Checking Data Before and after Running Program

These notes are designed to assist with the checking of the input data into the "Required Data" Sheet of the "Input Pro Forma" File. They are quite different from the program function within the file that checks the actual validity of the data. This document is intended to help identify areas of poor quality data in order to avoid misleading financial predictions.

The inbuilt data validation program within the file simply checks that the data will operate within the program. It makes little attempt to check that it is reasonable.

These notes do not cover how to operate the model. Their purpose is to offer some suggestions for checking the input data to identify potential problem areas that may deliver incorrect of misleading modelling results.

There are two areas that will be looked at as detailed below:-

Section 1 Checking data within the "Input Pro Forma" File before the program is run.

Section 2 Checking the "Asset Graphs" File once the program has been run

1.0   Checking data within the "Required Data" Sheet

The six recommended areas for examination are:-

1. The condition Distribution
2. The Degradation curve
3. Unit Renewal rate
4. The percentage of the consumption rate being met
5. The Intervention level
6. Asset Life

1.1 The condition Distribution

This is the starting point of the modelling process and is perhaps the key element in the whole operation. If the condition information is of poor quality then the whole modelling process may well be a waste of time or even worse may deliver totally misleading results.

The Moloney model requires a 0 - 10 condition rating for the assets, with 0 being new and 10 having no remaining life. It is felt that all assets can be rated on this scale and it is the smallest scale that will provide meaningful modelling results. It is very difficult if not imposable to deliver accurate modelling results with a 1 - 5 single integer condition scale.

Figure 1 below is a view of Graph GR 1 within the "Graphs" sheet of the "Input Pro Forma" file. The figures within the graph are linked to the 40 condition distributions within table 2 on the "Required Data" Sheet. There is a toggle button at Cell K1 that can scroll through all 40 condition distributions.

The data set being viewed here is data set 1 and at first view it looks to be a very good representation of a set of long life assets that have been built over a very long period. The things to

look for in this view are the general shape of the distribution and then the three indicator boxes around rows 3 - 5 for Standard deviation Largest single percentage and an accuracy indicator.

These indicators are difficult to pin down for all situations, but if any of your distributions have figures outside of the broad recommended range then they probably need to be looked at more closely. However if the sample size is small this can result in very odd distributions.

For long life (50+ years) assets built over a long period with a large sample size, the condition distribution should be close to a normal or skewed normal distribution. As total asset life gets shorter the distribution will flatten out. For assets with a 10-year service life the ideal shape would be flat with an even extent of assets within each condition rating.
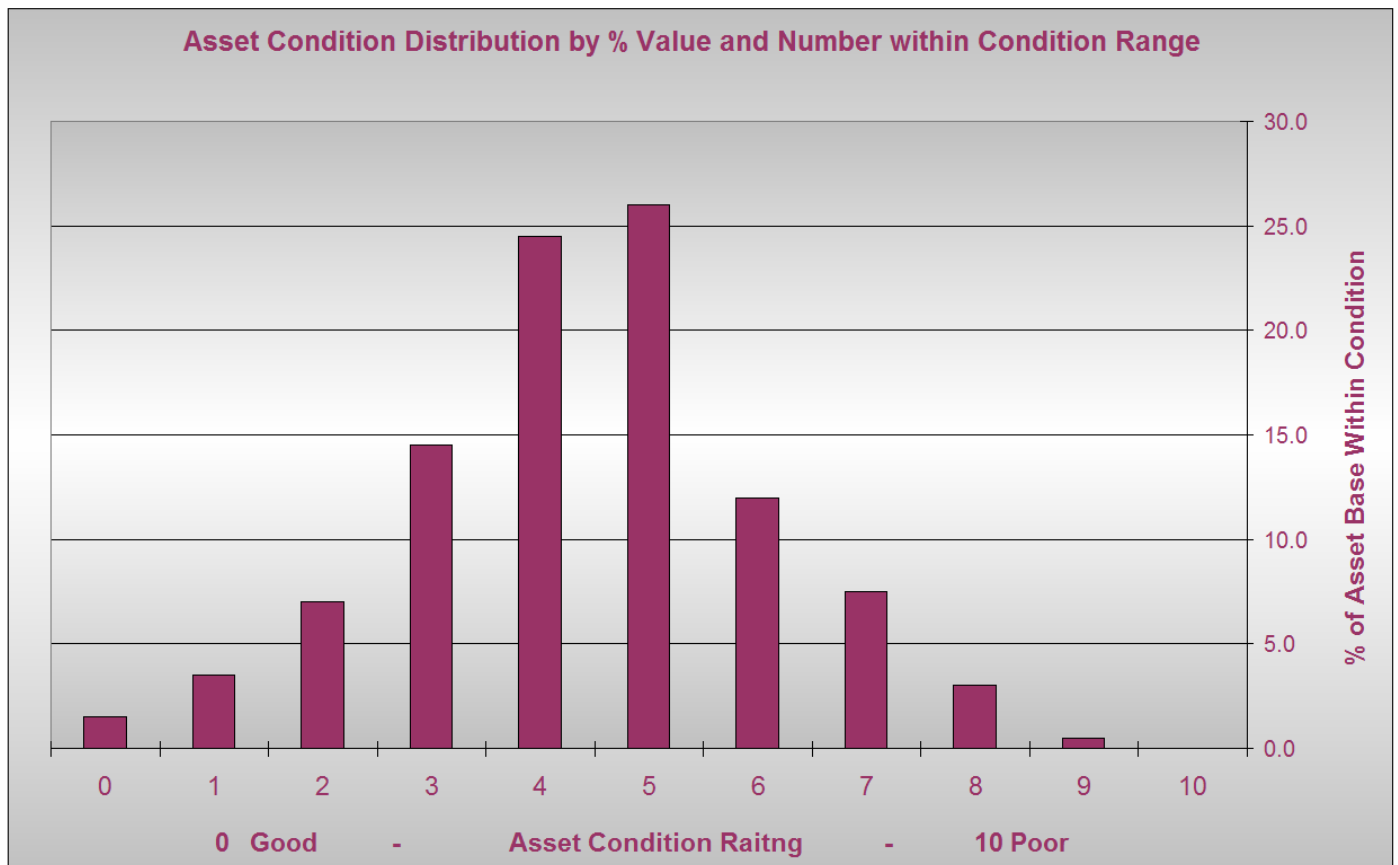

Fig 1 Sample of actual Condition Distribution for long life assets built over a long period

Next to Graph GR1 is Graph GR 3. There is also a toggle operated set of distributions for this graph, operated from around cell Y1. The Moloney software has 6 default condition distributions inbuilt for a range of 20 different asset types. Provided the correct asset type has been selected within row 58 on the "Required Data" sheet, you will be able to view 6 typical condition distributions for the asset set type, based on the following generalised condition rating (for the whole data set).

1. Very Good
2. Good
3. Above average
4. Average
5. Below Average
6. Poor

Figure 2 represents the closest distribution to the one within data set 1. It is a "Poor" condition asset set and if yours were considered to be good then you may need to review your data.

Scrolling between the 6 default condition distributions for long life assets such as sealed road pavements you will see a normal distribution for all 6, with the peak extent of assets moving from condition 3 for "very good" up to condition 5 in "poor".

