TS-TN-021 - Specification of Pedestrian Movement Operation

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1.2	14 Jul 2016	Imported into new template and rebranded according to current corporate identity. Removed unnecessary references to Masterlink/Flexilink in sections 3.3 and 3.4. Updated references in section 7. Updated figures 3, 6 and 7.	C Moran, GM Road Network Operations

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1. Introduction

This document provides a description of the method to be adopted in specifying the function of pedestrian pushbutton demands at signalled locations. It replaces the Standard Tables for Pedestrian Movements [1].

In addition, a set of standard pedestrian pushbutton tables has been established to assist in the selection of the pushbutton function in the preparation of the intersection design plan. The benefits of such a set of standards are significant with regard to design and the adaptive engineering required to translate that design into a controller personality.

The basic functions of a pushbutton are to demand a phase(s) appropriate to the pedestrian demand. The schedule defines in detail the conditions applying to the function of each pushbutton.

An abbreviated symbolic language is used to define:

(a)   The period during which the function occurs.

(b)   Any other conditions affecting the function.

The schedule is to be initiated at the design stage of an intersection and included on all signal design plans, except simple two phase, standard "Single Diamond" and standard "Double Diamond" overlap designs.

Within the traffic signal controller the pushbutton demands are recognised as part of a series of inputs which are termed detectors. Detector operation and specification are described in the Specification of Detector Logic Operation, [12]. Pushbutton demands, and hence pedestrian movements, are special types of detectors and are dealt with in this document.

1.1   Conventions, Definitions and Abbreviations

Term	Meaning
AT	'A' phase clearance time. BT would be 'B' phase clearance time.
A/B	Implies the A/B signal group. This notation is not to be used and is only included to facilitate understanding of older intersection designs.
A(WALK)	Implies the pedestrian signal group controlling the pedestrian movement which occurs in A phase. This notation is not to be used and is only included to facilitate understanding of older intersection designs.
A/C(WALK)	Implies the pedestrian signal group controlling the pedestrian movement which occurs in both A and C phases. This notation is not to be used and is only included to facilitate understanding of older intersection designs.
DDO	Double Diamond Overlap
ECO	Early Cut Off
EPD	Example Personality Data
LC	Long Clearance
LM	Library Macro
LTOR	Left Turn On Red
OD	Operational Description
PD	Permanent Demand
P2(WALK)	Implies the signal group controlling a pedestrian movement. The unique sequential numeric allocated in accordance with signal group labelling in Traffic Signals Practice [9]. This notation is the current standard and should be used instead of the A(WALK), A/C(WALK) notation.

Term	Meaning
RMS	Roads and Maritime Services
SDO	Single Diamond Overlap
TAE	Typical Application Example
V2	Implies the signal group controlling a vehicular approach. The unique sequential numeric, 2, is allocated in accordance with signal group labelling in Traffic Signals Practice [9]. This notation is the current standard and should be used instead of the A/B notation.

1.2 References

[1] Standard Tables for Pedestrian Movements (RMS Standard Personality), 2 Feb 1990

[2] VD018-10, Standard for Detector Specification Schedule, 23 December 1988 (*also titled Standard Tables for Detector Logic, RMS Standard Personality, 24 November 1988*)

[3] VD018-5, Standard for Single Diamond Overlap Design

[4] VD018-6, Standard for Double Diamond Overlap Design

[5] VD018-8, Standard for Signal Group Displays

[6] VD018-11, Design Principles for SCATS Controlled Intersections, Issue A, 15 March 1985

[7] VD018-14, Standard for Single Diamond Overlap Phasing with Filter Option

[8] TS-QA-156, Personality Standard Tables Management – Standard Operating Procedure

[9] Traffic Signal Design – RMS, February 2008

[10] RMS-TC-106, Traffic Signal Operation, Version 1.4, January 2013

1.3 Associated Documents

[11] TS-TN-019, Specification of Vehicle Group Operation – Guidelines for Developing

[12] TS-TN-020, Specification of Detector Logic Operation – Guidelines for Developing

[13] TS-TN-022, Specification of Ancillary Operation – Guidelines for Developing

[14] TS-TN-023, Layout of Macros for Standard Tables – Guidelines

[15] TS-TN-026, Standard for Single Diamond Overlap Phasing

[16] TS-TN-027, Standard for Double Diamond Overlap Phasing

[17] RTA-TC-185, RMS Standard Personality Reference Manual (Phases)

2. Design Steps

The complete process for developing an intersection design correctly is given in Traffic Signals Practice, Design, [9] and briefly outlined below.

1. Prepare a sketch of the intersection including lane markings, pedestrian crossings and detector locations. Make sure to distinguish between shared and exclusive lanes.

2. Prepare a sketch of the movements permitted in each phase (one sketch per phase) with arrows indicating the direction of movement.

3. Determine what signal groups are required in accordance with TS-TN-019 [11] as appropriate.

4. Add the primary lanterns for each signal group to the sketch.

5. Add labelling to the signal group lanterns in accordance with TS-TN-019 [11].

6. Label each pedestrian movement pushbutton in the form Px, where x is a unique sequential number in accordance with traffic signal design [9].

