The Moloney Financial Model

An Outline of the modelling methodology

September 2015

1.0 The aim of this document

To provide an understanding of the basis of the Moloney model its assumptions, input requirements and primary outputs.

It is not intended as a manual for the use of the software but rather a very simple explanation of the mechanics behind the model.

2.0 Input Requirements

The basic input requirements are as detailed below.

1. Present Condition of the assets - Input as a Condition Distribution
2. Performance of the assets with time - Input as a Degradation of Performance Curve
3. Replacement cost of the assets when they become due for renewal
4. Level of Service required - or at what condition point you wish to renew the assets

With all of the above information assembled it really becomes a mathematical exercise to undertake the financial modeling and that is all that the Moloney model does.

3.0 The Two Modelling paths

There are two distinct modelling paths within the Moloney Model.

1. Model 1 - Predicts future condition based on a proposed Expenditure pattern
2. Model 2 - Predicts Future Renewal Demand based on desired condition outcome

The model is a whole of asset set model that predicts the financial performance of the entire asset set. It does not attempt to predict the performance of an individual asset within an asset set. For example you may have 3000 individual assets within an asset set. The model predicts the financial performance of the whole asset set but not any one of the 3000 individual components.

4.0 Present condition of the assets - Condition Distribution

The model required the present condition of the assets to be in a specific format. That format is a 0 - 10 condition rating scale with 0 (no faults) or a brand new asset, through to condition 10 where there would be no remaining value within the asset.

The individual condition ratings for the assets are best established via a condition inspection. But if this is impractical or not available it could be established based on the age of the assets. The Moloney software also has inbuilt condition distributions for a range of overall asset conditions and asset types as listed below

- Very good
- Good
- Above average
- Average
- Below Average
- Poor

It is felt that all assets can be rated on this simple system and it should also align neatly with the ratio of the replacement value to the present value of the assets as used for accounting purposes.

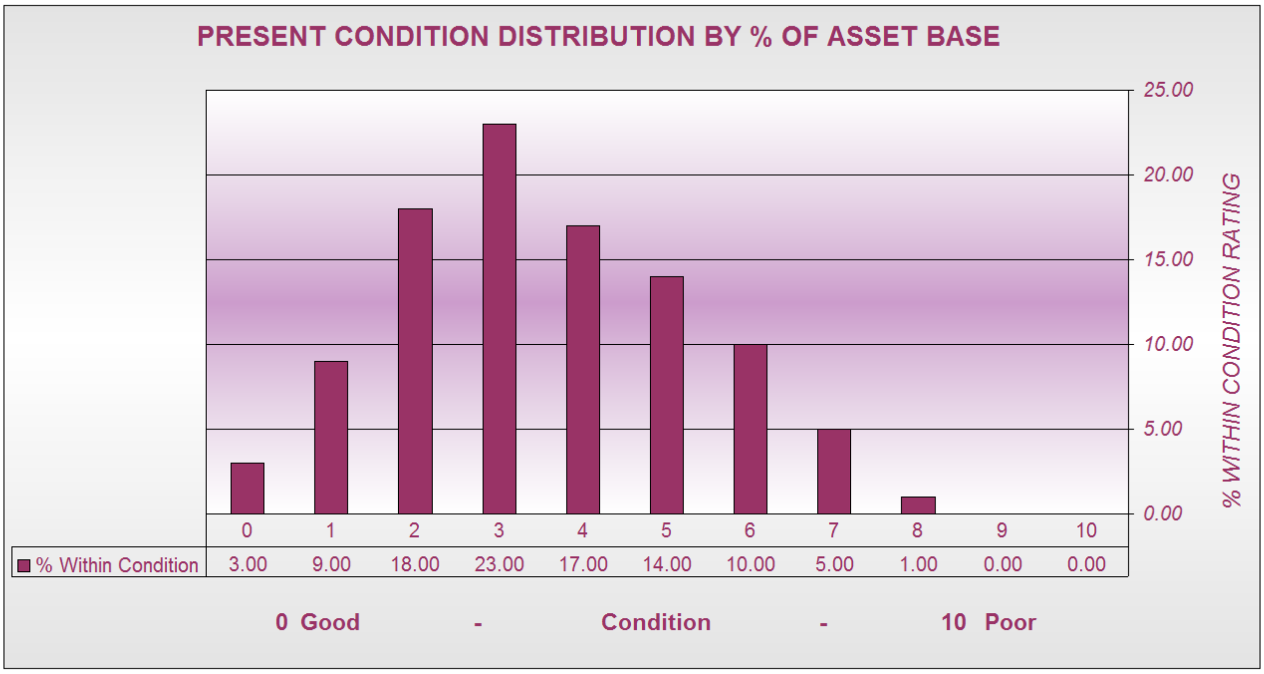


Figure 1 Example of a 0 - 10 condition Distribution

The condition of the assets is entered into the system as the percentage of the total asset base within each of the eleven possible condition rating scales 0 -10. Within the example above there are 3% of the assets in condition zero, 9% in condition 1, 18% in condition 2 etc. The total percentage MUST add up to 100.

The condition distribution is a really good way to view the overall condition of the assets. For large numbers of long life assets built over a long period Figure 1 is what would be expected (a normal distribution). The shape of the condition distribution in many cases a strong indicator of how sound the condition information is.