Default Condition Distribution Viewer

Distribution No. ◀ ▶ **6**

Generally Acceptable Range	5 -15	14 - 35	1 - 8
SD of Dist.	9.43	Largest % 26.00	Accuracy 2.45

NOTE

Default Condition Distribution For: *Poor*   *Asset Set*

Asset Description Type: *Sealed Rd Pavements*

Default Distributions for Comparison   *Wt Av Asset Condition 4.7*   *GR 3*
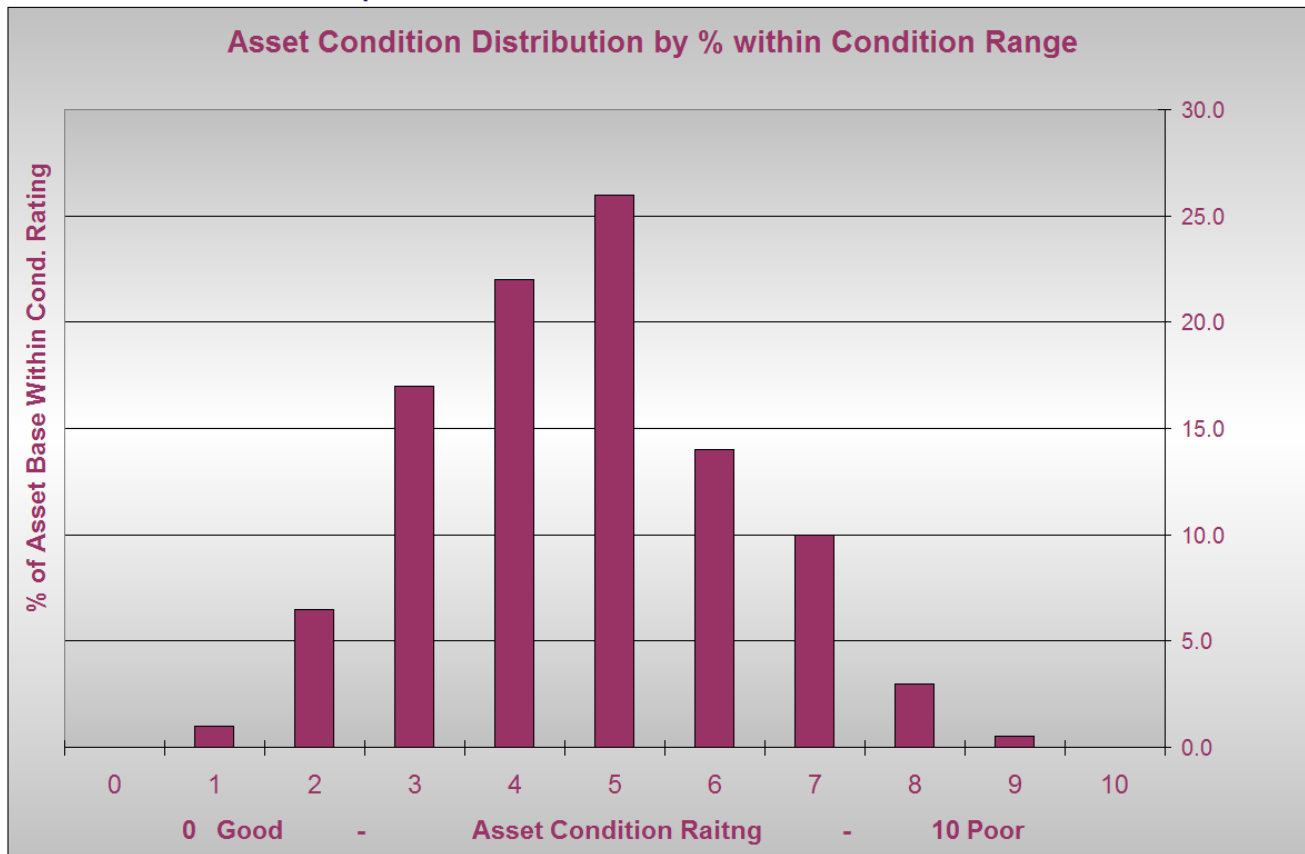

Fig 2 Best match in the default distributions "Poor"

Any of the six default condition distributions can also be imported into the model itself if your condition information is either missing or un-reliable. The prime purpose is to provide a reference set of condition distributions, but they can be adopted as your modelling distribution by selecting them within 36 of the "Required Data" Sheet

Some very strange distributions can arise when the asset sample size is low. At the extreme end of this scale if you have only one item in the data set 100% will be in a single condition. The model is not really designed for this situation but is a strange sort of way it will still deliver a reasonable average demand in the long term.

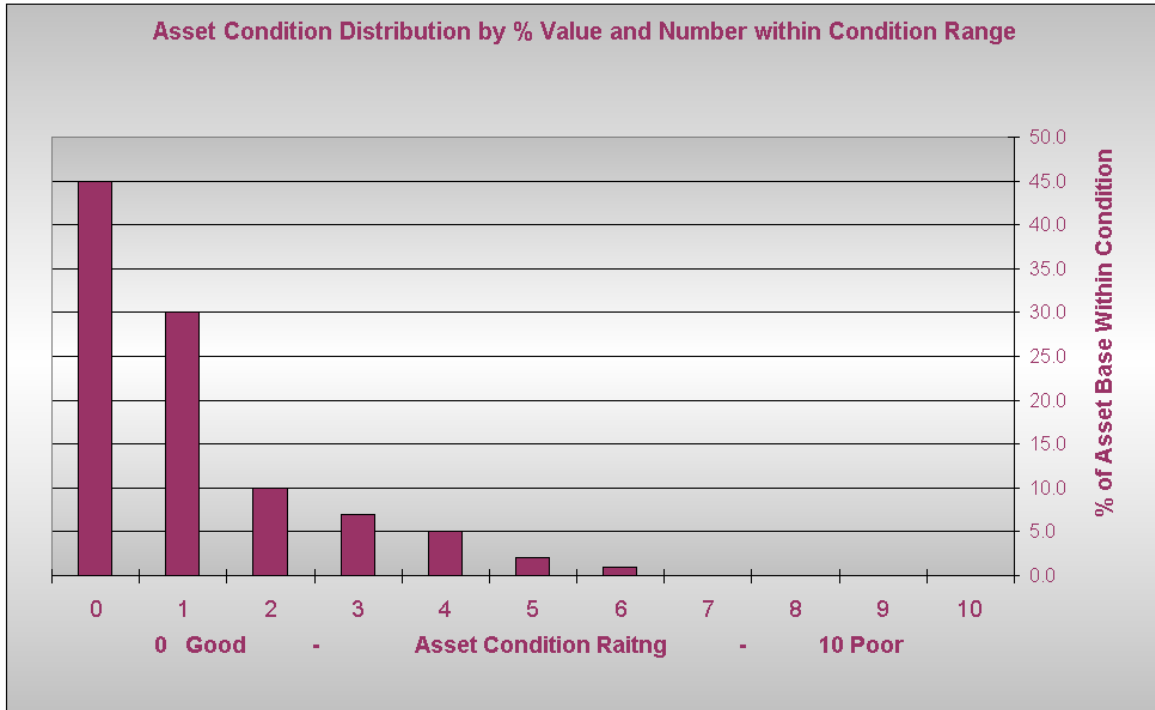## 1.1.1 Examples of some problem Distributions

Fig 3 Condition Distribution shape that is too good to be believed for long life assets