7. Draw a pedestrian movement specification schedule as described in sections 3 and 5.

8. Add any further requirements for the pedestrian movement, such as protected/unprotected.
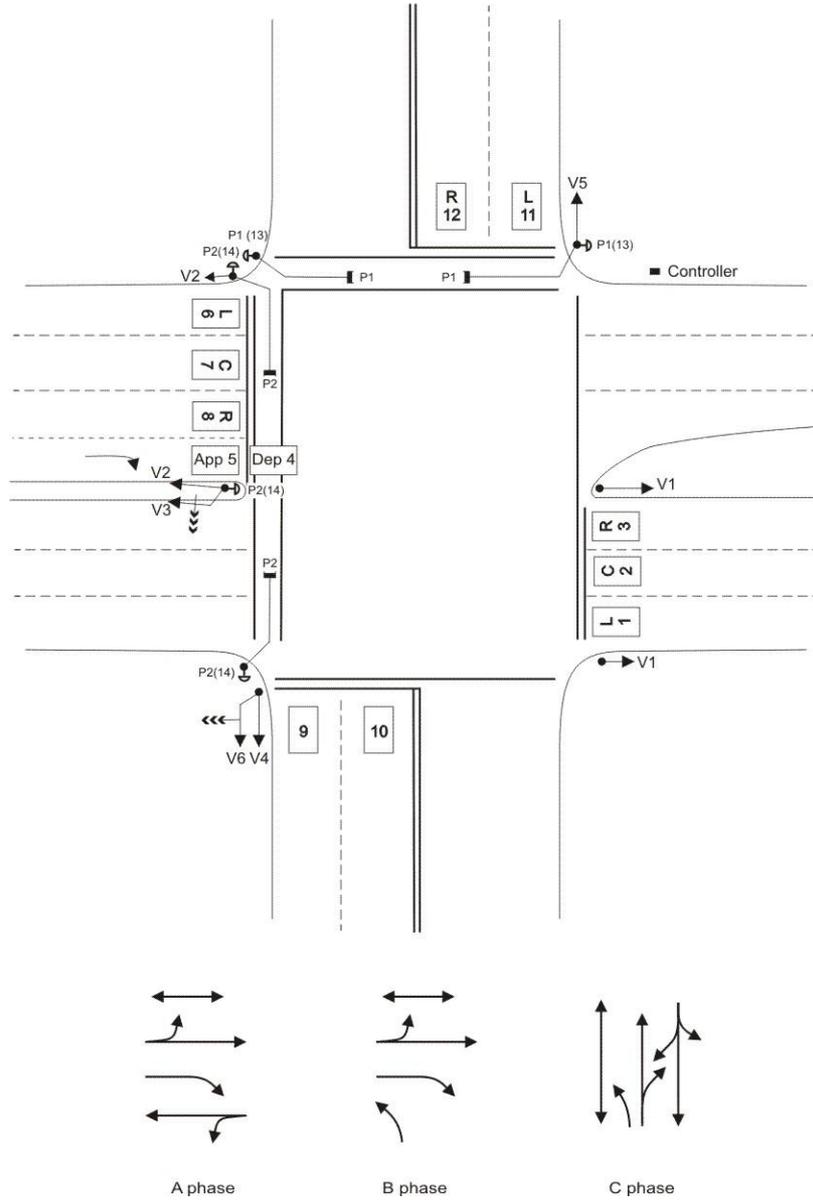
Figure 1   Labelling of signal group lanterns and pushbuttons

3.   Format and Explanation of Terms

The specification schedule is to be set out in a schedule as follows:

Pushbutton	Specification			
	FN			
	SG/PS			
	DS			

Where:

Term	Meaning
FN	The pedestrian pushbutton Function
SG/PS	The Signal Group or Phase Status
DS	The Demand Status or other conditions affecting the function

The pushbutton label is placed in the left box of the schedule and symbols are used in the columns to specify the pushbutton Function, Signal Group/Phase Status and Demand Status.

Symbol	Meaning
a dot (.)	Placed between symbols means "and"
a plus (+)	Placed between symbols means "or"
a bar (–)	Placed over a symbol means the opposite or inverse of the same symbol without a bar

The following subsections outline the rows to be completed (downwards) for each column.

3.1 Pushbutton Function (FN)

The pushbutton function is to be specified in the form X(Y), where X is the phase demanded and Y (in brackets) is the actual function.

Eg: A(L) means actuation of this pushbutton registers a locked demand for A phase.

The following is a list of functions and their meanings. (This is not an exhaustive list and may be expanded as new functions are required.)

Symbol	Meaning	Function
L	Locked Demand	The pushbutton places a demand for the specified phase.
PB	Pedestrian Demand	The pushbutton places a demand for the phase for the pedestrian movement.
	Re-introduce WALK	The pushbutton places a demand for the pedestrian movement. The WALK may be introduced late in the pedestrian movement phase if there is sufficient time in the phase for the pedestrian movement. Re-introduction may ONLY be used for a pedestrian movement where there is no conflict.
	Auto Intro	The pedestrian movement is automatically introduced at a specific point in the phase for the pedestrian movement.
	Walk for Green	The pedestrian movement is introduced by demand, and displays Walk for the phase running intervals.

For the sake of brevity, two demand functions can be combined with an "and" symbol in the specification schedule if the SG/PS and DS are the same, e.g. A(L).B(L). However, they cannot be combined with an "or" symbol, e.g. A(L)+B(L) is illegal.

In all cases, the demand may be cancelled by the conditions specified in the SG/PS and DS entries.

3.1.1 Examples of Pushbutton Function

Symbol	Meaning
C(L)	Registers a locked demand for C phase.
A(PB)	Registers a locked demand for the pedestrian movement P1 and the phase in which the pedestrian movement runs, in this case A phase.

3.2   Signal Group/Phase Status (SG/PS)

This entry specifies the period during which the pushbutton function (FN) is acknowledged and the demand is acted on.

The phase during which the pushbutton function applies is specified by a single letter, e.g. A for A phase, etc. Similarly, a pushbutton function may be qualified by the status of a signal group. In this case the signal group designation is specified in the SG/PS entry, e.g. V1.

The method provides a concise means for specifying the duration for commonly used functions. Brevity has taken precedence over clarity, and the exact meaning of the SG/PS entry should be interpreted in the appropriate manner for each function type. Examples are given in the sections relating to specific types of pedestrian movement introduction and operation.

In some instances it is necessary to specify the duration of the function in a rigorous manner. In such cases a parameter in brackets is appended to the SG/PS entry to accurately specify the phase intervals or the signal group colours. For example, the duration of the A phase pedestrian walk signal is specified by the entry, P1(WALK). The following list of symbols describes those currently in use.

Symbol	Meaning
LS	Late start interval
MIN	Minimum green interval
ECG	Early cut off green interval
Y	Yellow interval
AR	All-red interval
I	Intergreen interval
WALK	Walk interval
CL	Clearance interval (flashing don't walk)
W&CL	Walk & Clearance intervals
EXT	Extension green interval
VIG	Variable initial green interval

The function may be cancelled when the condition specified in the SG/PS entry is no longer true.

3.3   Demand Status (DS)

This entry specifies any extra conditions which apply to the pushbutton function. Boolean logic is used to combine the conditions into a compound entry. The following list of symbols, which associated meanings, detail the conditions currently in use. This list may be expanded as new conditions are required.

Symbol	Meaning (Function)
A	Presence of a phase demand, (specified by the phase letter, A phase in this case).
A(NEXT)	The next phase to follow the running phase, (A phase in this case).
P1(PB)	Presence of a pushbutton demand for pedestrian movement 1.
Z-	Z- special facility signal.
Z+	Z+ special facility signal.
Z5	Masterlink Z5 special facility signal.
Q-	Q- special facility signal.

