## Estimating Capacities for Pedestrian Walkways and Viewing Platforms



A Report to Parks Victoria



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## Estimating Capacities for Pedestrian Walkways and Viewing Platforms

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## Introduction

Parks Victoria currently has no standard method for estimating the capacity of walkways, boardwalks and viewing platforms. Heavily used areas such as the viewing platform at Twelve Apostles at Port Campbell National Park are under increasing pressure as visitor numbers increase. This is particularly apparent now that the new visitor centre and parking lot have been constructed. Without a reliable way of estimating the capacity of walkways and viewing platforms it is impossible to project into the future the likelihood of these facilities becoming overcrowded with the concurrent drop in visitor satisfaction. In addition, without a reliable method for estimating pedestrian capacities, design of new facilities becomes a "hit and miss" effort, resulting in high levels of uncertainty in determining if the time, money and resources invested in upgrading facilities will actually cater to demand.

This report provides background on methods of estimating pedestrian capacities developed in the United States, and then adapts these methods to day-use recreational facilities for National Parks in Victoria. Pedestrian use patterns particular to tourism behaviour, such as taking photographs, requires a modification to the methods developed in the United States for traffic modelling. Recommendations for Quality of Service (QOS) objectives for walkways, viewing platforms, stairways and queuing areas are provided with the corresponding Level of Service (LOS).

## Measuring pedestrian capacity – U.S. methods

The United State Federal Highway Administration (FHWA) has published a Highway Capacity Manual (HCM) that provides procedures for analysing uninterrupted and interrupted pedestrian flows on walkways (Rouphail et al., 1998). Interrupted pedestrian flows refer to pathways intersected by traffic lights and other mechanisms to halt pedestrian flow for vehicular traffic. Since most of the walkways in National Parks in Victoria are exclusively pedestrian flows.

## Pedestrian Characteristics

### Body ellipse and body buffer zone.

Rouphail et al. (1998b) recommends the use of a body ellipse of 50 cm by 60 cm for standing areas  $(0.3m^2)$ . However for walking areas a body buffer zone of 0.76 m<sup>2</sup> is recommended for walking, areas smaller than this produce what Pushkarev and Zupan (1975a) refer to as "unnatural shuffling" in pedestrians. Figure 1 shows the body ellipse in plan view.

BODY ELLIPSE



Figure 1 Recommended pedestrian body ellipse for standing areas. (from Rouphail et al., 1998)

#### **Pedestrian Walking Speeds**

Rouphail et al. (1998b) recommends a pedestrian crosswalk walking speed value of 1.2 m/s (4.32 km/hr) for most conditions. For older pedestrians a recommended crosswalk walking speed of 1.0 m/s (3.6 km/hr) is suggested.

#### **Grades and stairs**

Rouphail et al. (1998b) recommends that a speed reduction of 0.1 m/s (a drop of 0.36 km/hr) is used on grades greater than 10 percent (1:10 slopes) and on stairs.

#### Fundamental Speed-Flow-Density Relationships

Chapter 13 of the 1994 *Highway Capacity Manual (HCM)* begins with a description of the basic principles of pedestrian traffic flow on sidewalks, crosswalks, and street corners. It provides the following relationship among fundamental pedestrian flow parameters (from *Fruin, 197*1):

 $\mathbf{v} = \mathbf{S}/\mathbf{M}$ 

where:

- v = flow or volume;
- S = speed; and
- M = pedestrian area module ("space") = 1/density.

In tables 1 and 2, the units ped/min/m width represents a pedestrian *flow rate* (ped/min), normalized by width (m). The units of  $m^2$ /ped represent the average *space available* (in  $m^2$ ) per pedestrian (ped).

## Level of Service

Level of service is a quantitative measure used to measure the quality of service from a user's perspective. Qualitative criteria defined by Milazzo include:

#### **Qualitative Measures of Pedestrian Flow**

- Freedom to choose desired speeds
- Freedom to pass slower pedestrians
- Ability to cross a stream of pedestrians
- Ability to walk in the reverse direction of a stream of pedestrians
- Ability to maneuver without conflicts
- Delay at signalized intersections
- Delay at unsignalized intersections

It is important to note that these qualitative measures are made in the context of pedestrians in an urban or residential environment. Qualitative measures in a National Park setting are likely to include other criteria such as:

- Freedom to stop (to enjoy views, take pictures, or read interpretive signs) without impeding other pedestrian traffic.
- Ability to view and experience nature with unimpeded by man-made structures or other visitors.

