Distributional Impacts of Transport Schemes:

Winners and Losers of Streetspace Allocation Exercises

Case Study: Bloxwich High Street, West Midlands

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Appendix:

User Guide for the Distributional Impacts Spreadsheet

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1. Introduction

This report has been produced as part of the four-year EPSRC-funded DISTILLATE Project, which is intended to develop improved tools and processes to assist local authorities in developing and delivering more sustainable transport policies. This study is concerned with developing methods for examining the distributional impacts of the appraisal of transport schemes, in particular with appraising scheme designs that are concerned with streetspace allocation. It complements

Urban streets make physical provision for a wide variety of activities, both on the carriageway and on the footway. These can be broadly associated either with meeting the needs of street users undertaking 'Link' activities or 'Place' activities (Jones, Boujenko and Marshall, 2007), the former relating to movement through the area, and the latter to the use of the street as a destination in its own right.

Link-related activities require space allocation in the form of design elements that are largely continuous in nature, such as traffic running lanes, bus and cycle lanes, clear footways, etc. plus pedestrian crossings at junctions.

Place-related activities are much more varied and less continuous in their requirements (Jones, Roberts and Morris, 2007), and can include the need for provision for:

- Seating and other footway public amenities
- Bus stops, and associated shelters, lighting, information and seating
- Footway parking for cycles and kerbside parking for cars (differentiating between resident, blue badge and general public parking)
- Kerbside provision for loading and for bus bays; and
- Pedestrian crossing facilities between major road junctions.

Thus, any pattern of allocation of streetspace consists of design elements that provide specific levels of provision of space/capacity for particular kinds of Link and Place activities carried out by certain street user groups. Since streetspace is limited, it is not usually possible to meet the full aspirational requirements of all groups of street users, so this usually implies that - under any streetspace allocation design - some street user groups will gain at the expense of others.

This report describes the development and application of a method for comparing designs that have different streetspace allocation patterns, in terms of their likely impacts on the various Link and Place-related groups which use the street. These different design options will vary in their levels of provision of the elements that make up a street, such as different numbers of parking bays, crossing places or benches, for instance. Because each of the elements has a different relevance and utility for each type of user, the different designs will impact differentially across the spectrum of street user groups. By comparing a proposed streetspace allocation design with the existing situation, it is possible to establish who gains and who loses under the proposed scheme(s). The approach has been operationalised through the development of an Excel spreadsheet, which is described in more detail in two Appendices to this report.

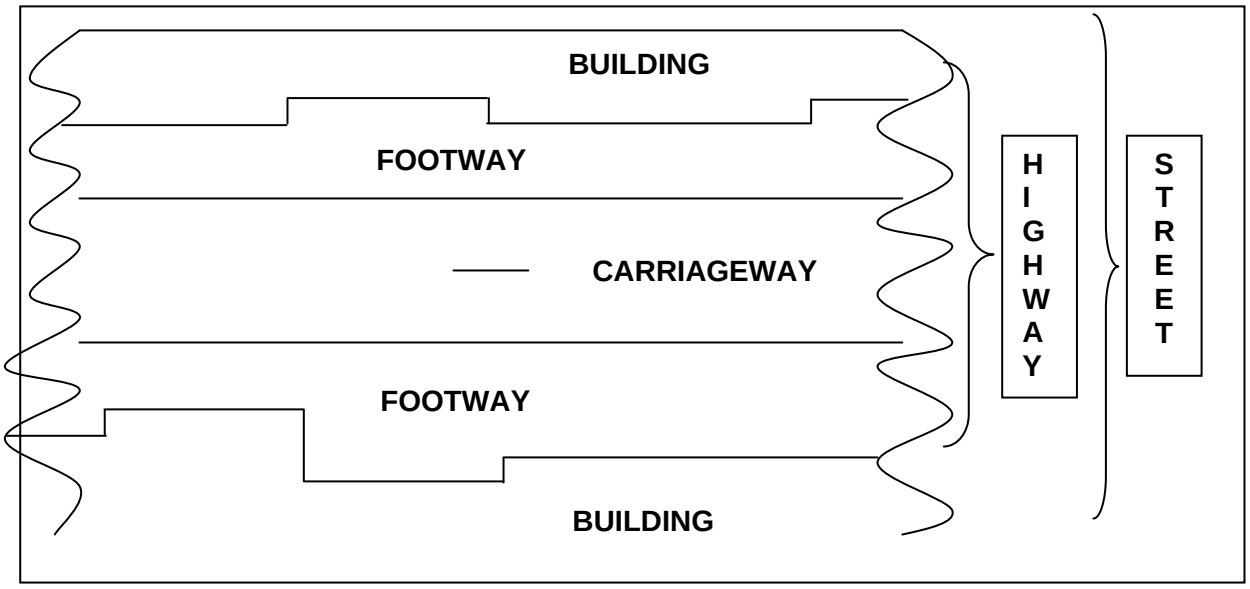
To the authors' knowledge, there is no existing framework for systematically exploring the impacts of street design options on different street user groups. The environmental justice and Accessibility Planning literatures (see Upton and Jones, 2007) define stakeholders at a broader level of population groups (e.g. based on household circumstances and relative geographical location). The body of work most comparable in nature is that of 'community impact assessment' (Lichfield, 1996), but while it does consider the relevant stakeholder groups for a new road scheme, it does not deal explicitly with detailed street level design options.

The work reported here uses the redesign of the high street in Bloxwich, West Midlands as a case study for developing and applying the methodology, but the aim is to develop a general distributional appraisal tool that can be applied to similar situations elsewhere. In Bloxwich, the stimulus for the redesign exercise came from the decision of Walsall Council to implement a Red Route along the A34, as part of a West Midlands wide initiative. This involves developing a streetspace allocation design that meets a number of specific objectives, including reducing delays to all road users, reducing traffic accidents and improving the number and quality of Place-related design elements on the high street.

The planning and consultation process for the Bloxwich High Street redesign is fully described in Jones and Thoreau (2007). This began with a 'Planning-for-Real' type exercise, in which design groups composed of local business people and residents used scale colour blocks and acetates, representing a broad range of potential street design elements, to develop streetspace allocation design options. The final versions of these options were then computerised and converted to GIS format in LineMap, a package developed by Buchanan Computing Ltd. LineMap can display these options in both colour block and road line marking formats, and can automatically calculate the numbers of each type of street element contained in each design option.

2. Primary dimensions for developing street design options

Streets typically consist of three main components, as shown in Figure 1, namely: the Buildings, the Footways and the Carriageway. The term 'highway' encompasses the 'footway' and the 'carriageway'. In addition to this, the 'street' takes into account the buildings bordering the highway. However, for the purposes of streetspace reallocation in this study, it was assumed that the buildings and building line are fixed and that the main focus is on locating design elements on the footway and the carriageway (i.e. within the Highway). However, the method could also deal with situations where the street is more fundamentally reconfigured.



Source: Jones, Roberts and Morris (2007), Figure 1.1

Figure 1: The main components of a street

Within the Highway, streetspace allocation design options are defined and constrained in three dimensions:

1. The **width** of the street
2. The **length** of the street, and
3. The **timing** of provision

Each street design element occupies certain amounts of street width and length, and operates at specified points in time. Unless a major redevelopment is proposed as part of the scheme, then the overall width and length of the high street are generally fixed. In such tightly constrained situations, the timing of streetspace provision can provide a useful way of accommodating more user needs within a finite space, by varying the allocated uses by time of day, day of the week, or by season.

There is also considerable scope for adapting designs to meet local needs through the details of the **layout of provision** (although this is not currently captured in the LineMap summary of provision, as discussed later in this report).

2.1 Street width

Street width is generally the most constraining of the design dimensions and, to varying degrees, needs to accommodate three broad kinds of street activities:

(i) Footway activities, associated both with Link and Place street user groups
(ii) Kerbside activities, from bus bays to parking and loading provision, all generally associated with Place activities; and
(iii) Main carriageway activities, catering for various mechanised transport modes passing through the area, all generally associated with Link user groups.

Footway activities and main carriageway activities generally have a degree of priority over most kerbside activities (which potentially can be provided off-street, but in close proximity). So where the total street width is very restricted, or where Link demands for through movement are very high, then there may be a complete ban on kerbside stopping activities, with all the available space used exclusively for moving traffic and footway activities.

From a design perspective, there are seven distinct types of 'zones' in cross section, where design elements would typically be located to meet certain types of activity requirements. With the exception of the median strip, all can potentially be duplicated on both sides of the street. The full range of potential zones is illustrated schematically in Figure 2 – recognising that only very rarely would there be sufficient space (or need) to accommodate all these zones.

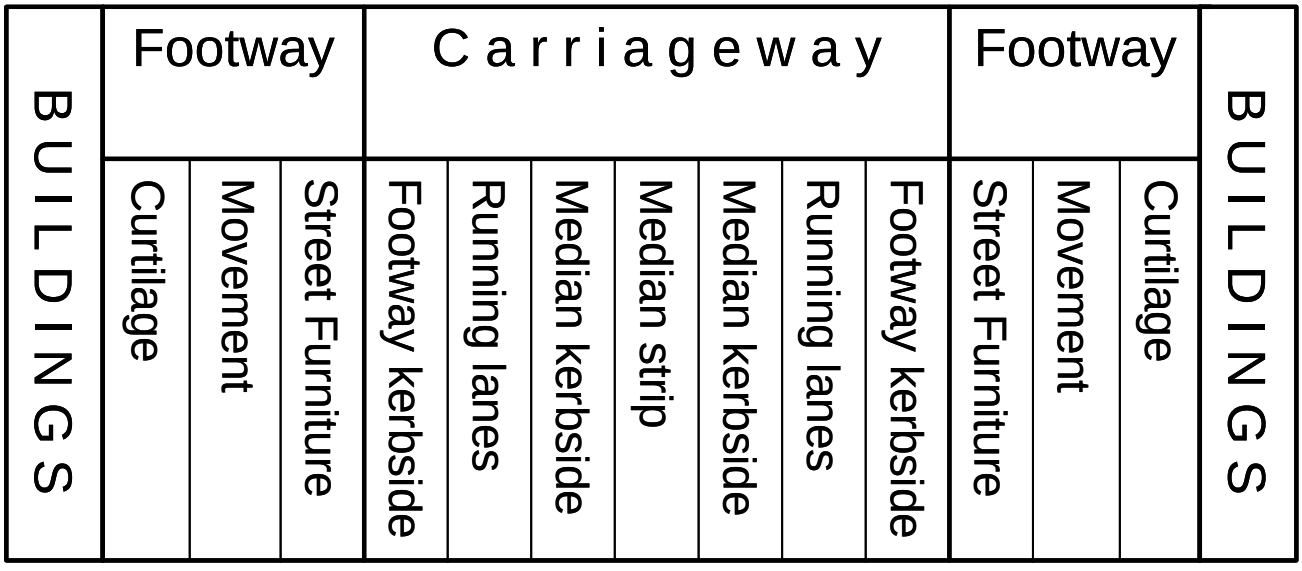


Figure 2: Potential cross sectional street design zones

2.2 Street length

Having determined whether or not there is sufficient street width to accommodate certain broad types of street design element (e.g. kerbside parking and loading bays), then the available street length determines the maximum possible extent of that provision. For example, street length limits the number of parking/ loading bays that can be provided along that section of street, or the total length of cycle lane that can be accommodated.

However, not all of the street length can be used for adding design elements. Side road junctions can occupy a significant proportion of the street length on both sides of the highway, thereby precluding any exclusive footway provision at these points, and any kerbside activities – both at the junction itself and for some metres in either direction (to allow for turning movements and sight lines). Pedestrian crossing facilities also preclude all kerbside activities at the crossing point itself and for some distance on both approaches (within the white zig zag lines) – unless the carriageway is sufficiently wide to allow kerbside bays to be set back from the main carriageway, with kerb build-outs and so to be inserted 'behind' the zig zag lines.

2.3 Timing of provision

More intensive use can be made of the space within the envelope of the available width and length along a street, by limiting the availability/operation of certain types of design element to particular time periods. For example:

- Bus lanes might be provided in peak periods, when traffic is heavy, and released for kerbside parking and loading at off-peak times;
- Kerbside space might be used by street stalls on market days, and released for general parking and loading uses on other days of the week.
- Footway parking or loading may be permissible outside shopping hours, when demands for footway space are more limited; and
- Blue badge parking spaces might be designated during the daytime only, enabling general parking or loading activity at night.

To measure the extent of provision in this temporal context, it might be appropriate to record total metre-hours or square metre-hours of provision of a particular design element, perhaps distinguishing between weekdays and weekends.

2.4 Layout/pattern of provision

Within a particular defined street width and length, there is considerable scope to vary the location of provision of a given set and quantity of street design elements. Elements can be arranged in both the cross-sectional and longitudinal dimensions of the street.

Options for placement in the **cross-sectional** dimension:

1. Where the provision of traffic running lanes required to meet the needs of traffic passing through the street takes up less than the full carriageway width, then these could be located in four different cross sectional configurations, as shown in Figure 3:

Figure 3: Cross sectional location options for traffic running lanes

2. Where there is sufficient carriageway width to accommodate parking/loading bays, in addition to the running lanes, then these could be positioned at three places, in cross section, as shown in Figure 4:

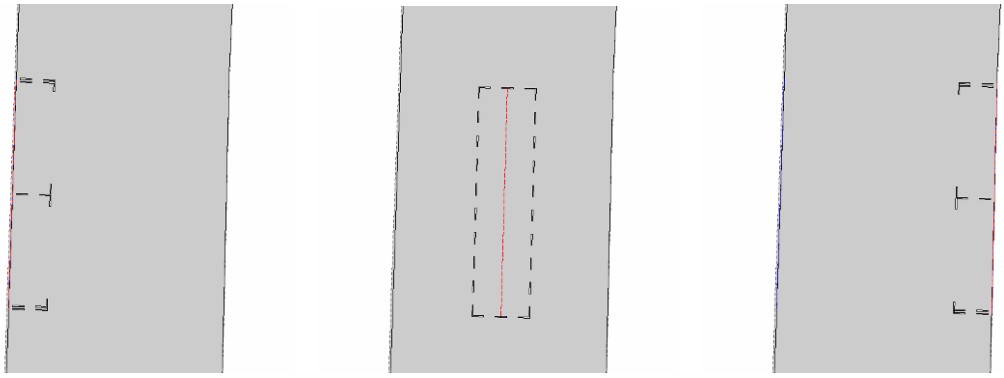


Figure 4: Cross sectional location options for parking/loading bays

Options for placement in the **longitudinal** dimension:

The degree of flexibility when locating design elements is much greater, since there are many permutations of the use of space along the length of the street; for example, kerbside space can be allocated to car parking at one point and loading at another point, and these positions can be modified in different designs. One option is illustrated in Figure 5.

Figure 5 uses the signing and colour coding conventions used in the Bloxwich consultation exercise to illustrate one possible layout for a row of four general parking bays (in yellow) and a bus stop bay (in orange) on the north side of a street, close to a row of shops.

