# Failing to Plan is Planning to Fail: Quantifying and Benchmarking the Unfunded Liability of 600 Condominium Buildings in British Columbia, Canada

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## Abstract

Residential condominium buildings in British Columbia have historically not funded their long-range capital reserve accounts to adequate levels. The owners in this form of common interest community have generally been ill-prepared financially for the renewal of their major capital assets, such as roofs, boilers and elevators. New legislation has been introduced with the intent of shifting these communities towards a proactive approach to asset management and condominium corporations are now required to commission a reserve study to enable the ownership to make informed decisions about appropriate replacement reserves.

The challenge for local consultants is the establishment of a standard for quantifying the extent of underfunding based upon a formula that returns a realistic and defensible estimation of capital costs over long-range forecasts. This paper explores the methodology that was developed as part of a longitudinal study to gain insight into the funding requirements associated with 600 buildings at various stages in their respective lifecycles, ranging from one-year old buildings to heritage buildings over 100 years old.

## 1 Introduction

There are approximately 28,000 condominium corporations in British Columbia, Canada [1], which have been constructed since the late-1960s. In the late-1990s it was determined that the majority of the owners of these buildings were significantly underfunding their long-range replacement reserve accounts for capital projects, such as roof renewal, boiler retrofit and elevator control modernization.

Recognizing a looming infrastructure deficit, and the urgent need for consumer protection, two significant pieces of legislation were introduced over a 10-year period to compel condominium owners to effectively apply the principles of asset management to their tangible capital assets. In 1999 it became mandatory for developers/builders to provide maintenance plans as part of the commissioning of all new construction projects and also for contractors to deliver same after completion of any significant asset rehabilitation or renewal project [2]. In 2011 changes were made to the local Condominium Act [3] requiring owners to commission a Depreciation Report (commonly referred to elsewhere in North America as a Reserve Study) to quantify, disclose and mitigate their unfunded liability.

The maintenance plan informs owners and their managers on how to preserve their tangible capital assets to achieve their full intended service lives and the reserve study enables these stakeholders to anticipate the short-term and long-range funding needs for eventual renewal of their depreciating and wearing assets.

## 2 The Challenge

In theory, these two asset management tools are intended to empower owners to make informed decisions based on their tolerance for risk and the desired standard of care for stewardship of their assets.

Low condo dues/fees were historically perceived as a "badge of honour" that facilitated the resale of the suites. However, it was false economy for owners to ignore the reality that special assessments - to finance capital projects due to a shortfall in replacement reserves - were actually deferred condo dues. There is an emerging realization that the true cost of ownership includes both condo dues for annual operating expenses (opEx) and replacement reserves (capEx).

In practice, the efficacy of the legislation has varied to date, primarily due to the challenge of having to "catch up" for many years of lost time (funding backlog) and also "keep-up" with significant on-going requirements based on 30-year forecasts. This has been further complicated as thousands of condominium corporations gradually learn to make the necessary shift in their thinking from the previous myopic focus on short-term needs (tactical planning) and reconcile this with long-range requirements (strategic planning) by adopting the principles of mixed-scanning.

In British Columbia there is no industry standard for calculating funding requirements. A reserve study is a ‘living document’ and it requires sophisticated tools to enable the owners to synchronize their regular annual cash inflows (annual operating budgets) with the irregular outflows for large projects (long-range capital budgets).

# 3 The Methodology

Over the past 15 years, and during passage of the two complementary pieces of legislation, the authors were directly involved in the preparation of over 600 maintenance plans and reserve studies for a cross-section of buildings, including high-rise (HR), low-rise (LR) and townhouses complexes (TH).

Approximately 100 hours of consulting time was allocated to each building, which was distributed across three teams: technical, clerical and software. The technical teams focused on collecting data using a variety of techniques, including field work, document reviews and facility staff interviews. The software team administered an SQL database with web-based interface for data entry and developed algorithms for gaining insight into the key performance indicators.

The data for the 600 buildings was collected over a period of nine years by a multi-disciplinary team of engineers, architects, building science technologists and reserve planners. An average of two site visits was conducted at each building.

The asset inventory for each building was structured according to the ASTM Uniformat-II classification system at a granularity down to level-4 and level-5. At level-1, the data is organized into eight primary physical systems as follows: enclosure (including exposed structural elements); electrical; mechanical; elevators; fire safety; interior finishes; amenities; and sitework. On average, 80 assets were identified at each building.