What needs to be established, is the relationship between the quality of service (QOS) and the level of service (LOS). The inherent assumption in the LOS classification is that the relationship between QOS and LOS is that the LOS level A represents the highest QOS and LOS level F represents the lowest QOS.

### Walkways

The FHWA has adopted 6 Levels of Service (LOS) as shown in Table 1 and illustrated in Figure 2 below.

| LOS <sup>a</sup> | Space                 | Flow Rate      | Average Speed  |
|------------------|-----------------------|----------------|----------------|
|                  | (m <sup>2</sup> /ped) | (ped/min/m)    | (m/s)          |
| А                | <u>&gt;</u> 5.6       | <u>&lt;</u> 14 | <u>&gt;1.3</u> |
| В                | 3.7-5.6               | 14-21          | 1.27-1.30      |
| С                | 2.2-3.7               | 21-33          | 1.22-1.27      |
| D                | 1.4-2.2               | 33-49          | 1.14-1.22      |
| Е                | 0.75-1.4              | 49-60          | 0.75-1.14      |
| F                | <u>≤</u> 0.75         | var.           | <u>≤</u> 0.75  |

Table 1 Recommended *HCM* walkway Level of Service (LOS) criteria. (*adapted from Rouphail et al.*, 1998)

<sup>a</sup>Instead of *HCM* LOS designations "A"-"B"-"C"-"D"-"E"-"F", Pushkarev and Zupan use "Open"-"Unimpeded"- "Impeded"-"Constrained"- "Crowded"- "Congested"- "Jammed" The simplest measure of LOS in table 1 is space (measured in square metres per pedestrian). LOS level F (jammed) should be seen as the maximum number of pedestrians that can physically occupy a walkway or viewing platform. This is certainly undesirable from the point of view of visitor experience. During busy times at the 12 Apostles viewing platform it is not uncommon to see Levels of service at level D (crowded) and E (congested). It is apparent from this table that the density of pedestrians increase, the flow rate increases, however the average speed decreases.



Figure 2. Illustration of proposed walkway Level of Service thresholds. SOURCE: *TRB*, 1994; adapted from *FRUIN*, 1971.

#### Stairs

Table 2 shows the recommended HCM pedestrian LOS criteria for stairs.

| LOS | Space    | Flow Rate   | Avg. Horiz. Speed |        |
|-----|----------|-------------|-------------------|--------|
|     | (m2/ped) | (ped/min/m) | (m/min)           | (m/s)  |
| Α   | 1.9      | 16          | 32                | 0.53   |
| В   | 1.6-1.9  | 16-20       | 32                | 0.53   |
| С   | 1.1-1.6  | 20-26       | 29-32             | 0.48   |
| D   | 0.7-1.1  | 26-36       | 25-29             | 0.42   |
| Е   | 0.5-0.7  | 36-49       | 24-25             | 0.4    |
| F   | < 0.5    | var.        | < 24              | < 0.40 |

 Table 2. Recommended HCM pedestrian Level of Service (LOS) criteria for stairs. (adapted from Rouphail et al., 1998)

#### **Queuing Areas**

Queuing areas are designated areas where pedestrians can comfortable wait for access to use of a facility. Table 3 shows the FHWA LOS criteria for queuing areas.

|     | Space         | Interperson Spacing |
|-----|---------------|---------------------|
| LOS | $(m^2/ped)$   | (m)                 |
| А   | <u>≥</u> 1.21 | 1.2                 |
| В   | 0.93-1.21     | 0.9-1.2             |
| С   | 0.65-0.93     | 0.7-0.9             |
| D   | 0.27-0.65     | 0.3-0.7             |
| E   | 0.19-0.27     | < 0.3               |
| F   | < 0.19        | negligible          |

Table 3. Existing HCM queueing area Level of Service (LOS) criteria. (adapted from Rouphail et al., 1998)

SOURCE: TRB, 1994; from Fruin, 1971.