Symbol	Meaning (Function)
Q+	Q+ special facility signal.
MLINK	Masterlink mode of operation.
FLEXI	Flexilink mode of operation.
ISOL	Isolated mode of operation.
V1(VEH RUN)	Vehicle signal group has run during this cycle.
P1(PED RUN)	Pedestrian signal group has run during this cycle.
A(PHASE RUN)	Phase has run during this cycle.

The complement of a condition is expressed by placing a line above the particular condition.

Note that a dash, "–" , is used for the DS entry if there are no extra conditions.

3.4   Examples of Demand Status:

Symbol	Meaning
A	A phase demanded.
$\overline{A}$	A phase not demanded.
B+C	B or C phase demanded.
B.C	B and C phase (both) demanded.
$\overline{B}.\overline{C}$	No demand for B phase and no demand for C phase.
$\overline{B}$+P2(PB)	No demand for B phase, or a pushbutton demand for P2 pedestrian.
B1(NG)	No expiry of gap timer on B1 detector.
Z+	Z+ signal is present.

The function will be cancelled if the conditions specified in the Demand Status (DS) entry are not met.

4. Pedestrian Movement Operation

The operation of the pedestrian movement is described in Traffic Signal Operation, [10] and is briefly outlined below.

Pedestrian movements are normally grouped with vehicle movements to form a phase. This grouping should be such that the pedestrian movements run concurrently with parallel vehicle movements when appropriate. Where turning vehicles can cross a pedestrian movement, it may be necessary to provide pedestrian protection as discussed in section 4.4. If pedestrian movements are grouped into one phase without any vehicle movements, then it is said to be an exclusive pedestrian phase.

The pedestrian movement is divided into three sequential time intervals called walk, clearance 1 and clearance 2. This can be preceded by a delay interval. The delay period is seldom used. When it is used, it is normally to delay the registration of a pedestrian demand.

The duration of the walk display is divided into walk 1 and walk 2. Walk 1 is a timed interval to provide a minimum time for the walk display. This is intended to allow time for pedestrians to begin their crossing. Upon expiry of the walk 1 interval, the pedestrian movement enters the un-timed walk 2 interval, where it rests until the walk display is terminated.

The clearance 1 and clearance 2 intervals provide time for the pedestrians to complete their crossing. When a pedestrian movement is introduced, the phase normally cannot terminate until the clearance 1 interval has finished. (An exception is when the pedestrian movement is allowed to overlap.) The clearance 2 interval can run concurrently with the phase clearance. It should not be longer than the phase clearance period (i.e. early cut-off green + yellow + all-red), otherwise the phase will be held in the all-red interval until the clearance 2 interval finishes timing.

The relatively long time that pedestrians take to cross a road can mean the pedestrian clearance represents a significant amount of wasted time which could have been used by vehicle movements in another phase. Therefore, pedestrian movements are usually introduced only by demand through the pushbutton activated by the pedestrian.

4.1 Introduction

The pushbuttons associated with a pedestrian movement, demand a phase in a similar manner to a locked demand from a vehicle detector, as well as demanding the pedestrian movement. Both these demands are cleared when the pedestrian movement receives a walk display.

Table 1 Normal pedestrian movement specification schedule

P1 (PB)	FN	A(PB)
	SG/PS	$\overline{P1(WALK)}$
	DS	-

The pedestrian movement generally commences from the start of the phase. However, if a late demand for the pedestrian is received (i.e. during the phase in which it runs), the pedestrian movement may still be introduced in some circumstances. This operation is referred to as late introduction. If the controller is operating in isolated or Flexilink-isolated mode, then the pedestrian movement may be late introduced if there are no:

- Demands for other phases; and

- Conflicting vehicle movements running (this includes turning movements).

If the controller is operating in full Flexilink mode, then the walk signal may be introduced at the demand phase pulse. If the controller is operating in Masterlink mode, then the walk signal may be introduced in the stretch phase upon permission from SCATS. The operation of pedestrian movements at SCATS-controlled sites is further described in Design Principles for SCATS Controlled Intersections, [6].

When a pedestrian movement has already run in a phase, a further demand for the movement can result in re-introduction subject to the same conditions as for late introduction. Re-introduction can occur while the pedestrian movement is timing the pedestrian clearance intervals, but once a phase has terminated (i.e. left the extension green interval), demands will be stored for the next cycle.

Table 2 Re-introduction specification schedule

P3 (PB)	FN	Re-introduce WALK
	SG/PS	$\overline{C.P3(WALK)}$
	DS	$\overline{A}.\overline{B}$

4.1.1 AUTO Switch

Each pedestrian movement has an AUTO switch. This is used to automatically introduce a pedestrian movement each time the specified phase is run.

Table 3 Automatic introduction specification schedule

P1 (PB)	FN	Auto Intro
	SG/PS	A
	DS	-

4.2   Overlap

Pedestrian movements may overlap in a similar manner to vehicle signal groups. In this case, the walk or clearance or both may overlap from one phase to another. The overlaps are determined by the data in the personality.

4.3   Termination

The duration of the walk 1 interval is governed by the walk time setting. In isolated operation, this usually corresponds with the duration of the walk display as walk 2 is skipped. This is called a timer terminated pedestrian movement. Pedestrian movements may also be terminated by:

- The end of the extension green interval (called walk for green).

- The presence of an opposing phase demand (called demand terminated).

- The presence of a special signal from SCATS (called early cut-off termination).

- The arrival of a phase command from SCATS (called command termination of phase walk).

The operation of pedestrian movements at SCATS-controlled sites is further described in Design Principles for SCATS Controlled Intersections, [6].

4.4   Protection

When a vehicle movement conflicts with a pedestrian movement, it may be necessary to provide protection for the pedestrians by displaying a red aspect arrow or roundel. The degree of protection depends on the severity of the conflict, the five degrees of protection being:

- No protection.

- Timed protection for part of the walk interval.

- Protection for the whole of the walk interval.

- Protection for whole of the walk interval and timed for part of the clearance interval.

- Full protection for the whole of the walk and clearance intervals.

When there is no protection, vehicles are permitted to filter through the pedestrian movement with the statutory requirement that turning vehicles must give way to pedestrians. When timed protection is used for part of the walk period, vehicles are held on a red signal so that the pedestrians can establish their movement and then changes to off to allow vehicles to filter. The duration of the red signal is usually controlled by a special timer.