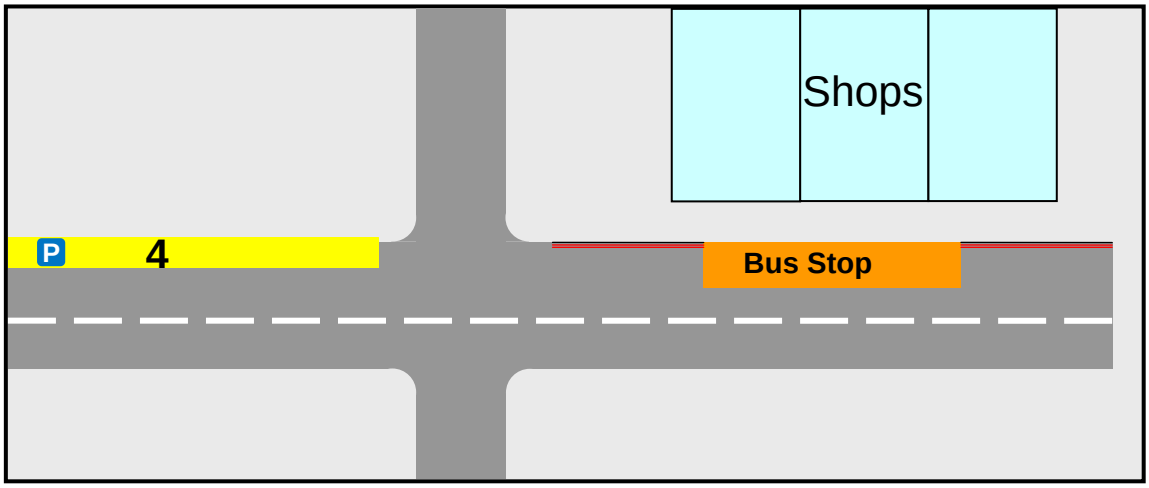


Figure 5: One possible layout of parking bays and a bus bay in relation to a row of shops

If designs were compared purely on the overall numbers of bays, then this layout will be considered to be identical to one where the locations of the bus stop and parking spaces have been reversed. However, in the example above it can be seen that the location of the bus stop is more convenient for those who are visiting the shops than are the parking bays; anyone parking in the latter has further to walk to the shops and must cross a side street to reach the shops.

Thus, the location as well as the quantity of the various elements should also be taken into account in some way when comparing designs.

3. Stages of the street design and appraisal process

Figure 6 shows the proposed stages and sequence of a comprehensive street design and appraisal process, from the determination of street functions through to the assessment of 'winners' and 'losers'. It also itemises the various inputs that are required at each stage, and highlights in **bold** the stages that deal primarily with assessing distributional impacts.

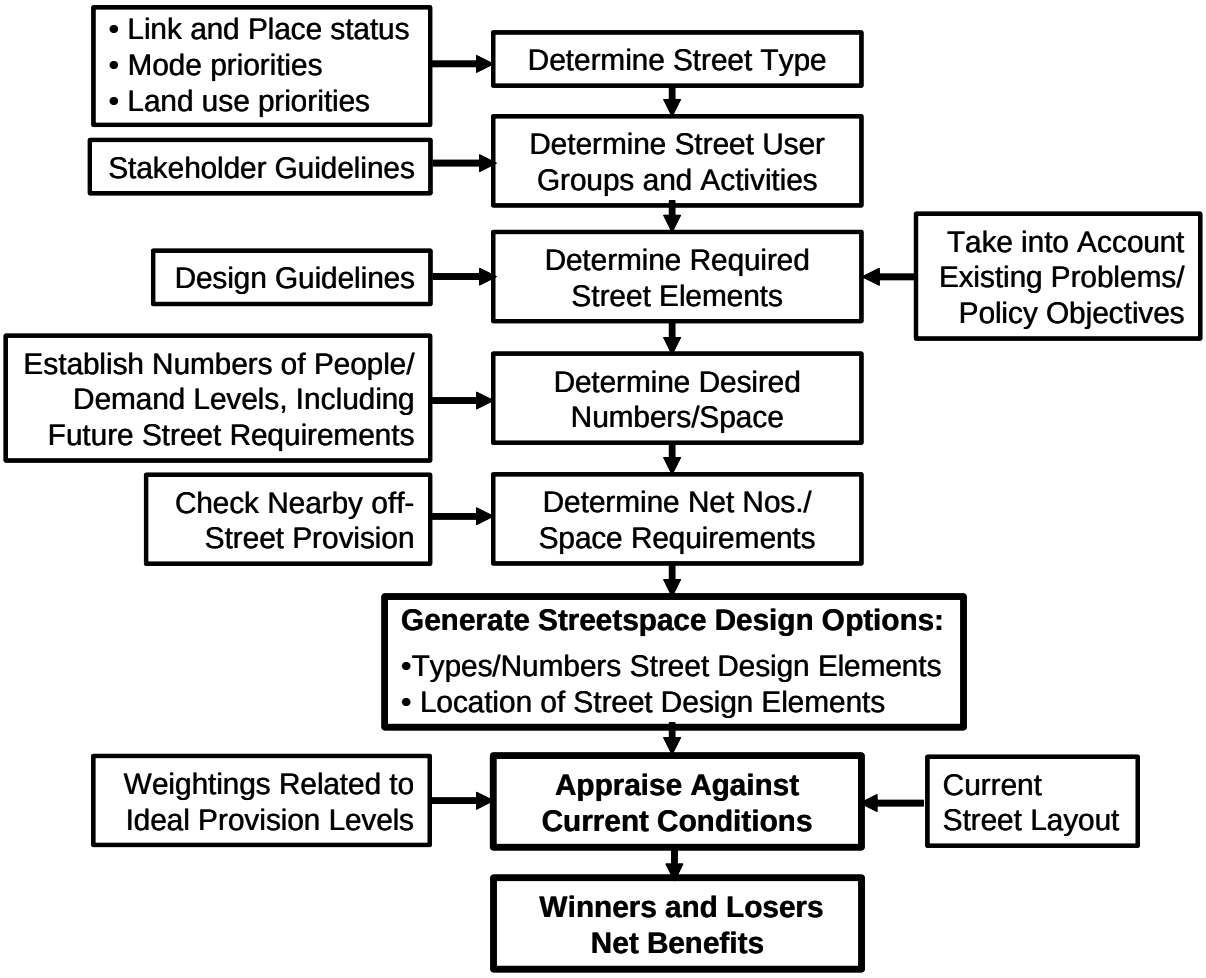


Figure 6: Stages and inputs to the street design and appraisal process

The characteristics of these various stages and the inputs that are required are described in section 4, and a case study application of the appraisal process is presented in section 5 and subsequent sections.

4. Stages and inputs to the street appraisal process

4.1 Determination of street type

Streets perform a wide variety of different functions, catering for a variety of users with requirements for different kinds of street design element. A primary distinction can be made between 'Link' and 'Place' related functions. Link functions relate to the street as a movement artery, enabling people and vehicles to pass along the street, with minimum hindrance; this has implications both for the design of parts of the carriageway and the footway. Conversely, Place functions are associated with the street as a destination in its own right, and include provision for parking/loading as well as footway activities (e.g. window shopping, or resting); again, these affect the use of both parts of the carriageway and the footway.

The EU 'ARTISTS' project developed a two-dimensional street status classification based on Link and Place status. This has subsequently been refined in work carried out in conjunction with Transport for London, as shown in Figure 7 (see Jones, Boujenko and Marshall, 2007). In this example, there are five levels of street Link status (I – V), and five levels of Place status (A – E). To this basic categorisation has been added a sub-classification that records the main land use(s) along the street (e.g. retail, residential), and a record of any modal priorities (e.g. bus priority route).

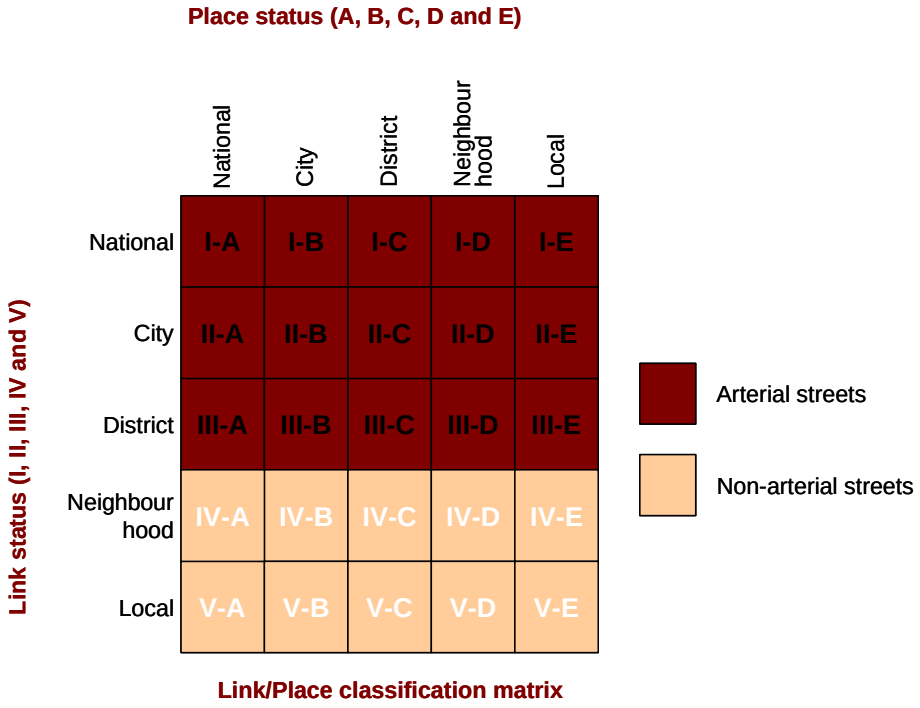


Figure 7: Link and Place street classification

4.2 Determination of relevant stakeholder groups and desired activities

There is a very wide range of groups of people who use, or have an interest in, streets. The nature and extent of this interest depends mainly on the street status, but also the characteristics of the local residential population. We can characterise these people and their interests primarily in two ways, as shown in Figure 8.

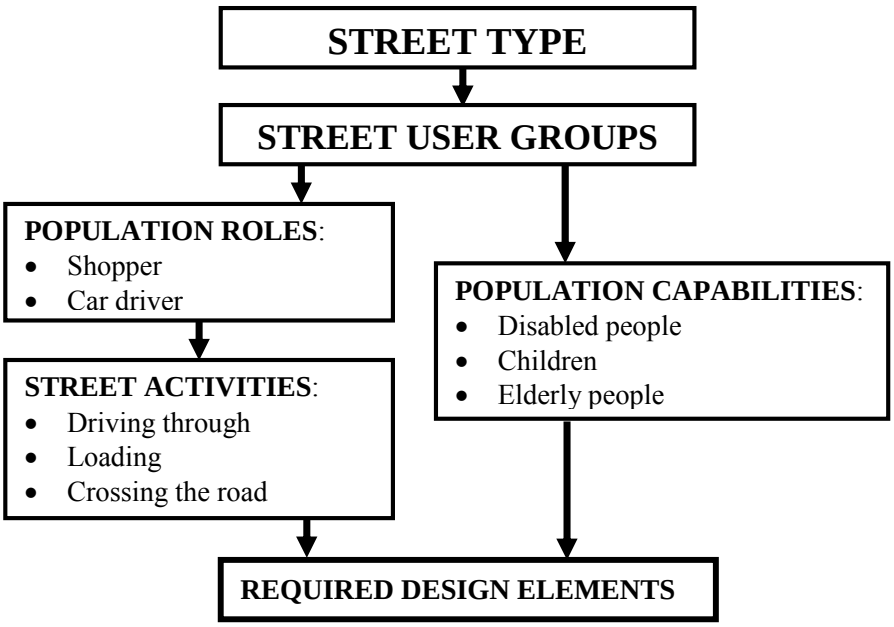


Figure 8: Factors contributing to demand for street design elements

Firstly, street users can be classified in terms of the roles they are playing while using the street (e.g. as a shopper, resident, through car driver), and the associated activity(ies) and concerns that are associated with these roles. Secondly, street users can be categorised in terms of their physical and mental capabilities for operating in the street environment. Both these factors have an influence on the types and characteristics of the street design elements that are required by, or are desirable for, these groups.

The characteristics of the population living within the catchment area of the street can be obtained from census or related data. Empirical relationships need to be established between the various cells of the Link/Place street types/status levels matrix and the relevant street user groups (albeit subject to local modification and augmentation). Such data is currently limited, but the principle is illustrated schematically in Figure 9.

	Street type					
User groups	…	I - E	…	III - B Retail	…	V - E
Pedestrians				✓		✓
Pedestrians who have mobility difficulties				✓		✓
Those using the street to socialise/relax				✓		
Cyclists				✓		✓
Bus users visiting the street				✓		
Those travelling to other destinations		✓		✓		
Car users (non-disabled) visiting the street				✓		✓
Disabled car users visiting the street				✓		✓
…						

Figure 9: Street user groups associated with different street types

4.3 Determination of types of required street elements

The types of street user groups and activities associated with a particular street type, along with the set of local population capabilities, will determine the kinds and form of the street design elements that need to be provided.

Examples might include:

- Pedestrians (including the users of mobility aids):
  Requirement: a minimum uncluttered pavement width and protected crossing places
- People who want to sit and socialise or watch the world go by:
  Requirement: seating and standing space
- People who arrive at the street by bicycle:
  Requirement: cycle lanes and cycle stands
- People who arrive/depart by bus:
  Requirement: bus shelters and information
- People travelling along the street to reach other destinations:
  Requirement: free-flowing running lanes
- People accessing the street by car:
  Requirement: general and disabled parking bays on the street, or in close proximity
- Shopkeepers:
  Requirement: loading bays and local parking for customers

Table 1 illustrates the kinds of street design elements that would assist in meeting the requirements of different kinds of street user groups and their associated activities. Various guides exist that assist in the selection and design of these street elements – but, again, further research is required.

Table 1: Examples of street design elements required by different street user groups

	Lanes			Kerbside provision					Other		
	General traffic lanes	Bus lanes	Cycle lanes	Parking bays	Disabled parking bays	Loading bays	Bus bays	Crossing places	Traffic islands	Street seating	Cycle stands
Pedestrians								●	●		
Pedestrians who have mobility difficulties								●	●	●	
Those using the street to socialise/relax										●	
Cyclists	●	●	●								●
Bus users visiting the street	●	●					●	●	●		
Those travelling to other destinations – all modes	●										
Car users (non-disabled) visiting the street	●			●							
Disabled car users visiting the street	●			●	●					●	
Shopkeepers						●					

In addition, further design requirements might be determined by the existence of particular local problems (e.g. a high accident rate at a junction), or by local policy objectives (e.g. improve the quality of the urban realm).

4.4 Determine desired levels of local provision

In terms of Link-related activities, there are many national and local standards and guidelines setting out capacity requirements (usually in the form of numbers of running lanes and lane widths). This often specify ranges (e.g. for lane widths) in terms of maximum and minimum dimensions, or circumstances under which uses might be shared (e.g. combined bus and cycle lane). The main criteria here influencing recommended levels of provision relate to traffic volumes and the degree of priority to be given to particular modes of transport.

At present we largely lack equivalent standards or empirical evidence with regard to the desired levels of provision for different kinds of Place-related street activities. These design elements tend to be more diverse in nature, ranging from cycle parking or loading facilities, to the provision of seating, public toilets, etc. Such guidance is likely to emerge from a combination of normative judgements (e.g. a street of type X should provide Y seats), and from empirical studies looking at current levels of provision and levels of user satisfaction under different circumstances. Again, levels of demand, in terms of numbers of street users of given types, will be an important consideration (e.g. numbers of blue badge holders seeking to park along the street). As with the Link-related design elements, it is likely that guidance will need to indicate ranges of provision, from the desirable to the minimum. Again, further research is required.

4.5 Determine net levels of on-street provision

Having determined the required levels of provision of different kinds of street design elements (where appropriate, at both desired and minimum levels of provision), it is necessary to check whether:

(i) Provision of certain design elements already exists off-street (e.g. through private forecourt or rear parking and loading provision, public off-street car parking), or is available in nearby streets (e.g. on-street parking); or
(ii) Where space is at a premium, whether suitable provision could be made off the main street. For example, by providing a suitable cycle route for through cyclists on parallel residential streets, or building public amenities (e.g. seating) adjacent to the street.

The outcome of this process would be a set of minimum (and possibly maximum?) design requirements. Part of such a set of requirements is illustrated schematically below in Table 2, comparing existing and desired levels of provision, which was used as an input to the design exercise in Bloxwich.