This distribution has 85% of the asset base at or better than condition 2 meaning that 85% of the asset base has lost no more than 20% of its value this would be a most unlikely scenario and if used would deliver extremely low renewal demand for many years.
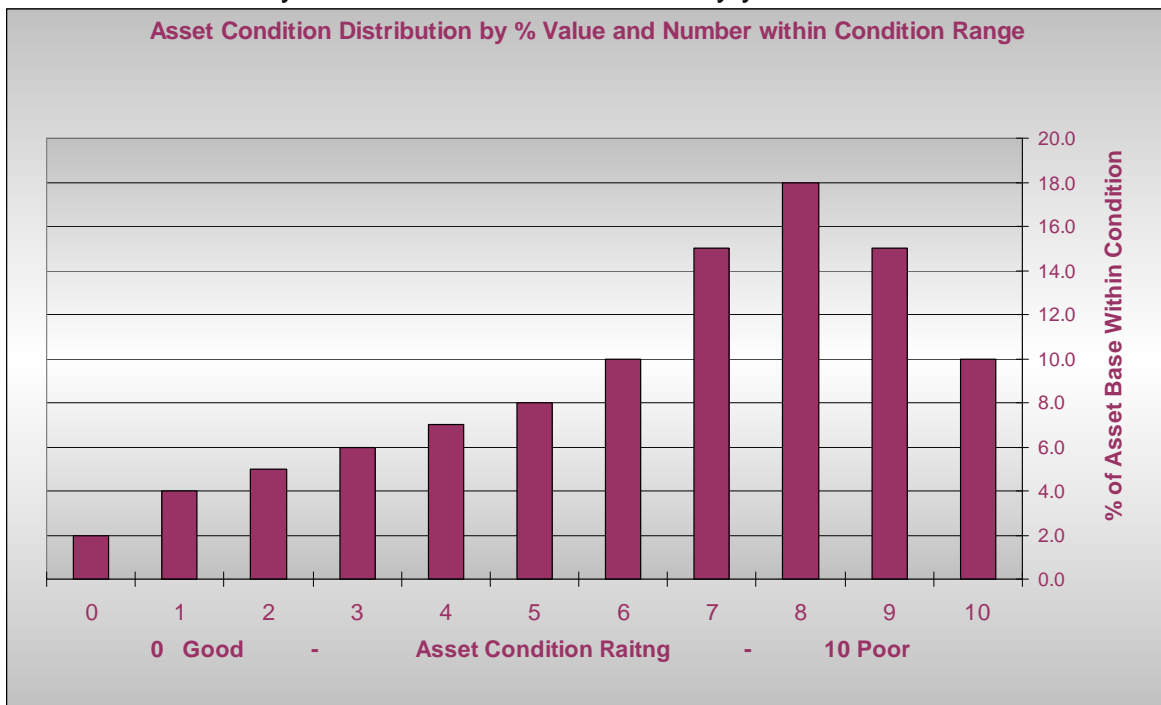

Fig 4 Condition Distribution shape with too high extent of Poor assets for long life assets

This distribution is the opposite of Figure 3. Typically an asset needs to be replaced at around condition 8 and this asset set has 43% at and above condition 8. A most unlikely scenario.
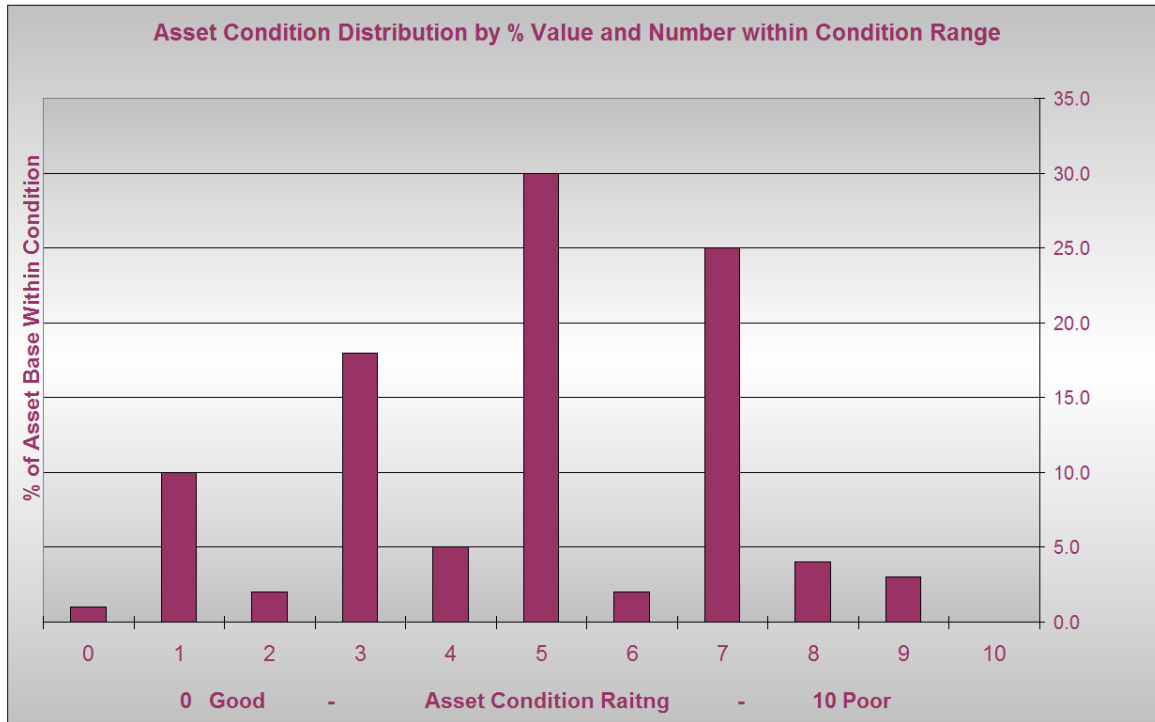

Fig 5 Condition Distribution shape too variable for long life assets with a big sample size

The jerky shape here suggests that there has been bias in the condition rating process or that it is the subject of a poor conversion form a narrower condition scale
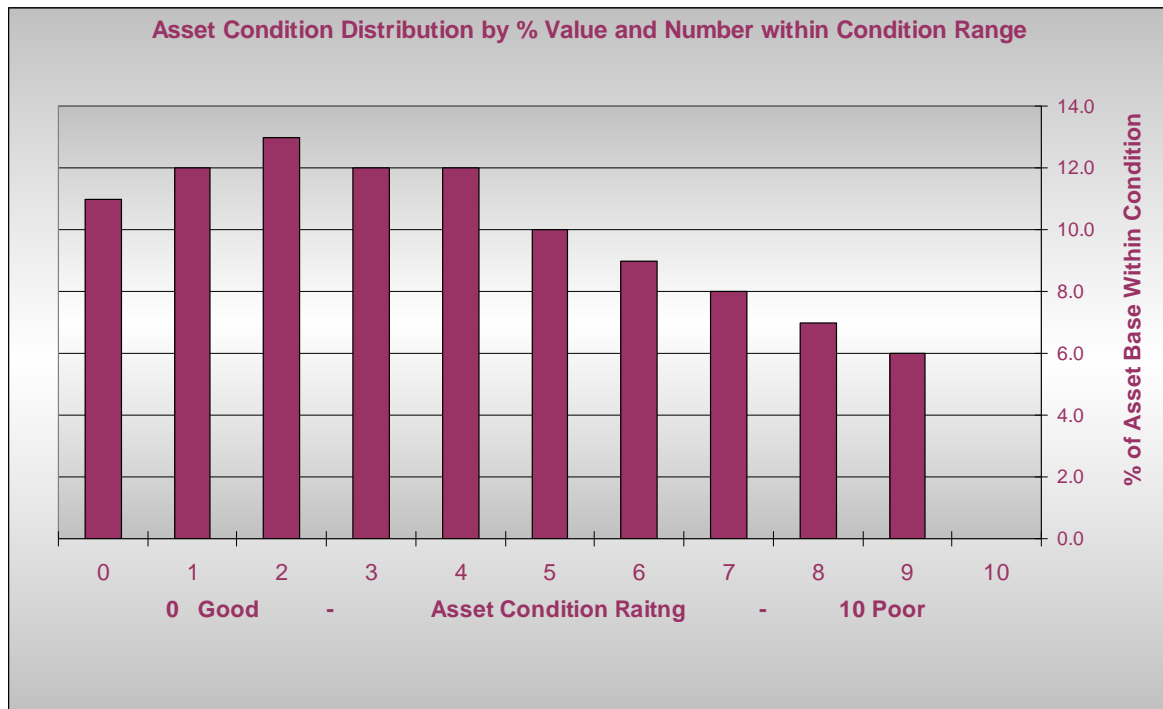