When protection is used for the whole of the walk interval, the operation is the same, except that the red signal is held for the walk interval and then goes off to allow vehicles to filter through the pedestrian movement clearance interval.

When protection is provided for the walk interval and then timed during the clearance interval, vehicles are held on a red signal so that the pedestrians can establish their movement and then changes to off to allow vehicles to filter. The duration of the red signal is usually controlled by a special red-arrow timer with a minimum of the walk interval being provided. This longer timed protection is more for multiple lane, ie wide, roads.

When full protection is used, vehicles are held on a red signal for the whole of the walk and clearance intervals. It is assumed that the vehicle movement conflicts dangerously with the pedestrian movement because of the angle of the intersection or multiple lanes of traffic turning

through the pedestrian crossing. The pedestrian movement is fully protected by holding the vehicle signal group red for the whole of the walk and clearance intervals.

When protection is provided, the signal group is said to be "conditional" if the green display is affected by the running of the pedestrian movement.

When pedestrian protection is provided, there will be some cases where it is possible to introduce the green arrow after the pedestrian clearance has completed. However, this can only be done if it is possible to display the green signal for a minimum period. This period is called a signal group minimum green.

4.5   Call Away

If a pedestrian demand is received after the parallel vehicle green aspect is displayed, it would be unsafe to introduce the pedestrian movement due to the conflict with left-turning or right-turning traffic. To avoid such situations, and where there is no demand for another phase, the pedestrian push-button actuation first demands a "call away" to another phase to stop the parallel traffic for a minimum period. The pedestrian and vehicle green aspects may then be introduced simultaneously.

Table 4 Call away specification schedule

P1 (PB)	FN	C(L)
	SG/PS	‾‾‾‾‾‾ A.P1(WALK)
	DS	

4.6   Walk for Green

The pedestrian movement is automatically introduced in the specified phase. The WALK display is held for the duration of the phase running intervals (late start to extension). The WALK is terminated (and enters clearance) automatically when the controller steps to the Early cut off green interval, regardless of the controller operating mode.

Table 5 Walk for Green specification schedule

| P1 (PB)	FN	Walk for Green
	SG/PS	A
	DS	-

5.   Preparation of Schedule

1.   Consider each pedestrian in sequence (P1, P2, P3, etc.) and determine specification as follows.

2.   Each pedestrian should be separately listed.

3.   Demand Functions

(a)   On the "FN" line specify, in correct order which phase is demanded and the type of demand (L, NL etc.). One vertical column is to be used for each function, except "demand and cancel" function [e.g. A(L).B(L)] which may be included together in one column for detectors on an overlap approach.

(b)   On the "SG/PS" line, specify the period(s) during which the above function may or may not occur.

(c)   On the "DS" line, specify any demand status or other condition which affects the above demand function of the detector.

Provided below is an example of the pedestrian movement specification schedule format. This does not need to be shown on simple two phase signal design plans. For more complex intersections with single and double diamond turns with alternative overlaps, refer to standards for Single Diamond and Double Diamond Overlap Phasing, [3] and [4] respectively.

Example:
- THREE PHASE (adaptable to either sequence A-B-C or A-C-B)

- Exclusive lane and filtering right turn

- Short red arrow protection for P1 pedestrian movement.
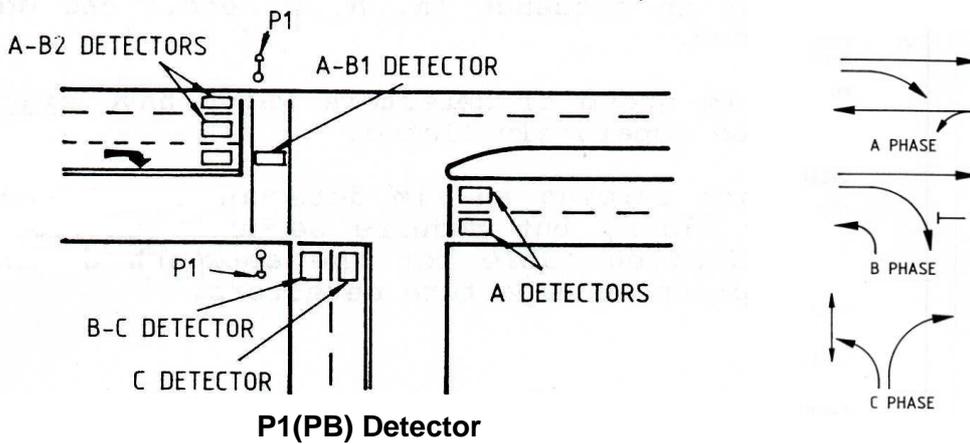
P1(PB) Detector

4. Demands C phase WALK when the P1 WALK is not green.
5. Demands A phase during C phase when the P1 WALK is not green and there is no demand for A phase or B phase.

DETECTOR	SPECIFICATION		
P1(PB)	FN	C(PB)	A(L)
	SG/PS	$\overline{\text{P1(WALK)}}$	$\overline{\text{C.P1(WALK)}}$
	DS	-	$\overline{A}.\overline{B}$

6. Standard Table Format

The following sub-sections describe conventions within the standard tables which might not be self evident to the inexperienced reader.

6.1 Structure

Each table has five sections:

- Operational Description – provides a brief, human readable, layperson description of how the table operates. This will allow intersection designers to confirm that they have made the correct choice in table request for the Personality development.

- Typical Application Example – provides a layman generic situation, in diagrammatic form, where it might be used and the specification that would reflect the example.

- Example Personality Data – provides the code that would be generated, with specific situation values for a specific situation. Explanation of the terms used in this section can be found in the Standard Personality Reference Manual, [17]. Note: the code given may not match the generic situation given in the Typical Application Example.

- Library Macro – provides the code which is used to generate the standard table code based on the answers given by the user to the questions asked by RGEN. Explanation of the terms used in this section can be found in guidelines for Layout of Macros for Standard Tables, [14].

- Revision History – provides a history of the changes to the table, including a brief summary of changes made before the tables were under formal change control procedures. OD, TAE, EPD and LM refer to the sections (identified above) of the table changed/affected.

Changes to the standard Pedestrian tables are controlled using the Standard Operating Procedure for Personality Standard Tables Management, [8]. The operational description, typical application example and example personality data can be extracted and used to form the notes file used in RGEN to aid the Personality developers. The Library Macro can be extracted to form the macro used in RGEN.