Table 2: Examples of some requirements for the provision of street design elements, as an input to a street redesign exercise

	Existing Spaces	Design Spaces
Parking Bays	10	12
Loading Bays	10	14
Disabled Bays	2	4
Bus Stops	4	4
Crossings	3	3

4.6 Generating design options

Jones and Thoreau (2007) describe the development of a set of physical and computer-based tools for generating streetspace allocation options, with the involvement of local stakeholder groups, and their application in a case study in Bloxwich in the West Midlands.

Figure 10 illustrates a 'hands on' design workshop in action, and Figure 11 shows how this information is subsequently translated into a GIS-based format for on-line editing (using the 'LineMap' program). Both use coloured blocks to indicate the different kinds of streetspace allocation (e.g. yellow for general parking, and blue for disabled, blue badge parking spaces). On completion of the exercise, LineMap provides a summary of the main design elements that have been included (e.g. length and number of parking bays, length of cycle lane), enabling a quick comparison between options.

Figure 10: Participants in the Bloxwich street design workshop (left) and a close up of the scale maps and blocks used in the design workshops (right).

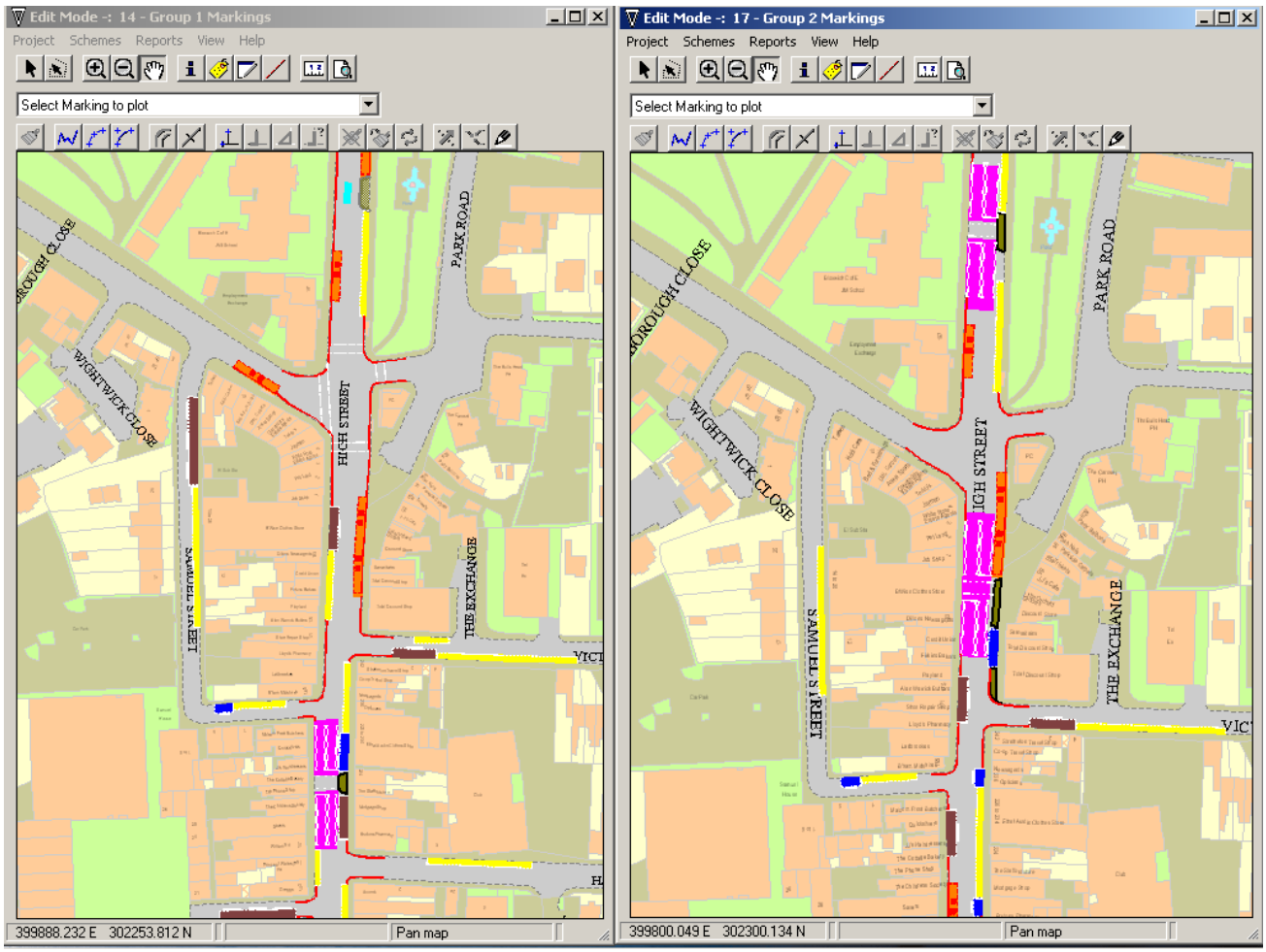


Figure 11: Computer-based comparison and editing of design options

It is the data derived from this pubic engagement exercise that is used to illustrate the development and application of the distributional impacts spreadsheet, later in this main report and in the Appendices.

Characterising key features of different street design options

Having generated one or more design options, it is then necessary to determine how the key features of each design will be characterised and measured, as the basis for conducting a distributional appraisal of the option(s) against the existing situation.

Here there are two key measurement dimensions:

(i) Numbers/capacity of different street design elements
(ii) Location of design elements

At present we have not developed a suitable set of metrics for measuring the locational characteristics and advantages of the siting of particular design elements at specific points along the street (as discussed in section 2.4). This requires both further methodological research, and in its application will probably require more detailed information on frontage land uses along the street.

4.7 Appraising design options

It is extremely unlikely that a design option will be able to fully satisfy all the requirements of the various street user groups. Some judgement will, therefore, need to be made about how much

weight should be given to different competing street users' requirements, and whether one option is 'better' than another. This can be addressed by applying various explicit weighting procedures.

Weighting different components of the appraisal

The application of weights within the appraisal process is likely to involve at least three types of consideration:

(i) How important the needs of one user group are considered to be relative to those of others. These distributional impacts may be influenced by:
- The Link and Place status of the street
- Local or general policy considerations (e.g. presence of an agreed street user hierarchy)

(ii) The extent to which a particular design element satisfies the requirements for a particular group/activity; and

(iii) Any diminishing returns associated with increasing levels of provision of a particular street design element.

For example, in relation to points (i) and (ii), there might be a policy decision to weight the needs of blue badge holders looking for parking spaces at three-times non-disabled drivers, and to give a lower weighting to through car traffic than to those passing through on a cycle or in a bus. Similarly, in most circumstances, a segregated cycle lane is likely to be more attractive to a cyclist than a shared bus/cycle lane, and this might be reflected in a differential weighting.

Sections 4.4/4.5 discussed how to identify maximum/minimum required levels of net provision for different street elements. We can assume that, once the higher level of provision has been reached, there will be no substantial benefit from increasing levels of provision. The issue then is how to characterise the gain in benefit, as provision is increased from zero to the minimum and then to the maximum level of provision (i.e. point (iii) above). Two possible functional forms are shown in Figure 12, using parking space provision as the illustrative example. The first assumes a simple linear relationship, and the second a concave relationship. In practice, more complex step functions might be preferred.

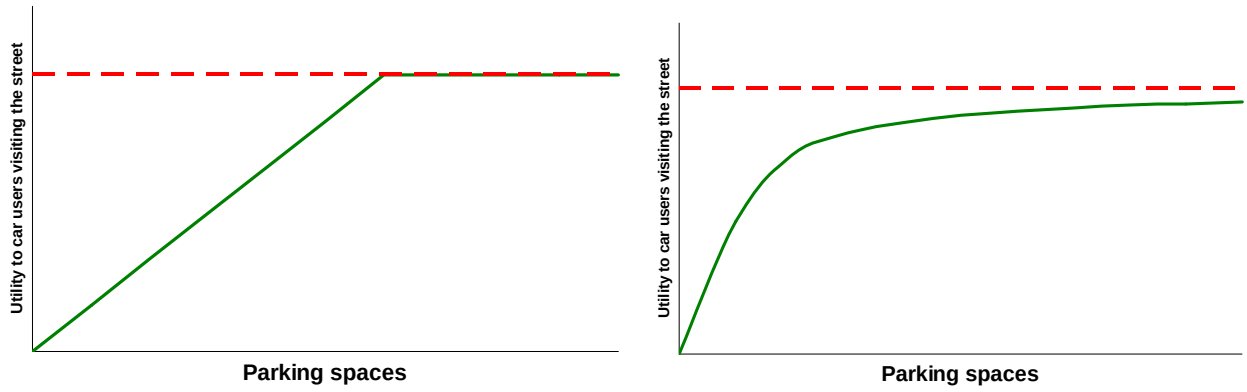


Figure 12: Two forms of relationship between level of provision and benefit

4.8 Assessing 'winners' and 'losers', and net benefits

This process involves bringing together the various kinds of data from the previous stages outlined above, in a spreadsheet designed for this purpose. In particular, it is necessary to identify the street user groups who will benefit from the different design elements included in the options, and then applying any person type and scale of provision weightings, as outlined in section 4.7. The process is illustrated in the following sections of the report.

A further consideration concerns the spatial - and possibly temporal - extent of the impacts that are being taken into account in the assessment. The streetspace allocation exercise will have defined a **Design Area** for study, but there will also be a wider **Impact Area**, over which the consequences of any reallocation of street space among street design elements will be significant. For example, if parking is displaced from a high street, then there will be additional pressure on parking spaces in the surrounding residential areas, and some increase in traffic searching for a parking space.

It is thus important to carry out the distributional appraisal over the wider Impact Area, as this is where some significant consequences might be experienced.

5. Illustrative study for exploring distributional impacts

This illustrative application is based on a short section (c.120m) of Bloxwich High Street and around 50 metres of residential streets on either side. Three design options are shown below in Figure 13:

- Scheme A represents existing provision, in the form of a bus stop with run ins (in orange), two disabled parking bays (in blue), four standard parking bays (in yellow) and two loading bays (in brown);
- Scheme B adds 6 disabled parking bays in one of the residential side streets; and
- Scheme C instead adds 6 standard parking bays along the same stretch of residential side street.

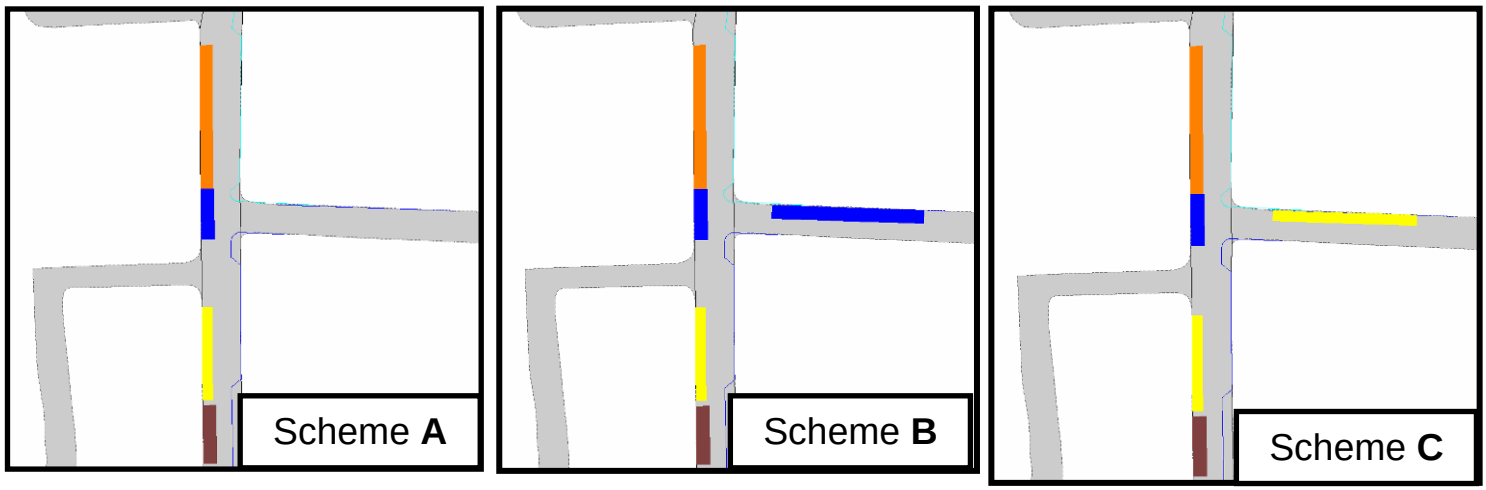


Figure 13: Three design options for part of Bloxwich High Street

A summary of the three option schemes is shown below in Table 3. It can be seen from this table (and by comparing the scheme diagrams in Figure 13) that Scheme B benefits disabled drivers wishing to park in the area, while Scheme C benefits anyone arriving by car and Scheme A benefits those who want to travel along the residential street on the east side of Bloxwich High Street.

Table 3: A comparison of the three scheme options

		Scheme A	Scheme B	Scheme C
General Parking	**Yellow**	4	4	10
Disabled Parking	**Blue**	2	8	2
Loading	**Brown**	2	2	2
Bus Stop	**Orange**	1	1	1

Where there is an existing base scheme, the method may also be used to provide **relative** scores, by showing the performance of each option in comparison to the existing situation.

Using these examples, the next section illustrates the main stages of an Excel spreadsheet that has been developed to assess the distributional impacts of different street design options. This uses the relative performance formulation. A fuller description is provided in the Appendices to this report.

6. *Application of the distributional impacts spreadsheet*

6.1 The main stages of the process

These mirror the later appraisal stages of the process shown in Figure 6 in **bold**. In particular:

- Develop a matrix of Street User vs. Design Elements, showing benefits and disbenefits
- Assess overall Street User Group impacts of each scheme option
- Add weightings, to reflect:
  - Relative priority given to different Street User Groups
  - Extent to which a street design element meets a specific user requirement
  - Diminishing value of increasing levels of provision of particular design elements

Each stage is outlined below, and described more fully in the Appendices.

6.2 Street User/Design Elements 'Benefits Matrix'

Figure 14 shows a simple version of the Street User/Design Elements Benefits Matrix, with the key Street User Groups relevant for that case study street depicted along the columns, and a selection of relevant street design elements on the rows. The relationship between users and street design elements is simply captured at this stage based on scores of '0' for no impact/relevance (these cells have been left blank in Figure 14), +1 (benefit) and -1 (disbenefit).

Here there are no weights reflecting (i) any differences in priority given to the needs of different Street User Groups, nor (ii) the extent to which a design element meets a user need, nor (iii) any diminishing returns from increasing provision.

Return to Inputs & Impacts sheet | Return to Select Relationships | Reset All to Overall SDE | Reset All to Linear

User Group/Design Elements Matrix: Basic Relationships

User Group / Street Design Element	Pedestrians	Pedestrians who have mobility difficulties	Those using the street to socialise/relax	Cyclists	Bus users visiting the street	Those travelling to other destinations - all modes	Car users (non-disabled) visiting the street	Disabled car users visiting the street	Shopkeepers
Lanes									
General traffic	-1	-1		1	1	1	1	1	
Bus lane				1	1				
Cycle lane				1					
Bays and Crossing Places									
Parking bays							1	1	
Disabled parking bays								1	
Loading bays									1
Bus bays					1				
Crossing places	1	1			1	-1			
Other Design Elements									
Traffic Island	1	1			1				
Street seating		1	1					1	
Cycle stands	-1	-1		1					

Figure 14: Benefits Matrix of Street Design Elements for different Street User Groups (without weighting)

6.3 Assessing scheme impacts (no weighting)

Using the values in this matrix, a total score for a scheme option can be produced by noting how many of each of the street design elements are included in the design and then applying the relevant scores from the cells in Figure 14. For example, each *crossing place* adds one point to the total for *pedestrians*, but takes a point away from *those travelling to other destinations.* This process is repeated, as appropriate, for each street design element.