Fig 6 Typical Condition Distribution for shorter life assets

As the total asset life gets shorter the amount of asset renewal annually becomes more constant and figure 6 would represent a good distribution for a large set of assets with a 10 - 15 year life.
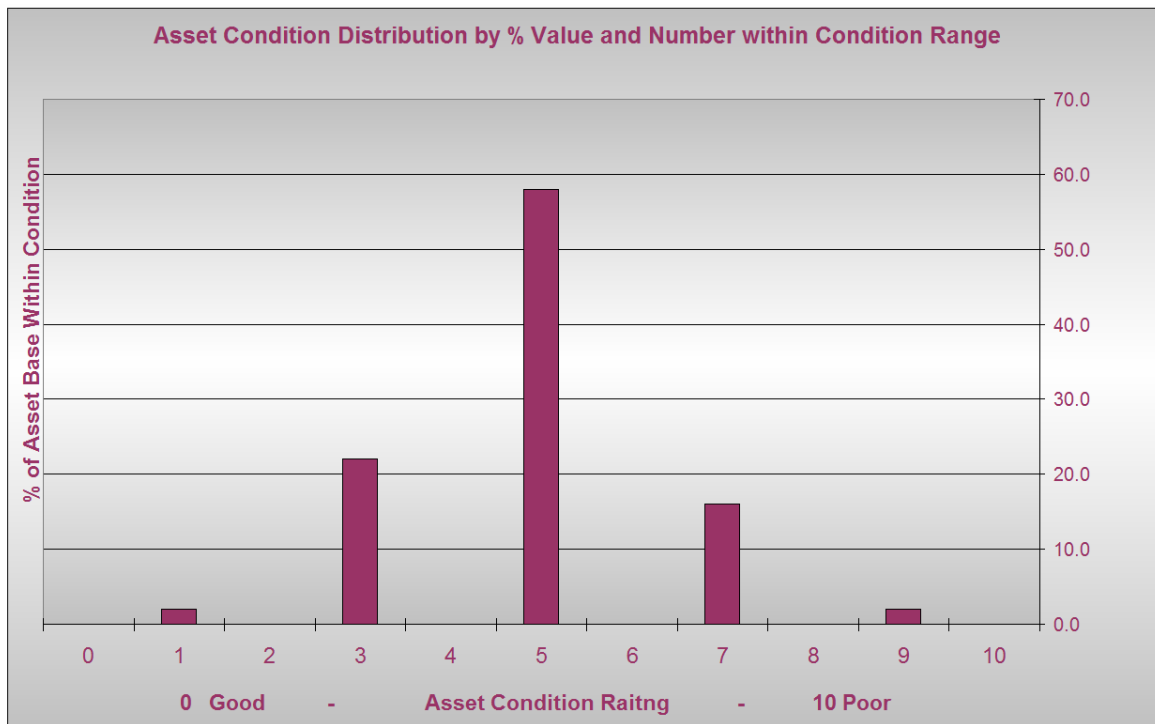
Fig 7 Typical problem with a 1 - 5 total single condition scale distribution

Figure 7 provides a picture of what we see for so many 1 - 5 condition rating distributions where there in only one condition parameter recorded for asset condition. Very little ends up as new in 1. The same occurs for condition 5 (which has become 9 here). And a very big percentage ends up in condition 3 (5 here).

Effectively you end up with about 90% + of the assets on a 2 - 3 - 4 condition rating scale with a close to 50% jump in life from 2 - 3 and also from 3 - 4

1.1.2 Condition Distribution - Summary

The condition distribution should look believable. For long life assets with a large sample size it would be expected to approximate a normal distribution. If it looks wrong then it probably is and you should go back to the source of the data to check it. It may be better to adopt one of the six default condition distributions than to base the modelling on poor condition information.

1.2 The Degradation curve

The degradation curve is used within the model to simulate the passage of time on the assets. The degradation curve delivers the average time in years that an asset will sit within each condition rating range. This is then used to degrade the whole of the asset set with time.

For example within figure 8 the degradation curve has 5-years average life within condition 0 thus 20% of the condition 0 assets would be degraded to condition 1 each year. This goes on right across the whole condition range and simulates the average performance of the asset set with time.
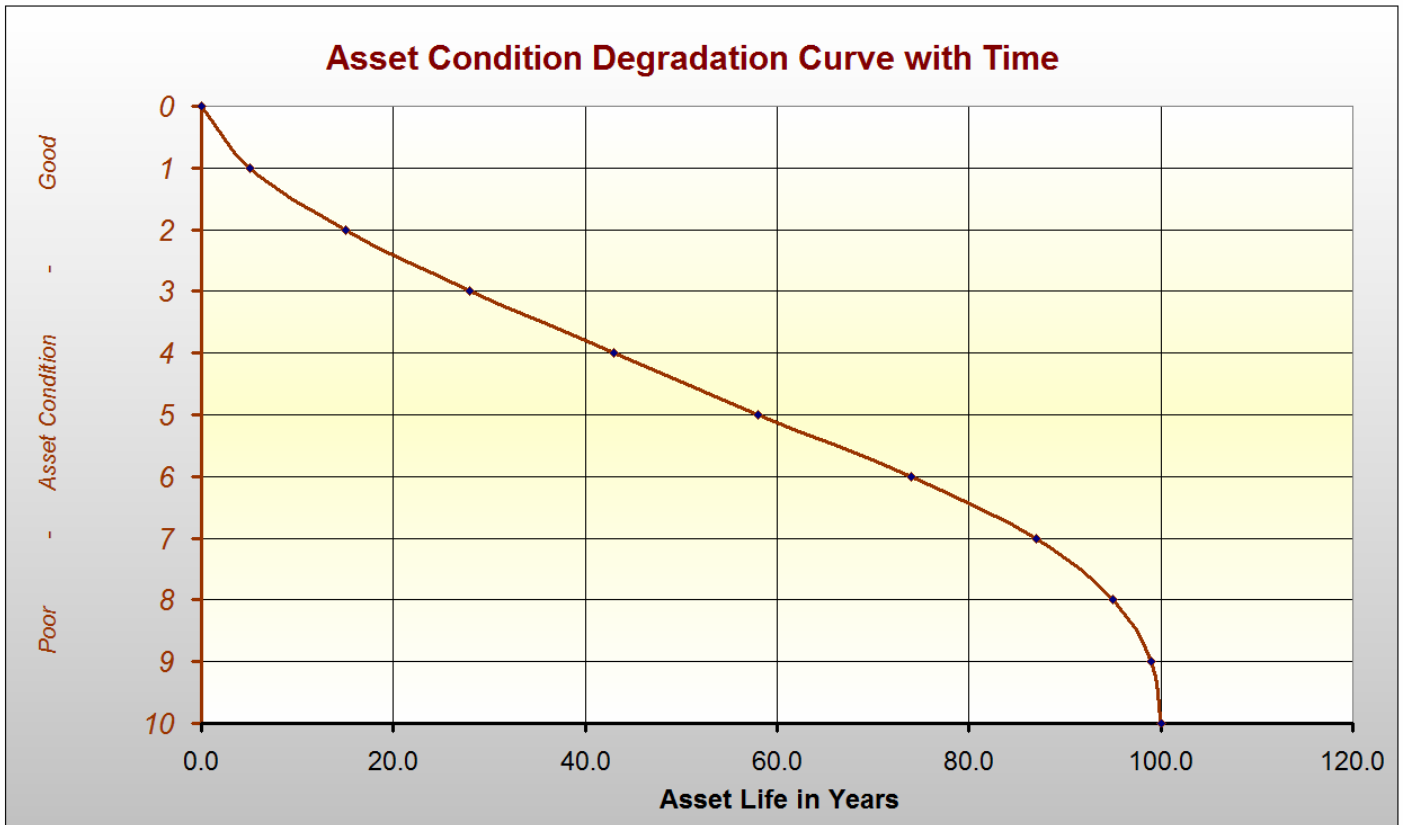
Fig 8 The Degradation curve

Figure 8 comes from Graph GR 2 on the graphs sheet and represents the degradation curve being used for data set 1. As with the condition distribution it moves between asset sets via the toggle button at Cell M1. Next to Graph GR 2 is a default degradation curve in Graph GR 4 which is provided as a reference to the shape of your adopted graph.