7. Summary of Pedestrian Tables

Table	SCATS pulse or timer termination
1	Normal unprotected WALK – single phase
2	Normal protected WALK – single phase
3	Unprotected WALK – re-introduction – single phase
4	Unprotected WALK – automatic intro – single phase
5	WALK for GREEN – automatic intro – single phase

Table	SCATS pulse or timer termination
6	Normal unprotected WALK overlap
7	Normal protected WALK – overlap
8	Unprotected WALK – re-introduction – overlap
9	Unprotected WALK – automatic intro – overlap
10	WALK for GREEN – automatic intro – overlap

Table	SCATS pulse or FLEXILINK pulse or timer termination
11	Unprotected WALK – single phase
12	Protected WALK – single phase
13	Unprotected WALK – re-introduction – single phase
14	Unprotected WALK – automatic intro – single phase

Table	SCATS pulse or FLEXILINK pulse or timer termination
15	Normal unprotected WALK – overlap
16	Normal protected WALK – overlap
17	Unprotected WALK – re-introduction – overlap
18	Unprotected WALK – automatic intro – overlap

Table	SCATS pulse or timer termination
19	Unprotected WALK – intro with SG Green
20	Unprotected WALK – automatic intro – single phase – with pushbutton(s)
21	WALK for GREEN – automatic intro – single phase– with pushbutton(s)

Table	SCATS pulse or timer termination
22	Normal unprotected WALK – overlap – one way
23	Normal protected WALK – overlap– one way
24	Unprotected WALK – automatic intro – overlap – with pushbutton(s)
25	WALK for GREEN – automatic intro – overlap – with pushbutton(s)

Table	SCATS pulse or timer termination
26	Normal unprotected WALK – overlap
27	Unprotected WALK – automatic intro – overlap – with pushbutton(s)
28	WALK for GREEN – overlap – with pushbutton(s)
29	WALK for GREEN – automatic intro – single phase – re-introduction
30	WALK for GREEN – automatic intro – overlap – re-introduction
31	Normal unprotected - Repeat phase with Z+ or XSF
32	Normal unprotected - automatic intro – Repeat phase with Z+ or XSF – with pushbuttons
33	Normal unprotected – Double Cycle situation
34	Normal protected – Repeat phase with Z+ or XSF

Table	SCATS pulse or timer termination
100	Normal unprotected WALK – SDO/DDO overlap – no filter *
101	Normal protected WALK – SDO/DDO overlap– no filter *
102	Normal unprotected WALK – DDO overlap – with/without filter option *
103	Normal protected WALK – DDO overlap – with/without filter option *
104	Normal unprotected WALK – SDO/DDO overlap – filter option *
105	Normal protected WALK – SDO/DDO overlap – filter option *
106	Unprotected WALK – re-introduction – SDO/DDO overlap– no filter
107	Normal unprotected WALK – SDO/DDO overlap – no filter
108	Normal protected WALK – SDO/DDO overlap – no filter
109	Normal unprotected WALK – SDO/DDO overlap – filter option
110	Normal protected WALK – SDO/DDO overlap – filter option
111	Normal unprotected WALK – DDO overlap – with/without filter option
112	Normal protected WALK – DDO overlap – with/without filter option