Figure 15 shows how a scheme option score is built up using entries within the *Inputs & Impacts* sheet. Details of each option are entered in the group of tables labelled *Street Design Elements*. The

elements that make up the current provision are entered using the tables in the top left section of the sheet (marked I in Figure 15), while the elements for the proposed provision under one of the options are entered in the tables in the top right section (marked II in Figure 15). The resulting impacts for each street user group (calculated using the matrix in Figure 14) are shown in the lower table, labelled *Impacts* (marked III in Figure 15).

The impacts are presented separately for the current provision and a proposed scheme, and the difference between the two is given in the right hand column; in this example, the comparison is between Scheme A and Scheme B in Figure 13.

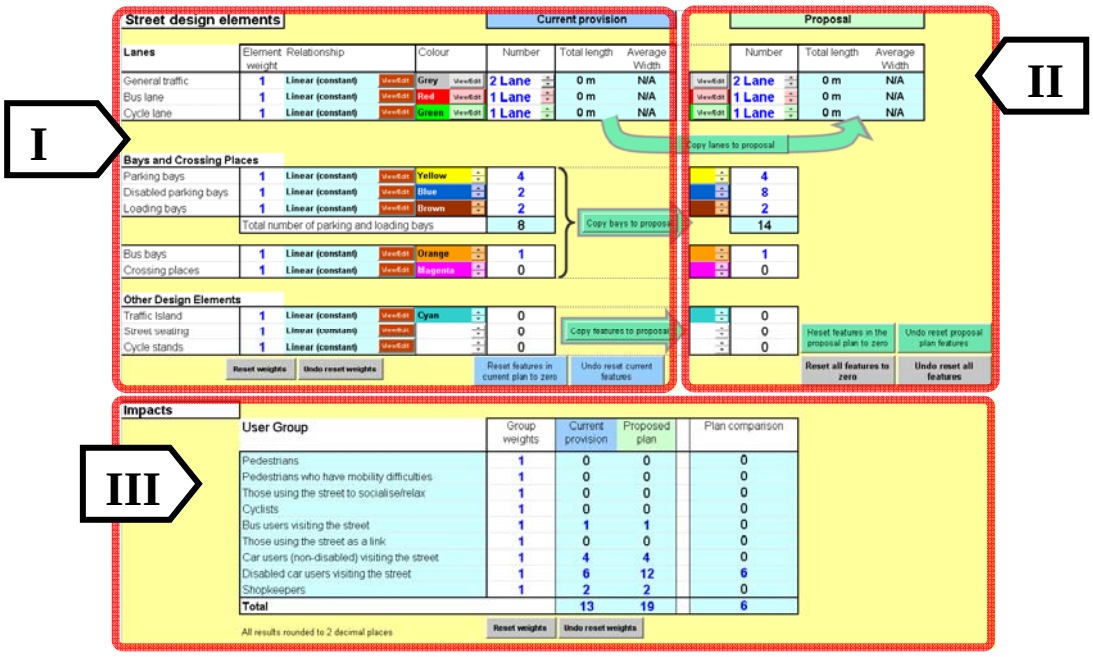


Figure 15: Using the Inputs & Impacts worksheet

The results of applying this approach to all three of the schemes in Figure 13 can be seen in Table 4, where Scheme A has been used as the reference case (existing situation). The results show that Scheme C is the best overall option. However, this assumes that the disabled car users gain as much from standard parking bays as they would from disabled parking bays. The result would change if we altered the weighting for either general or disabled parking spaces for disabled drivers. This is considered further below (see Table 5).

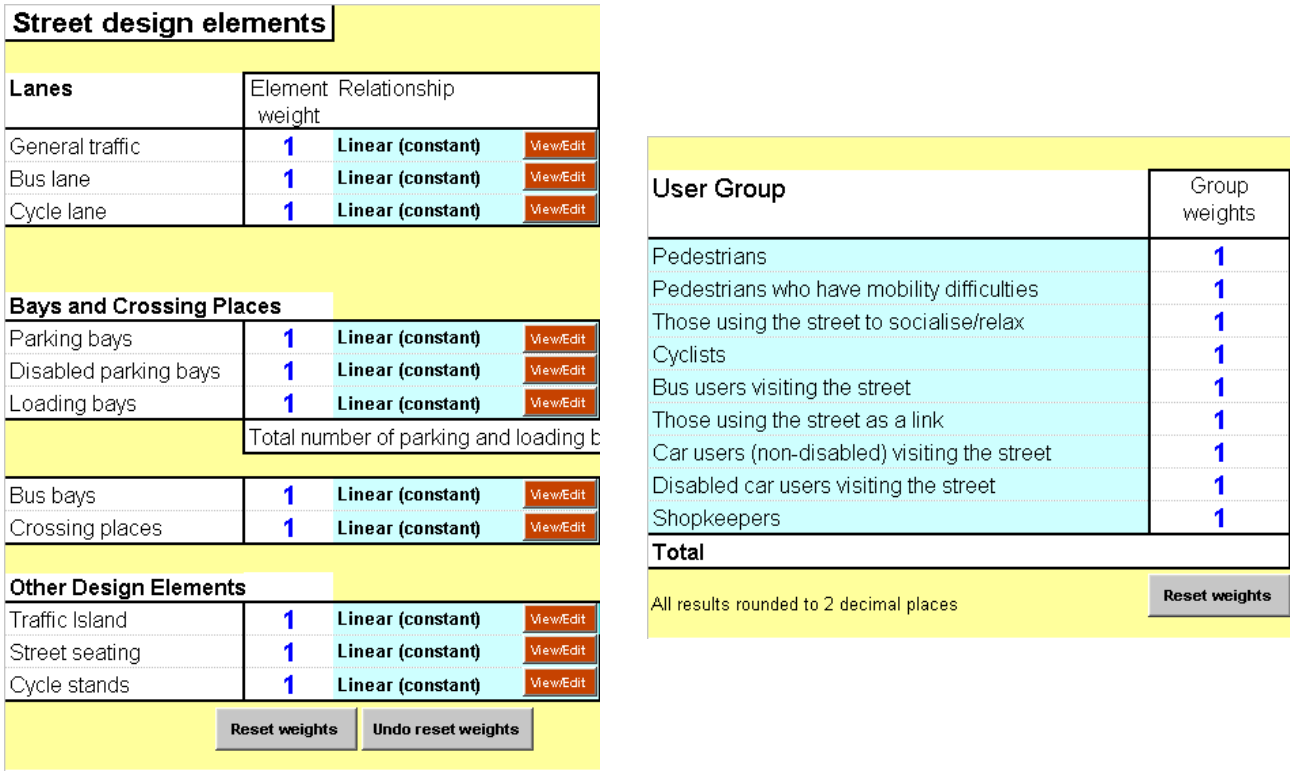
Table 4: Comparison of the three schemes using the user group benefit matrix

	Scheme A	Scheme B	Scheme C
Pedestrians	Reference case	0	0
Pedestrians who have mobility difficulties		0	0
Those using the street to socialise/relax		0	0
Cyclists		0	0
Bus users visiting the street		0	0
Those travelling to other destinations - all modes		0	0
Car users (non-disabled) visiting the street		0	**6**
Disabled car users visiting the street		**6**	**6**
Shopkeepers		0	0
TOTAL (NET) SCORE		**6**	**12**

6.4 Addition of street user/design element weightings

To reflect differences in the priority given to meeting the needs of different street user groups (e.g. resulting from policy priorities or the numbers of each category of people on the street), or the suitability of different design elements to meet a given type of requirement (e.g. a blue badge bay

would be more suited to the needs of a disabled driver than a normal parking bay), we can apply weights to each street user group (SUG) and street design element (SDE). In the former case, this is equivalent to weighting columns in the Benefits Matrix (shown in Figure 14), and in the latter case this involves a weighting of rows. Figure 16 shows the part of the spreadsheet that is used to change the default weightings of 1.0 for the street user groups and street design elements.



Street design elements

Lanes	Element weight	Relationship	
General traffic	1	Linear (constant)	View/Edit
Bus lane	1	Linear (constant)	View/Edit
Cycle lane	1	Linear (constant)	View/Edit
Bays and Crossing Places			
Parking bays	1	Linear (constant)	View/Edit
Disabled parking bays	1	Linear (constant)	View/Edit
Loading bays	1	Linear (constant)	View/Edit
	Total number of parking and loading b		
Bus bays	1	Linear (constant)	View/Edit
Crossing places	1	Linear (constant)	View/Edit
Other Design Elements			
Traffic Island	1	Linear (constant)	View/Edit
Street seating	1	Linear (constant)	View/Edit
Cycle stands	1	Linear (constant)	View/Edit

Reset weights | Undo reset weights

User Group	Group weights
Pedestrians	1
Pedestrians who have mobility difficulties	1
Those using the street to socialise/relax	1
Cyclists	1
Bus users visiting the street	1
Those using the street as a link	1
Car users (non-disabled) visiting the street	1
Disabled car users visiting the street	1
Shopkeepers	1
Total	

All results rounded to 2 decimal places | Reset weights

Figure 16: Detail showing street design element (left) and user group (right) weighting

It is also possible to apply a specific weight to an individual SUG/SDE cell (i.e. to reflect the particular importance of a specific street design element for one street user group, over and above the general user group and design element weightings), by editing the individual cells in the benefits matrix (shown in Figure 14). For example, a Traffic Island might be considered to be of particular benefit to 'Pedestrians who have mobility difficulties', and given a score of '2' for that group only.

An example of the consequence of doing this is illustrated in Table 5, where the value of the cell in Figure 14 showing the weighting of general parking spaces for disabled drivers has been changed from +1 to +0.5. As can be seen, this results in a lower net score for Scheme C, where the six general parking bays (see Table 3) now score only 3 for disabled drivers instead of 6 units.

Table 5: Effect of changing the weighting of the 'disabled drivers/general parking bay' cell in Figure 14

	Scheme A	Scheme B	Scheme C
Pedestrians	Reference case	0	0
Pedestrians who have mobility difficulties		0	0
Those using the street to socialise/relax		0	0
Cyclists		0	0
Bus users visiting the street		0	0
Those travelling to other destinations - all modes		0	0
Car users (non-disabled) visiting the street		0	**6**
Disabled car users visiting the street		**6**	**3**
Shopkeepers		0	0
TOTAL (NET) SCORE – Unweighted (Table 4)		**6**	**12**
TOTAL (NET) SCORE – Weighted		**6**	**9**

After changing the weighting for disabled drivers, Scheme B appears to offer more benefits for disabled drivers than Scheme C, although the overall net benefits to street user groups are still higher for Scheme C – on the assumption that each group is given equal weighting. It is clear that some care must be taken in assigning the weights to matrix cells if detailed comparisons between schemes are to be made. Some justification should be given for the relative weights that are used.

6.5 Dealing with degrees of provision and diminishing returns

As noted in section 4.7, there is also a need to define relationships between the degree of provision (DoP) of a street design element and the relative benefit resulting from that level of provision, since there are likely to be diminishing returns from the increasing provision of many types of design element. This requires the ability in the spreadsheet both to specify relationships (linear or non-linear) and change points in those relationships (e.g. from linear increasing to flat, if there is no additional benefit to be gained from further provision above a certain threshold level).

Figure 17 shows the spreadsheet screen for selecting an appropriate DoP relationship for each street design element. In this example for Parking Bays, the value for the change point has been set at 5; up to this point the relationship is linear, rising one unit with each space, while after this point each extra *parking bay* only has a 0.25 benefit rather than 1. Figure 18 shows a graph of this relationship with the Change Point set at 5.

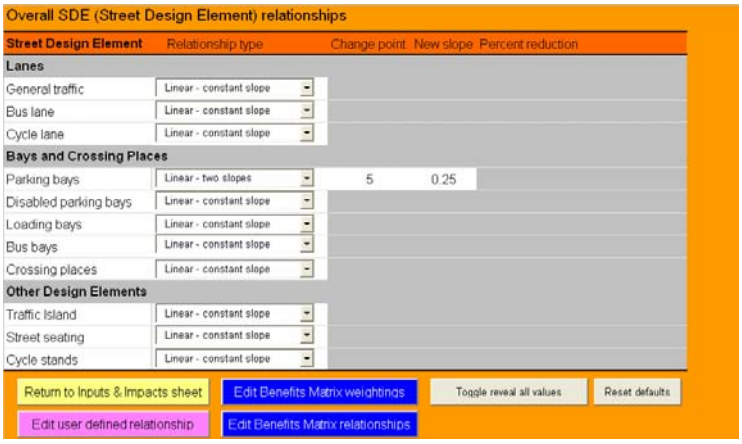


Figure 17: Spreadsheet *SelectRel* screen for setting relationships

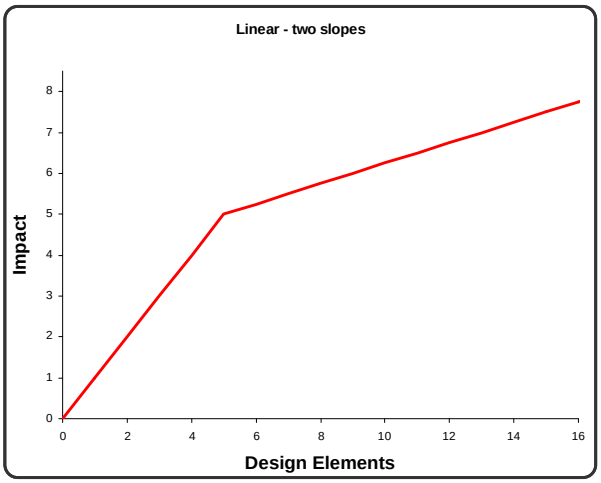


Figure 18: Graph of modified relationship set up in Figure 16

Figure 19 shows the implications for scheme scores of applying this non-linear relationship in the case where the Street User Group (SUG) and Street Design Element (SDE) weightings have been set at 1.0. Setting the number of parking bays to five has resulted in a score of '5' for the two car user groups. However, it can be seen from the right of Figure 19 that, beyond the change point of 5,

it takes a further four spaces to increase the benefits by one more point, to '6' for each group, as each additional space now only has a quarter point impact.

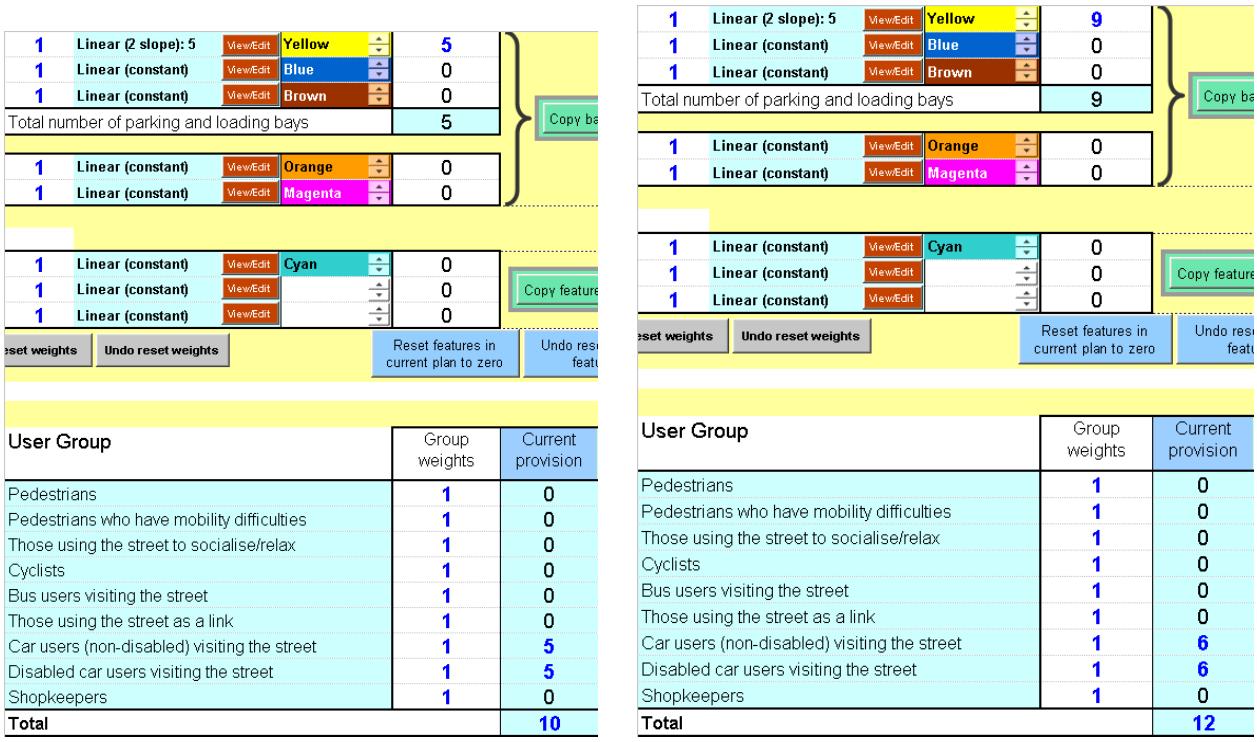


Figure 19: Result of adding a change point and a second linear section

Note that the total row score for each Street User Group (m) for a particular scheme is made up by multiplying three weights as follows:

$$\sum_{n}^{1} WSUG_m \times WSDE_n \times DoPSDE_n$$

[This excludes specific SUG/SDE combination weights]

6.6 Customising street design element relationships

Section 6.5 describes how a relationship between level of provision and benefit can be defined for a particular street design element. The default setting is that the same relationship applies to all the street user groups, referred to in the spreadsheet as the *Overall SDE relationship*, where SDE stands for street design element. If a different relationship is required for a particular pairing of street design element and user group, this can be edited in the spreadsheet by clicking the *Edit Benefits Matrix relationships* shown in Figure 17.

