# STANDARDIZED CLASSIFICATION SYSTEM TO ASSESS THE STATE AND CONDITION OF INFRASTRUCTURE IN EDMONTON

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## ABSTRACT

In 1998, in response to continuing deterioration of the infrastructure and the difficulty in obtaining adequate funding for required rehabilitation and growth programs, the City of Edmonton adopted an *Infrastructure Strategy* and established the Office of Infrastructure. Extensive work has been done by the Office of Infrastructure to explore and investigate various tools and processes to improve infrastructure management and optimize existing and potential sources of funding. One of the tools is a consistent and comprehensive method that describes the state of the City's infrastructure and identifies areas of deficiency. This information is essential to assist Senior Management and City Council in investment planning and decision making.

An overview of the development of standardized Classifications and Definitions for Operations, Maintenance, Rehabilitation, Replacement/Reconstruction and Retirement/Removal will be provided. The development of a consistent ranking system (Assessment Classifications) used to describe the state of the City of Edmonton's infrastructure will be discussed. The Assessment Classifications consist of three separate categories; Physical Condition, Demand/Capacity and Functionality which allow for a comprehensive ranking system which can be applied to both 'hard' and 'soft' infrastructure areas. The procedure and process of implementing the standardized systems, including the establishment of an external stakeholder committee working in parallel with internal committees, will also be described.

The significant challenges associated with the deterioration of municipal infrastructure and the difficulty in maintaining on-going and reliable funding sources for rehabilitation and development programs is not unique to the City of Edmonton. The City of Edmonton is taking a proactive approach in the implementation of a standardized ranking system for all corporate infrastructure that will allow for better decision making, long-term planning and overall infrastructure management.

## INTRODUCTION

The City of Edmonton is taking an active role in developing a variety of innovative infrastructure management tools. One of these tools is a consistent ranking system to evaluate the state and condition of existing infrastructure. The development of a ranking system in conjunction with consistent definitions for operation, maintenance, rehabilitation, replacement/reconstruction and retirement/removal will assist departments in improved allocation of capital and operation budget dollars. In addition to supporting better decision-making and long-term planning, it has fostered and nurtured collaborative efforts among a variety of stakeholders.

## BACKGROUND

Edmonton City Council recognized the need to address the state of its infrastructure and therefore adopted the City's *Infrastructure Strategy* in 1998. The Office of Infrastructure was created in 2000 with the mandate to implement the strategies outlined in the *Infrastructure Strategy* and with an overall goal to ensure that the City's infrastructure is in a good state of repair and rehabilitation and development programs are adequately funded on an ongoing basis.

Determining the state and condition of the City of Edmonton assets was one of the first tasks undertaken by the Office of Infrastructure as this information was essential for the effective management of these assets. The diversity of the assets owned and managed by the City of Edmonton required that this information be gathered in a uniform manner that could be applied corporate-wide. This strategic perspective of the state and condition of our infrastructure was necessary for taking care of what we own and planning for what we need in the future.