5.0 Degradation curve - Performance of assets with time

The degradation curve attempts to simulate the performance of an average asset from new condition in year zero through to the end of its life in condition 10. Figure 2 below indicates that on average an asset within this asset class would commence at condition zero in year zero and take 3 years to reach condition 1 and 12 years to reach condition 2 through to 80-years to reach condition 10.

The degradation curve represents the performance of an average asset. Some will degrade quicker some slower. The average performance is best developed by analysing the change in condition between two condition surveys some years apart.

For example, if two condition assessments were undertaken 2-year apart and half of the assets that were in condition zero degraded to condition 1 over that period then the average time for an asset to remain within condition zero before it degraded to condition 1 would be 4 years. And if we wanted to simulate the passage of time on the assets into the future we would degrade 25% of the condition zero assets up to condition 1 every year.

Unique degradation curves developed via an analysis of condition change between two surveys some years apart, will deliver a really strong means of simulating the affect of time on the assets. In an indirect way the degradation curve takes all variables into account in that it simply measures the rate of degradation in the past and so, can then be used to predict future performance when we have the average number of years spent within each condition rating.

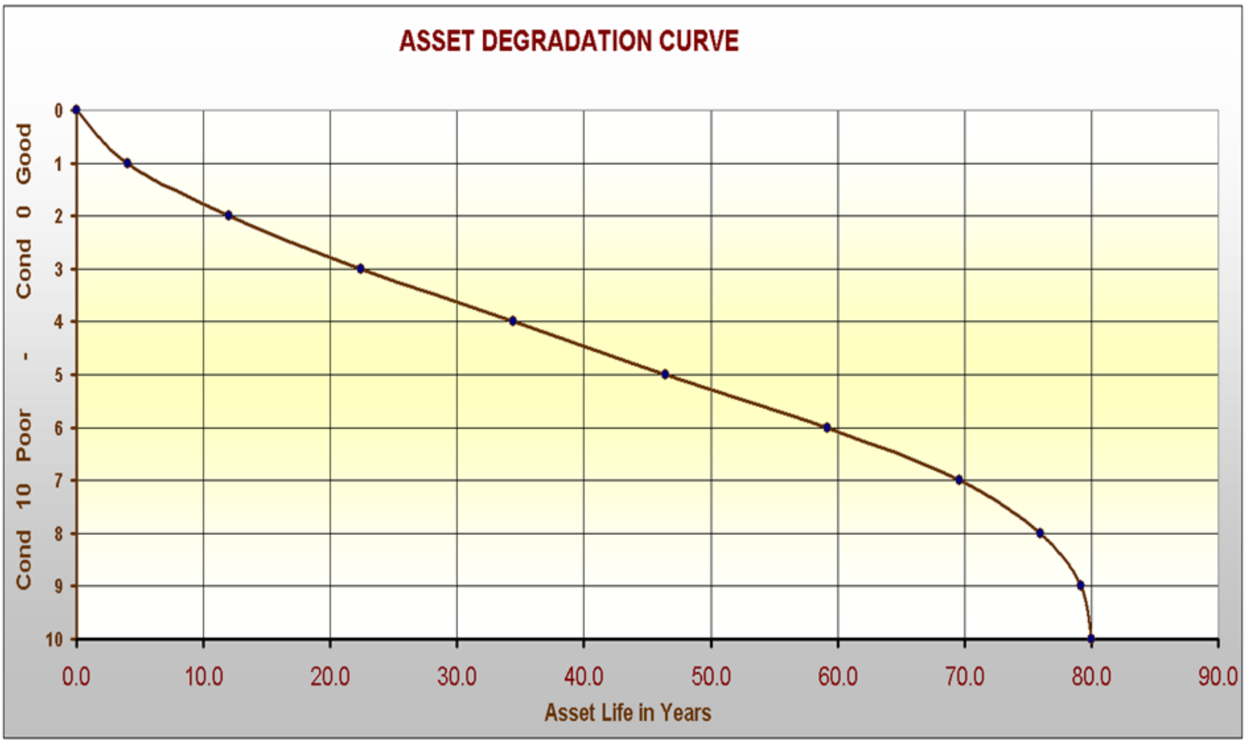


Figure 2 Example of a Degradation Curve

Figure 2 provides a profile of the expected degradation of the average asset within an asset set. The degradation curve is used within the model by taking the average number of years that an asset is expected to remain within each condition rating, dividing that into 100 and then degrading that percentage of the assets each year across the whole condition range.

Condition Factor 0 Good 10 Bad	Expected Life in Years Within Condition	Percentage of Total Asset Life within Cond. Rating
9	0.8	1.0
8	3.2	4.0
7	6.4	8.0
6	10.4	13.0
5	12.8	16.0
4	12.0	15.0
3	12.0	15.0
2	10.4	13.0
1	8.0	10.0
0	4.0	5.0
Years to Cond 10	80.0	100.0
Years to Intervention	76.0	