The aim should be to develop unique degradation curves based on a statistical analysis of condition change between two or more condition surveys. We have available a piece of basic software that is used to develop degradation curves and offer it free to our modelling customers. Contact us for if interested in more details.

1.2.1 Degradation Curve - Summary

View all degradation curves to endure that they appear reasonable. Errors here can have a big impact on modelling outcome. If in doubt go back to the source of the curve or adopt the default degradation curve for that asset type. There should be no large or sudden changes in the curve other than perhaps towards the end of the life period.

1.3 Unit Renewal rate

The unit renewal rate for the data sets is not a direct input. It has been provided as a calculated field within Row 9 of the "Required Data" sheet. It is calculated by dividing the total replacement value of the whole asset set in row 14 by the asset quantity in row12.

For data set 1 in Figure 9 the unit rate for the construction of the High Traffic Urban Pavements is $32.00 per sqm. This is a reasonable figure. But data set 2 delivered a Pavement renewal rate of

only $3.00 per sqm. Clearly this is not correct and further investigation is needed to see if the total replacement value of $5,824,587 or the asset quantity of 1,917,093 are in error.

Row No	Table No 1 Asset Quantity					
6	Asset Group No	1	1	1	1	1
7	Asset Set No.	1	2	3	4	5
8	% of the Required Exp Being Met	113	893	65	73	59
9	Av Unit Renewal Cost $	$32.0	$3.0	$14.5	$14.5	$7.1
10	Asset Group Name	Urban Roads Group	Urban Roads Group	Urban Roads Group	Urban Roads Group	Urban Roads Group
11	Asset Set Description	Pavement (High Traffic) Urban	Pavement (Low Traffic) Urban	Asphalt Seal (High Traffic) Urban	Asphalt Seal (Low Traffic) Urban	Spray Seal (High Traffic) Urban
12	Asset Quantity	1,250,000	1,917,093	913,683	2,048,067	359,668
13	Units	sqm	sqm	sqm	sqm	sqm
14	Total Asset Group Renewal Cost $	$40,000,000	$5,824,587	$13,275,814	$29,758,414	$2,539,256
15	Annual Renewal Exp.	$450,000	$520,000	$430,028	$1,200,000	$99,375
16	Annual Maintenance Exp.	$0	$100	$479,264	$1,074,294	$91,208
17	Retreat. Intervention Condition	7.5	8.0	7.5	5.0	7.5
18	Return Cond after Renewal	0	0	0	0	0
19	Life to Condition 10 in Years	100.0	100.0	20.0	18.0	15.0
20	Life in years to Intervention Level	91.0	95.0	18.8	13.0	14.3

Fig 9 Calculated Fields on the "Required Data" Sheet

1.3.1 Unit Rate - Summary

The unit rate calculated field within row 9 of the "Required Data" sheet needs to be checked for all data sets. If data set 2 above were to be modelled with a $3.00 replacement value when it should have been $30.00 then the modelling results would be out by a factor of 10.

1.4 The percentage of the consumption rate being met

This again is a calculated field that should be checked for all data sets. Figure 9 contains a sample of the first 5 data sets and indicates that there is a real problem with data set 2 where the expenditure is at 893% of the consumption rate.

The figure is calculated by first delivering an estimate of the consumption rate. This is done by dividing the total replacement value in row 14 by the life to the selected intervention level in row 20. Finally this is compared with the planned expenditure in row 12 and returned to row 8 as the percentage of the consumption rate that is being met. Note that the life to intervention in row 20 is only established once the program has been run. It is influenced by total life to condition 10, the intervention level and the degradation curve.

This figure can be as low as zero if asset condition is very good. But if this figure were high and asset condition when compared to the default condition distributions (see section 1.1) was good then there is a mismatch of information that would need to be investigated further. Either the entered condition distribution is better than it should be or the wrong renewal expenditure has been entered.

1.4.1 Summary - The percentage of the consumption rate being met

The two calculated fields within row's 8 and 9 of the "Required Data" sheet provide a quite valuable filter for the identification of problem data. You should satisfy yourself that the figures are reasonable for all data sets being modelled. This check won't find all problems but it will identify the glaring ones that need to be looked at.

1.5 The Intervention level

A low intervention level can result in a very high early renewal demand. The intervention level represents the level of service that is required.
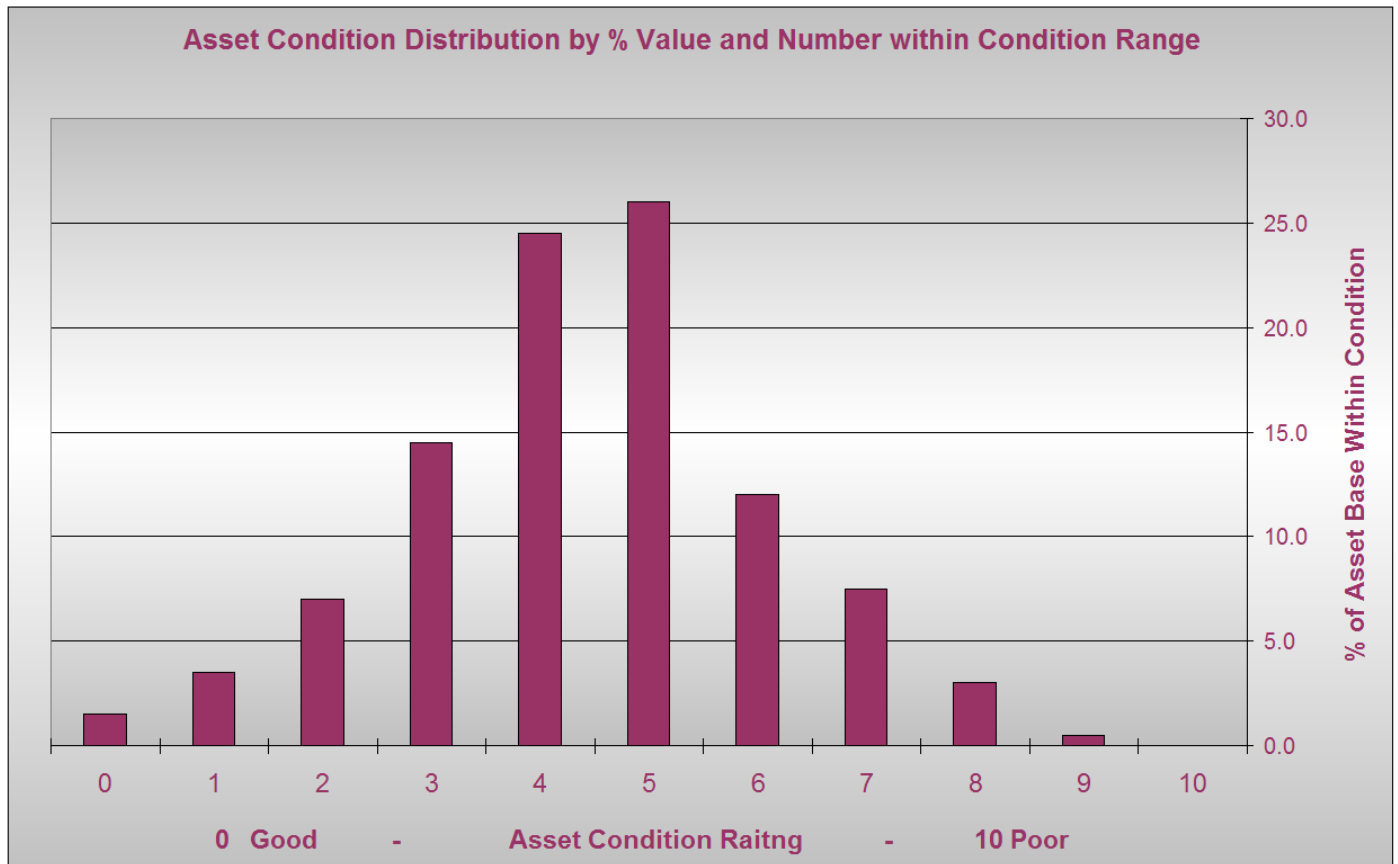