# Implications for Walkway capacity measures for Parks Victoria

#### Walkways and Boardwalks

#### **Uninterrupted flows**

As indicated in the discussion of Table 1, the maximum capacity of a walking path (LOS F) can be calculated by dividing the total area of the walkway in square meters by  $0.75m^2$ . This capacity results in a maximum flow rate of 75 pedestrians / minute / metre assuming uninterrupted flow. This level of service probably exceeds acceptable levels of perceived crowding for walkways with uninterrupted flows<sup>1</sup> in national parks.

**Recommendation**: Current research by Melbourne University for Parks Victoria should investigate the relationships between levels of service as defined in Table 2 and perceived levels of crowding and satisfaction to determine the LOS level that Parks Victoria should target in different recreational contexts.

#### Pedestrian flows in the context of day use outdoor recreation

The assumption of uninterrupted flows is probably unrealistic in the context of dayuse recreation areas in national parks since pedestrians are likely to stop and take pictures, or take in the view. LOS levels in table one assume uninterrupted flows.

**Recommendation:** Given the nature of visitor use in National Parks, a *maximum* working capacity for walkways in should be set at LOS level D (1.4 - 3.7 m<sup>2</sup>/pedestrian). This LOS should be revised or reviewed based on QOS measures made from field perceptions studies of visitors.

<sup>&</sup>lt;sup>1</sup> Uninterrupted flows in National Parks are likely to be seen only along walkways with no views or interpretive signs.

To visualise this level of service, the FHWA Pedestrian Facilities Users Guide (Zegeer et al., 2002) recommends a walkway width of 1.5 metres will comfortably allow two people to walk side by side. If space is provided for two pedestrians using the level D Level of service, as recommended above, that means each person will have a walking buffer of 1.8m by  $0.75m (1.4 m^2)$  up to 2.93m by  $0.75m (2.2 m^2)$  for LOS D. If we remove the body ellipse from figure 1 this leaves a space forward of the viewer of 1.3m to 1.8m. This allows adequate room for stopping along the side of the path to take pictures or enjoy the view, while letting other pedestrians pass single file.

## Viewing Platforms and Viewing Areas

Viewing areas are often defined simply by widening a walking path or boardwalk with the addition of an interpretive sign and/or a railed fence to demarcate the gathering area for visitors.

**Recommendation:** In cases where the viewing area is simply a widened area of the path. Capacity measures should use either the length of the railed fence (if one is provided) or the length of the trail pull out divided by 0.7 metres. This capacity measure assumes that the useable area for viewing is one person deep from the side of the path with the view.

**Recommendation:** In locations where a viewing platform is defined with a safety rail and a defined area for gathering, it is suggested that the capacity be calculated by dividing the area of the viewing platform by  $1.4 \text{ m}^2$  to  $2.2 \text{m}^2$ . (LOS D from table 1).

## **Queuing Areas**

Once again it is likely that visitors in national parks will be intolerant to LOS E and F in table 3 for queuing areas. However this should be confirmed through perception studies in different site contexts with different user groups.

**Recommendation:** As a rule of thumb queuing areas for facilities should be designed targeting LOS D (Table 3) as the minimum area per pedestrian. These levels should be confirmed through on-site perceptions studies.

These guidelines serve to determine the recommended area per pedestrian in a queuing area, but do not provide guidance on the number of pedestrians that should be accommodated. These numbers can be determined through on-site observations during peak traffic periods or through simulation using software such as RBSim.

#### **Stairs**

Where stairs have access to views, the LOS target should be set to allow room for pedestrians to stop to look at the view, while allowing others to pass. Where stairways have no views a higher level of service can be used.

**Recommendation:** Where stairways have access to views or interpretation signs LOS C is recommended. Where stairways are used only for access LOS D or E may be appropriate.

# Examples of proposed pedestrian capacity measures at Port Campbell National Park.

## 12 Apostles viewing platform

The viewing platform and walkways at the 12 Apostles site at Port Campbell National Park is a heavily used facility with thousands of visitors per hour during peak periods of use. The viewing platform consists of a wooden walkway approximately 2 metres wide that parallels the cliff edge. Figure 5, shows the approximate dimensions (accurate to 10 cm/10 metres) of the west-facing stairway, boardwalk and viewing platform. Table 4 shows the Level of Service for each of these facilities based on the FHWA tables for each corresponding facility.