Figure 20 shows a version of the *Benefits Matrix* that includes information about the type of relationship that is active for each cell. Cells where there is no relationship between a street design element and a street user group, and that are blank in Figure 14, are greyed out here.

Initially all the cells in a row take on the overall street design element relationship, shown after the street design element name on the left of the screen. Each cell contains a shortened version of the relationship name followed by +ve or –ve, indicating whether the relationship has been defined as positive or negative in the simple *Benefits Matrix* (Figure 14). All positive relationships cells are shown in blue, all negative relationship cells are shown in red, matching the colour scheme used in the simple *Benefits Matrix*.

Clicking the *Edit* button in any cell brings up the dialog box shown in Figure 21; this allows any relationship to be selected for that cell, including custom relationships (described in appendix B). Using this screen it is possible to fine tune the relationship for each pairing of user group and street design element in the *Benefit Matrix*.

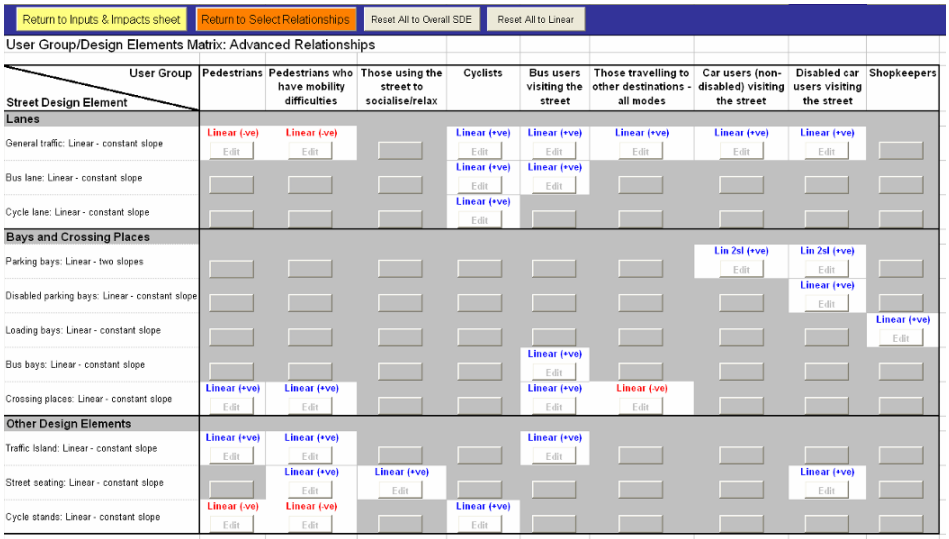


Figure 20: Screen used to edit the relationships for each cell in the Benefits Matrix

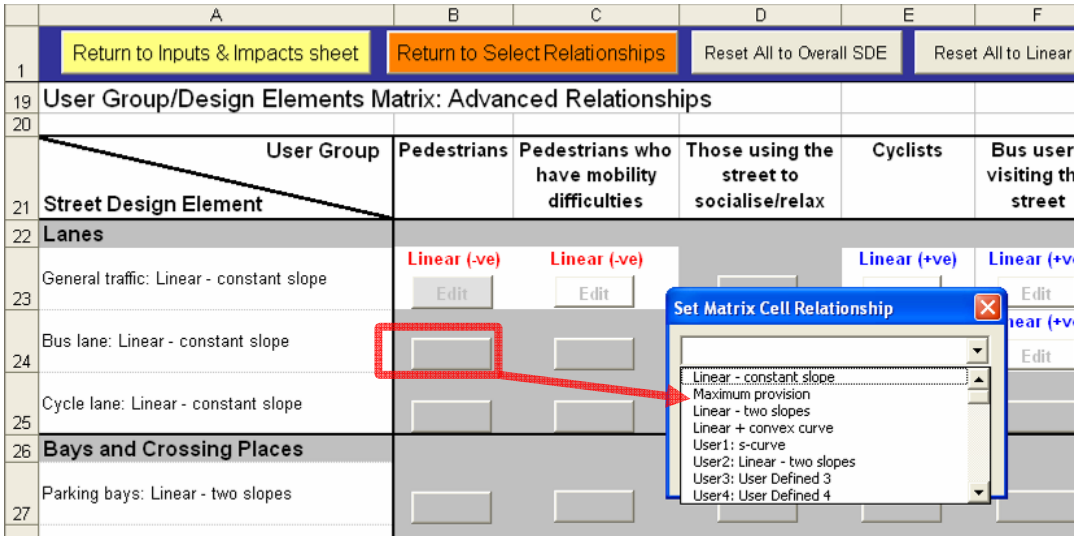


Figure 21: The *Set Matrix Cell Relationship* Dialog box used to select relationships for individual cells

7. Scope for further development

There are several ways in which the basic spreadsheet presented here could be expanded or reformatted, to take into account a wider range of factors. Some possible improvements are outlined below.

7.1 Taking into account the duration of provision

In its current form the spreadsheet only takes into account the number of street design elements of a given type, not the period of time over which they are available. Simple temporal variations could be accommodated, for example, by making separate assessments for peak and off-peak periods (e.g. to assess the effect of a peak bus lane and off-peak parking bays); or, more comprehensively, by taking into account the hours of provision of a street design element during a 24 hour period. In the process of doing so, there might be a case for varying user group and street design element weightings by time of day.

7.2 Taking into account the location of provision

The spreadsheet does not deal with the relative benefits of locating a given number of street elements in different configurations (see section 2.4). So, for example, there is no way of assessing the differential benefits for various groups of locating a given number of disabled blue badge parking bays on main roads versus adjacent side roads.

7.3 Varying the number of Street User Groups and Street Design Elements

In the current version of the spreadsheet, the number of and labels for both the street user groups and the street design elements are fixed as shown in Figure 14 (although the user can indicate that certain groups and street elements are not applicable in a given situation). It would be desirable in future to make this more generic, by enabling the user to vary the number of rows and columns and to readily change the labels for user groups and street elements.

7.4 Empirical data on user needs

The profession currently lacks empirical data relating to several of the stages outlined in Figure 6, in particular:

- Relevant Street User Groups associated with different Street Types (see section 4.2);
- Types of Street Design Elements required by different Street User Groups (see section 4.3);and
- Desired and Minimum level of provision of selected Street Design Elements, by Street User Group and Street Type (see section 4.4).

7.5 The treatment of running lanes

It is currently possible to include information about the characteristics of the running lanes included in a street plan option, using a separate form in the spreadsheet; when this is done, a summary of width and average length appears on the *Inputs & Impacts* sheet. However, lane lengths are currently included in the calculations by treating a predefined length (e.g. 50m) of each lane in the same way as the provision of a parking bay. Further thought needs to be given as to how this representation can be refined.

7.6 Weights

A mix of additional empirical evidence and professional/political judgement is required to determine the appropriate weights to be applied in the spreadsheet (see section 4.7) with regard to:

- Relative importance of needs of different Street User Groups;
- Extent to which a Street Design Element meets the needs of particular groups; and
- Relationships between increasing levels of provision and marginal benefits.

8. Case study: applying the scheme comparison spreadsheet

This section demonstrates an application of the scheme comparison spreadsheet to a real world example, linked to other work carried out under the DISTILLATE project.

8.1 The case study area

Figure 22 shows a series of plans of the Bloxwich high street area, used as the case study for this application. The area highlighted in red in Figure 22A shows the study area; it covers the running lanes and footways for the main shopping area of the high street. Figure 22B shows a plan of the existing provision. The schemes produced by the stakeholder design workshops, which allowed local people to formulate their own design options, are shown in Figures 22C and 22D. Two groups of stakeholders developed street designs with the assistance of members of Walsall Metropolitan Borough Council. A full description of the consultation process can be found in Jones and Thoreau (2007). Figure 22E shows the final council developed scheme that incorporated elements from both of the stakeholder options and was presented for comment at a formal public consultation exercise (see http://www.walsall.gov.uk/index/red_routes_bloxwich.htm).

The stakeholder scheme options (22C and 22D) and the final council scheme (22E) will be compared against the existing provision (Figure 22B) in this section, using the spreadsheet described in preceding sections of this report.

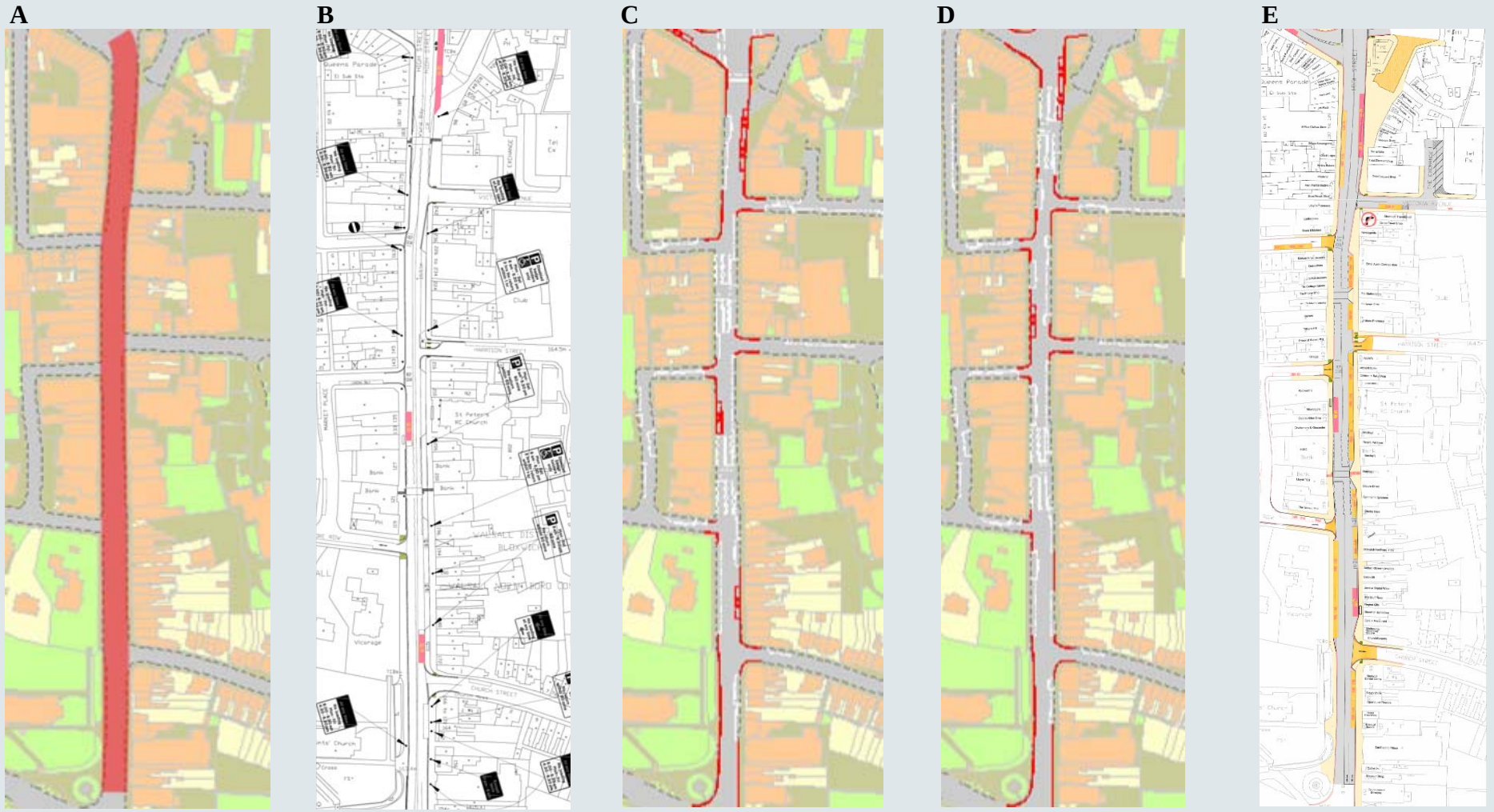


Figure 22: Plans and scheme options for Bloxwich High Street: **A.** The scheme comparison area: the main movement and shopping area
B. Existing provision on the street
C. Design produced by stakeholder group 1
D. Design produced by stakeholder group 2
E. Final design put forward for consultation

The first stage of the scheme comparison process is to describe the existing provision in terms that can be entered into the spreadsheet. For the proposed schemes shown in Figures 22C, 22D and 22E, LineMap outputs were used to derive information on the numbers of different types of street design elements. The existing scheme (Figure 22B) was not available as a LineMap file and although some bays, such as bus bays, are marked, the rest of the provision has been estimated from the street signs.

It should be noted that this comparison example is limited to the section highlighted in Figure 22A. The highlighted section only includes the provision on the main section of the high street and **does not include** any of the provision on side streets or north of the shopping section.

8.2 Stakeholder street designs

The first set of comparisons will evaluate the two stakeholder options (as shown in Figures 22C and 22D) against the existing street provision (Figure 22B).

First, the number of each of the street design elements contained in the existing provision and both stakeholder options is determined, as shown in Table 6. Here we can see, in particular, that both stakeholder options substantially increase the number of parking bays on this section of the high street.

Table 6: Street design elements in the existing provision and the two stakeholder group design options

	Existing provision	Group 1 scheme	Group2 scheme
Parking bay	15	34	30
Disabled parking bay	5	2	7
Loading bay	7	8	8
Bus bay	4	2	3
Crossing places	2	2	2
Traffic Islands	0	0	0

Table 7 shows the net impacts for each street user group, and in total, using the scoring system previously described in the development of the scheme comparison spreadsheet (though without the addition of any weightings).

Table 7: Comparing the impacts of the two stakeholder design options against existing provision

Street user group	Group 1 scheme	Group2 scheme
Pedestrians	0	0
Pedestrians who have mobility difficulties	0	0
Those using the street to socialise/relax*	0	0
Cyclists*	0	0
Bus users visiting the street	-2	-1
Those using the street as a link	0	0
Car users (non-disabled) visiting the street	19	15
Disabled car users visiting the street	16	17
Shopkeepers	1	1
Total	**34**	**32**

*The street plans available for the comparison did not include details of street seating or cycle stands.