A variety of empirical data was collected by the assessment teams, including: photographs and descriptions of the assets; chronological age and effective age of each asset; estimation of remaining service life of the assets; quantity take-off measurements to estimate replacement costs; and scope definitions for the appropriate type of renewal project based on deterioration models and anticipated asset behaviour.

Quality control was managed through a peer review process and the SQL database included checks and balances to detect missing data, erroneous data, and to alert the team to any variances relative to the larger dataset.

Working closely with hundreds of different owner groups, and also for the purposes of internal quality control measures, the team developed analytics to help benchmark the buildings using a variety of metrics, including: age cohorts, gross floor area, building reproduction value, geographical location, construction type and other pertinent attributes.

# 4 Identification of Funding Parameters

The asset management literature is rich with articles offering alternative ways and means for calculating funding requirements. Included below are some of the key attributes that vary between the funding models.

### 4.1 Termed Modelling vs. Continuous Modelling

A “Termed Model” identifies a base year from which to start the funding calculations and a terminus year at which to end the calculations. The time period between base year and terminus year is referred to as the planning horizon. In British Columbia, and many other North American jurisdictions, the planning horizon for a reserve study is set at 30-years. Capital projects beyond the thirty-year period are not required to be factored into the funding calculations.

A “Continuous Model”, on the other hand, looks to the longest life asset within the subject building and is not constrained by a planning horizon. Some assets are durable, long-life assets reaching up to 75 years in some case. Depending on the age of the building at the time of the reserve study, the funding calculations in a continuous model can sometimes be higher or lower than a termed model,

Figure 1 illustrates a 30-year planning horizon that recognizes projects beyond-the-horizon, which will eventually move into-the-horizon.

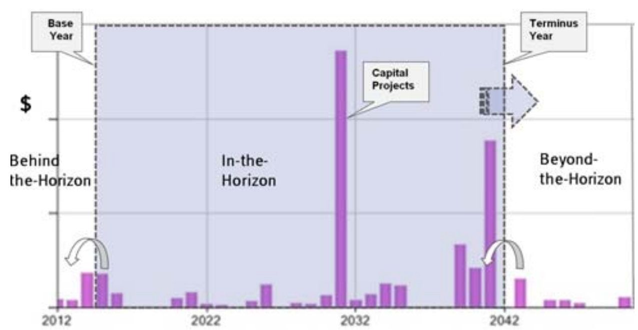


Figure 1: The key elements of a planning horizon

The team selected a formula with 30-year termed constraint in order to satisfy the local statutory requirements and to avoid the challenges that would arise from claims by condominium owners of unrealistic and onerous funding levels.

### 4.2 Current Values vs. Future Values

“Current values” (CV) are construction costs at the base year of the reserve study, which are then inflated with annual compounding, to “future values” (FV) as of the forecast year of each capital project. In British Columbia the 30-year historical average for construction cost escalation has been approximately 2%, which has a doubling period of 35 years.

The team selected a funding formula that allows for inflated values since this provides condominium corporations with realistic forecasts of funding requirements (“keep-up”). It should be noted, however, that meaningful information on unfunded liability ("catch-up") is not affected by escalation, which is addressed, instead, through the concept of proximity.

### 4.3 Proximity vs. Non-proximity

Proximity refers to the distribution of the individual capital projects over time, within a prescribed planning horizon, and relative to the base year. For example, a roof renewal that has been forecast for the year 2020 has closer proximity than a roof renewal in 2025. Proximity has a significant financial impact on funding requirements as it has a bearing on the amount of time the owners have to raise the monies for each project. Proximity models provide a straight line calculation to each capital event across the planning horizon but the straight line is always set to the base year.

Non-proximity models, on the other hand, attempt a straight line to each capital event starting from the last placed-in-service date of each asset, which may fall behind the base year. Non-proximity funding models do not account for unfunded liability, which is graphically represented in the figure below.

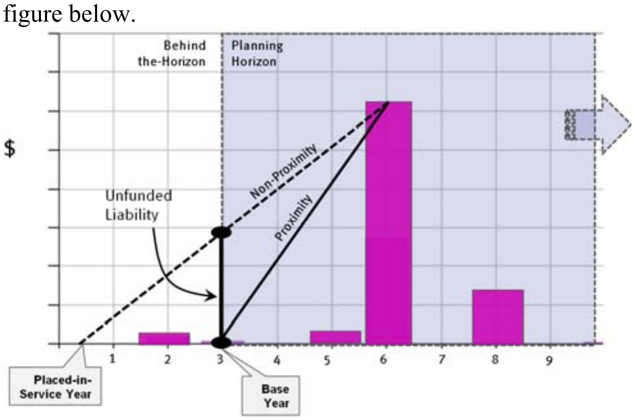


Figure 2: Proximity vs. non-proximity funding.