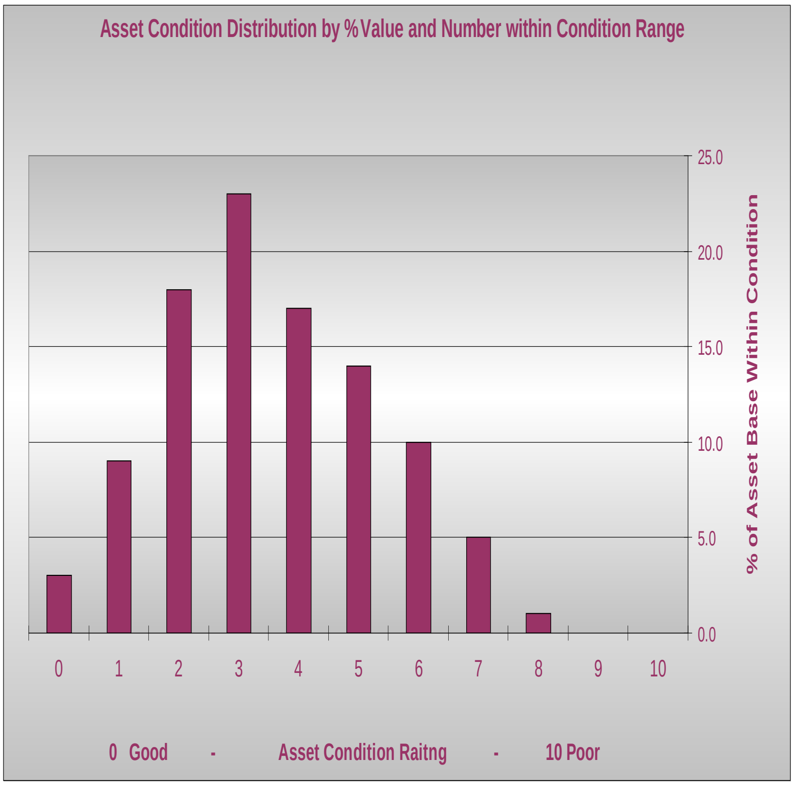
Figure 3 Degradation curve in Table format

Figure 3 is a tabular representation of the same degradation curve as in Figure 2. Towards the bottom of the table it can be seen that there are on average 4 years of life for a new asset commencing at condition zero before it jumps to condition 1, and 8 - years within 1 before it jumps to 2. The percentage of the total life within each condition is recorded in the right column so that the total life (in this case 80-years) can be amended to generate new expected lives (in years) in the centre column.

Note that the total life of 80-years is to reach condition 10. In practice it is rare to allow an asset to reach the absolute end of the condition range and it will often be renewed or replaced when it reaches the 7 - 9 range. In this case it is planned to be replaced at condition 8 thus the total service life (or life to intervention) is recorded as 76.0 - years at the bottom of the table. That is we do not use the life within condition 8 and 9 as the assets are planned to be renewed once they reach condition 8.

6.0 Model 1 - Predicted condition from a Proposed Expenditure

This model predicts the future asset condition based on the planned renewal expenditure profile.



The Modelling Process Model 1

1. Commence with the present condition distribution on the left as per Figure 4
2. Apply the degradation curve to the condition distribution and degrade assets each year
3. Select a proposed renewal expenditure profile and retreatment intervention level
4. The model predicts the future condition of the assets.
5. Future condition can be expressed in a number of ways but the most useful is the movement in the extent of over intervention assets.

Figure 4 Model No 1 Summary of Process

6.1 Commencing point for Model No 1

The commencing point for both models is the present condition distribution of the asset set as detailed within Figure 4 above

6.2 Applying the degradation curve

In the degradation curve within Figures 2 and 3 above we have 4-years of life on average for an asset within condition zero. Hence the model degrades 1/4 or 25% of the condition zero assets into condition 1 each year. There is an average life of 8-years within condition 1 so the model degrades 1/8 or 12.5% of the condition 1 assets into condition 2 each year. This goes on across the whole condition range for the full 50-years of the modelling capacity.

6.3 Select a proposed renewal expenditure profile and Intervention level

The renewal expenditure that you wish to allocate each year is selected. This can vary year to year based on available funding, or it can be a flat expenditure for the whole modelling period. Within Figure 5 the selected renewal expenditure profile commenced at $400,000 pa and then is raised by 2% compounding for 15-years. Just to demonstrate that the profile is fully user definable there was a one off higher planned expenditure of $800,000 in 2030.

Then the retreatment intervention level that you want is selected. Normally within the 7 - 9 range. This is the asset condition at which you consider the asset should be replaced or rehabilitated. In this case condition 8 has been selected.

6.4 The model predicts the future condition of the assets.

The model does have a few condition indicators that can be tracked (see the Model All File) but the most useful is considered to be the extent of the asset base that is predicted to rise above the selected intervention level. (Or the extent of the asset base that is considered to be unserviceable)

The commencing extent of over intervention assets is initially taken directly from the present condition distribution in Figure 4. In this case an intervention level of condition 8 has been adopted and there is 1% in condition 8. Thus the commencing extent of over intervention assets is 1% as recorded at the top of figure 5.