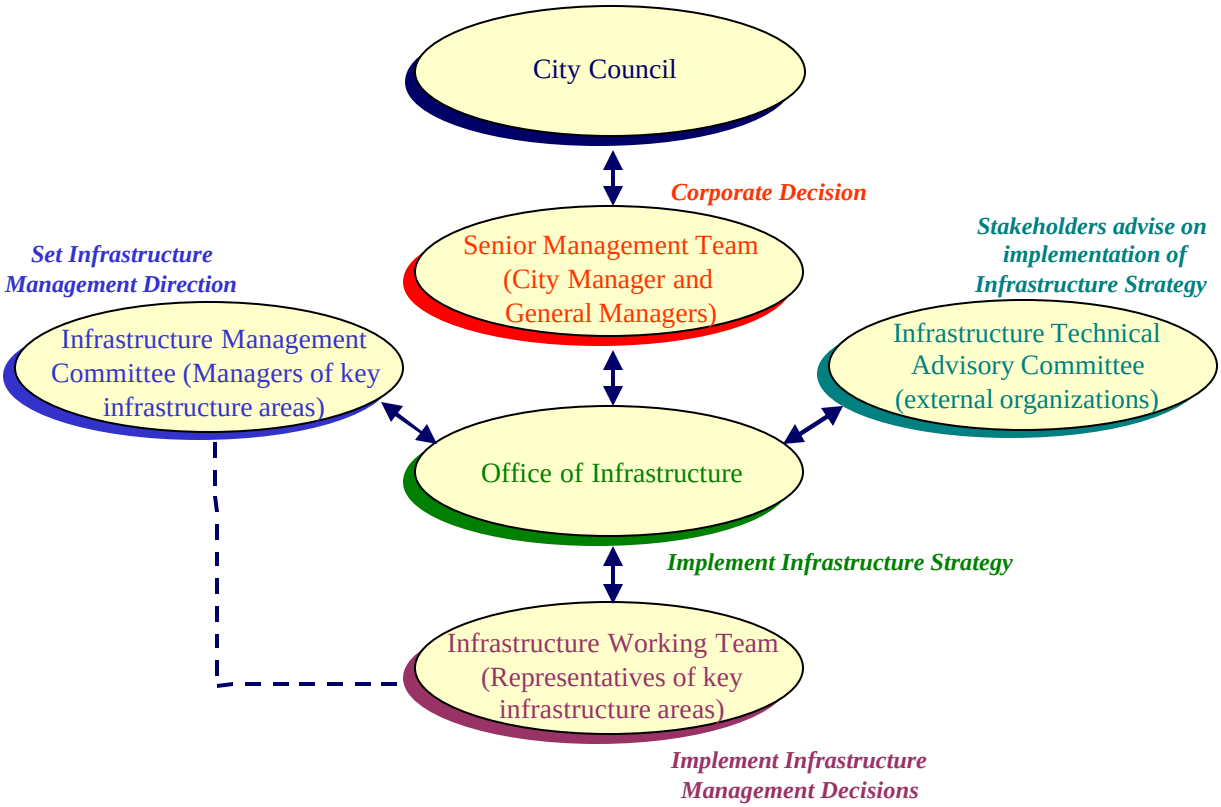
## STAKEHOLDER INVOLVEMENT

The implementation of the *Infrastructure Strategy* is a collective effort between the Office of Infrastructure, two inter-departmental teams, and an external stakeholders group. An Infrastructure Management Committee (IMC), comprised of nine managers from key civic departments, provides general guidance regarding infrastructure management issues. An Infrastructure Working Group (IWT) has 20 delegates who represent the different infrastructure areas within the City of Edmonton. These members work together to implement new tools and processes and to assess and report on the state and condition of infrastructure.

The external group, an Infrastructure Technical Advisory Committee (ITAC) was created in September 2001 to provide an opportunity for consultation with key

external stakeholders. The 20 technical groups represented in ITAC have expertise in infrastructure design, development, construction, and management. The ITAC members contribute their knowledge and expertise while presenting the perspective of their appointing organization on infrastructure issues and have proven to be an invaluable resource for the City of Edmonton.

The following figure illustrates the coordination and reporting procedures that are used in the implementation of the *Infrastructure Strategy.* Also included are brief descriptions of the responsibilities of both the internal and external stakeholders.




***Infrastructure Strategy* Management**

## DEFINITIONS FOR OPERATIONS, MAINTENANCE, REHABILITATION, REPLACEMENT/RECONSTRUCTION AND RETIREMENT/REMOVAL

The City of Edmonton recognized the need for a common understanding of maintenance and rehabilitation and held a Maintenance Definition Workshop in May 2001 with representatives from various City of Edmonton departments. The purpose of the workshop was to clarify the definitions of operations, maintenance, rehabilitation and reconstruction, and to discuss and recognize the budget implications of the definitions. The failure to clearly define these differences and the potential impact on asset management was examined.

The City of Edmonton funds the operations and maintenance of infrastructure through the operating budget whereas rehabilitation and reconstruction projects are funded from the capital budget. In many cases, partnering opportunities must be matched by the City's capital money and would not include any project designated as either operations or maintenance. Also, since most grants, such as the Provincial Fuel Grant Rebate, are commitments for specified capital purposes, and not for operations and maintenance, it was important that a consistent definition be used across the corporation.

Several recommendations for action resulted from the workshop and included the:

1. Need to define and monitor real operation and maintenance costs.
2. Need to attach operation and maintenance costs to "growth" capital assets when requesting budget money.
3. Need to approve life cycle (cash flow) expenditures for new projects.
4. Need to establish a common database to record operation and maintenance costs.

Also, during the discussion it was decided to include retirement/removal as an additional element and to include reconstruction with the definition of replacement.