The team selected a non-proximity formula to calculate future funding requirements ("keep-up" costs) and resolved proximity through a separate calculation to quantify the historical levels of unfunded liability ("catch-up" costs).

### 4.4 Linear vs. Lumpy

A linear funding model provides for a consistent contribution to the reserve account for each year over the planning horizon. This method asks the question: *"If the owners fund at level x, what special assessments will result?"* It provides the owners with regularity in the annual funding contributions. Linear funding models are best suited to younger buildings where the capital projects do not yet have proximity and the owners have not yet accumulated a significant unfunded liability. Linear funding models are less helpful for older building as the funding level will not be adequate to scale "lumps" associated with capital projects that have close proximity, particularly if they are significant in value.

A lumpy funding model provides for fluctuations in funding levels each fiscal year. This method asks the question: *"What should the funding be each year to ensure that the owners never encounter a special assessment?"* A lumpy model recognizes the realities of varying cash flow requirements at different points in time, particularly over long planning horizons. The challenge with lumpy models, however, is to ensure that the sizes of the lumps are not too large. Mitigation measures to flatten the lumps can include increased funding in the certain years, particularly the lead period to significant projects.

The team selected a linear funding formula that allows the owners to plan for consistent funding over the planning horizon.

## 5. Evaluation of Funding Formulas

A review of the literature reveals several formulas for calculating funding requirements for buildings [4,5,6,7], which can be classified as: a) building valuation models; b) lifecycle (actuarial) models and c) mathematical (parametric) models. These three classes of models are all based on theoretical principles and can be considered "top-down" approaches to estimating funding requirements.

The longitudinal study on 600 buildings is grounded primarily in empirical data that was collected as part of a "bottom-up" approach. The team evaluated the relative merits of three formulas based on the manner in which each formula addresses the general funding attributes and jurisdictional funding requirements addressed in the previous section of this paper. The following figure provides a conceptual representation of the three formulas.

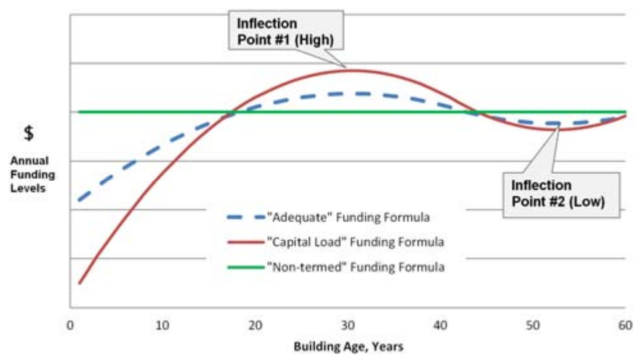


Figure 3: Annual funding requirements returned by the three alternative formulas

The horizontal (x-axis) indicates the advancing age of the building (1-50 years) and the vertical (y-axis) indicates the annual funding levels recommended by each formula.

### 5.1 "Capital Load" Formula

This formula sums the value of all capital projects that are forecast to occur over the planning horizon (30 years), typically in future values (FV) and then divides the results by the planning horizon. In other words, the load is divided into the load period. For example, if all projects in future values add up to $30 Million and it is divided into a 30 year planning horizon, the owners need to set aside $1 Million per year.

This model is quick to generate and it considers both escalation and unfunded liability as a portion of the funding requirements. Depending on the age of the facility the funding requirements can fluctuate significantly. This model works best for young buildings and with asset frequencies that divide equally into the planning horizon, such as intervals of 2, 3, 5, 6, 10, 15 years.

While this formula provides a linear funding trajectory, it fails to recognize that projects are distributed unevenly across the 30-year horizon and, therefore funding may not be adequate at certain years due to the close proximity to certain projects. This model misrepresents renewal activities that have a frequency that does not divide equally into the planning horizon (30 years), such as projects at 20 or 25 year intervals.

The summary of funding attributes for this formula is provided in the table below.

| | Variables or Parameters | Formula |
|---|---|---|
| 1 | Termed vs. Continuous | Termed (30 years) |
| 2 | Inflated vs. Non-inflated | Future Values (FV) |
| 3 | Proximity vs. Non-proximity | Non-Proximity |
| 4 | Linear vs. Lumpy | Linear |
| 5 | Funding vs. Funded | Funding ($ per year) |
| 6 | Catch-up Costs vs. Keep-up Costs | Keep-up and Catch-up (one formula) |

Table 1: Funding Parameters for the Capital Load Model

This fist method was considered too simplistic for quantifying the unfunded liability for the purposes of meaningful and realistic benchmark analysis.