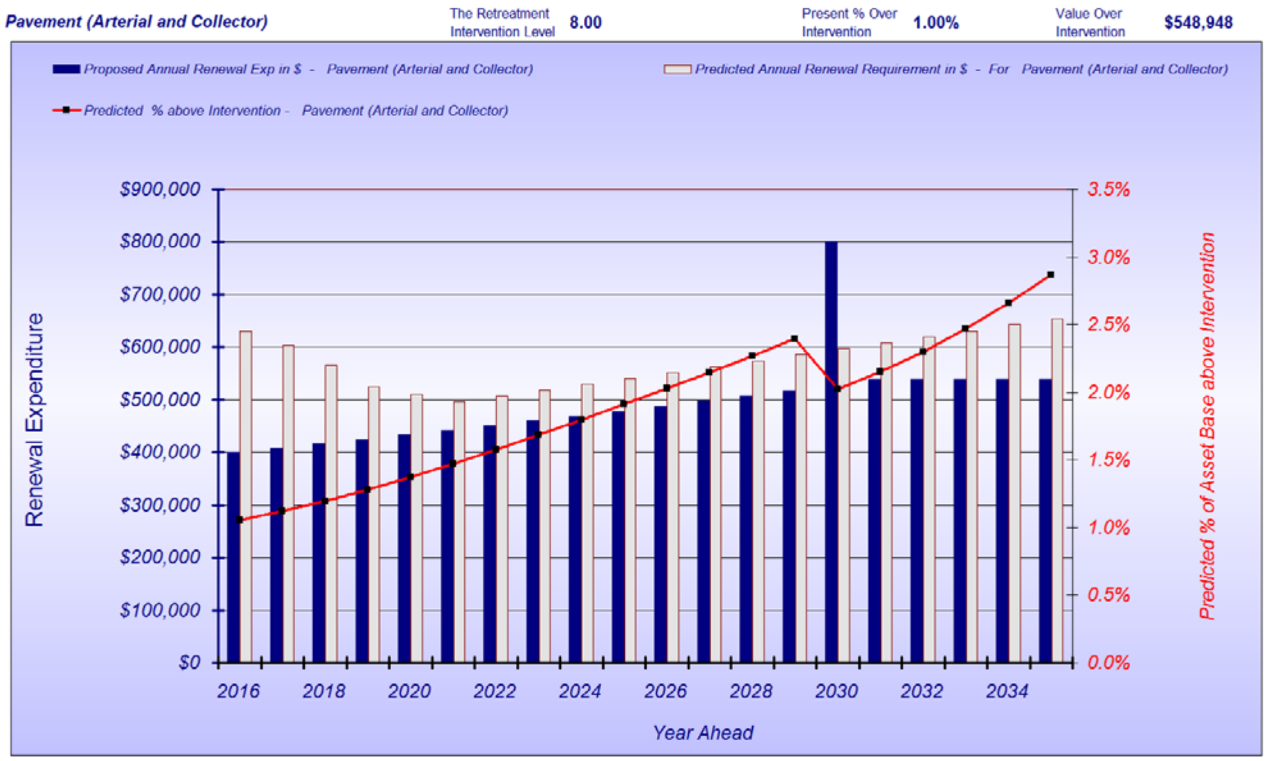


Figure 5 Model No 1 - Predicted condition from proposed Expenditure profile

Figure 5 is one of the strongest graphs within the Moloney modelling system. It plots 3 series

- The Blue Bars: Represent the planned renewal expenditure profile
- The red Line: Is the predicted extent of the asset base that will rise above the intervention level based upon the adoption of the planned renewal expenditure profile (blue bars).
- The Grey bars: These don't really belong to this model and are in fact the results for model No 2. They represent the expenditure necessary to have no asset over the intervention level. The results are provided here for comparison purposed. See Section 7 for more details.

Note that year 1 in the graph is always the year after the current year (next year). It is the first reporting year after the present year and gives the condition results based on one years worth of degradation and one years planned renewal expenditure. In this cast the planned renewal expenditure is less than expenditure required to treat all assets that reach the intervention level and so the extent of over intervention assets has risen to 1.05%. The commencing year of reporting can be brought forward or back (see cell B32 on the "Modelling Variables Sheet of the Model All" file for details).

6.4 Model 1 Summary

The model commenced with the present condition distribution of the asset set. It then degraded the assets year by year based upon the adopted degradation curve. At the same time it takes off the value of the poorest condition asset annually corresponding to your planned renewal expenditure profile and returns them as new assets in condition zero.

The primary predicted condition output is the extent of the asset base that is predicted to be over the selected intervention level. (Spend high and it will drop. Spend low and it will rise).

There are other condition outcomes such the predicted condition distribution in a selected future year. Figure 6 below is an example of the predicted condition distribution in 10-years based on the above data set.