*   These tables have the walk timer reset in the diamond phase and are no longer in general use.
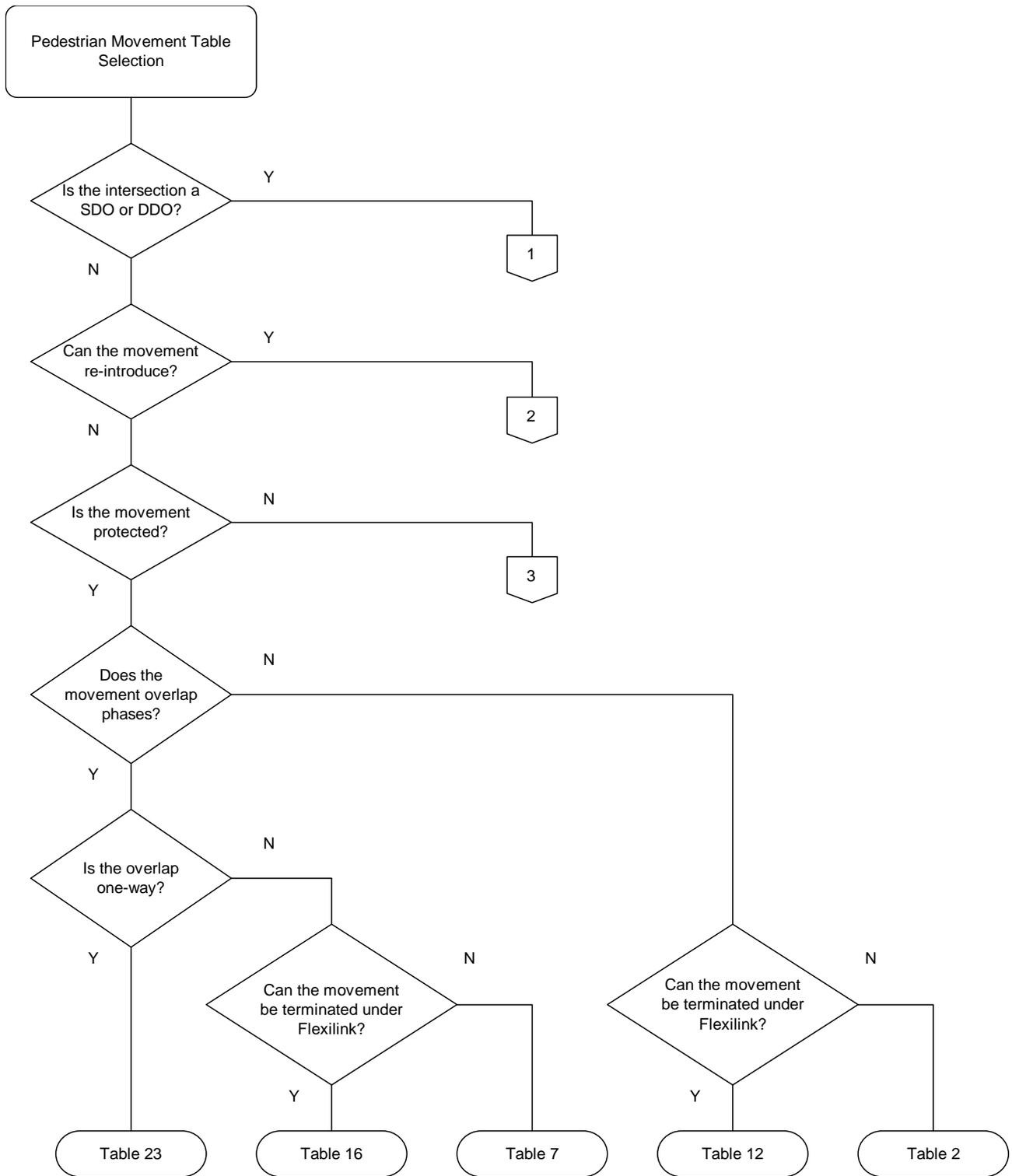
7.1   Table Selection Flowcharts
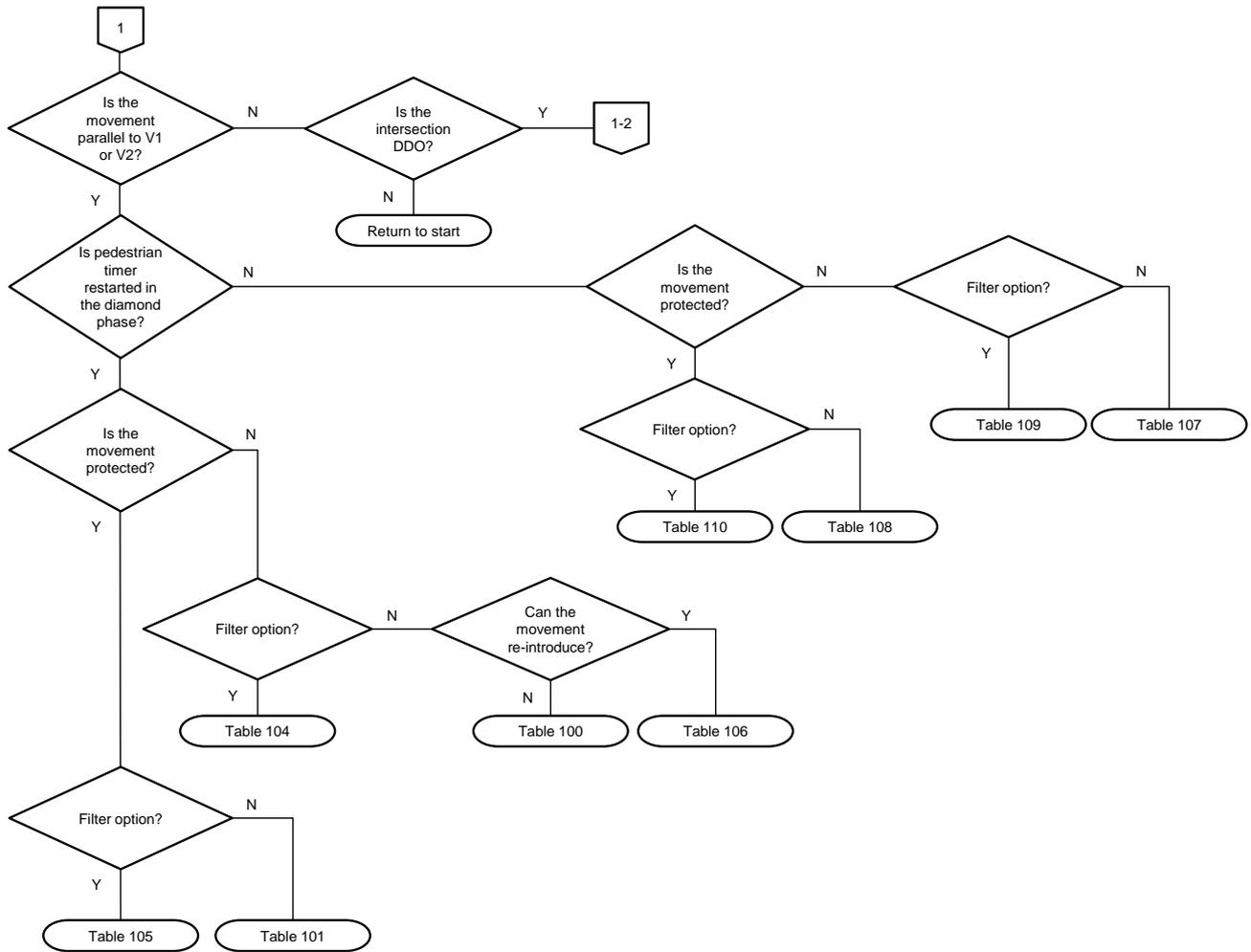

