sufficiently to allow for future expansion.

Public Works, Corporate Buildings & Technical Services and Office of Energy Initiatives jointly completed an informal RFQ to determine the best chillers for renewal of our core chiller plants. Following the Corporate Energy Policy guidelines, five chiller suppliers were evaluated and ranked based on twenty year life cycle costs, Energy Efficiency, and Initial Capital costs. For the larger chillers the Johnson Controls York chillers were found to be the most cost effective on the market. A second supplier (Smardt) has been carried for specific applications where efficiency, noise and vibration are key considerations. The Smardt chiller is the most efficient chiller on the market, and the only Canadian made chiller.

**ANALYSIS / RATIONALE:**

Various aspects of the Chiller’s operational characteristics, including; efficiency, loading/unloading options, maintenance, and type of refrigerant were built into the twenty year life cycle analysis.

Other considerations, such as experience within the City and surrounding area, market share and controls options, were also built into the evaluation.

Efficiency and price were key components. The Rating Criteria included the following elements:

- Upfront Price
- IPLV (Integrated Part Load Value)
- NPLV (Non-standard Part Load Value)
- Life Cycle Costs (As per the Corporate Energy Policy)
- Controls Options
- Meantime between failures
- Extended Warranty
- Comprehensive Maintenance Price
- Support Team
- Chillers sold in Hamilton and Ontario
- Previous experience with the City of Hamilton
- District Cooling experience
- Optimal Control of Cooling Plant
- Pros and Cons of Refrigerant
- Percentage of Market Share
- Other Propositions

Hydrochlorofluorocarbons (HCFC's) such as refrigerant R-123 are targeted for elimination from both production and use under the Montreal Protocol. The weighting for the rating criteria on Refrigerant reflects the potential for significant issues if R-123
were to be chosen. The Industry is moving away from R-123 due to the fact that it will be difficult to source halfway through the life of the chiller as there is only one company who manufactures R-123. R-123 has higher toxicity, which may result in needing a self contained breathing apparatus for the equipment room (determined by Occupational Health and Safety Committee). LEED has additional reporting and auditing requirements when R-123 is in a facility.

Johnson Controls-York chillers and Smardt chillers have R-134a refrigerant which does not have a phase out date. The information available to date does not indicate that this refrigerant will be phased out in the future.

The decision to work with two different Chiller manufacturers is due to the specialized requirements of the different facilities. The Central Utilities Plant requires larger capacity chillers while the library requires smaller, quieter chillers with no vibration. Johnson Controls-York manufactures the larger units while Smardt manufactures the smaller, quieter, extremely efficient chillers.

**ALTERNATIVES FOR CONSIDERATION:**

The alternative option would be to replace the chillers on a one-for-one basis, which has been done in the past. This alternative is not recommended by staff, as it is not as efficient and reliable as the proposed district cooling system.

**FINANCIAL/STAFFING/LEGAL IMPLICATIONS:**

**Financial:**

The current approved Capital budget forecasted the $6 million be funded from block funding over the next three years.

This report proposes the same level of funding requirement with alternate funding from a combination of reserve funds and borrowing to be repaid according to the Current Borrowing from Reserve Policy. Financing costs will be paid from a variety of expected savings (see Appendix B): equipment lease cost savings $359,960 in the operating budget and projected annual energy savings of $181,000.

In addition to using operating budget savings, various external funding sources are being explored to minimize the cost to the city. Any external funding secured will be used to offset debt requirements and financing.

Staff is currently negotiating with the Ontario Power Authority and Horizon Utilities Inc. about further incentives contributions to offset capital costs.

Staff is in communication with the Ontario Government (known as Ellen Fairclough Building) at 119 King Street West which is serviced by the Central Utilities Plant (C.U.P.). The lease agreement between the Province of Ontario and the City of Hamilton includes conditions that deal with the sharing of costs related to major capital replacement. The province’s contribution as part of their lease agreement with the City would equate approximately to $362,500.

The Office of Energy Initiatives has applied for funding from the Federation of Canadian Municipalities (FCM) to offset some of the costs associated with this work. The Green Municipal Fund (GMF) application was submitted to FCM in July 2008 and may generate grant funding and a partial loan towards the overall project cost. Under the
GMF guidelines, approved projects are eligible to receive funding for up to 80% of the eligible project costs up to a maximum of $2 million loan and $300,000 grant per project. The value of the grant cannot exceed 15% of the loan requested amount.

A response from FCM regarding the application is expected late 2008.