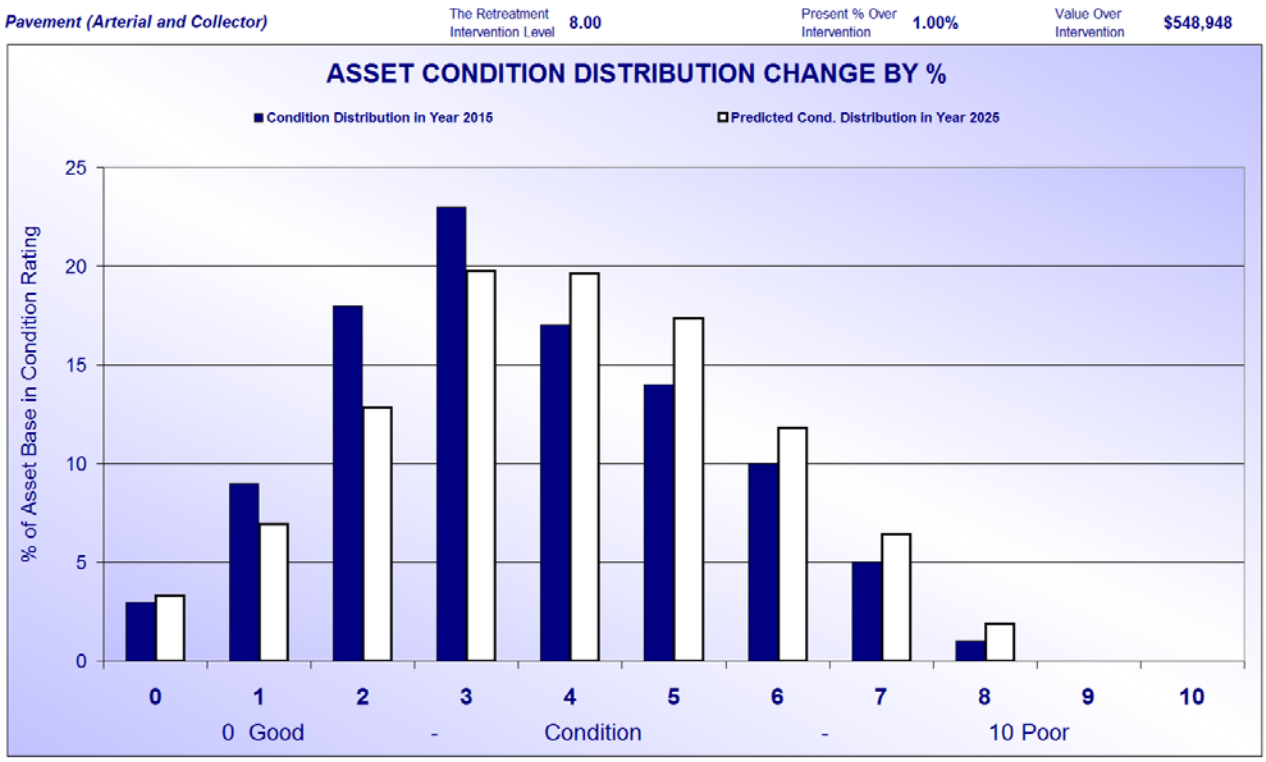


Figure 6 Model No 1 - Predicted condition from proposed Expenditure profile

Note that the planned expenditure is a little less than the required expenditure and as a consequence after 10-years the predicted condition distribution has all moved across to the poorer side and it is predicted that the extent of over intervention assets will be 1.91%

7.0 Model 2 - Predicted future renewal demand

The results of this model have already been displayed within the grey bars in figure 5 above. We could have left them out and just displayed the other 2 series but the addition of the predicted capital requirement profile does assist in an understanding of Model No 1.

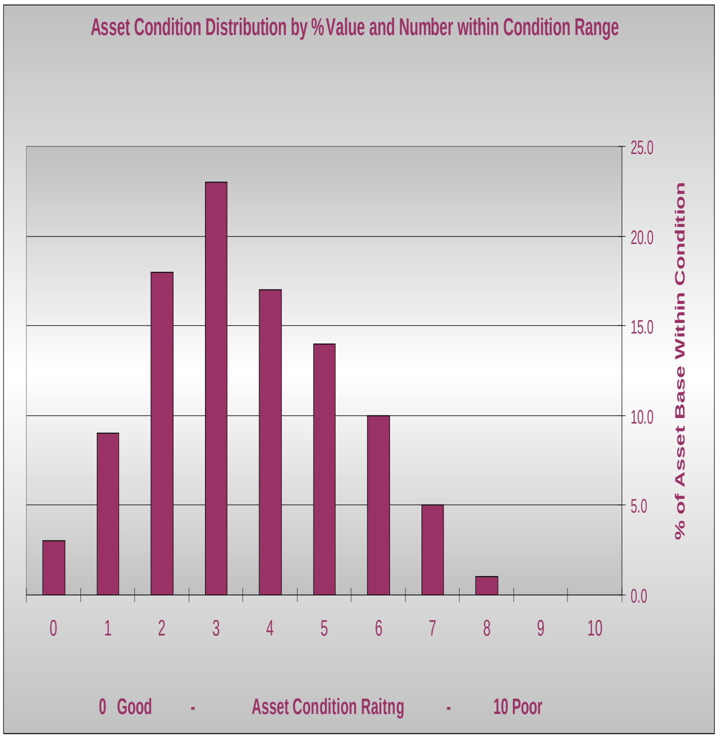


Figure 7 Model No 2 Summary of Process

The Modelling Process Model 2

1. Commence with the present condition distribution on the left as per Figure 4
2. Apply the degradation curve to the condition distribution and degrade assets each year
3. Select a retreatment intervention level
4. The model degrades the assets annually
5. The asset value that reach the intervention level through the degradation process are returned as new assets and the model output is the annual renewal expenditure necessary to keep all assets below intervention.

7.1 Commencing point for Model No 2

As with model 1, this model commences with the present condition distribution of the assets.

7.2 Applying the degradation curve

Exactly the same as 6.2 above

7.3 Select an Intervention level

The same as part of 6.3 above. If you are operating with this model alone then you don't need a planned expenditure profile. The intervention level can be seen as the level of service that is planned. Note also that it can be a decimal eg 7.8.

7.4 The model predicts the renewal expenditure demand

The model predicts the renewal expenditure pattern that will keep all assets below the selected intervention level. It does this by applying the degradation curve to the present condition distribution and taking off the value of the assets that reach the intervention level each year. These are then returned as condition zero assets, as the model assumes that the funding demand is been met annually.