The finalized definitions and associated caveats for operations, maintenance, rehabilitation, replacement/reconstruction and retirement/removal are shown in the following table.

| *DEFINITION* | *CAVEAT* |
|---|---|
| **Operations**<br>"The set of ongoing activities that allow the use of the asset for its intended function." | ▪ *It is the necessary expenditure to use the asset.* |
| **Maintenance**<br>"That set of activities required to keep a component, system, infrastructure asset or facility functioning as it was originally designed and constructed." | ▪ *It must preserve the service life and asset value.*<br>▪ *Maintenance may take the form of preventative or corrective, as follows:*<br>*Preventive Maintenance – Planned actions undertaken to retain an item at a specified level of performance by providing repetitive scheduled tasks that prolong system operation, i.e. inspection, lubrication and cleaning (non janitorial or aesthetic) and replacement of consumable parts.*<br>*Corrective Maintenance – Work to restore damaged, failed or worn out equipment to such condition that it may be effectively utilized for its designated purpose.* |
| ***Rehabilitation***<br>"The action of restoring a component, system, infrastructure asset or facility functioning to a former condition or status; this can also result in an improved function." | ▪ *It may improve or increase physical output, service capacity, or quality of output.*<br>▪ *It may involve upgrading and extending the service life of a portion or a segment of the asset.*<br>▪ *It may involve periodic expenditures to meet or exceed the asset life and target service levels.* |
| ***Replacement / Reconstruction***<br>"The action of new construction or replacement." | ▪ *It may improve or increase physical output, service capacity, or quality of output.*<br>▪ *It generally involves replacing/ rebuilding an existing asset.*<br>▪ *It may involve a change in service levels.* |
| **Retirement /Removal**<br>"The action of decommissioning or removal of the asset from active service through disposal, abandonment, demolition, or sale." | ▪ *It may involve retiring deteriorated assets and recovering salvage value.* |

**Definitions of Operations, Maintenance, Rehabilitation, Replacement/Reconstruction and Retirement/Removal**

## ASSESSMENT CLASSIFICATIONS

2002 marks the first year that a standardized classification system, to compare diverse infrastructure assets for the City of Edmonton, was developed and implemented. These high level classifications were created to provide consistent descriptions of the state of the city's infrastructure, identify the areas of deficiency across different infrastructure areas and provide useful input for decision-making and investment planning.

One of the first tasks accomplished by IWT was the grouping of the City of Edmonton assets into 12 different infrastructure areas. During the early discussions it soon became apparent that, due to the uniqueness of each department and their assets, it would be difficult to apply a generic classification corporate wide. The following table describes the infrastructure areas and the diversity of their elements.

| | |
|---|---|
| **Drainage** | Sanitary, storm and combined sewers (incl. manholes, catchbasins) and wastewater treatment. |
| **Road Right-of-Way** | Roads (arterials, collectors, local; and curb and gutter), sidewalks, bridges and auxiliary structures (such as gates, streetscapes and others). |
| **Parkland** | Horticulture, trails, hardsurfaces, playgrounds, sportsfields, park infrastructure and parks. |
| **Transit Facilities & Equipment** | Light Rail Transit (LRT) system facilities and equipment (including cars), transit centres, bus equipment and systems, trolley system. |
| **Fleet** | Transit buses, city vehicles and shop equipment. |
| **Buildings** | Civic offices, public works and operation facilities (e.g.yards), emergency response buildings, police buildings and libraries. |
| **Traffic Control & Street Lighting** | Traffic signals, signs, markings, street lighting and parking meters. |
| **Recreation Facilities** | All major recreational facilities (e.g. arenas, leisure centres) and amenities. |
| **Affordable Housing** | Non-profit housing, community housing and senior lodges/cabins. |
| **Waste Management Facilities** | Operation and administration facilities, transfer stations and public facilities, processing facilities and operating landfills and appurtenances. |
| **Technology Equipment** | Servers, network, and all communication equipment. |
| **Others** | Emergency response and police equipment, and library contents and materials. |

**Categorization of Infrastructure Assets**

The ‘hard’ infrastructure areas, such as transportation and drainage, felt that their assets could best be described using physical condition and demand/capacity classifications. However, the ‘soft’ infrastructure areas, such as community services, felt that a good portion of their assets were related more to program delivery needs than to the physical condition or demand/capacity of the asset. It was because of this that the three different classifications, the physical condition, demand/capacity and functionality were developed, to describe all of the City of Edmonton infrastructure assets. The following are the finalized definitions of physical condition, demand/capacity and functionality:

| | |
|---|---|
| ***Physical Condition*** | Physical condition refers to the condition of the physical infrastructure that allows it to meet the intended service level. |
| ***Demand/Capacity*** | Demand/capacity represents the ability of the physical infrastructure to meet service needs. |
| ***Functionality*** | Functionality is the ability of the physical infrastructure to meet program delivery needs. |

A road can be used as an example to illustrate the use of the three classifications. The presence of potholes would be an indicator of the physical condition of the road and traffic congestion would indicate if the capacity of the road was able to meet the demand of the user. The functionality aspect would be demonstrated by the ability of the road to meet the demands of the user in that the path from Point A to Point B would be the most direct and efficient route.