The viewing platform on the south end of the walkway is 56 square metres. Figures 3 and 4 shows this platform with 11 and 20 pedestrians respectively. Figure 3 is LOS A and Figure 4 is LOS C. (Note these photographs were taken with a telephoto lens which tends to make horizontal distances appear shorter than perceived on-site.)



Figure 3. Twelve Apostles west viewing platform with 11 pedestrians, LOS A.



Figure 4. Twelve Apostles west viewing platform with 20 pedestrians. LOS C.

### 12 Apostles West Walkway

The plan in figure 5 shows the west walkway has a total area of approximately 70 square meters (2 metres wide by 35 metres long). This report recommends level of service D from the FHWA walkway capacity  $(1.4m^2 \text{ to } 2.2 \text{ m}^2 \text{ per pedestrian})$ . This translates into a capacity of 25 to 40 pedestrians for this walkway. Figures 6 and 7 show LOS B and C for sections of this walkway to give a visual impression of how these standards apply at the Twelve Apostles west walkway.



|                       |                       | 1 . C 1       |                        | /            | 10 /10 / )        |
|-----------------------|-----------------------|---------------|------------------------|--------------|-------------------|
| Figure 4 I welve A    | nostles west viewing  | nlattorm with | approximate dimensions | (accurate to | 10cm/10 metres)   |
| 1 15ulo 5. 1 wolvo 11 | positios west riewing | planoini with | upproximate annensions | (uccurate to | 100ml 10 metros). |

| Level of | Viewing Platform | Walkway         | Stairway          |
|----------|------------------|-----------------|-------------------|
| Service  | 56 sq m.         | 70 sq m.        | 12.6 sq m.        |
| А        | <10 pedestrians  | <13 pedestrians | <7 pedestrians    |
| В        | 10 to 15 ped.    | 13 to 19 ped.   | 7 – 8 pedestrians |
| C        | 15 to 25 ped.    | 19 to 32 ped.   | 8 – 11 ped.*      |
| D        | 25 to 40 ped. *  | 32 to 50 ped.*  | 11 – 18 ped.      |
| E        | 40 to 74 ped.    | 50 to 93 ped.   | 18 – 25 ped.      |
| F        | > 74 ped.        | > 93 ped.       | > 25 ped.         |

Table 4. Levels of service for viewing platform, walkway and stairway for the west viewing platform at Twelve Apostles National Park. The asterisk (\*) indicates the level of service recommended in this report for day-use facilities in National Parks in Victoria.



Figure 6. Twelve Apostles west walkway with 4 pedestrians in 20 sq metres. LOS B. Note that on the 2 metre wide boardwalk, two pedestrians can walk side by side.



Figure 7. Twelve Apostles west walkway 12 pedestrians in 30 sq m. LOS C. At this level on the two metre wide boardwalk, traffic begins to move slower and if a couple meets one or more person walking in the opposing direction, one party has to stop, and step aside to the other part pass. Given the intensity of use at peak periods, this boardwalk is undersized.

## 12 Apostles Stairway entrance to west boardwalk.

The stairway to the west-viewing platform consists of two flights of 10 steps separated by a short landing. The useable width of the stairway is 1.8 metres and the horizontal distance from the top tread to the bottom tread is approximately 7 metres (See drawing in figure 3). Table 4 shows that this stairway could accommodate 25 pedestrians at LOS F. However, this stairway is an excellent example of how these standards need to be reconsidered when used in an outdoor recreation context.

The photograph in figure 8 shows the context of these stairs. When visitors arrive at the top of the stairs, this is the first view they have of the sea stacks at Twelve Apostles after leaving the visitor centre. Typically, visitors carrying cameras will stop at the top of the stairs to take pictures, and if people are travelling in a group, they will stop to take photographs standing at the rail at the bottom of the steps. This impedes the flow of other visitors coming down the stairway creating a bottleneck. Increasing the width of the stairway or building a new viewing platform to the left of the

stairway to allow room for group pictures in front of the view could alleviate this bottleneck. In essence the stairway is currently serving a duo purpose as a stairway and as a viewing platform. The function of the stairway as access to the lower viewing area is made less effective.



Figure 8. Context of stairway for west facing boardwalk showing first view of 12 Apostles.



Figure 9. Stairway to lower walkway at 12 Apostles showing typical pedestrian use. Note man stopped at top of stairs taking videos, people stopped midway, waiting for people lower down to take pictures of view or other people in group. 9 People, LOS C for stairways.