Figure 2   Pedestrian movement selection

Figure 3   Pedestrian movement selection (continuation sheet 1)
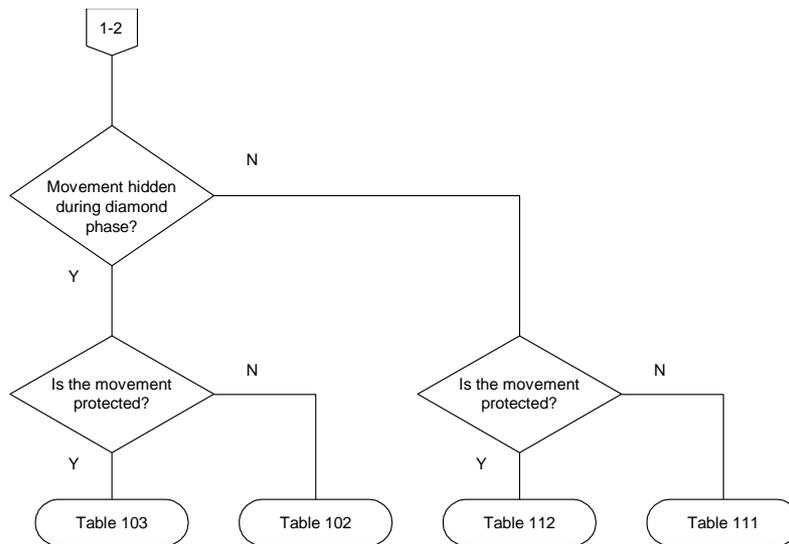
Figure 4   Pedestrian movement selection (continuation sheet 1-2)
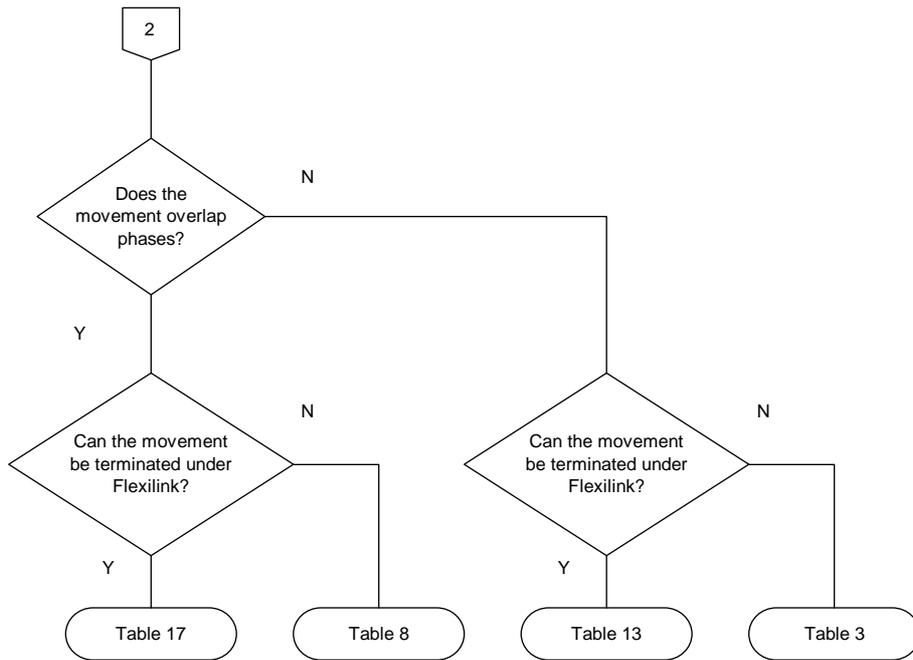
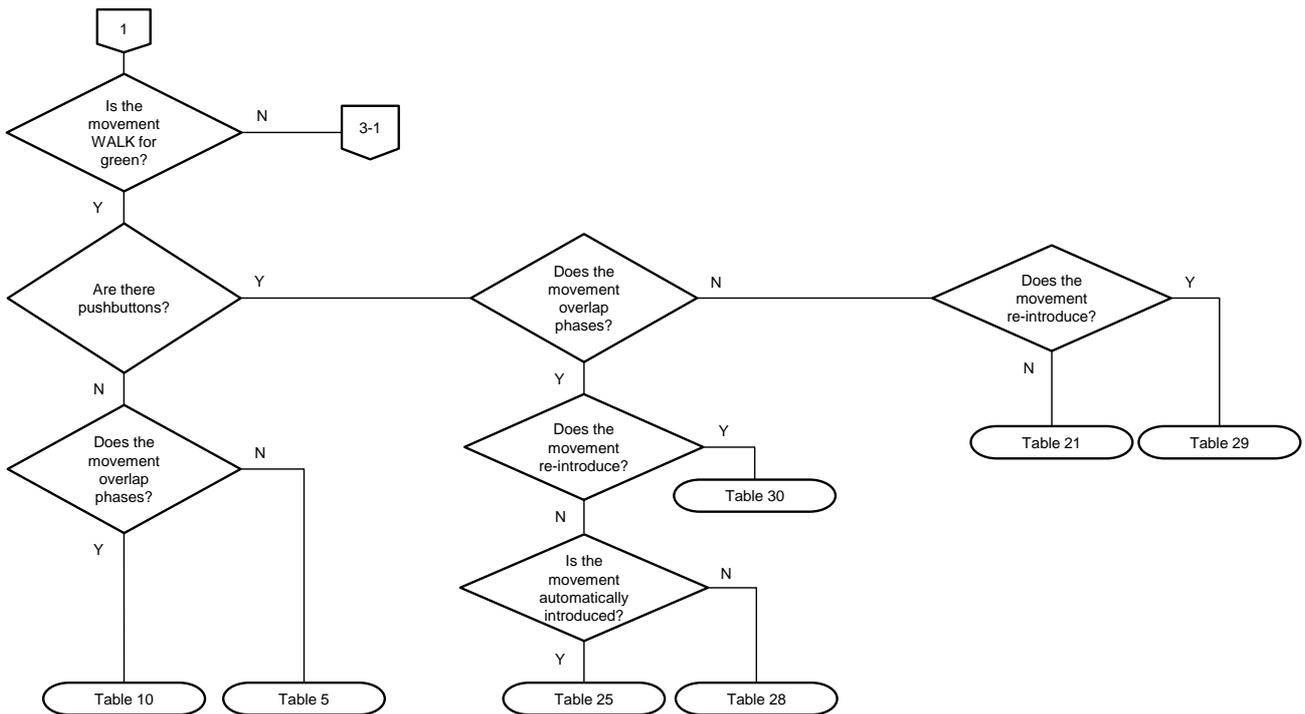**Figure 5   Pedestrian movement selection (continuation sheet 2)**