Some of the infrastructure areas did not have an existing system in place to rank their assets because of the difficulty in the gathering, organizing and tracking of the asset information. A side benefit from the implementation of the standardized classification system was the creation of departmental teams to address their specific infrastructure issues and to develop an improved method for tracking their assets.

## RANKING SYSTEM

After numerous meetings, a five-point ranking system was determined to be the most effective approach that could cross interdepartmental boundaries and provide a consistent asset ranking system corporate- wide to compare diverse assets. The five levels were described as *A* and *B* which are *Very Good* and *Good*, C which is *Fair,* and *D* and *F* which would be considered *Poor* and *Critical.* Infrastructure with a *D* or *F* ranking is not performing to its designed function and not meeting program

and service delivery needs. The following table shows the finalized descriptions for the five-point ranking system.

| MARK | STATE | DESCRIPTION |
|---|---|---|
| **PHYSICAL CONDITION** | | |
| Very Good | A | The element is physically sound and is performing its function as originally intended. Required maintenance costs are well within standards and norms. Typically, element is new or recently rehabilitated. |
| Good | B | The element is physically sound and is performing its function as originally intended. Required maintenance costs are within acceptable standards and norms but are increasing. Typically, element has been used for sometime but is within mid-stage of its expected life. |
| Fair | C | The element is showing signs of deterioration and is performing at a lower level than originally intended. Some components of the element are becoming physically deficient. Required maintenance costs exceed acceptable standards and norms but are increasing. Typically, element has been used for a long time and is within the later stage of its expected life. |
| Poor | D | The element is showing significant signs of deterioration and is performing to a much lower level than originally intended. A major portion of the element is physically deficient. Required maintenance costs significantly exceed acceptable standards and norms. Typically, element is approaching the end of its expected life. |
| Critical | F | The element is physically unsound and/or not performing as originally intended. Element has higher probability of failure or failure is imminent. Maintenance costs are unacceptable and rehabilitation is not cost effective. Replacement/major refurbishment is required. |
| **DEMAND/CAPACITY** | | |
| Very Good | A | Demand corresponds well with design capacity and no operational problems experienced. |
| Good | B | Demand is within design capacity and occasional operational problems experienced. |
| Fair | C | Demand is approaching design capacity and/or operational problems occur frequently. |
| Poor | D | Demand exceeds design capacity and/or significant operational problems are evident. |
| Critical | F | Demand exceeds design capacity and/or operational problems are serious and ongoing. |
| **FUNCTIONALITY** | | |
| Very Good | A | The element meets all program/service delivery needs in a fully efficient and effective manner. |
| Good | B | The element meets program/service delivery needs in an acceptable manner. |
| Fair | C | The element meets most program/service delivery needs and some inefficiencies and ineffectiveness present. |
| Poor | D | The element has a limited ability to meet program/service delivery needs. |
| Critical | F | The element is critically deficient and does not meet program/service delivery and is neither efficient nor effective. |

## Five-Point Ranking System for Assessment Classifications

During the discussions, some of the key infrastructure areas indicated that they had existing ranking systems in place for their specific department. The Transportation and Streets Department use a Pavement Quality Index (PQI) to describe the physical condition of their roadways and a Volume/Capacity (V/C) ratio to describe the demand/capacity. Drainage Services also has an existing system in place to rate the condition of their sewer systems. To assist in the conversion of the existing departmental rankings into the newly developed rankings, a translator was developed. Areas with existing ranking systems in place submitted a translator to directly apply their existing ranking system to the newly developed five-point ranking system. The following is an example of translator application.

**Infrastructure Element:** Roads

**Sub-element:** Primary Highways

**Physical Condition**

| Mark | State | Translator | Percentage |
|---|---|---|---|
| Overall pavement condition is represented by a Pavement Quality Index (PQI). This index is a weighted average of visual condition, riding comfort and structural capacity of the pavement. The PQI is based on a scale of 0 (very critical) - 10 (new or like new). | | | |
| A | Very Good | PQI 8.1 - 10.0 | 16.0% |
| B | Good | PQI 6.1 - 8.0 | 47.0% |
| C | Fair | PQI 4.1 - 6.0 | 35.0% |
| D | Poor | PQI 2.1 - 4.0 | 2.0% |
| F | Critical | PQI 0.0 - 2.0 | 0.0% |