### 5.2 "Non-Termed" Formula

The second formula determines funding requirements for a building by calculating each renewal activity divided by its frequency. For example, a boiler replacement every 10 years (Frequency) at $10,000 (Current Value) must be funded at $1,000 per year. The following equation is a summation notation collected for each Renewal Activity.

$$\sum \mathbf{Cost_o / F}$$

Where,

$Cost_o$ Current Value (CV) of Renewal Activity
F Frequency of the Renewal Activity

In order to determine the unfunded liability, it is necessary to calculate the total funds that should be contained in the reserve account at the base year. For example, if the boiler, noted above is in its 5th year, then the reserve account should contain $5,000. The difference between the amount calculated and the amount that has accumulated in the reserve account is considered the unfunded liability. The following equation is required to determine the amount that should be in the reserve account at the base year.

$$\sum \mathbf{(Cost_o / F) \times (F - (EY - BY))}$$

Where,

$Cost_o$ Current Value (CV) of Renewal Activity
F Frequency of Renewal Activity.
EY Event Year, year of Renewal Occurrence
BY Base Year, year when the QTO was taken

This formula is not impacted by the planning horizon or the time value of money. The summary of funding attributes for this formula is provided in the table below.

| | Variables or Parameters | Formula |
|---|---|---|
| 1 | Termed vs. Continuous | Continuous |
| 2 | Inflated vs. Non-inflated | Current Values |
| 3 | Proximity v. Non-proximity | Non-Proximity |
| 4 | Linear vs. Lumpy | Linear |
| 5 | Funding vs. Funded | Funding ($ per year) |
| 6 | Catch-up Costs vs. Keep-up Costs | Keep-up and Catch-up (two formulas) |

Table 2 Funding Parameters for the Non-Termed Model

This second method was considered inadequate for the benchmark analysis as it does not recognize the passage of time.

### 5.3 "Adequate Reserve" Formula

The third formula evaluates each renewal activity divided by the frequency of the renewal activity or the length of the planning horizon, whichever is less, and also accounts for escalation. For example, a boiler replacement every 10 years (Frequency) at $10,000 (Current Value), escalated (at 2%) is $12,190, and should be funded at $1,219 per year.

Renewal activities with a frequency greater than 30 years may be included or excluded from the formula depending on whether the next renewal occurrence is inside or outside the planning horizon, which will depend on the age of the building. The following equation is for each renewal occurrence.

$$\sum \mathbf{IF\{EY > PH+BY, 0, Cost_y / [IF(F > PH, PH, F)]\}}$$

Where,

$Cost_y$ Future Value of Renewal Event
EY Event Year, year of Renewal Occurrence
BY Base Year
PH Planning Horizon (30 Years)
F Frequency of the Renewal Activity

Similar to the Non-Termed formula, the following formula is used to determine the amount that should be in the reserve account at the base year.

$$\sum \mathbf{IF\{EY > PH + BY, 0, (Cost_y / [IF(F > PH, PH, F)]) \times ([IF(F > PH, PH, F)]) - (EY - BY))\}}$$

Where,

$Cost_y$ Future Value of Renewal Event
EY Event Year, year of Renewal Occurrence
BY Base Year
PH Planning Horizon, 30
F Frequency of the Renewal Activity

The combination of both equations provides the funding requirements moving forward (keep-up) and the unfunded liability looking backwards (catch-up). This model will fluctuate through the life of the building as capital renewal projects that are initially beyond-the-horizon come into the planning horizon.

The summary of funding attributes for this formula is provided in the table below

| | Variables or Parameters | Formula |
|---|---|---|
| 1 | Termed vs. Continuous | Termed (30 years) |
| 2 | Inflated vs. Non-Inflated | Future Values (FV) |
| 3 | Proximity v. Non-Proximity | Non-Proximity |
| 4 | Linear vs. Lumpy | Linear |
| 5 | Funding vs. Funded | Funding ($ per year) |
| 6 | Catch-up Costs vs. Keep-up Costs | Keep-up and catch-up (two formulas) |

Table 3: Funding Parameters for the Adequate Reserve Model

This third method was selected for the analysis as it respects a planning horizon and escalation.

# 6 Normalization of the Data

The data from the 600 buildings was normalized to provide meaningful benchmarking for comparative purposes, recognizing differences in construction type, size, shape, age, value of the building, geographical location, and other factors.