Figures 9 and 10 show the stairway under typical use. Figure 9 shows 9 people using the stairway (LOS C for stairways). This photo was taken during a day of moderate to light use. The photograph in figure 10 shows 6 people on the same stairway (LOS A). Even at this light level of use, it is clear that the use of the stairway as a viewing platform is in clear conflict of its function as a stairway.



Figure 10. LOS A at stairway, 6 people (not counting man at bottom standing at rail or the baby in man's arms). Note the group waiting at the landing while the woman in purple takes a picture of the man standing at the rail in front of the view. Also the man with the baby is having his picture taken by a woman standing out of the picture to the left. This behaviour is typical indicating that the stairway is serving a duo purpose as a stairway and a viewing platform.

## **Summary of Recommendations**

Table 5 shows the summary of recommendations for setting capacities for day use facilities in national parks. These recommendations apply to day use areas and assume a Quality of Service that is deemed to be reasonable given the context of outdoor recreation settings. As indicated earlier in this report, perception studies currently underway by Melbourne University should attempt to set these standards on the basis of visitor perceptions.

| Walkways            |     | Viewing<br>Platforms* |     | Stairways           |     | Queuing Areas       |     |
|---------------------|-----|-----------------------|-----|---------------------|-----|---------------------|-----|
| m <sup>2</sup> /ped | LOS | m <sup>2</sup> /ped   | LOS | m <sup>2</sup> /ped | LOS | m <sup>2</sup> /ped | LOS |
| 0.7-1.1             | D   | 1.4-2.7               | D   | 0.27-0.65           | D   | 0.27-0.65           | D   |

Table 5 Level of Service recommended for day use facilities in national parks

\*In instances where viewing areas are designated by a widening of the path or a fence rail or where the viewing platform is <2 metres in depth, capacities are to be measured by dividing the length of the area (or fence) in metres by .7 m.

**Recommendation 1**: Current research by Melbourne University for Parks Victoria should investigate the relationships between levels of service as defined in Table 2 and perceived levels of crowding and satisfaction to determine the LOS level that Parks Victoria should target in different recreational contexts.

**Recommendation 2:** Given the nature of visitor use in National Parks, a *maximum* working capacity for walkways in should be set at LOS level D (1.4 - 3.7 m<sup>2</sup>/pedestrian). This LOS should be revised or reviewed based on QOS measures made from field perceptions studies of visitors.

**Recommendation 3:** In cases where the viewing area is simply a widened area of the path. Capacity measures should use either the length of the railed fence (if one is provided) or the length of the trail pull out divided by 0.7 metres. This capacity measure assumes that the useable area for viewing is one person deep from the side of the path with the view.

**Recommendation 4:** In locations where a viewing platform is defined with a safety rail and a defined area for gathering, it is suggested that the capacity be calculated by dividing the area of the viewing platform by  $1.4 \text{ m}^2$  to  $2.2 \text{m}^2$ . (LOS D from table 1).

**Recommendation 5:** As a rule of thumb queuing areas for facilities should be designed targeting LOS D as the minimum area per pedestrian. These levels should be confirmed through on-site perceptions studies.

Appendix A applies the recommended standards to viewing platforms at Port Campbell National Park based on field survey on the 4<sup>th</sup> and 5<sup>th</sup> of June 2002.

# Implementation of Levels of Service for new pedestrian facilities.

The level of service recommendations in this report can be used as a guide in designing or upgrading pedestrian facilities in national parks. The following steps are provided as a guideline for sizing boardwalks and viewing platforms.

## Sizing viewing platforms

Viewing platforms serve as an area where visitors can congregate off the main walkway to take in a view or point of interest. If the viewing platform presents a good view then provision should be made to allow enough room for group photographs. Because viewing platforms are often built in areas of difficult terrain, fragile ecology, or other limitations, the following guidelines only address the size of the viewing platform in terms of visitor numbers. Extraneous limitations on siting the viewing platform or platforms should be considered once the desired size from these guidelines has been established.

### 1. Define the Level of Service to be provided

The level of service should be determined by the Quality of Service to be provided. This report recommends Level of Service D for viewing platforms from Table 1. This means that the viewing platform is sized by multiplying the capacity by  $1.4 \text{ m}^2$  to  $2.2\text{m}^2$ . The larger the multiplier, the higher the quality of service.