The primary output is as detailed within figure 8 below. This is a graph of the predicted annual renewal expenditure requirement that will keep all assets below the intervention level. The intervention level does not have to be an integer it can be a decimal and the model apportions the demand on a linear basis between the two relevant condition ratings

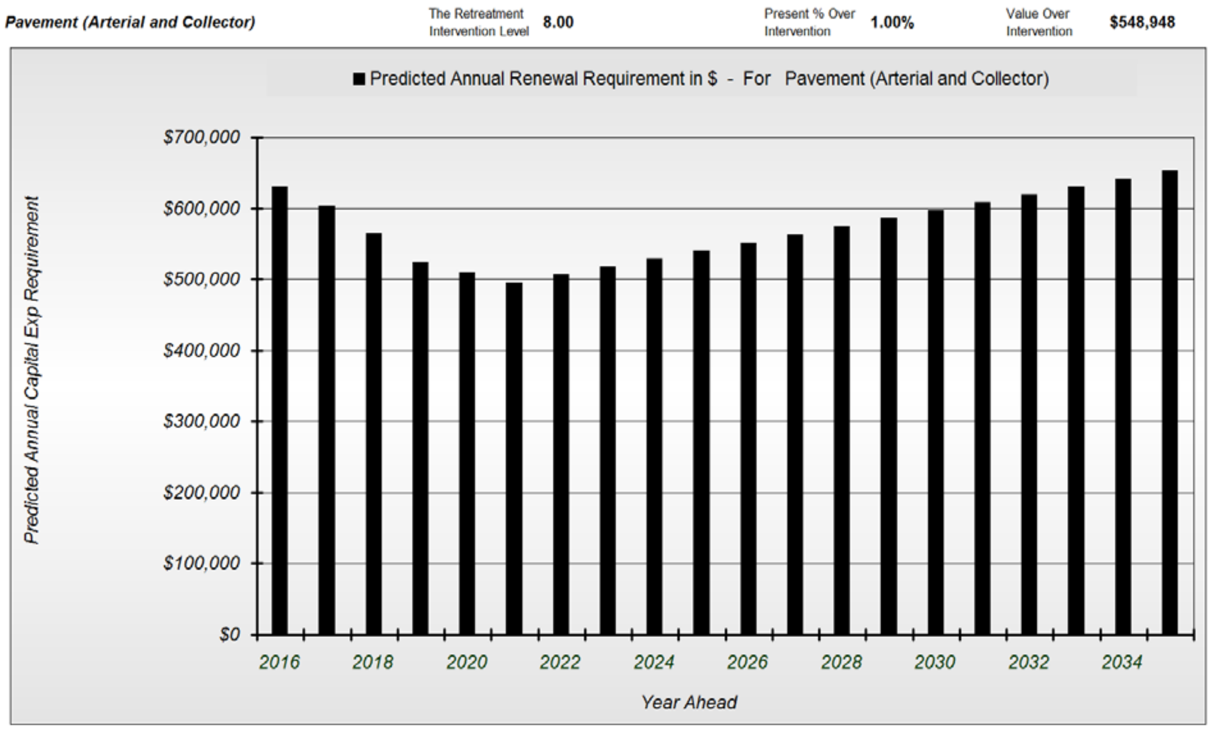


Figure 8 Model No 2 Summary of Process

Note that the present extent of the asset base that is over the intervention (at the top of figure 8) is $548,948 but the year 1 renewal demand is predicted at $631,000. This is because the model will have degraded some of the condition 7 assets into 8 over the first modelling year and the additional $82,000 is what the model degraded from 7 to 8 in that first year.

One other thing to note is that if the raw difference in the renewal demand between years one and two is greater than 30% then the model eases in the difference over a five year period. If we had selected an intervention level of condition 7 in the above example then the full year one demand would have been a little over 6% of the asset base or around $3,350,000 (all conditions 7 + 8 + some degraded 6's) with the year 2 raw demand being around $700,000. No council would fund such a pattern and so the model eases in the demand over 5-years as illustrated in figure 9