## 6.1 Building Types

Firstly, the buildings were grouped into three broad facility classes: a) high rise buildings (HR); b) low-rise buildings (LR; and c) townhouse complexes ("TH"). More refined classes that contemplate mixed-used and mixed-densities were not considered at this time.

The following table provides a summary of building counts and average values for each of the three building classes.

| Physical Attributes | All | HR | LR | TH |
|---|---|---|---|---|
| Building Count | 598 | 217 | 247 | 134 |
| Asset Count, average | 66 | 76 | 68 | 47 |
| Building Age, average (years) | 19 | 16 | 23 | 18 |
| Gross Floor Area, GFA, averages, thousands | | | | |
| - In square metres | 12 k | 19 k | 8 k | 9 k |
| - In square feet | 130 k | 208 k | 84 k | 96 k |
| Cost of Reproduction New (CRN), average, $ Millions | 25.04 | 44.82 | 14.83 | 15.09 |
| Suites, average | 85 | 132 | 63 | 55 |

Table 4: Building Attributes, Averages

To illustrate the significant amount of real estate that was analyzed in the longitudinal study, the next table provides the total values for each of the three building classes.

| Physical Attributes | All | HR | LR | TH |
|---|---|---|---|---|
| Gross Floor Area, GFA, totals, millions | | | | |
| - In square metres | 7.3 | 4.2 | 1.9 | 1.2 |
| - In square feet | 78.7 | 45.1 | 20.7 | 12.9 |
| CRN, total, $ Billions | 15.4 | 9.73 | 3.66 | 2.02 |
| Suites, total, thousands | 51.5 | 28.6 | 15.6 | 7.4 |

Table 5: Building Attributes, Totals

## 6.2 Building Reproduction Values

Secondly, the normalization process included cross-referencing of the annual funding forecasts, derived by the Adequate Reserve formula, against the Cost of Reproduction New (CRN) for each building. CRN is defined as follows:

> *The cost of construction, at current prices, of an exact duplicate, or replica facility, using the same materials, construction standards, design, layout, and quality of workmanship, and embodying all of the deficiencies, superadequacies, and obsolescence of the subject building.*

The value of the land is not included in Cost of Reproduction New.

## 6.3 Building Ages, Life-Cycles and Life-Stages

Thirdly, the buildings were grouped into life-stages based upon their age at the base year. The team utilized its experience with asset deterioration models to identify the types of projects and scale of projects at different life-stages during the first 50-year life-cycle of a building, as follows:

- Life-stage 1 (less than 1 year) where warranties are still active on all assets;
- Life-stage 2 (2-16 years) where short-life assets, typically of low value, are renewed;
- Life-stage 3 (17-30 years) where projects such as roof renewals and boiler retrofits are most common;
- Life-stage 4 (31-50 years) where significant capital costs are usually incurred; and
- Life-stage 5 (51+ years) where the building has completed most of the renewal projects.

The five life-stages together represent one life-cycle of a building. The team expects that most residential buildings in BC will continue to operate through multiple life-cycles. The necessary and sufficient maintenance during the first life-cycle (years 1-50) will prepare the owners for the 2$^{nd}$ life-cycle (years 51-100).

The following figure provides a graphically representation of the age distribution of the 600 buildings within each life-stage.

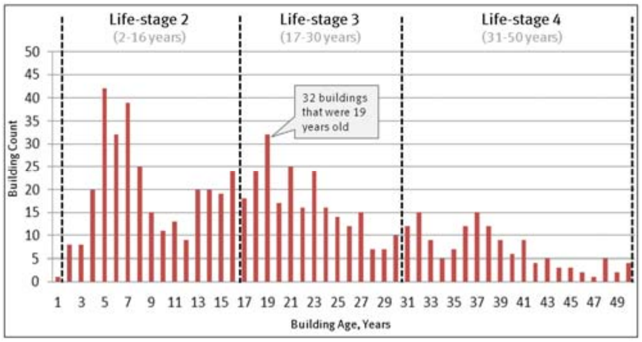


Figure 4: Age distributions within each of the five life-stages over the first 50-year life-cycle

The data set is considered to be a representative sample of the approximate 28,000 condominium buildings in British Columbia.

## 7 Benchmarking the Unfunded Liability

The data for each building was collected independently, merged into a central database and represented on a scatter plot alongside other buildings of the same class. The data was evaluated and the best fit curve was determined to be a polynomial-order 2. Each point on the scatter plot represents a single building or, in some cases, a group of buildings that form one condominium ownership structure. The horizontal axis represents time from year 1 to year 50. The vertical axis indicates annual funding requirements.