**Demand/Capacity**

| Mark | State | Translator | Percentage |
|---|---|---|---|
| The City of Edmonton Regional Travel Model was used to determine Level of Service (LOS) for Arterial Roadways within the City. The critical Volume/Capacity (V/C) ratio for each arterial link was determined from either the AM Peak hour or the PM Peak hour (i.e. highest V/C of the two peak hours). The volume (that corresponded to the highest V/C ratio) of all arterial links that fell within each LOS category was then divided by the total volume of all arterial links in all LOS categories. | | | |
| A | Very Good | V/C < 0.25 | 6.0% |
| B | Good | 0.25 ≤ V/C < 0.50 | 29.0% |
| C | Fair | 0.5 ≤ V/C < 0.75 | 38.0% |
| D | Poor | 0.75 ≤ V/C < 0.90 | 15.0% |
| F | Critical | V/C ≥ 0.90 | 12.0% |

**Functionality**

| Mark | State | Translator | Percentage |
|---|---|---|---|
| Functionality considerations include: geometry (eg. lane width, road width, turning movement accommodations), reductions in posted speeds, shortcutting and safety improvement requirements (considered but difficult to even quantify). | | | |
| A, B, C | Very Good | | 99.0% |
| | Good | | |
| | Fair | | |
| D, F | Poor | | 1.0% |
| | Critical | | |

Note: Percentage to be calculated based on replacement value

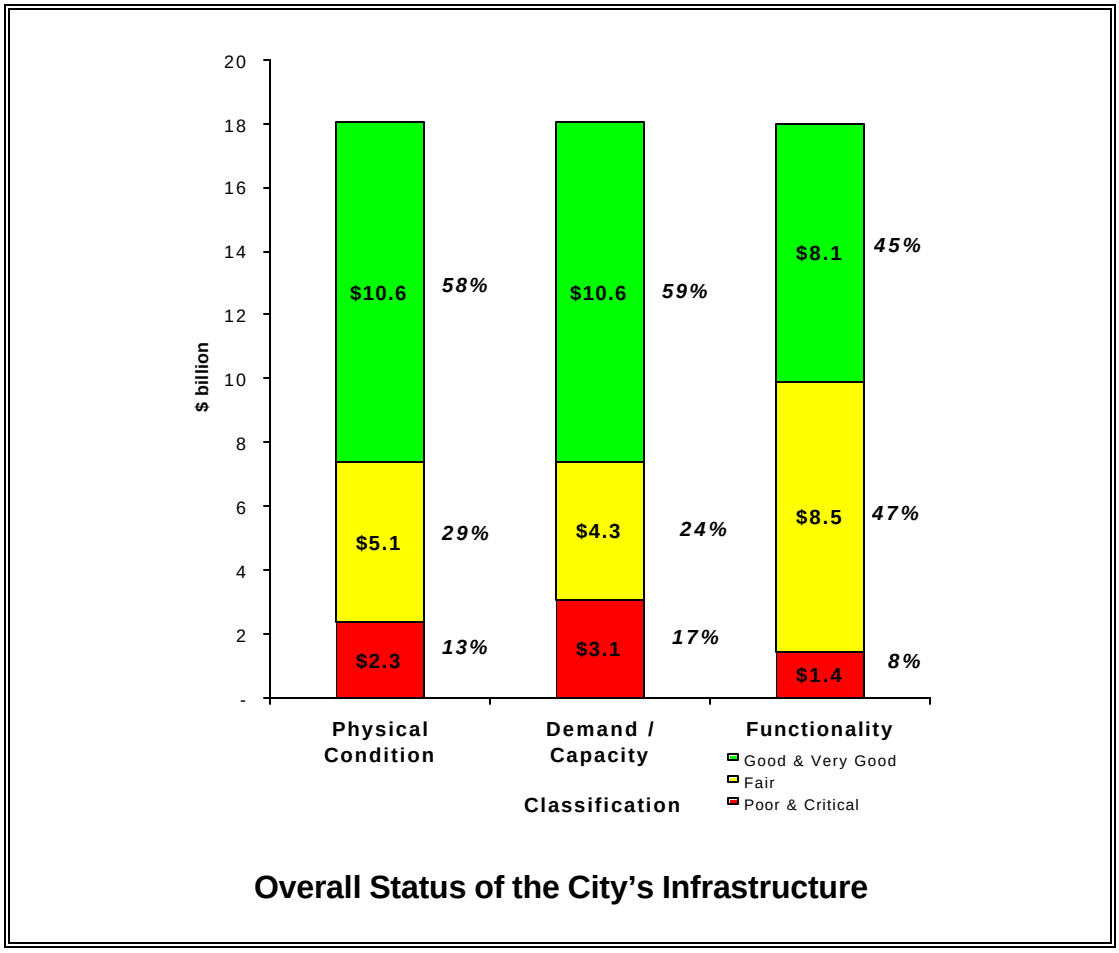
**Translator**

## OVERALL ASSESSMENT CLASSIFICATIONS FOR CITY INFRASTRUCTURE

The new assessment classifications and ranking system facilitates improved comparisons of the condition of disparate infrastructure elements – roads to drainage, or parks to information systems – in order to support improved decision-making and capital project prioritization.