**Staffing Implications:**
N/A

**Legal Implications:**
N/A

**POLICIES AFFECTING PROPOSAL:**

- **Corporate Strategic Plan - Vision:** To be the best place in Canada to raise a child, promote innovation, engage citizens and provide diverse economic opportunities. The district cooling system impacts a number of focus areas of the City’s new Corporate Strat Plan, including:
  - Skilled, Innovative and Respectful Organization
  - Financially Sustainable
  - Growing Our Economy
  - Environmental Stewardship

- **The Public Works Strategic Plan, Innovate Now: A Compass for Public Works to 2017,** addresses issues and opportunities identified in a department-wide Employee Survey and outlines specific activities that will direct Public Works in achieving our vision: To be recognized as the centre of environmental and innovative excellence in Canada. This district cooling project demonstrates both innovation excellence and environmental leadership in ‘greening’ and stewardship in the City

- **Corporate Energy Policy** - The key components of the district cooling project that impact the City of Hamilton’s Energy Policy are:
  - Facilitate the achievement of City-wide energy reduction targets
  - Provide for ongoing Energy Monitoring and Targeting of utility usage
  - Define policies re capital investment related to energy

- **VISION 2020:** Hamilton’s Commitment to Sustainability describes what we want to see in Hamilton over the long-term. It is the commitment made by City Council, community groups, organizations, businesses and citizens to work towards our goal to build a sustainable community. First developed and adopted in 1992, VISION 2020 has been renewed by the community and re-adopted by Council in 2003 as the shared Vision for the City of Hamilton.

- **Current Borrowing from the Reserve Policy**

**RELEVANT CONSULTATION:**

- Public Works Department - Energy, Fleet & Facilities Division
- Finance and Corporate Services
  - Purchasing
  - Budgets & Finance
The Office of Energy Initiatives, Corporate Buildings & Technical Services and Purchasing met in April to review options to purchase the equipment based on life cycle costs as opposed to lowest upfront costs. There was an agreement to proceed with an informal RFQ to determine the best supplier(s) of chillers for the applications.

CITY STRATEGIC COMMITMENT:

By evaluating the “Triple Bottom Line”, (community, environment, economic implications) we can make choices that create value across all three bottom lines, moving us closer to our vision for a sustainable community, and Provincial interests.

Community Well-Being is enhanced. ☑ Yes  ☐ No

Environmental Well-Being is enhanced. ☑ Yes  ☐ No

Economic Well-Being is enhanced. ☑ Yes  ☐ No

Does the option you are recommending create value across all three bottom lines? ☑ Yes  ☐ No

Do the options you are recommending make Hamilton a City of choice for high performance public servants? ☑ Yes  ☐ No
Existing Cooling Systems

CHILLERS

EXISTING COOLING LOOP
District Cooling System for City Facilities

Expanded Piping and New Chiller Locations
### Annual Repayment Schedule

<table>
<thead>
<tr>
<th>Description</th>
<th>DeptID</th>
<th>Account</th>
<th>Savings</th>
<th>Internal debt charge/Operating Acct.58123</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUP Operations</td>
<td>791301</td>
<td>55310</td>
<td>$ (359,960)</td>
<td>$ 359,960</td>
</tr>
<tr>
<td>Convention Centre</td>
<td>791303</td>
<td>56120</td>
<td>$ (25,800)</td>
<td>$ 25,800</td>
</tr>
<tr>
<td>Art Gallery</td>
<td>791304</td>
<td>56120</td>
<td>$ (14,240)</td>
<td>$ 14,240</td>
</tr>
<tr>
<td>Hamilton Place</td>
<td>791305</td>
<td>56120</td>
<td>$ (26,580)</td>
<td>$ 26,580</td>
</tr>
<tr>
<td>Copps Coliseum</td>
<td>791306</td>
<td>56120</td>
<td>$ (42,340)</td>
<td>$ 42,340</td>
</tr>
<tr>
<td>Ontario Government Building</td>
<td>791307</td>
<td>56120</td>
<td>$ (25,350)</td>
<td>$ 25,350</td>
</tr>
<tr>
<td>Hamilton Farmers Market</td>
<td>791314</td>
<td>56120</td>
<td>$ (8,980)</td>
<td>$ 8,980</td>
</tr>
<tr>
<td>Central Library Operations</td>
<td>791151</td>
<td>56120</td>
<td>$ (37,710)</td>
<td>$ 37,710</td>
</tr>
</tbody>
</table>

Note: All numbers have been rounded.