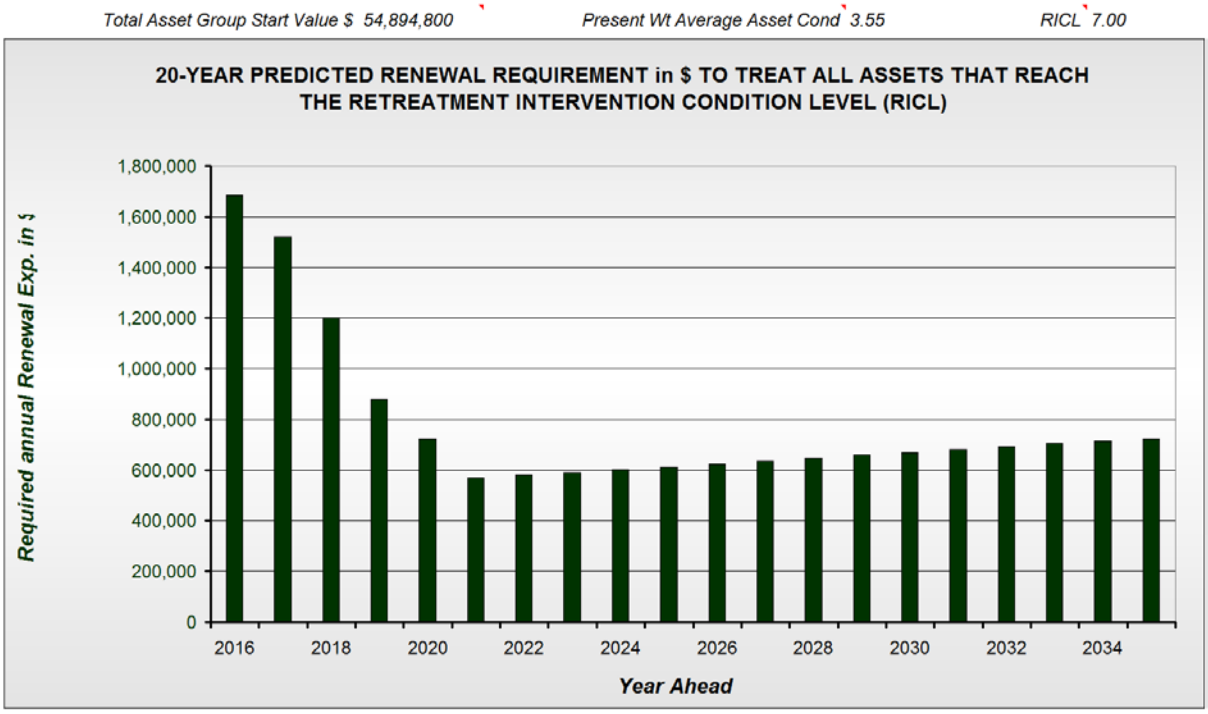


Figure 9 Model No 2 where year 1 demand is high

Figure 9 demonstrates how the renewal demand is eased in over the first five years when the raw demand between years one and two is greater than 30%. See the note within cell L1 on the "Model No 2 Predicted Capital Requirement" sheet of the "Model All File" for more details. Or consult the "Model All' Manual.

8.0 Renewal Gap

The renewal gap is simply the difference between the expenditure required to treat all assets that reach the intervention level through the degradation process with time and the planned expenditure over the same period.

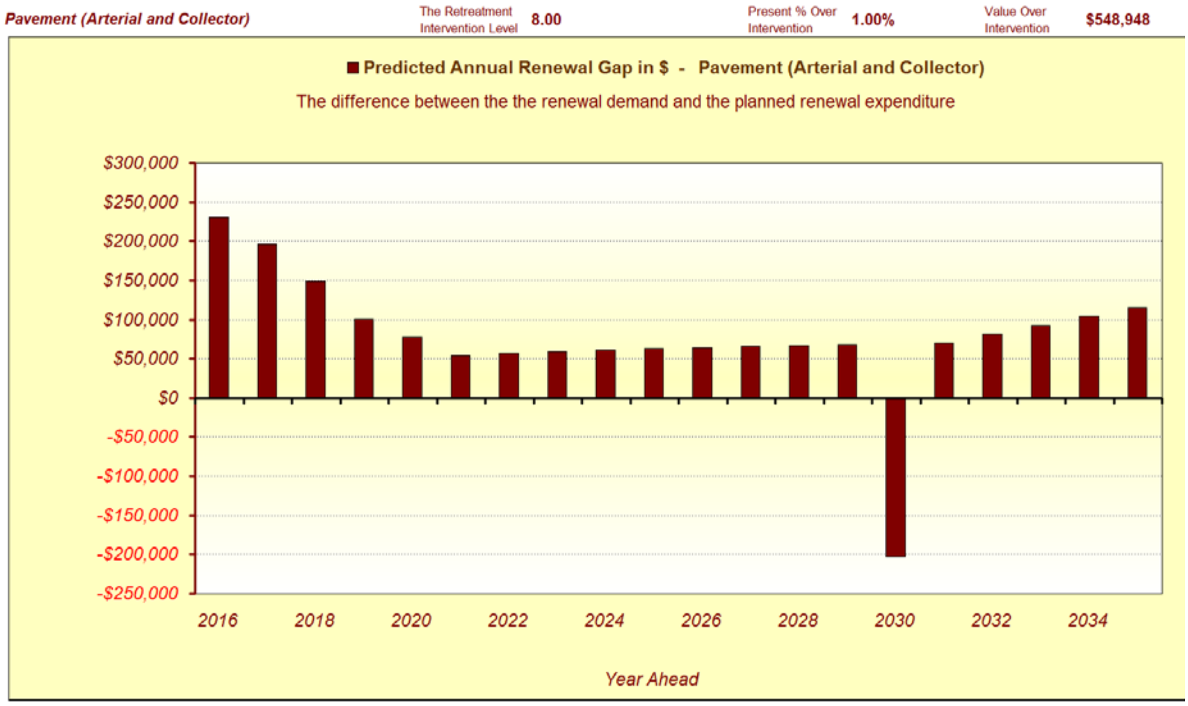


Figure 10 Annual Renewal Gap

Figure 10 shows the renewal gap or the ongoing shortfall in the planned renewal expenditure year by year. Note that the renewal gap after 10-years is around $62,000. But if you had been funding the asset renewals as per the planned renewal expenditure pattern in the blue bars within figure 5 then there would be an ongoing cumulative funding shortfall as illustrated within Figure 11 below.