#### 2. Define the expected arrival rates.

Parks Victoria designs facilities based on the 95<sup>th</sup> percentile of visitor use or for the 18 days of the year with highest visitor use (see discussion in Appendix 2). On existing facilities, peak user days should be monitored with pedestrian counters at key locations. The information that is required is the number of visitors, and the average duration of stay. If estimates of growth are required, time series data is required to calculate growth rate.

For sites with no existing facilities, expected visitors flows can be estimated by using data from "equivalent sites". These are sites with similar physical characteristics, distances to population centres and park facilities.

# 3. Use RBSim to simulate the pattern of visitor use and estimate the visitor use at peak times.

RBSim may be used to simulate the pattern of visitor use. To determine the working capacity of the viewing platform, the proposed platform is located on the network as a node and the capacity is set to an arbitrarily large number. The duration at the viewing platform may then be set to the expected range of times visitors typically use the viewing platform (e.g. 1 to 3 minutes). A stationary agent should then be placed on the viewing platform node with a small visibility radius set (e.g. 5 metres). On output the data from this agent is analysed to determine the number of visitors at the busiest times. Multiple simulation runs should be averaged to determine the visitor numbers to be used to size the viewing platform based on the level of service.

## 4. Calculate the viewing platform size

Once the visitor numbers at peak periods are determined, this number is multiplied by the level of service value for  $m^2$ / pedestrian from table 1 to determine the size in square metres. Where possible a minimum width of 3 metres should be maintained to allow room to safely stand on the platform while taking group photographs. The length of the platform should be perpendicular to the principle view direction. Where the viewing-side length is restricted, multiple level platforms should be considered to increase the access to the view and provide more flexible opportunities for photography.

## Sizing pedestrian walkways

The critical size for walkways is the usable width. The minimum width is 1.5m to allow two people to walk comfortably side by side. This minimum width is usually inadequate in areas with two-way traffic and/or heavy use. The critical variable to determine for sizing pedestrian walkways is the flow rate in pedestrians per minute. The methodology is similar to viewing platforms and will be repeated for completeness.

## 1. Define the Level of Service to be provided

The level of service should be determined by the Quality of Service to be provided. This report recommends Level of Service D for walkways from Table 1.

| LOS <sup>a</sup> | Space                 | Flow Rate   | Average Speed |
|------------------|-----------------------|-------------|---------------|
|                  | (m <sup>2</sup> /ped) | (ped/min/m) | (m/min)       |
| D                | 1.4-2.2               | 33-49       | 68.4-73.2     |

Table 6. Recommended level of service for walkways in National parks. (Average speeds have been converted from metres to second to metres per minute from table 1.)

## 2. Define the expected arrival rates.

Parks Victoria designs facilities based on the 95<sup>th</sup> percentile of visitor use or for the 18 days of the year with highest visitor use (see discussion in Appendix 2). On existing facilities, peak user days should be monitored with pedestrian counters at key locations. The information that is required is the number of visitors, and the average duration of stay. If estimates of growth are required, time series data is required to calculate growth rate.

For sites with no existing facilities, expected visitors flows can be estimated by using data from "equivalent sites". These are sites with similar physical characteristics, distances to population centres and park facilities.

## 3. Use RBSim to simulate the pattern of visitor use and estimate the visitor use at peak times.

RBSim may be used to simulate the flow rates of visitor use. To determine the working capacity for walkways a node should be placed along the proposed walkway. The minimum and maximum duration for the node should be set to 1 second. The simulation time-step should be set to one second. The output time-step should be set to be the same as the simulation time-step. On output the data from this agent is analysed to determine the flow rate for pedestrians. This should be expressed in pedestrians per minute and graphed to show the peak periods of use. Multiple simulation runs should be averaged to generate a stable rate of flow estimate.

#### 4. Calculate the walkway size

Once the visitor flows at peak periods are determined in pedestrians per minute, this number is divided speed in metres per minute (68.4 metres/minute) to calculate the space requirements per pedestrian (this result is in square metres). To determine the final width divide by either 0.6 metres (the width of the body ellipse from figure 1) or 0.75 metres (half the recommended with for two people walking side by side). If the resulting figure is less than 1.5 metres then you should make the walkway 1.5 metres.