Table 7 shows the overall impact of each scheme to be positive in comparison to the reference case, in this case the existing provision, although there is a small net disbenefit for bus users. These results, however, do not fully take into account any differences in the traffic carrying capacity of the high street between the three designs. Enhancing the way that the spreadsheet deals with running lanes is one of the recommended improvements (see Section 7.5).

8.3 Final street design

A final scheme, taking into account the designs resulting from the stakeholder workshops, was prepared by Walsall Metropolitan Borough Council for formal public consultation. A plan of the final street design is shown in Figure 22E, and the mix of street design elements that it includes are shown in Table 8, compared to the current provision. Again, there is a substantial increase in parking bay provision along this section of the high street.

Table 8: Comparing street design elements for existing provision and final proposed scheme

	Existing provision	Final proposal
Parking bay	15	26
Disabled parking bay	5	1
Loading bay	7	8
Bus bay	4	4
Crossing places	2	2
Traffic Islands	0	0

Table 9 shows the result of comparing the final proposed scheme with the existing provision, using the same scheme comparison worksheet.

Table 9: Relative impacts of the final proposed scheme, compared against existing provision

Street user group	Final proposal
Pedestrians	0
Pedestrians who have mobility difficulties	0
Those using the street to socialise/relax	0
Cyclists	0
Bus users visiting the street	0
Those using the street as a link	0
Car users (non-disabled) visiting the street	11
Disabled car users visiting the street	7
Shopkeepers	1
Total	**19**

Again, there are considerable overall net benefits, without disbenefits to any of the street user groups. This comparison has not used any weighting or modified relationships to represent priorities or changes in impact with changing levels of provision.

8.4 Comparing all scheme options in the Bloxwich case study

Table 10 compares the results for all the Bloxwich High Street design options, showing the impacts on each group and in total of the varying provision of street design elements under each option.

The results in Table 10 show that the overall impact of each scheme option is positive in comparison to the reference case (i.e. the existing provision). The scheme devised by Group 1 has the highest overall net positive benefit (+34); however, it also has the largest negative impact for a user group, in this case *Bus users visiting the street* (-2). The finally selected design does not give the highest overall benefit, but it avoids negative scores for any of the street user groups, and also scores more highly in ensuring the free flow of traffic along the high street (not currently taken into account in the spreadsheet calculations).

These results, however, do not take into account any side road provision adjacent to the scheme comparison area, where complementary provision (e.g. for disabled parking provision) has been made, in some cases; this could be addressed by carrying out the comparison using a wider scheme impact area.

Table 10: Summary of the relative impacts for each design option in the Bloxwich case study (unweighted)

Street user group	Existing provision	Group 1 scheme	Group2 scheme	Final proposal
Pedestrians	Reference case	0	0	0
Pedestrians who have mobility difficulties		0	0	0
Those using the street to socialise/relax		0	0	0
Cyclists		0	0	0
Bus users visiting the street		-2	-1	0
Those using the street as a link		0	0	0
Car users (non-disabled) visiting the street		19	15	11
Disabled car users visiting the street		16	17	7
Shopkeepers		1	1	1
TOTAL (NET) SCORE		**34**	**32**	**19**

Finally, we can refine the results of the Bloxwich scheme comparison, by including weights and relationships between benefits and levels of provision. In Table 11 the impacts shown above have been recalculated with the following illustrative weightings and relationships:

- A diminishing return of 10% per space for additional car parking spaces after 20 for all user groups – to represent the diminishing usefulness of additional parking spaces
- A weight of 2 given to bus stops for all user groups – to prioritise bus use
- A weight of 0.5 given to standard parking spaces for disabled car users – to represent the decreased usefulness of standard parking bays for disabled car users

Table 11: Summary of the relative impacts for each design option in the Bloxwich case study (weighted)

Street user group	Existing provision	Group 1 scheme	Group2 scheme	Final proposal
Pedestrians	Reference case	0	0	0
Pedestrians who have mobility difficulties		0	0	0
Those using the street to socialise/relax		0	0	0
Cyclists		0	0	0
Bus users visiting the street		-4	-2	0
Those using the street as a link		0	0	0
Car users (non-disabled) visiting the street		11.94	10.86	9.22
Disabled car users visiting the street		2.97	7.43	0.61
Shopkeepers		1	1	1
TOTAL (NET) SCORE – Unweighted (Table 11)		*34*	*32*	*19*
TOTAL (NET) SCORE – Weighted		**11.91**	**17.29**	**10.83**

Taking these weightings and relationship into account has a significant impact on the overall scores, resulting in a substantial drop in each case. In particular, the score from the stakeholder scheme from Group 1 drops well below Group 2, which now becomes the highest scoring option. Also the difference in overall score between the proposals from the stakeholder groups and the final proposal has been considerably reduced.

Clearly different relationships and weightings can lead to very different results. Judgements about weightings would be aided by empirical evidence about the relative needs of different street user groups, the extent to which different street design elements meets user needs, and the marginal benefits of increasing provision.

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User Guide for the Distributional Impacts Spreadsheet

Appendix A: Using the Scheme Comparison spreadsheet

The following is a short note on using the Scheme Comparison spreadsheet, including brief instructions on how to adjust the settings on the spreadsheet.

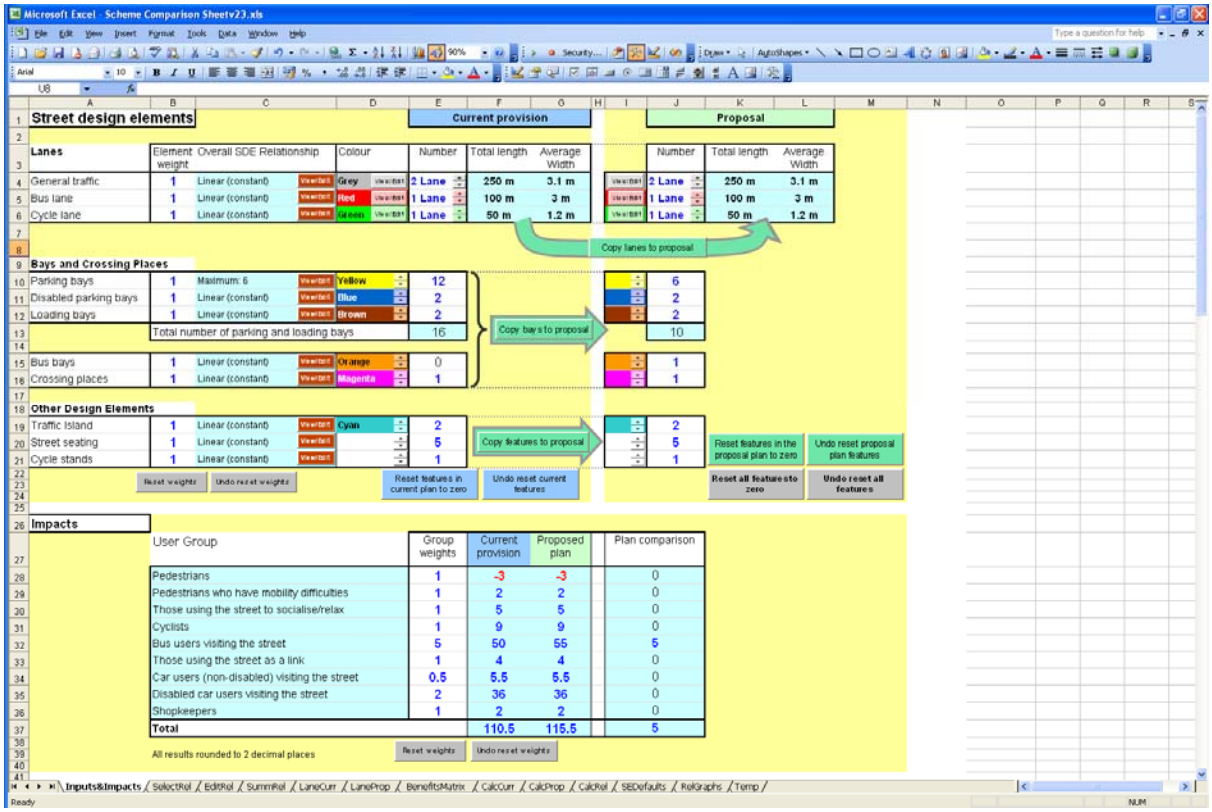


Figure A1: Spreadsheet screenshot

The spreadsheet, shown in Figure A1 above, is made up of thirteen sheets, the first seven of which can be edited by the user. The function of each sheet is briefly summarised below:

1. ***Inputs&Impacts*** – this sheet allows the user to add street design elements to the schemes, in order to represent current provision and proposed provision. This is the main sheet in the spreadsheet.
2. ***SelectRel*** – this sheet allows the user to edit details of the relationships between the number of units of street element provision and the impact/benefit. From here the user can link to the *EditRel* and *BenefitsMatrix* sheets, described below
3. ***EditRel*** – this sheet allows the user to define relationships using any combination of linear and curved sections (the curves are based on a percentage discount). The sheet displays a graph of the relationship as it is edited. Once defined a relationship can be saved to one of the 50 user defined relationship slots on the *SummRel* sheet.
4. ***SummRel*** – this sheet stores 50 user defined relationships, each one describes the relationship between the number of street design elements and their impact for up to 1,000 elements. The graphs associated with the custom relationship can be viewed on the *RelGraphs* sheet (described below)
5. ***LaneCurr*** – clicking on the *View/Edit* button for each lane type under *Current provision* will take the user to this screen, where they can add lane sections to represent the current provision.
6. ***LaneProp***– clicking on the *View/Edit* button for each lane type under *Proposal* will take the user to this screen, where they can add lane sections to represent the proposed provision.

7. ***BenefitsMatrix*** – This matrix specifies whether the relationship between Street Design Element and Street User Group is positive, negative or zero (unrelated). This sheet can also used to set more complicated relationships. Any relationship available on the *EditRel* sheet (including user defined relationships) can be used for each of the user group/design element pairs.
8. ***CalcCurr*** – this sheet contains the formulas used to calculate the impact of current provision, based on the settings in the *Inputs&Impacts* sheet.
9. ***CalcProp*** – this sheet contains the formulas used to calculate the impact of proposed provision, based on the settings in the *Inputs&Impacts* sheet.
10. ***CalcRel*** – this sheet performs calculations based on the settings entered on the *SelectRel* sheet.
11. ***SEDimens*** – Summarises information about the dimensions of the design elements used in the schemes.
12. ***RelGraphs*** – Allows the user to view graphs of the customised relationships, accessed from the *SummRel* sheet
13. ***Temp*** – Temporary values, used to allow a temporary 'undo' option when weights, street element counts and stored user defined relationships are reset to zero.

Figure A2 shows a map of sheets that will be used most often when using the spreadsheet. The arrows show the links between sheets, provided by navigation buttons included on the sheets. A user doesn't have to use the navigation buttons, all the sheets are accessible in the usual way (by clicking their names at the bottom of the excel worksheet). The links are designed to aid the user's workflow by providing easy links to sheets that are related to the one that is currently in use.

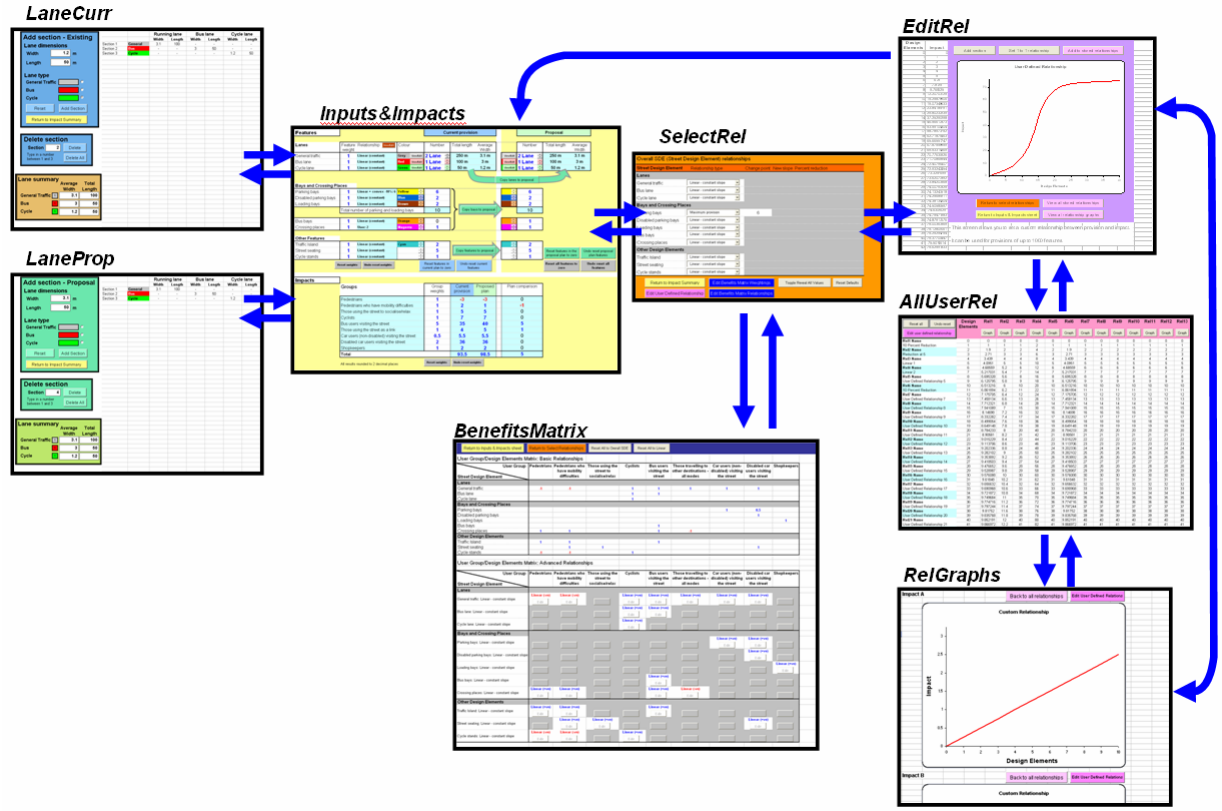


Figure A2: Spreadsheet map showing the screens that are designed to be edited by the user

Layout of the Inputs&Impacts sheet

This sheet allows the user to edit the discrete design elements (e.g. bays and seating) and the various weightings for the current and proposed plans. It also provides links to sheets that allow the level of provision, relationships and lane characteristics to be edited.

Figure A3 shows the *Inputs&Impacts* sheet with the weightings and all street elements set to their default values, '1' for weightings and '0' for the number of each Street Design Element.

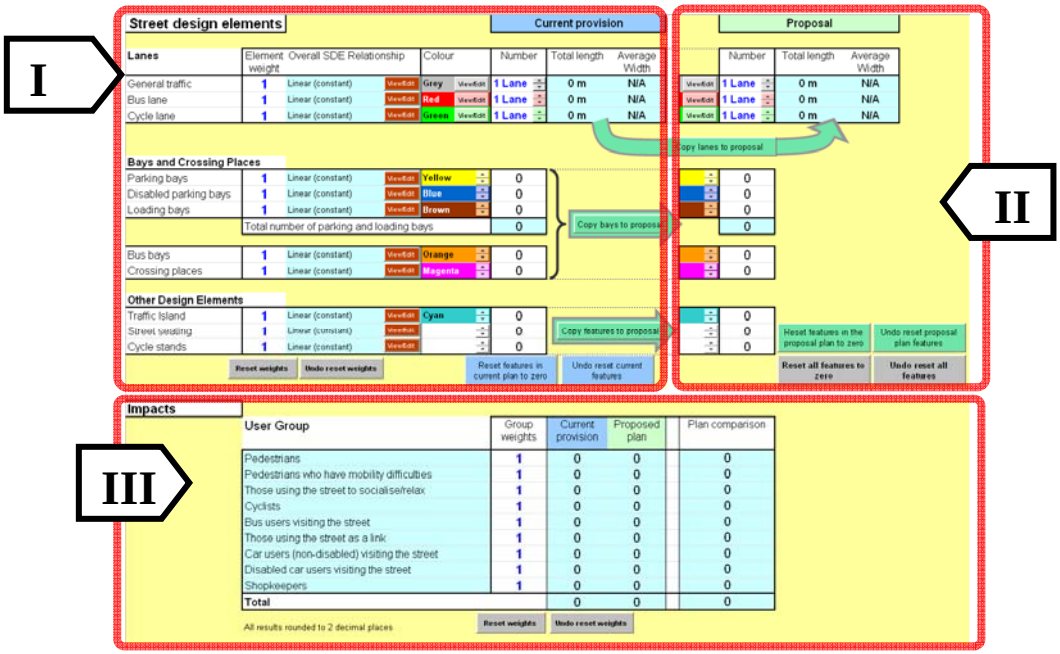


Figure A3: The three sections of the Inputs&Impacts sheet

The sheet is divided into three sections, as highlighted in Figure A3:

I. Current provision
II. Proposed provision
III. Comparison of impacts

Section I

In addition to allowing the street design elements for current provision to be edited, section I includes fields for design element weights and relationships.