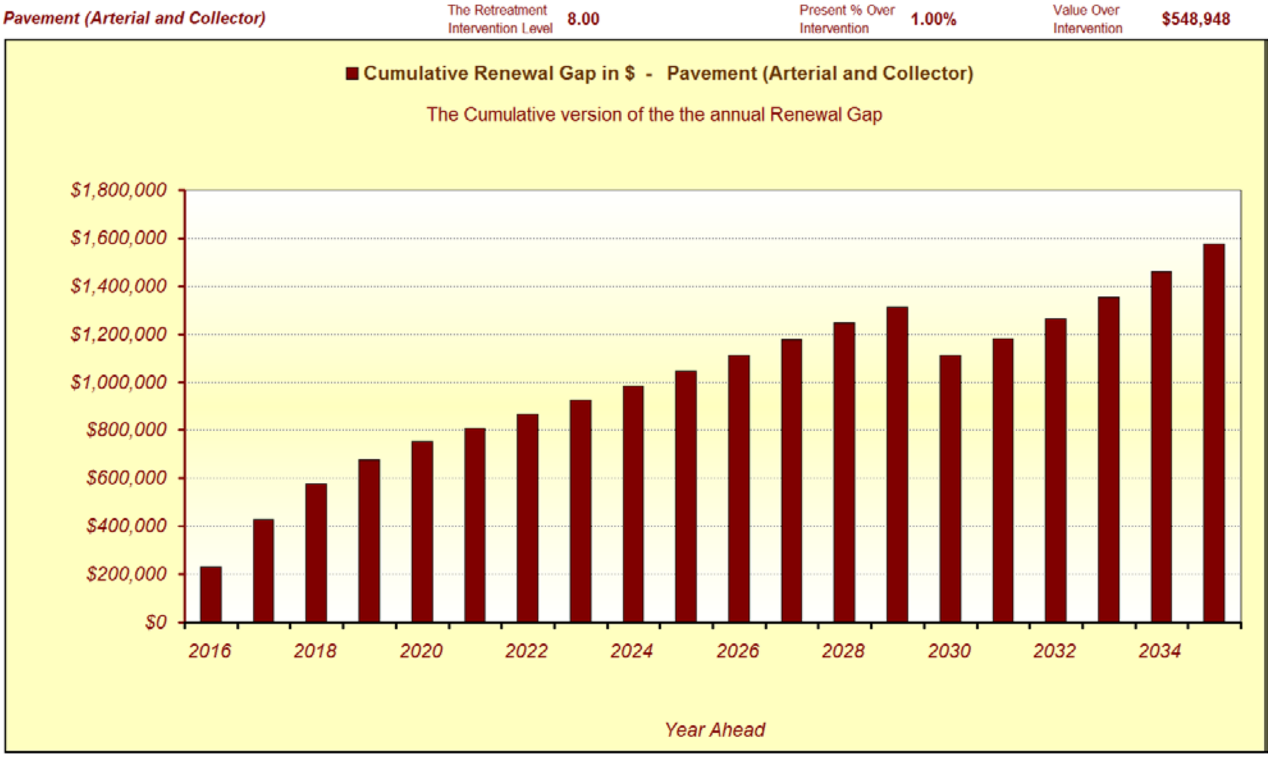


Figure 11 Cumulative - Ongoing Renewal Gap

Figure 11 demonstrates that each of the under funded years does have a cumulative affect and that after 20-years there will be just short of $1,600,000 in over intervention assets. Note also that the only year the cumulative renewal gap decreased was 2030 when the planned expenditure in Figure 5 was higher than the predicted renewal demand for that year.

If using the renewal gap outputs it is recommended that you adopt the cumulative output as illustrated in figure 11 as sometimes there can be some confusion with the annual renewal gap in figure 10. One common misconception with Figure 10 is that the problem is diminishing with time when in fact the aggregate problem is growing.

9.0 Other features of the model - Funding scenario finder

Model 2 provides a good reference as to what funding is required to do a complete job. In some ways it is the ideal word model. But often there will be a present extent of over intervention assets (1% in the above example) that is considered to be at an acceptable level.

Alternatively you may have a higher extent of over intervention assets than you would like to reduce, but can't afford to deal with them all up front. The model has an inbuilt scenario finder that will deliver a planned or recommended expenditure profile that will meet three designated input criteria.

We have a separate document covering this function called "Create a proposed expenditure profile function in Model All" and I would refer you to that, but basically the process is as detailed below.

We have reverse engineered Model No 1 so that through an iterative process it finds a planned expenditure pattern that delivers on three input criteria as detailed below.

- The percentage of over intervention assets that you want
- The time frame in years by which you wish to achieve this
- The amount of any annual percentage increase in renewal funding that you want.

In this way funding solutions can be found that often cost far less up front and also allow you to carry a tolerable extent of over intervention assets into the future.

10.0 Other Information

This document is intended as a brief explanation of how the Moloney model functions.

There are two manuals for the Moloney financial modelling software which are specifically designed to assist with the use of the software. They are

- Financial Modelling Version N3 Feb 2015
- Model All Manual Nov 2014

These documents along with the scenario finder are available from our web site to all, without the need to be a registered use. If you wish to understand the model further I would recommend that you download them and work your way through them.

If you are a licensed user with a current maintenance agreement then please don't hesitate to contact us for assistance if you have any problems at all with the model.

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