The polynomial curve for each of the three data sets provides the average percentage of the Cost of Reproduction New (CRN) for buildings of any given age from 2 to 50 years. For example, in the figure below, a building that is 8 years old (along the x-axis) should be funding its reserve account at approximately 0.7% of CRN per year.

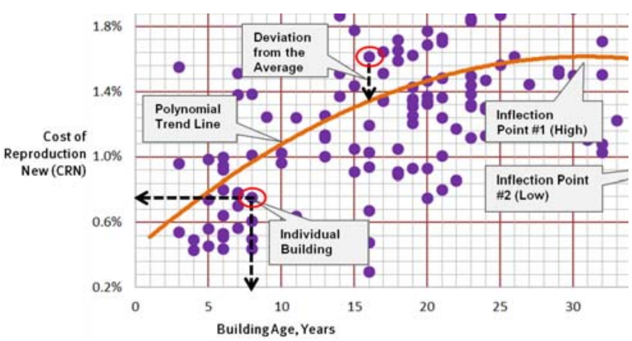


Figure 5: Cross-referencing of building age (x-axis) with average annual funding forecast (y-axis) per CRN

Statistical outliers, either above or below the polynomial trend line, have been validated for a variety of reasons, such as premature failure of a significant asset, economies of scale achieved with different architectural configurations, and robustness of materials used.

Each 50-year life-cycle of a building is represented by a pattern of funding over that life-cycle which increases to a high point (inflection year #1) and then decreases to a low point (inflection year #2). The first high-point inflection on the curve indicates the increasing funding requirements to enable the owners to effectively complete the most significant projects, within life-stage 4 (years 31-50). As the owners move beyond life-stage 4, funding requirements are lower and the 2nd life-cycle commences (years 51-100), albeit at a higher level that includes escalation.

### 7.1 High-Rise Buildings

The high-rise class of buildings have some unique attributes, including a larger number of assets, specialized safety assets such as emergency generators, and assets to move fluids longer distances such as booster pumps. Within the high-rise dataset of 217 buildings, the information is represented on the following scatter plot.


Figure 6: Annual "Adequate Reserve" funding forecasts relative to Cost of Reproduction New (CRN)

The kurtosis of the polynomial curve is relatively "flat" (platykurtic) with a curve delta of approximately 0.6% over the 50 year evaluation period. The polynomial curve has a negative skewness, where the curve starts at 0.6% of CRN and increases to 1.24% of CRN around year 34 (the point of inflection). The sampling of the high-rise data is not optimal above 30 years. The following table includes a summary of the data from the high-rise scatter plot.

| | High-Rise Attributes | Values |
|---|---|---|
| 1 | Building count | 217 |
| 2 | Delta, min.<br>Delta, max. | 0.22 % of CRN<br>2.25 % of CRN |
| 3 | Average | 0.97 % of CRN |
| 4 | Inflection year – 1st (high)*<br>Inflection year – 2nd (low) | At year 34<br>≈ year 50 (est.) |
| 5 | Life stage 1 (<1 year)<br>Life stage 2 (2-16 years)<br>Life stage 3 (17-30 years)<br>Life stage 4 (31-50 years)*<br>Life stage 5 (51+ years) | Not applicable<br>0.87 % of CRN<br>1.13 % of CRN<br>1.18 % of CRN<br>Insufficient data |
| 6 | Funding levels at Base Year, average (keep-up) | 0.23 % of CRN |
| 7 | Unfunded liability at Base Year, average (catch-up) | 13.07 % of CRN |

Table 6: High-rise building attributes

While high-rise buildings have funding requirements for projects of greater absolute cost they can sometimes leverage economies of scale that offset these larger amounts to levels comparable with the other building classes.

Funding requirements for high-rise buildings increase incrementally across life-stages 2, 3 and 4 with a high point (inflection #1) around their 34th anniversary. It is expected, based on the life-cycle model, that funding requirements will decrease in Life-Stage 5 with a low point (inflection #2) in around their 50th anniversary.

### 7.2 Low-Rise Buildings

The low-rise class of buildings is the most diverse of the three classes. Firstly, variability arises due the use of both types of construction: combustible (wood frame) and non-combustible (concrete). Secondly, the architectural configurations include a single building on a site and multiple buildings on a site. Thirdly, different floor plate geometries. Heritage buildings, which are always low-rise and usually over 100 years old, were not included in the data set at their original age but rather at the age of conversion to a condominium. The figure below provides a scatter plot of the data for 247 low-rise buildings.