Street Design Element weight

Section I allows the weights for the individual street design elements to be set; this setting applies to the design elements in both the current provision and the proposed provision. This setting allows the relative importance of a design element to be adjusted; for instance a strategy may call for the promotion of public transport, and the relative weighting of bus lanes or bus stops could be increased to reflect this priority.

N.B. Setting any street element weight to zero will remove it from the impact calculation.

Relationship

The default for the relationship field is generally 'linear – constant slope', shown on the *Input & Impacts* sheet as 'linear (constant)'. Here the slope is determined by the product of three numbers: the Benefits Matrix (positive, negative or no relationship), the weighting for the street element and the weighting for the user group. For instance a weight of 3 for loading bays combined with a weight of 2 for shopkeepers would give a slope of 6 to the linear relationship between design element provision and user impact. This is illustrated below in Figure A4.

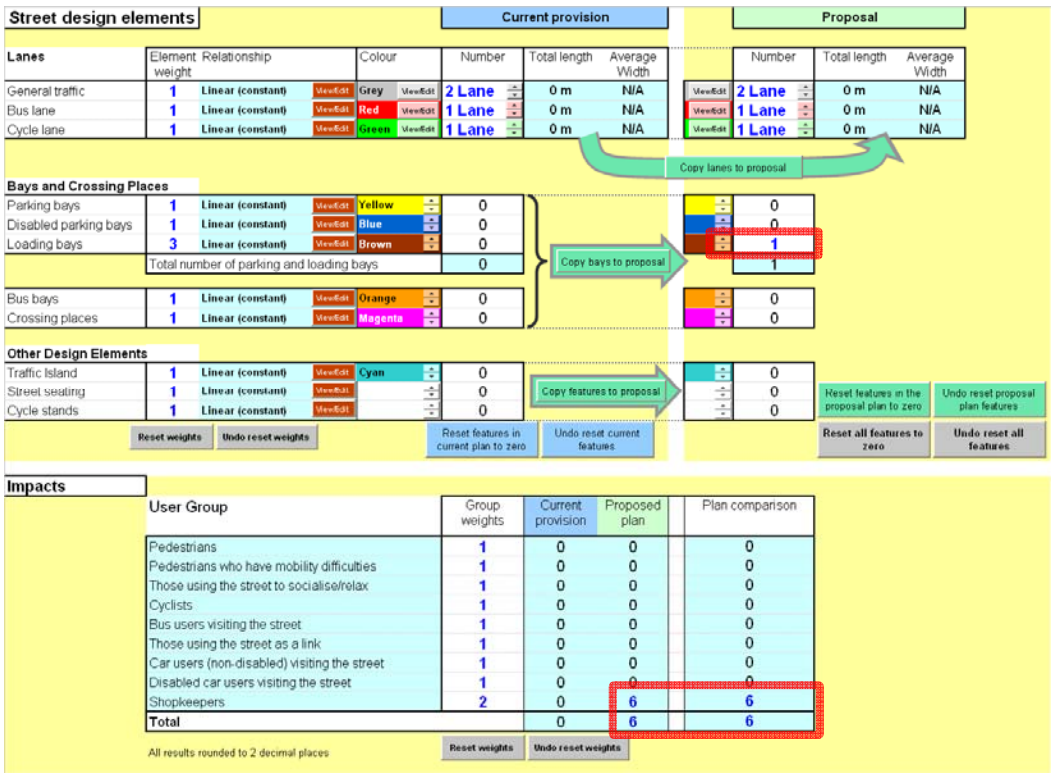


Figure A4: Example of weighting for loading bays and shopkeepers

Adding a single loading bay to the proposed plan has increased the impact for shopkeepers by 6; this is due to the combined weights for the street design element and the user group and the fact that the relationship is defined as positive in the Benefits Matrix.

Different relationships can be used to represent the impact of increasing the number of each type of street design element. The relationships are set using the *SelectRel* sheet, accessed by clicking any one of the View/Edit buttons in the *Relationship column* on the *Inputs&Impacts* sheet. Figure A5 shows the *SelectRel* sheet, where the possible relationships are as follows:

- ***Linear - constant slope*** – the relationship is a straight line with a gradient defined by the value in the Design Element/User Group matrix. This is the default setting.
- ***Maximum provision*** – the relationship is the same as *Linear - constant slope* until the change point is reached, after this point there is no increase in *Impact* with increasing provision of the Street Design Element. The change point is set by the user.
- ***Linear - two slopes*** – the relationship is the same as *Linear - constant slope* until the change point is reached, after this the relationship follows a new gradient. The change point and new gradient are set by the user.
- ***Linear + convex curve*** – after the change point each space only provides a fraction of the benefit of the previous space. The convex curve is based on a percentage reduction, which is set by the user. If for instance a user sets the percentage reduction as 10, each additional space will make 90% of the difference of the previous one.
- ***User (1-50)*** – user defined relationships that can be set using the *EditRel* sheet. Linear and curved sections can be combined along with a cut off point (as in the *Maximum provision* relationship) to produce a user defined relationship. Up to 50 user defined relationships can be stored in the spreadsheet. Using and creating user defined relationships is covered in detail in appendix B.

N.B. Only the first three, linear type, relationships are available for general traffic lanes, bus lanes and cycle lanes.

Figure A5 below shows how drop down boxes on the *SelectRel* screen can be used to specify the relationship for each Street Design Element. The detailed view on the right shows an open drop down box. Once the relationship is chosen, the user defines the relevant parameters; the sheet will only display the parameters that apply to that relationship - cells that do not apply will be grey.

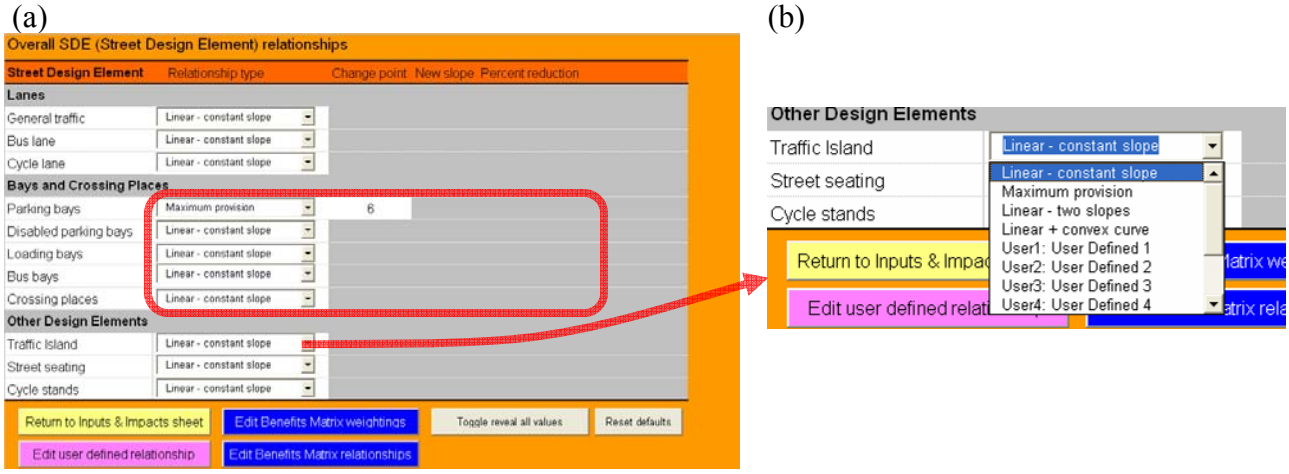


Figure A5: (a) The *SelectRel* sheet, where the relationship between street design elements and impact is selected. (b) Detail from the *SelectRel* sheet showing an example of a relationship drop down box.

If a user wants to see all the parameters, not just those relevant to the selected relationship, they can click the *Toggle Reveal All Values* button. This will make all the parameter cells visible, this is shown in Figure A6. Clicking the *Toggle reveal all values* button a second time returns the display to the style shown in Figure A5(a), showing only the relevant parameters.

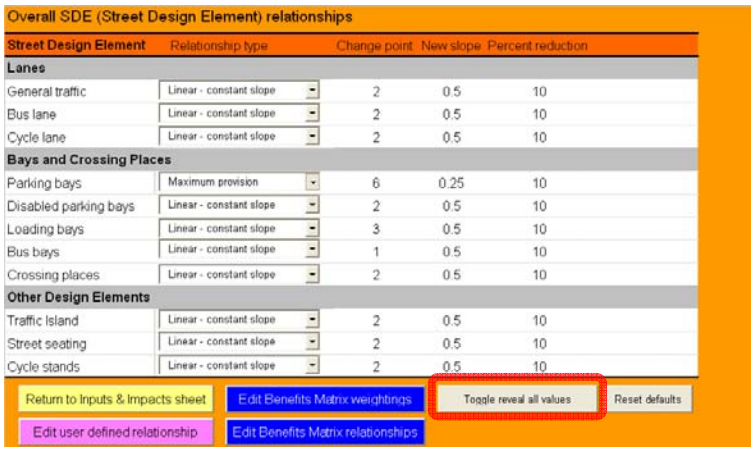


Figure A6: The *Toggle Reveal All Values* button on the *SelectRel* sheet reveals the values for all parameters

After the relationships have been selected, the user can return to the *Inputs&Impacts* sheet by clicking the yellow *Return to Inputs & Impacts sheet* button located directly below the list of street design elements. Figure A7, shows how the *Inputs&Impacts* sheet is updated to reflect changes made on the *SelectRel* sheet. Shortened versions of the relationship names are used on the *Inputs&Impacts* sheet, as can be seen in the highlighted section of Figure A7(b).

(a)

Bays and Crossing Places				
Parking bays	Linear - constant slope			
Disabled parking bays	Maximum provision	2		
Loading bays	Linear - two slopes	3	0.5	
Bus bays	Linear + convex curve	1		10
Crossing places	User1: User Defined 1			

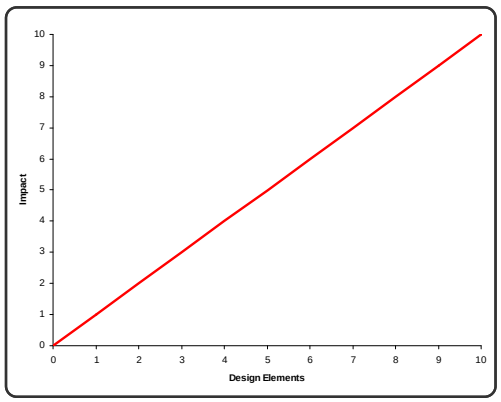
(b)

Bays and Crossing Places				
Parking bays	1	Linear (constant)	Yellow	12
Disabled parking bays	1	Maximum: 2	Blue	2
Loading bays	1	Linear (2 slope): 3	Brown	2
	Total number of parking and loading bays			16
Bus bays	1	Linear + convex: 1	Orange	0
Crossing places	1	UD1: User Defined 1	Magenta	1

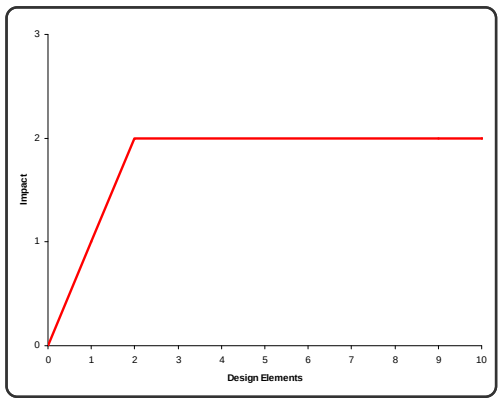
Figure A7: Changes made on the *SelectRel* sheet (a) are reflected on the *Inputs&Impacts* sheet (b).

Figure A8 shows a series of graphs displaying the relationships that were chosen on the *SelectRel* sheet in Figure A7. Here we can see that:

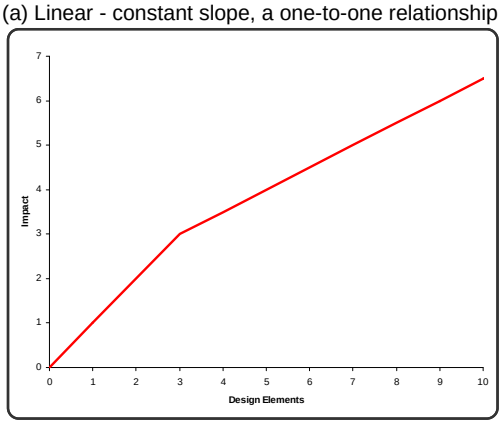
- A8(a) is the simple one-to-one linear relationship (the default relationship) that was selected for *Parking bays* in Figure A5.
- A8(b) is the maximum provision relationship, no increase in impact after 2 spaces, that was selected for *Disabled parking bays* in Figure A5.
- A8(c) shows a combination of two linear sections selected for *Loading bays* in Figure A5.
- A8(d) shows the convex curve selected for *Bus bays* in Figure A5.



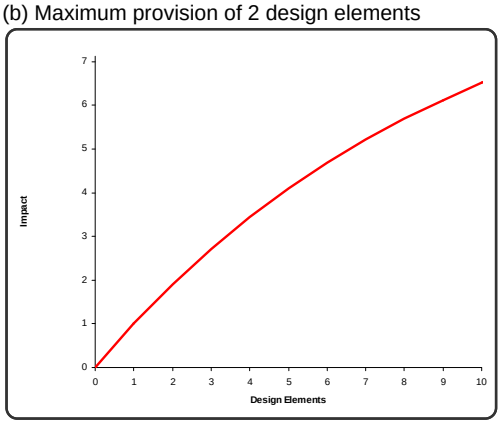
(a) Linear - constant slope, a one-to-one relationship



(b) Maximum provision of 2 design elements



(c) Two slopes, changing to a gradient of 0.5 after 3 design elements



(d) Linear + convex curve, 10 percent reduction for each additional design element

Figure A8: Example graphs of the relationship types that can be selected

If more complicated relationships are required these can be defined user the *EditRel* sheet, described in detail in appendix B.

Street Design Elements present in current provision

The design elements in the current provision can be altered by clicking the *View/Edit* buttons for the lanes, or the up and down buttons for the other elements.

Adding lanes

Clicking on any of the *View/Edit* buttons for the lanes, highlighted below in Figure A9, will open a lane section sheet (*LaneCurr* for current provision and *LaneProp* for proposed provision). The

editing process is the same for current provision and for proposed provision. Figure A10 shows the *LaneCurr* sheet.

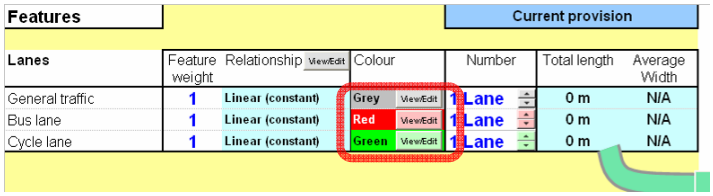


Figure A9: Editing lane sections

The width is set using the information in the *SEDefaults* sheet; at present the default length for each section is 50m. The user does not have to use the default width and length information, since both can be edited. Figure A10 shows how the default length has been replaced with 250m. The button marked *Add Section* then adds the section to the table on the right hand side of the page.