In cases where the walkway parallels a view (in other words where it is likely pedestrians may be stopping to take pictures or to stop to look at a view or interpretive sign, provision should be made for this behaviour by designing viewing platforms on the viewing side or by increasing the overall width of the walkway by 0.5 metres.

| Flow rate | Speed       | Space          | Recommended<br>width | Recommended<br>width |
|-----------|-------------|----------------|----------------------|----------------------|
| Ped/min   | m/min       | m <sup>2</sup> | Space / 0.6m         | walkway with         |
|           |             |                | m                    | views (+ 0.5m)       |
| 10        | 68.4 - 73.2 | 0.15 -0.14     | 1.5                  | 2.0                  |
| 25        | 68.4 - 73.2 | 0.37-0.34      | 1.5                  | 2.0                  |
| 50        | 68.4 - 73.2 | 0.73-0.68      | 1.5                  | 2.0                  |
| 100       | 68.4 - 73.2 | 1.46-1.37      | 2.44-2.28            | 2.3-2.8              |
| 150       | 68.4 - 73.2 | 2.19-2.05      | 3.65-3.42            | 3.4-3.9              |
| 200       | 68.4 - 73.2 | 2.92-2.73      | 4.87-4.55            | 4.6-5.1              |

Table 7 shows example calculations for a low estimate, a high estimate and the recommended width for areas with and without views.

Table 7. Example calculations showing recommended walkway widths for LOS D given different flow rates.

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## Appendix A – Viewing Platform capacities at Port Campbell National Park.

A site survey of existing conditions of viewing platforms at Port Campbell National Park was completed on the 4<sup>th</sup> and 5<sup>th</sup> of June 2002. Using the standards for viewing platforms in Table 5, Table 6 shows the capacities for existing facilities at each site surveyed in the field study.

| Site Name                | Type of Viewing | Measurement (m <sup>2</sup> | Capacity (number |
|--------------------------|-----------------|-----------------------------|------------------|
|                          | Area            | or m)                       | of pedestrians)  |
| Bay of Martyrs           | Platform/Fence  | 3 m                         | 4                |
| The Grotto Upper         | Platform/fence  | 3 m                         | 4                |
| platform                 |                 |                             |                  |
| The Grotto First         | Platform        | $6 \text{ m}^2$             | 3-4              |
| stairway deck            |                 |                             |                  |
| The Grotto Stair         | Platform        | $2 \text{ m}^2$             | 1-2              |
| Landing Deck             |                 |                             |                  |
| The Grotto – main        | Platform        | $10 \text{ m}^2$            | 4-7              |
| viewing area             |                 |                             |                  |
| London Bridge            | Platform        | $38 \text{ m}^2$            | 17-27            |
| East Platform            |                 |                             |                  |
| London Bridge            | Platform        | $29 \text{ m}^2$            | 13-21            |
| Central Platform         |                 |                             |                  |
| London Bridge            | Platform        | $12.5 \text{ m}^2$          | 6-9              |
| West Platform            |                 |                             |                  |
| The Arch Hexagon         | Platform        | $6 \text{ m}^2$             | 3-4              |
| Platform                 |                 |                             |                  |
| The Arch                 | Platform        | $7 \text{ m}^2$             | 3-5              |
| Rectangle Platform       | 1 multionin     | ,                           | 00               |
| Loch Ard Circuit         | Platform        | $16.8 \mathrm{m}^2$         | 8-12             |
| Walk East View           | Thuronn         | 10.0 m                      | 0 12             |
| Loch Ard Gorge           | Fence           | 2.5 m                       | 4                |
| Circuit walk             | T ence          | 2.3 111                     | I                |
| Razerback View           |                 |                             |                  |
| Loch Ard Gorge           | Fence           | 2.5 m                       | 4                |
| Circuit walk West        | Tenee           | 2.3 111                     | I.               |
| view                     |                 |                             |                  |
| Loch Ard Circuit         | Fence           | 7.8m                        | 11               |
| walk                     | 1 chee          | 7.0111                      | 11               |
| Valk<br>Loch Ard Circuit | Fanca           | 7m                          | 10               |
| walk Limestone           |                 | / 111                       | 10               |
| Curtaina view            |                 |                             |                  |
| Loop And View            | Dlotform        | 27 m <sup>2</sup>           | 12 10            |
| Distignment all ave      | Platiorin       |                             | 12-19            |
| Platform above           |                 |                             |                  |
| Limestone curtains       |                 |                             |                  |