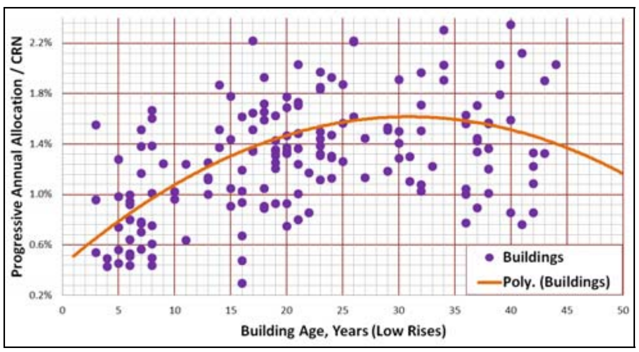


Figure 7: Annual "Adequate Reserve" funding forecast relative to Cost of Reproduction New (CRN)

The kurtosis of the polynomial curve has a "normal" distribution (mesokurtic) with a curve delta of approximately 1.1% over the 50 year evaluation period. The dispersion of the data is significant compared to the high-rise building class. The distribution of buildings for the low-rise data set is consistent across all age cohorts. The polynomial curve has a light negative skewness, which starts below 0.6% of CRN and increases until 1.64% of the CRN in year 31 (the point of inflection). The following table includes a summary of the data from the low-rise scatter plot.

| | Low-Rise Attributes | Values |
|---|---|---|
| 1 | Building count | 247 |
| 2 | Delta, min. % CRN<br>Delta, max. % CRN | 0.30 % of CRN<br>4.39 % of CRN |
| 3 | Average | 1.36 % of CRN |
| 4 | Inflection year - high<br>Inflection year - low | At year 31<br>≈ year 50 (est.) |
| 5 | Life stage 1 (<1 year)<br>Life stage 2 (2-16 years)<br>Life stage 3 (17-30 years)<br>Life stage 4 (31-50 years)<br>Life stage 5 (51+ years) | Not applicable<br>0.97 % of CRN<br>1.55 % of CRN<br>1.52 % of CRN<br>Insufficient data |
| 6 | Funding level at Base Year, average (keep-up) | 0.26 % of CRN |
| 7 | Unfunded liability at Base Year, average (catch-up) | 15.10 % of CRN |

Table 7: Low-rise building attributes

The low-rise buildings are relatively more expensive to maintain than the high-rises as they do not enjoy the same economies of scale.

### 7.3 Townhouse Complexes

The townhouse class of buildings have some unique attributes, such as the exclusion of a central mechanical plant, larger areas of site work, and significant buried infrastructure relative to the other two building classes. The figure below provides a scatter plot of the data for the 134 townhouse complexes.

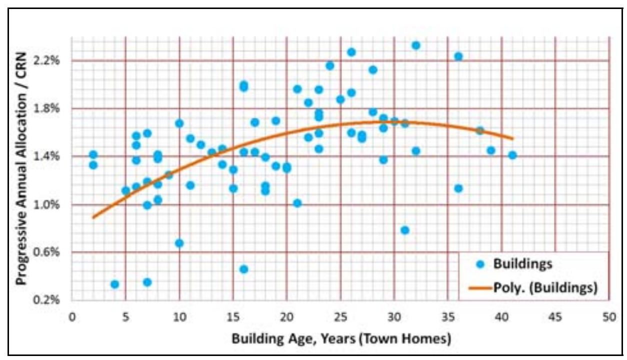


Figure 8: Annual "Adequate Reserve" Funding Forecasts relative to Cost of Reproduction New (CRN)

The kurtosis of the polynomial curve for townhouse complexes has a "normal" distribution (mesokurtic) with a curve delta of approximately 0.9% over the 50 year evaluation period. The polynomial curve has the least skewness of the three building classes as it starts below 1.0% of CRN and increases to 1.72% of CRN in year 29 (the point of inflection).