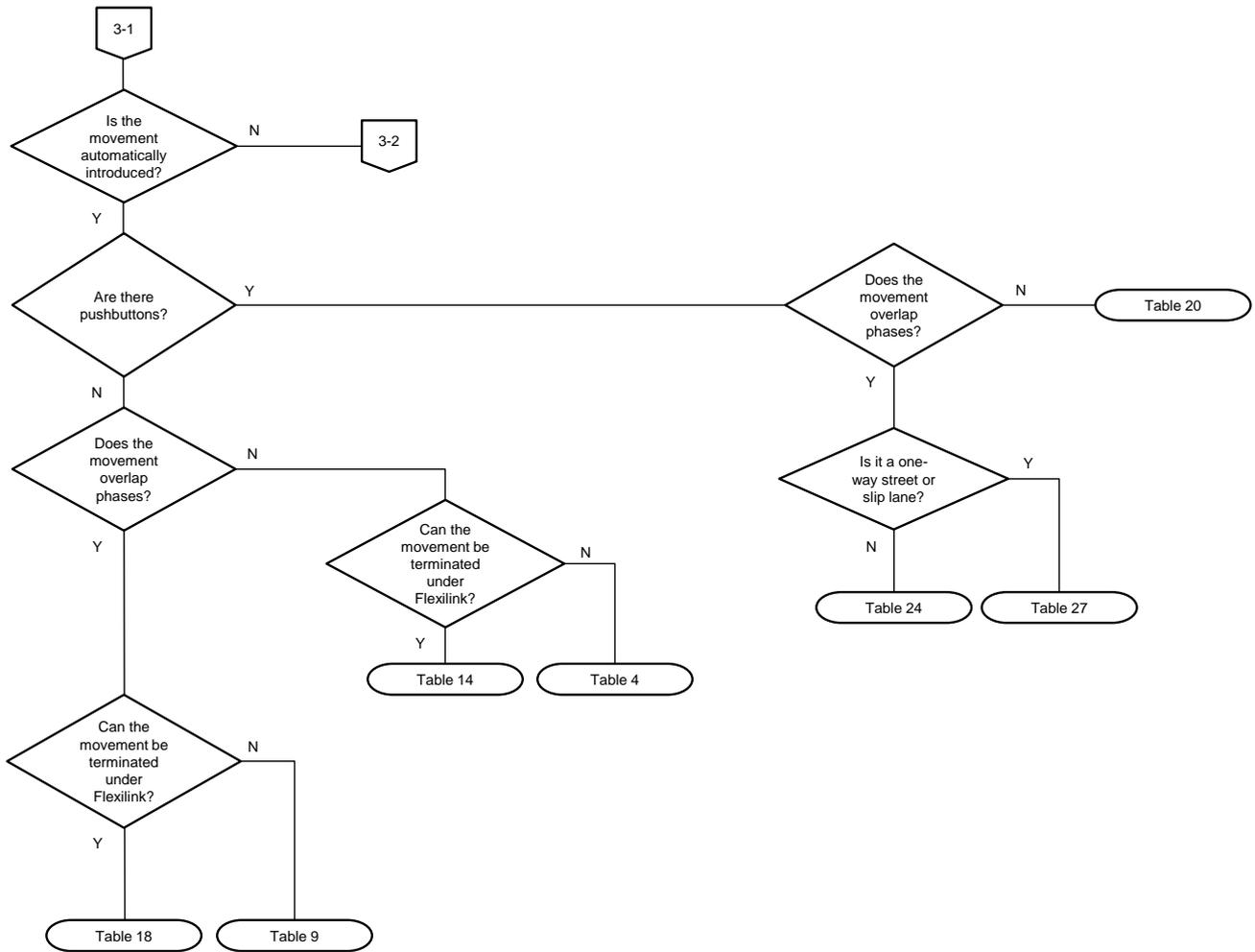**Figure 6   Pedestrian movement selection (continuation sheet 3)**

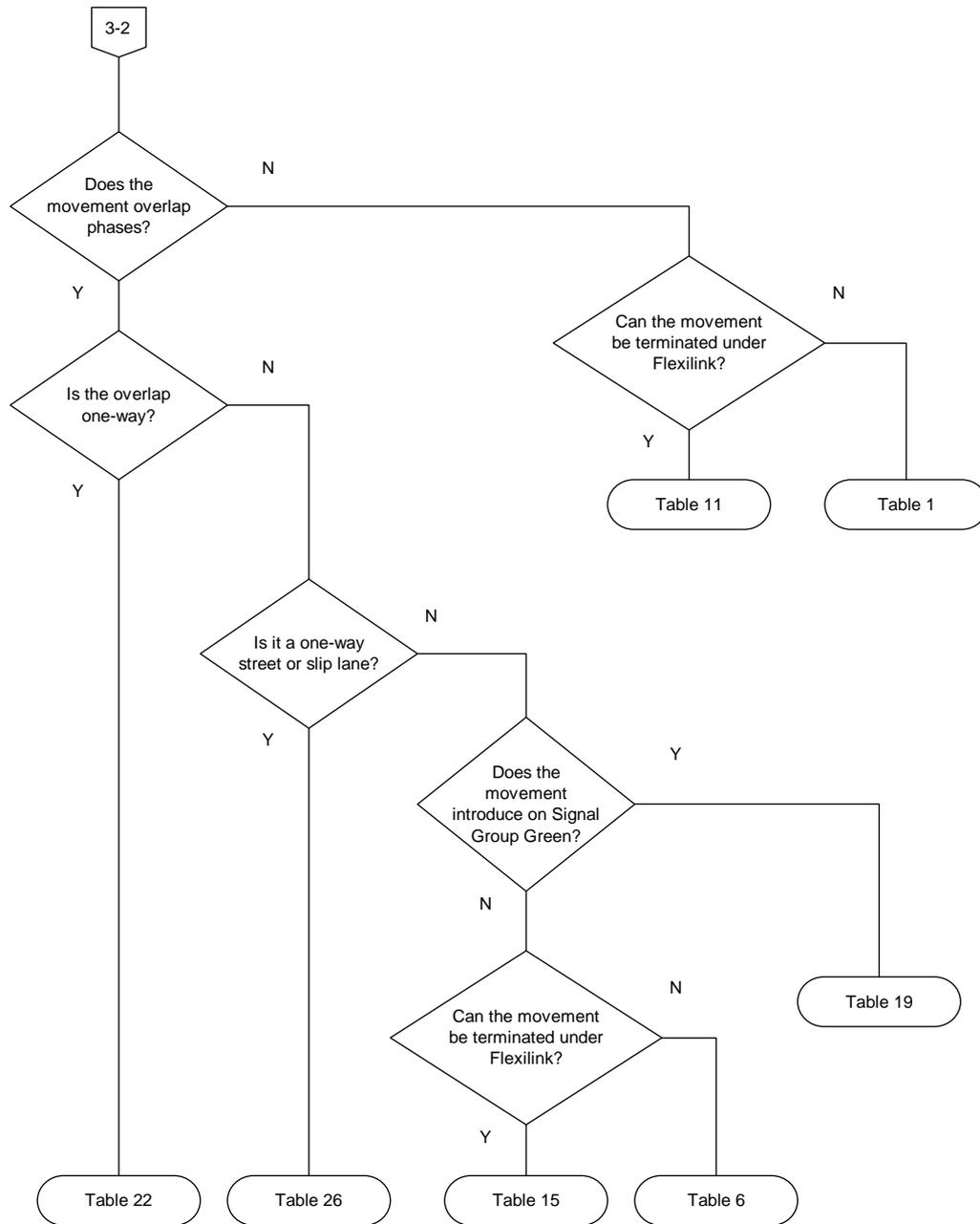**Figure 7   Pedestrian movement selection (continuation sheet 3-1)**

Figure 8   Pedestrian movement selection (continuation sheet 3-2)