Fig 10 Condition Distribution and Intervention level

As a guide to the setting of the intervention level it is recommended that you look at the condition distribution (see Figure 10 above) and see at what point there are no assets at or above a given condition. In this case that is condition 10. Thus what is currently being achieved is actually condition 10.

There is one small refinement to this practice and that is to consider the service life of the assets. This is data set 1 within figure 9 above which has a 100 year total life. Thus in the long term around 1% of the assets will need to be replaced on average each year. Our general rule of thumb is that you should be allowed to carry around 1 to 1.5 years worth of average long term renewal demand as a backlog.

Thus in the above example while you are actually achieving only condition 10 there is only 0.5% within condition 9 and 3.0% in Condition 8. Thus the practical intervention level here (in terms of what you are reasonably achieving is around 8.5

Just to give you some idea of how strongly influenced the predicted renewal demand is on the intervention level the table below details the predicted year 1 renewal demand based on a varying intervention level

Intervention Level	Predicted Year 1 demand
9.0	$380,000
8.5	$780,000
8.0	$865,000
7.5	$1,820,000

1.5.1   Summary - The Intervention level

The selected intervention level is all about the level of service that you want. If you ask for an intervention level that is much better than what you are current achieving it will deliver a high early renewal demand. This may be OK if you are using the Moloney Model 1 and tracking future condition movement based on a planned expenditure profile. But be very careful of this scenario if using the Moloney Model 2 (Predicted Capital Requirement).

In setting the intervention level be aware of what your are current achieving (via the condition distribution) and be prepared to adjust you estimate of what you are achieving based on the asset life.

1.6 Asset Life

Be realistic with your estimate of total asset life. A lower than realistic life will result in much higher renewal demand. Avoid being overly influenced by the few outlying assets that end up with far shorter than average lives. Remember the adopted life should be an average life for all of the assets within the group.

If there are significant differences in the lives within a single asset set, it might be better to separate them into different data sets with similar total life cycles for modelling. Be sure to check the adopted life of all assets and satisfy yourself that the lives are realistic.

1.6.1   Summary - Asset Life

Avoid unrealistic lives especially unrealistically short lives that will result in high renewal demand. All assets within a given asset set MUST have a similar total design life. As a bit of a guide don't group assets with a known difference in life cycle of more than around 25%.

2.0 Checking the "Asset Graphs" File

Once the program has been run and you have checked the inputs as per section 1 you should look at the results within the Asset Graphs file to check for any abnormalities. The asset graphs file reports at 3 different levels

1. Whole of organization level
2. Asset group level - Up to 10
3. Individual Asset set level - Up to 40

2.1 The Whole of Organization level of reporting

There are a series of 9 individual reporting graphs within each of the reporting sections of the "Asset Graphs" file. All have their use but I find I keep coming back to the series 1 and 2 graphs.
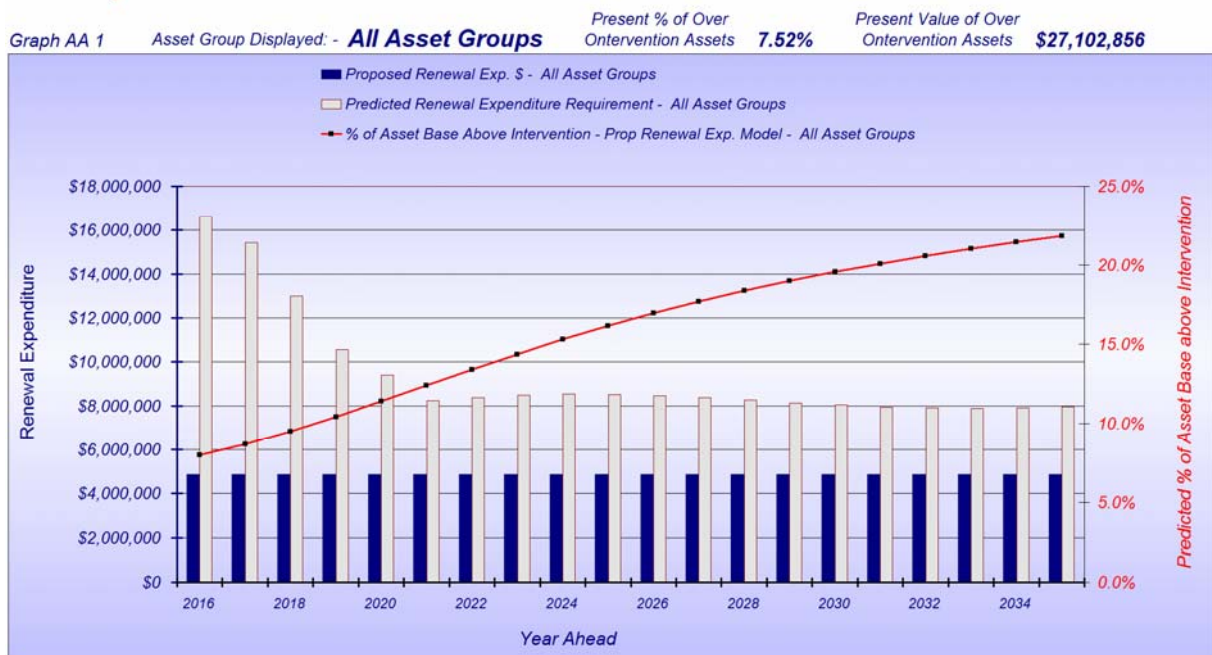

Fig 11 Whole of organization results - Series 1 Graph

Figures 11 provides a profile of the predicted renewal demand to treat all assets that reach the adopted retreatment intervention level through the degradation process (Grey bars). It also plots the extent of the asset base that is predicted to rise above the intervention level (red line), based upon the planned renewal expenditure profile (the blue bars).