The current total replacement value of the infrastructure assets developed and used by the City of Edmonton was determined to have a value of $18 billion in 2002. These associated replacement values and the rankings of the assets provide a snapshot of the magnitude of reinvestment needs in each classification category. The replacement values should not, however, be added together to determine the total reinvestment requirements – since investing in one category may resolve issues in the other categories without additional investment.

The following graph shows a roll-up of the overall status of the city's infrastructure.




**Overall Status of the City's Infrastructure**

The physical condition, demand/capacity, and functionality of the majority of the City's existing infrastructure is generally fair to good. However, there are areas with poor and critical rankings that require attention. The assessment classifications will also be used as input to the risk assessment methodology that is currently being pilot tested. The above figure illustrates the percentage distribution of the three rankings and the equivalent replacement values.

- 13% ($2.3 billion) of the infrastructure is in poor or critical physical condition;
- 17% (3.1 billion) of the infrastructure is in poor or critical condition with respect to meeting demand/capacity; and
- 8% ($1.4 billion) of the infrastructure is in poor or critical condition with respect to functionality.

This is a snapshot of the existing infrastructure and the needs for growth and new services are not reflected in the assessment.

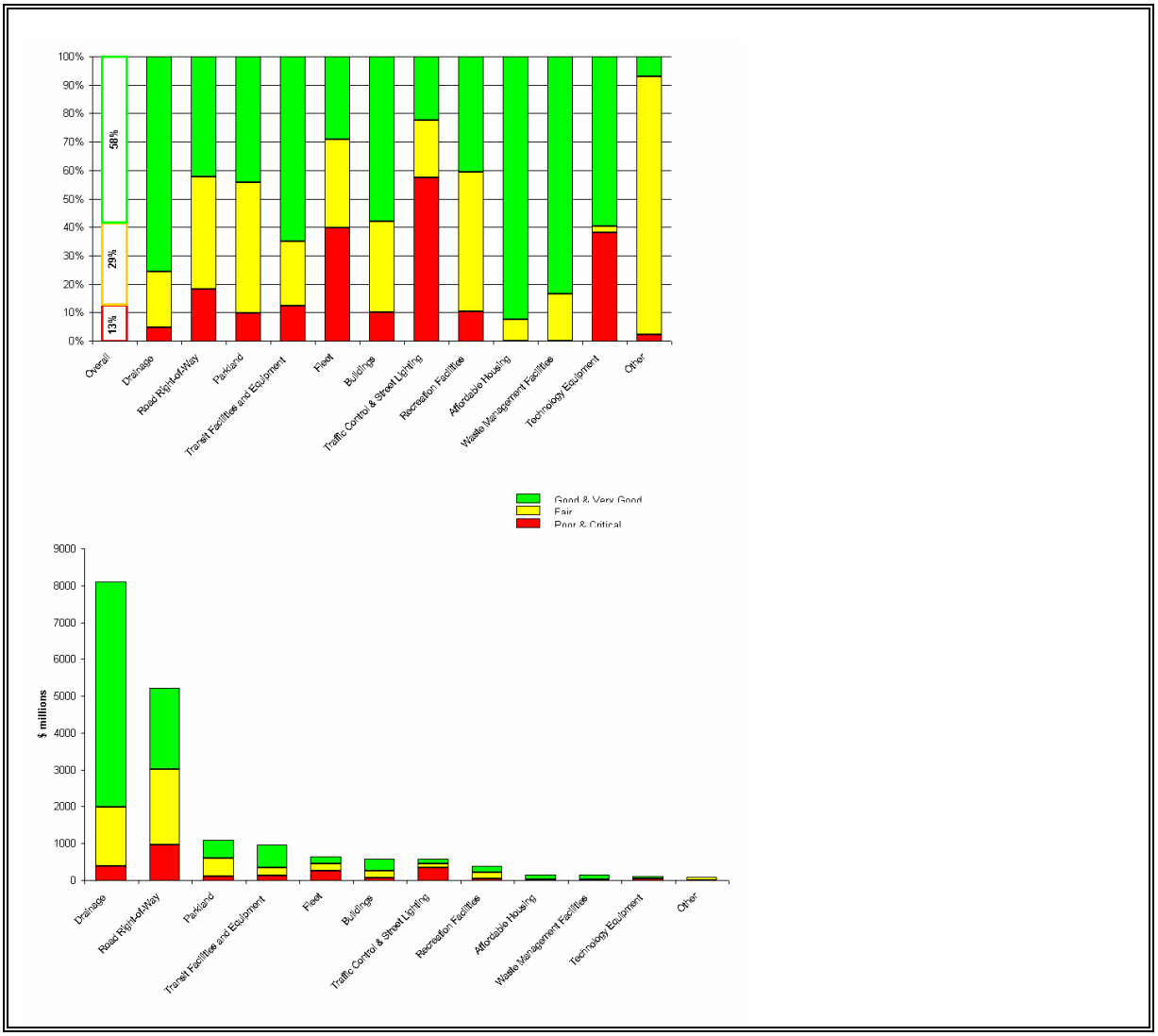
Although the quality of available data varies and requires some assumptions in the assessment, the new ranking system provides a strategic perspective of the state and condition of the City's infrastructure. Continued improvement to data collection and analysis will generate more consistent and accurate data for use in the next update.