While there are some statistical outliers, these are accounted for by unusual conditions at certain buildings. The data contains a good distribution of building cohorts ranging from 2-year to 40-year old buildings. The following table includes a summary of the data from the townhouse scatter plot.

| | Townhouse Attributes | Values |
|---|---|---|
| 1 | Building count | 134 |
| 2 | Delta, min.<br>Delta, max. | 0.10 % of CRN<br>2.84 % of CRN |
| 3 | Average | 1.47 % of CRN |
| 4 | Inflection year – high<br>Inflection year - low | At year 29<br>≈ year 50 (est.) |
| 5 | Life stage 1 (<1 year)<br>Life stage 2 (2-16 years)<br>Life stage 3 (17-30 years)<br>Life stage 4 (31-50 years)<br>Life stage 5 (51+ years) | Not applicable<br>1.22 % of CRN<br>1.67 % of CRN<br>1.56 % of CRN<br>Insufficient data |
| 6 | Funding levels at Base Year, average (keep-up) | 0.24 % of CRN |
| 7 | Unfunded liability at Base Year, average (catch-up) | 19.26 % of CRN |

Table 8: Townhome complex attributes

Of the three building classes, the townhouse complexes have the highest funding requirements relative to their CRN. This is a reflection of the significant in-ground infrastructure and the larger roof, wall and glazing areas relative to each unit.

### 7.4 Comparison of Funding Levels by Building Class

There are many commonalities in the funding requirements for all three classes of buildings. However, there are some trend analyses that can be made, particularly at different life stages. The following table summarizes the trend data for the three building classes.

| | Attributes | HR | LR | TH |
|---|---|---|---|---|
| 1 | Building Count | 217 | 247 | 134 |
| 2 | Delta, min.<br>Delta, max. | 0.22<br>2.25 | 0.30<br>4.39 | 0.10<br>2.84 |
| 3 | Average | 0.97 | 1.36 | 1.47 |
| 4 | Inflection years | 34 | 31 | 29 |
| 5 | Life stage 1 (<1 year)<br>Life stage 2 (2-16 years)<br>Life stage 3 (17-30 years)<br>Life stage 4 (31-50 years)<br>Life stage 5 (51+ years) | -<br>0.87<br>1.13<br>1.18<br>- | -<br>0.97<br>1.55<br>1.52<br>- | -<br>1.22<br>1.67<br>1.56<br>- |
| 6 | Funding levels, pre review, % of CRN (keep-up) | 0.23 | 0.26 | 0.24 |
| 7 | Unfunded liability accumulating per annum, % of CRN | 0.76 | 1.12 | 1.22 |
| 8 | Funding levels, post review, % of CRN (keep-up) | 0.39 | 0.58 | 0.43 |
| 9 | Unfunded liability % of CRN, (catch-up), | 13.07 | 15.10 | 19.26 |

Table 9: Financial attributes by building class

Using the high-rise building dataset as an example, the average high-rise building was setting aside approximately 0.23% of its CRN each fiscal year (as of 2012 base year) in preparation for long-range capital projects over a 30-year planning horizon (to terminus year 2041). The Adequate Reserve funding formula indicates that the high-rise buildings should ideally be appropriating 0.97% of CRN each year. Therefore, the high-rise unfunded liability is increasing by 0.74% of CRN per annum.

### 7.5 Changes Since Introduction of Legislation

In the two years since the introduction of the reserve study legislation in British Columbia, it has been observed that the average funding levels have started to increase for all three building classes, in some cases up to 100% of the original investment. By increasing the funding levels and reducing the unfunded liability levels, the condominium sector in British Columbia is accumulating significant monies in its reserve accounts. The local statutes govern that the monies must be invested in insured accounts with savings institutions in British Columbia. Management of these reserve funds is a significant undertaking that can further reduce the unfunded liability levels by leveraging the benefits of interest income accruing in the reserve accounts.

### 7.6 Comparison with other Real Estate Sectors

Annual facility investment guidelines have been published since the mid-1990s by various North American agencies, including post-secondary educational institutions, military facilities and civic facilities [4,5,6,7]. Essentially these guides indicate annual investment requirements ranging from 0.9% to 3.5% of CRN. The longitudinal study on residential buildings in British Columbia has confirmed average ranges from 0.97% to 1.47% of CRN.

### 7.7 The Efficacy of Financial “Rules of Thumb”

Building owners, managers and operators should be cautioned that the financial “rules of thumb” derived from this study cannot be applied universally to all buildings as there is significant variability amongst buildings within each class. While the data is considered to be supported by a rigorous methodology, including technical peer review, and provides useful statistical averages for global funding requirements to assist owners and operators in establishing long-range funding needs, it does not replace the need for a reserve study to reflect the behaviour of the assets and project planning at individual buildings. This is further reinforced by the fact that a compliant reserve study in BC must include both an expenditure plan (i.e., “*How much money will we need?*”) and a funding plan (i.e. “*How much money will we have?*”). An optimal program for a building will synchronize the inflows with the outflows, recognizing the unfunded liability of the subject building as of its base year (“catch-up”) and its trajectory over the planning horizon (“keep-up”).


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