In this case the planned renewal expenditure (blue Bars) is low and the extent of over intervention assets (red line) is predicted to rise steadily over the next 20-years. There is a very high early renewal demand in year 1 and to see what areas are contributing to this the series 2 graph in Figure 12 comes into play. Figure 12 indicates that the very high early renewal demand is coming from three asset group areas, Recreation, Buildings and Urban Roads. To investigate further we need to go down one level of reporting to the Asset Group level.
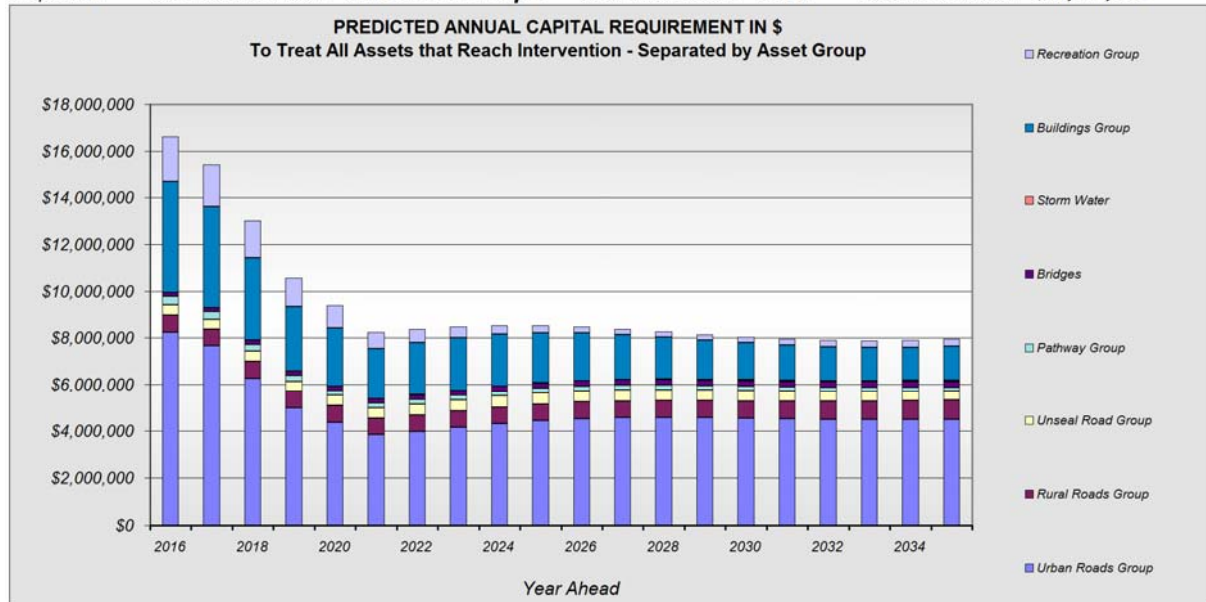
Fig 12 Whole of organization results - Series 2 Graph

2.2 Asset Group Reporting level

The same 9 reporting graphs are available within each of the 10 possible reporting groups. Here I have selected the buildings group to look at first as it appeared to have the greatest anamolies.
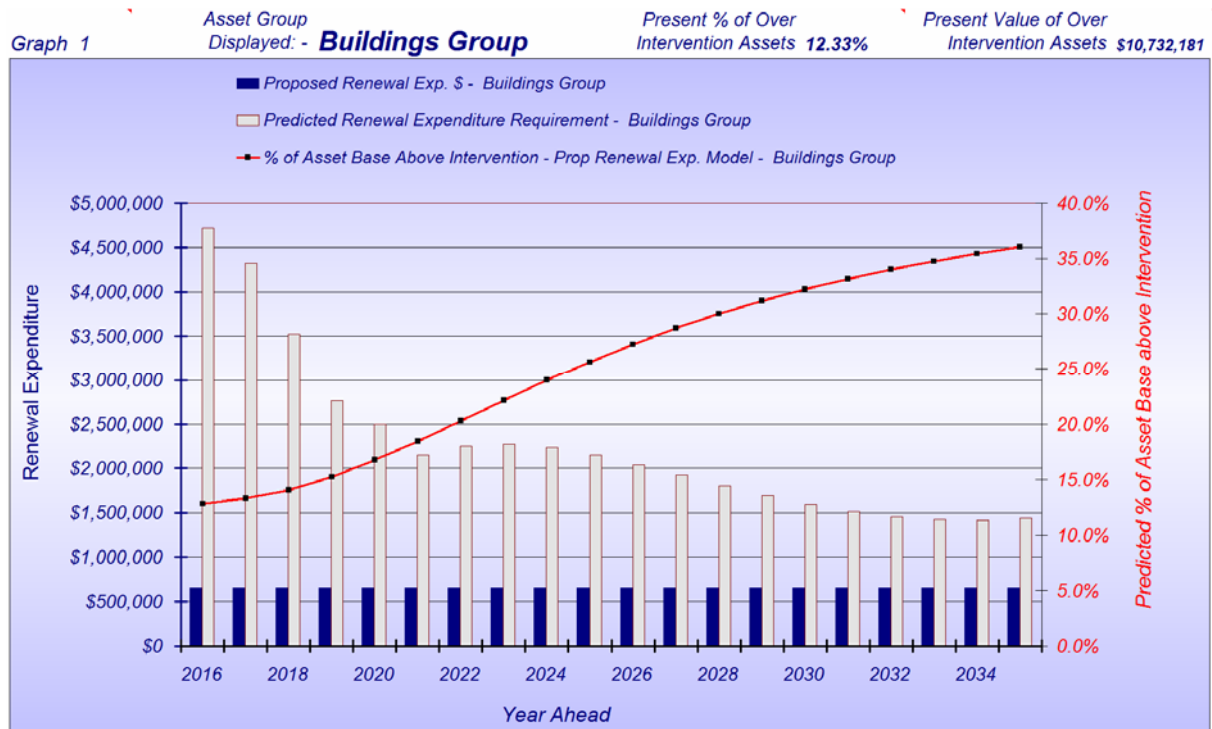

Fig 13 Asset Group level - Series 1 Graph

Figure 13 is in the same format as the graph in figure 11. But here total expenditure is very low compared to the demand and so condition declines rapidly with time.

To see what single asset or asset sets within the buildings group is causing the very high early renewal demand we need to go to the series 2 graph. Figure 14 indicates that there is a massive early renewal demand on the "Buildings Short Life" asset set so to learn moor we could go to the "Individual asset set graphs" Sheet and drill down a little deeper.

Note that we are just looking at one asset group in this document but you would also need to examine the other two problem areas that were identified in the Recreation and Urban Roads Group assets.
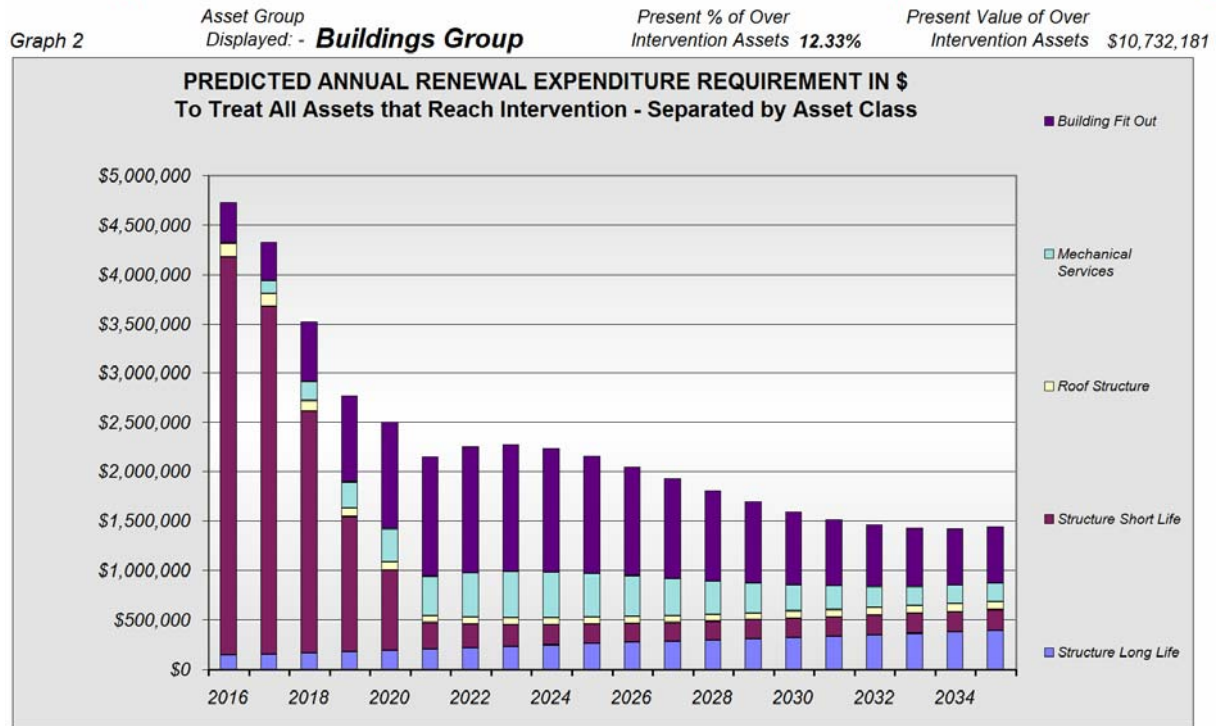

Fig 14 Asset Group level - Series 2 Graph

2.3   Individual Asset Set Graphs Reporting level

The modelling results for each of the 40 individual data sets can be viewed within the "Individual Asset Set Graphs" Sheet. There is a toggle button at the top of the sheet around cell F1 that switches between the 40 possible data sets.