## DETAILED ASSESSMENT CLASSIFICATIONS FOR CITY INFRASTRUCTURE

The first graph in each of the following classifications illustrates the percentages based upon the inventory of the infrastructure area. For example, under the Physical Condition heading, the first graph shows that approximately 5% of the drainage assets are in poor and critical condition, approximately 20% of the assets are in fair condition, and the remaining assets (75%) are in good and very good condition. The second graph uses the replacement value of the assets to determine a dollar value associated with the specific infrastructure area.

### Physical Condition

Overall, for physical condition, 58% of the infrastructure is rated Good to Very Good; 29% is Fair; and 13% is Poor to Critical. The figure shows that the areas with the highest percentage of poor and critical rankings are traffic control and street lighting followed by fleet and technology equipment. Taking the total replacement value of the infrastructure into consideration, the most significant investment needs are in the areas of roads, drainage, traffic control and street lighting, and fleet.




**Physical Condition**

One of the challenges facing the Office of Infrastructure was to relay the state and condition of the assets and the resultant impacts to Senior Management Team and City Council in a brief and comprehensive manner. The gradual deterioration of street poles was used to illustrate the use of the physical condition classification.

**Very Good**
Galvanized Steel – structurally sound

**Good**
Slight superficial rusting

**Fair**
Appears poor visually but is okay structurally - only superficial rusting

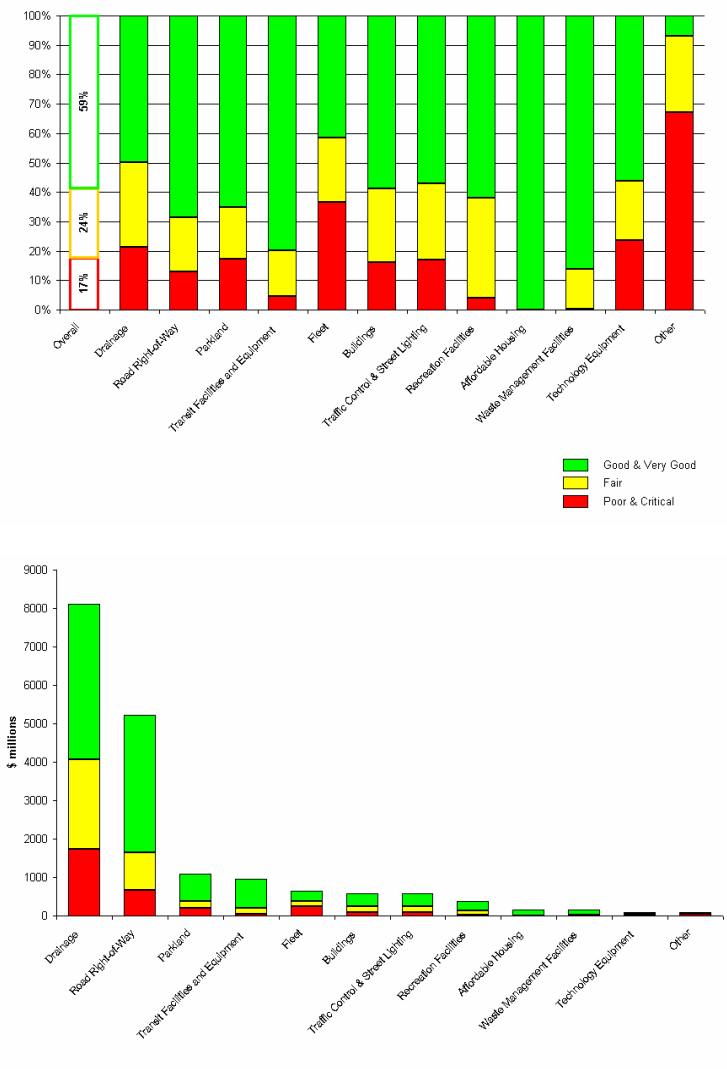
**Poor**
Deep scratches and rust spots

**Critical**
Rust spots have penetrated - structurally unsound

**Illustration of Physical Condition Assessment**

## Demand/Capacity

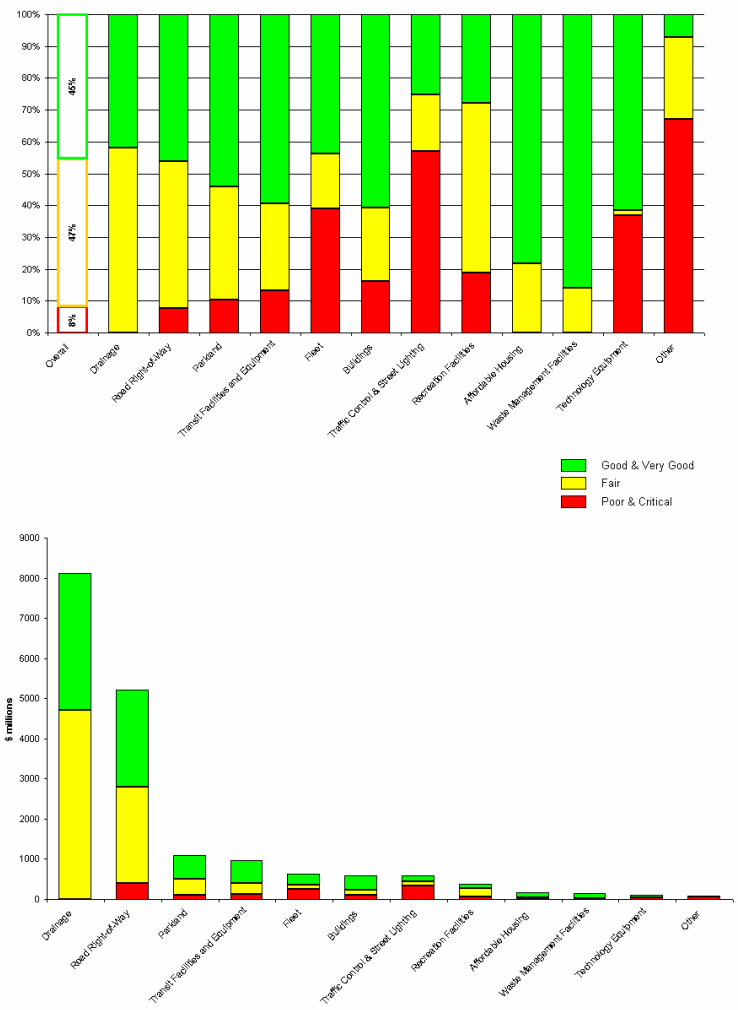