| Table 6. Application of recommended LOS standards to viewing platforms a | at |
|--|----|
| Port Campbell National Park  |    |

| Site Name          | Type of Viewing  | Measurement (m <sup>2</sup> | Capacity (number |
|--------------------|------------------|-----------------------------|------------------|
|                    | Area             | or m)                       | of pedestrians)  |
| Loch Ard Parking   | Platform         | $6 \text{ m}^2$             | 3-4              |
| Viewpoint          |                  |                             |                  |
| Loch Ard VP        | Fence            | 2 m                         | 3                |
| looking south      |                  |                             |                  |
| Loch Ard Platform  | Platform         | $15 \text{ m}^2$            | 7-11             |
| looking west to    |                  |                             |                  |
| Mutton Bird Island |                  |                             |                  |
| Loch Ard Mutton    | 3 level Platform | $123 \text{ m}^2$           | 56-88            |
| Bird Island View   |                  |                             |                  |
| Loch Ard Blow      | Fence            | 4 m                         | 6                |
| Hole South View    |                  |                             |                  |
| Loch Ard Blow      | Platform         | бm                          | 9                |
| Hole North View    |                  |                             |                  |
| Loch Ard Thunder   | Platform         | $7 \text{ m}^2$             | 3-5              |
| Cave               |                  |                             |                  |
| 12 Apostles        | Platform         | $56 \text{ m}^2$            | 25-40            |
| Southwest Viewing  |                  |                             |                  |
| Platform           |                  |                             |                  |
| 12 Apostles. East  | Platform         | $11.4 \text{ m}^2$          | 5-8              |
| facing platform on |                  |                             |                  |
| way to the bunker  |                  |                             |                  |
| 12 Apostles. West  | Platform/fence   | 3.7 m                       | 5                |
| facing platform on |                  |                             |                  |
| way to the bunker  |                  |                             |                  |
| 12 Apostles. "The  | Platform         | $42 \text{ m}^2$            | 19-30            |
| Bunker"            |                  |                             |                  |
| Gibson Steps       | Platform         | $6 \text{ m}^2$             | 3-4              |
| Hexagon Platform   |                  |                             |                  |

## Appendix B – Planning for the 95th percentile

The 95<sup>th</sup> percentile has been chosen as the benchmark for RBSim. Two different cases can be argued as to its appropriateness:

#### Case 1 – Comparison with other percentiles

The 100<sup>th</sup> percentile represents the most extreme case, and is generally too unreliable. Planning for the 100<sup>th</sup> percentile is very difficult and involves trying to identify this day within the year. For example, the 100<sup>th</sup> percentile may be only the Sundays two days after Christmas day or Australia Day when it falls on a Saturday. It is not a consistent measure and is prone to estimating error.

The 95<sup>th</sup> percentile offers stability as it represents the top 18 days per year (5% of 365 days) where visitation meets or exceeds the peak load. In terms of visitation at Twelve Apostles, this includes the week between Christmas and New Year, the Easter holiday period, and the school holiday period in January incorporating the Australia Day holiday. Hence, it provides a predictable measure of peak visitation from year to year.

The 90<sup>th</sup> percentile represents the top 36 days per year (10% of 365 days) where visitation meets or exceeds the peak load. The additional 18 days when compared to the 95<sup>th</sup> percentile extend the planning towards 'floating' days throughout the year, and are therefore more difficult to determine. Contributing factors that lift visitation into the 90<sup>th</sup> percentile include proximity to holiday days and periods and favourable weather patterns.

#### Case 2 – Parks Victoria as a service provider

Parks Victoria is an organisation where the services provided (parks and open space and the facilities within them) are generally over-supplied. That is, the services are aimed at higher visitation levels such as weekend and holiday use rather than the lower visitation that occurs on weekdays. In essence, management revolves around maximising the availability of recreation time, and this relies on managing the peak loads. At a venue like the Twelve Apostles, planning for the highest 18 days of visitation per year (95<sup>th</sup> percentile) assists in creating an environment where visitors can make the most of their available recreation time throughout the year.