In this case we found in Fig 14 above that there was a problem with very high early renewal demand within the Structure Short Life asset set within the buildings group (Data set 27). Figure 15 comes from the "Individual Asset Set Graphs" Sheet and id the series 1 graph on that sheet.

The graph indicates that 56.36% of the assets are over the selected intervention level of condition 8. This is a most unlikely scenario and figure 16 is the series 7 graph within the sheet that presents the condition distribution for the asset set. Clearly 50% in condition 9 is an unlikely scenario so it would be wise to go back to the source data and check for the condition 9 assets.

In this case it was a single outdoor poos shell that was valued at $9,000,000. A check of the valuation indicated that it should have been $900,000. A simple mistake that could cause a massive overstatement in the renewal demand for this asset class.

Fig 15 Individual Asset Set Graphs - Series 1 Graph

Fig 16 Individual Asset Set Graphs - Series 7 Graph
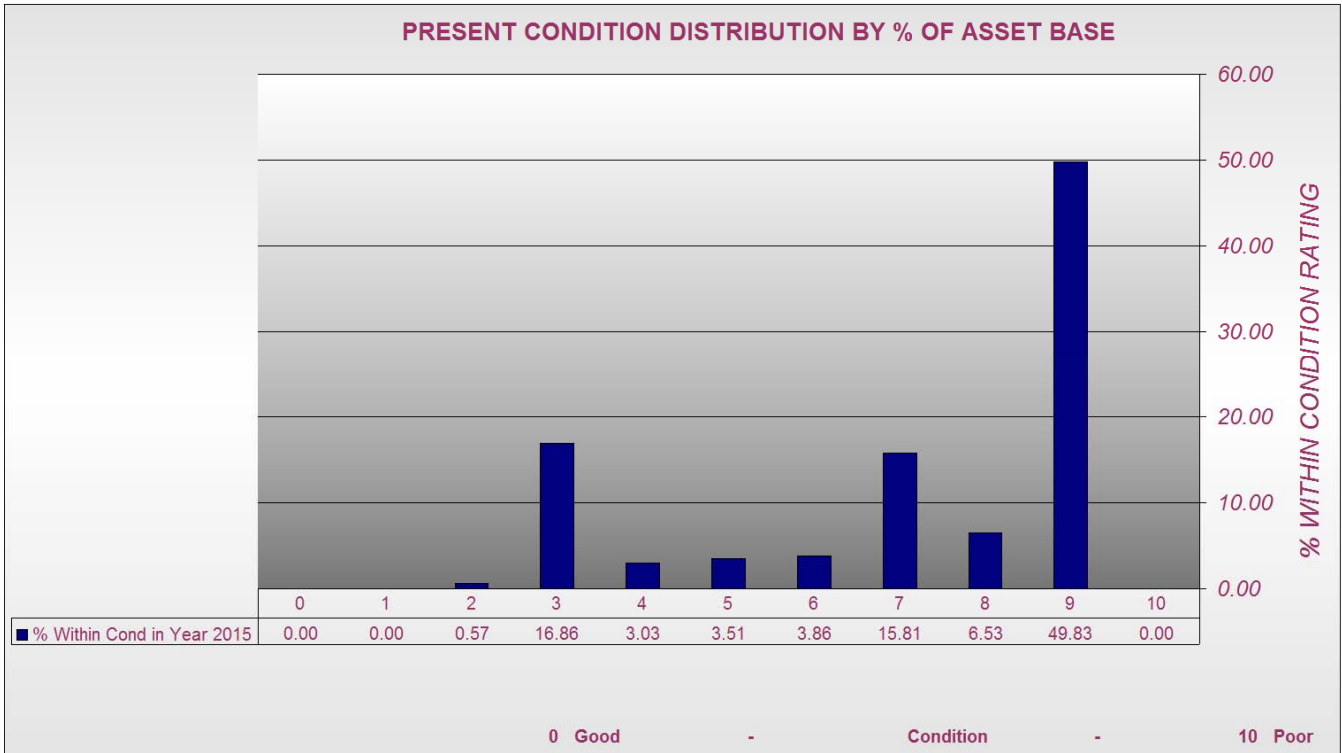
2.3.1 Individual Asset set results - Overall figures

At the top of the "Individual Asset Set Graphs" sheet is a table containing a variety of information relation to the individual asset set being displayed. Figure 17 is a copy of that table for asset set 27 "Structure Short Life"

			Asset Group Name: **Buildings Group**			◄ | ►	**27**
							Sheet Note
Table No IAS 1 Asset Performance			Asset Set Name: **Structure Short Life**				
Characteristic	Figure	Exp. Range	Characteristic	Figure	Exp. Range	% of Demand Type Being Met	% of Demand Type Being Met
Present Annual Renewal Expenditure	$150,000	N/A	Present Annual Renewal Demand From Modelling	$4,035,704	N/A	% of Present Demand Met	3.72%
Total Asset Group Quantity	24	N/A	Av Annual Long term Renewal Demand (Annual Depreciation)	$361,229	N/A	% Long Term Demand Met	41.52%
Units	No	N/A	Av Unit Renewal Cost in $/Unit	$752,559.81	N/A		Figures for All 40 Asset sets
Total Cost to Renew the Whole Asset Group in $	$18,061,435	N/A	% at and above Intervention Level (In Poor Cond)	56.36%	0 to 10%	Total Backlog as % of Network	7.52%
Annual Maintenance Exp.	$5,000	N/A	Present Value of assets above Intervention	$10,179,286	N/A	Present Total Backlog	$27,102,856
Retreatment Intervention Condition Level	8.00	7 to 10	% at & Under Cond 2 (%In Excellent Cond)	0.57%	< 35%		
Return Cond Level following Renewal	0.00	0 to 4	Largest Individual % in Starting Condition Dist.	49.83%	< 30%		
Life to Condition 10 in Years	50.0	10 to 250	St Dev of Condition Distribution	14.79	< 10.0		
Life in years to Intervention Level	46.5	10 to 250	Condition Distribution Accuracy Indicator	7.37	< 5.5		

Fig 17 Individual Asset Set Graphs - Top table

The figures for the individual asset set are in the grey shaded cells. The red shaded cells contain the expected range for the individual item. By its very nature this cannot be too fine because of the diversity of the asset types and conditions. So if there is something outside of the broad expected range it should be investigated.

Note that the extent of the asset base at and above the intervention level at 56.36% was recorded as well above the expected Maximum of 10% this presents another alert to the problem already established in Figure 16.

Summary - Checking Results in Asset Graphs

It is really important to look at all individually modelled data sets within the "Individual Asset Set Graphs" Sheet of the "Asset Graphs" file. In this one location you can view the modelling results for all 40 possible data sets and once you get a feel for interpreting the graphs and figures within the sheet, problem data will start to jump out at you.