Overall, 59% of the infrastructure is rated Good to Very Good; 24% is Fair; and 17% is Poor to Critical with respect to meeting current service demands. The figures show that the areas with the highest percentage of Poor and Critical rankings are in fleet, technology equipment, drainage and 'other' smaller value infrastructures (such as police and emergency services equipment, and library materials). Taking into account the replacement value of the different infrastructure elements, drainage, roads and fleet have the highest investment needs with respect to demand/capacity.




**Demand/Capacity**

## Functionality

Overall, 45% of the infrastructure is rated Good to Very Good; 47% is Fair; and 8% is Poor to Critical to meet functional and program needs. Traffic control and street lighting, fleet, technology equipment, and 'other' smaller value infrastructure have the highest percentage of Poor and Critical rankings. Based on replacement value, the most significant investment needs are roads, traffic control and street lighting, and fleet.




**Functionality**

## CLOSURE

The recent development of standardized classifications and definitions for Operations, Maintenance, Rehabilitation, Replacement/Reconstruction and Retirement/Removal for the City of Edmonton are in the process of being applied corporate wide. In addition, a consistent ranking system for the City of Edmonton assets provides the basis for comparing diverse infrastructure areas. This allows for a strategic perspective of the City's infrastructure, assists in the identification of areas of deficiency, and directs the focus and resources to the critical areas requiring immediate attention.

The considerable infrastructure challenges dictate that The City of Edmonton take a proactive approach in the successful implementation of a standardized ranking system for all corporate infrastructure that will result in better decision making, long term planning and overall infrastructure management.

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