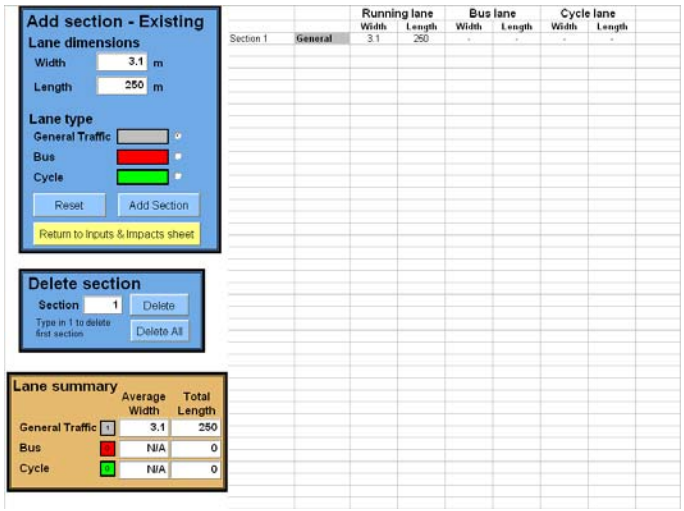


Figure A10: *LaneCurr* sheet

Clicking the yellow *Return to Inputs & Impacts sheet* takes the user back to the main *Inputs&Impacts* sheet. Figure A11 shows the *Inputs&Impacts* sheet is modified to reflect the changes made to the *LaneCurr* sheet.

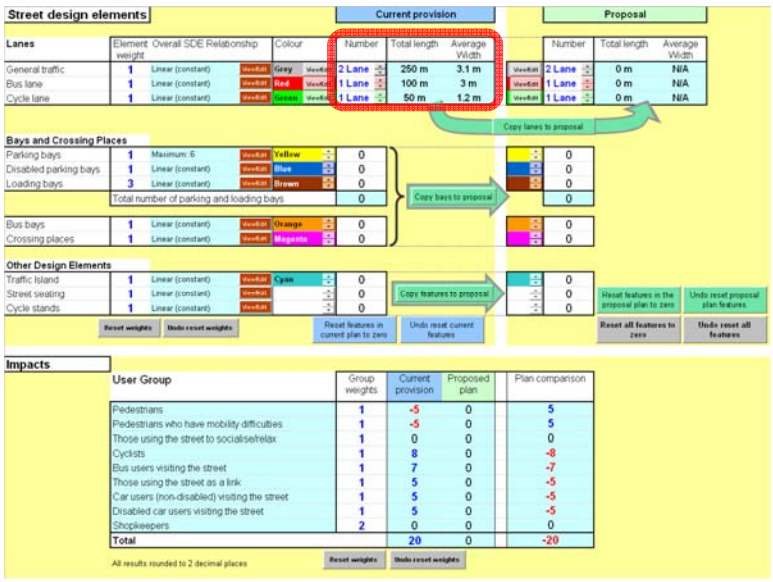


Figure A11: Inputs&Impacts sheet after adding lane sections to current provision

Sections of cycle lane and bus lane have also been added to the scheme. The *Number* field, to the left of the highlighted section in Figure A11, has been updated to remind the user that the 250m section of general traffic lane is made up of two (125m) running lanes. The value in the number field has no effect on the overall impact as it is currently calculated.

Adding bays and other design elements

All street design elements other than lanes are added by using the up and down arrows or by typing the number directly into the number field in the *Inputs&Impacts* sheet, as shown in Figure A12.

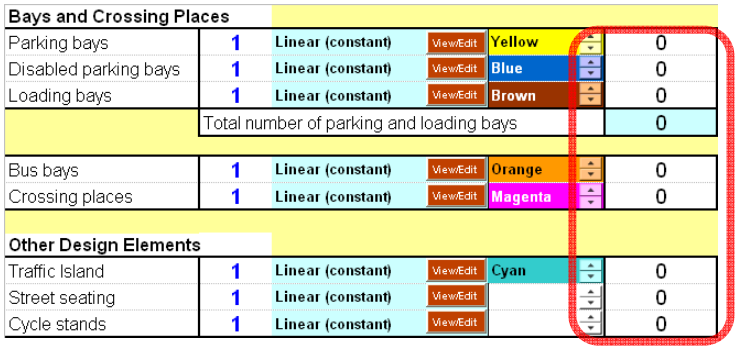


Figure A12: Editing street design elements in the current plan

Figure A13 shows an example of how Section I might be edited to represent a current scheme comprising: 12 parking bays, 2 disabled parking bays, 2 loading bays, a crossing place, 2 traffic islands, 5 seats and a cycle stand (in addition to the lane sections added in Figure A11).

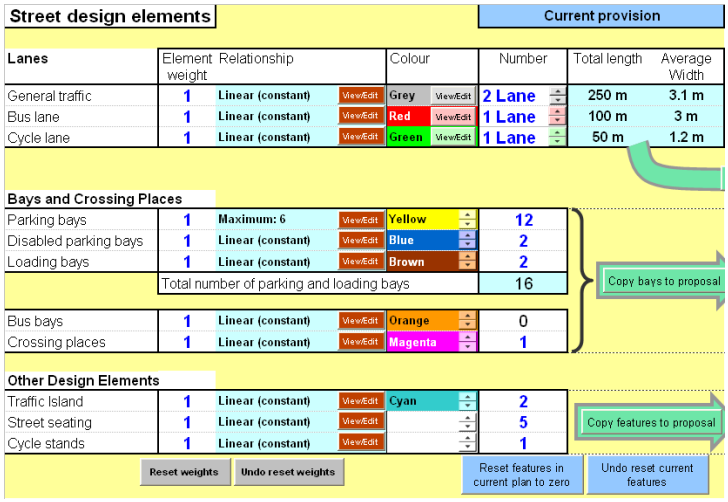


Figure A13: Example of current provision in the Inputs&Impacts matrix

Section II

Section II allows the street design and lanes under a proposed plan option to be edited. A useful time saver is that changes made to the current provision can be copied into the proposed provision by using the *Copy lanes to proposal, Copy bays to proposal* and *Copy design elements to proposal* buttons, shown below in Figure A14.

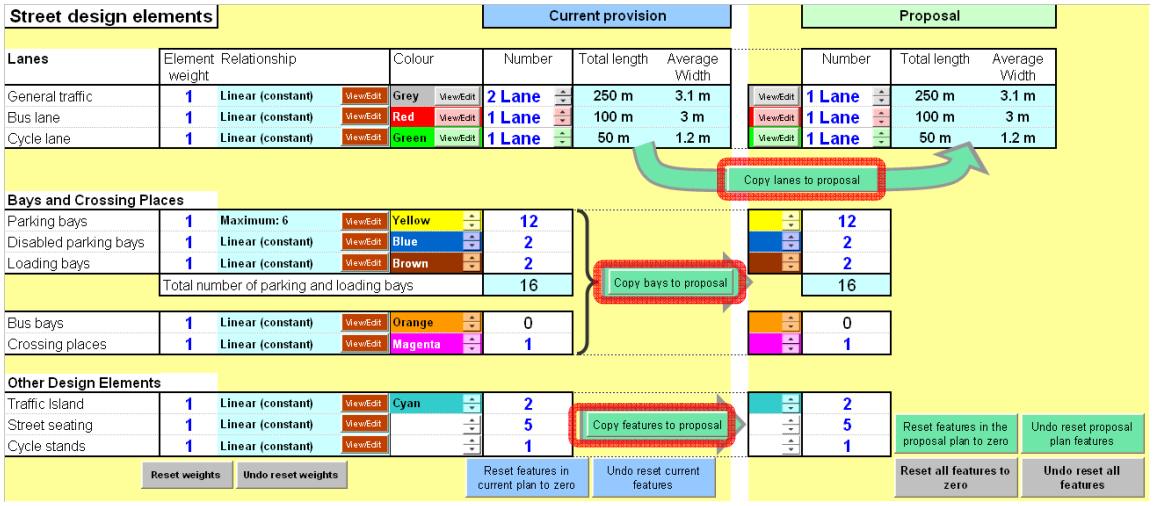


Figure A14: Copying current provision into the proposal

From this starting point it is possible to amend the current provision and observe the effects in section III. All alterations to the proposal provision are made in the same way as for the current provision, described above in Section I.

Section III

Section III compares the impacts resulting from the provision defined in sections I and II, and allows user group weights to be altered. Figure A15 shows the effect of replacing 6 of the parking bays from the example scheme (Figure A13) with a bus bay (taking into account that the maximum provision for parking has been set at 6).

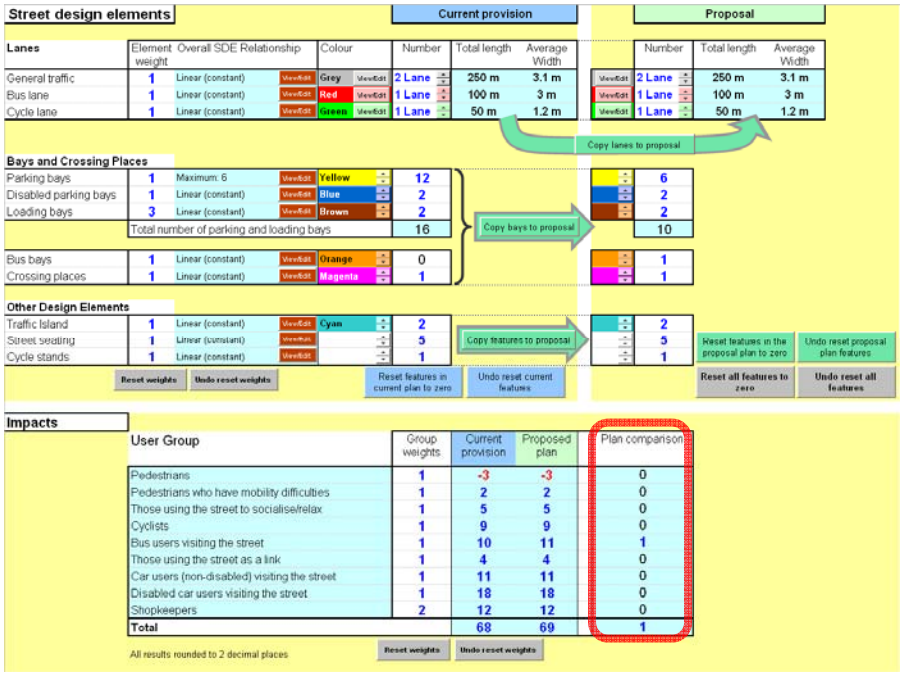


Figure A15: Comparing schemes

Figure A16 demonstrates the effect of changing user group weightings, edited by entering figures in the *Group weights* column in section III of the impact sheet. User group weightings are used to change the relative importance of different street user groups. The weights here have been used to favour bus users and disabled car users, and to give less weight to non-disabled car users.

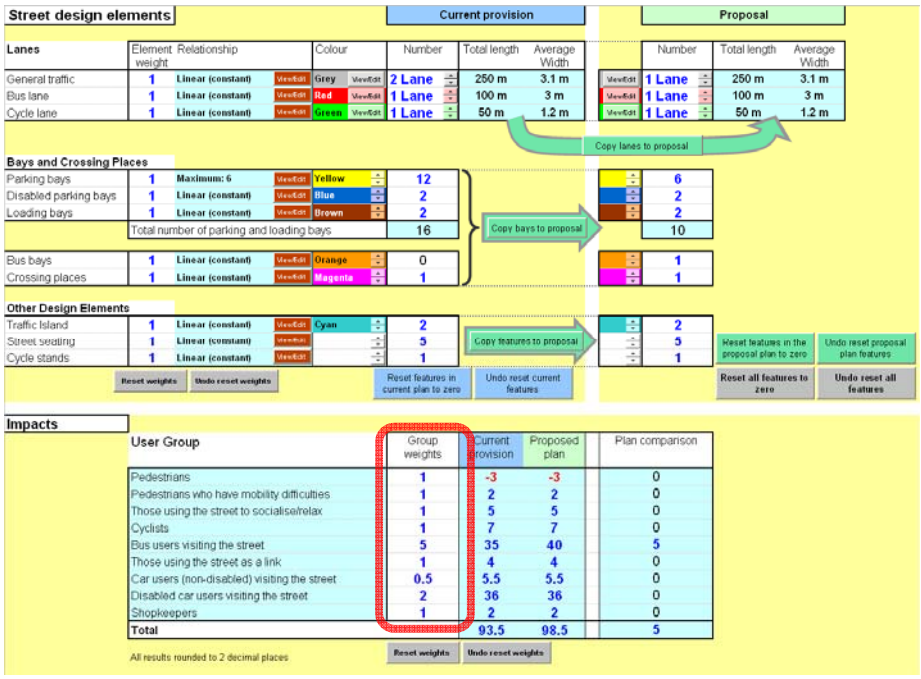


Figure A16: Effect of changing the user group weightings

This comparison shows that the second scheme benefits bus users, without causing negative impacts for the other user groups. However, this is due in large part to the values chosen for the user group and design element weights as well as the relationships chosen to represent the provision of design elements. It is clear that some thought must be given to the values and relationships chosen, giving justifications and where possible empirical backing.

Appendix B: Defining custom relationships

If the built-in relationships are not sufficient for the user's requirements then it is possible to define a custom relationship. User defined relationships are defined and edited on the *UserRel* sheet; this can be reached from the *SelectRel* sheet shown below in Figure B1.

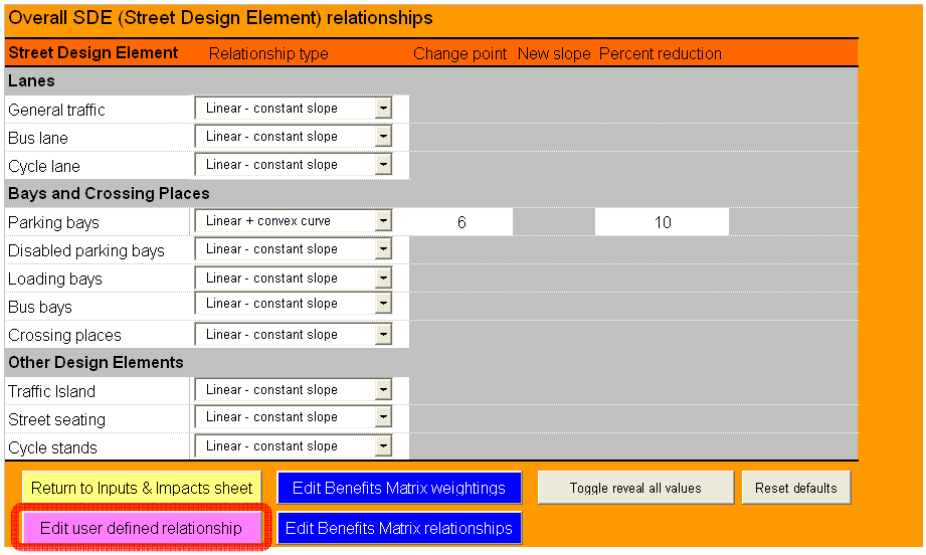


Figure B1: *SelectRel* sheet with the *Edit User Defined Relationship* button highlighted

Clicking the *Edit User Defined Relationship* button takes you to the *EditRel* screen, shown in Figure B2. On the left of the sheet is a table which is used to specify the relationship between the design element provision and impact; this can accommodate a maximum provision of up to 1,000 street design elements (e.g. car parking spaces, seats, etc.). The 1,000 element limit is arbitrary, chosen to limit delays caused by spreadsheet calculations, and could be increased if necessary.

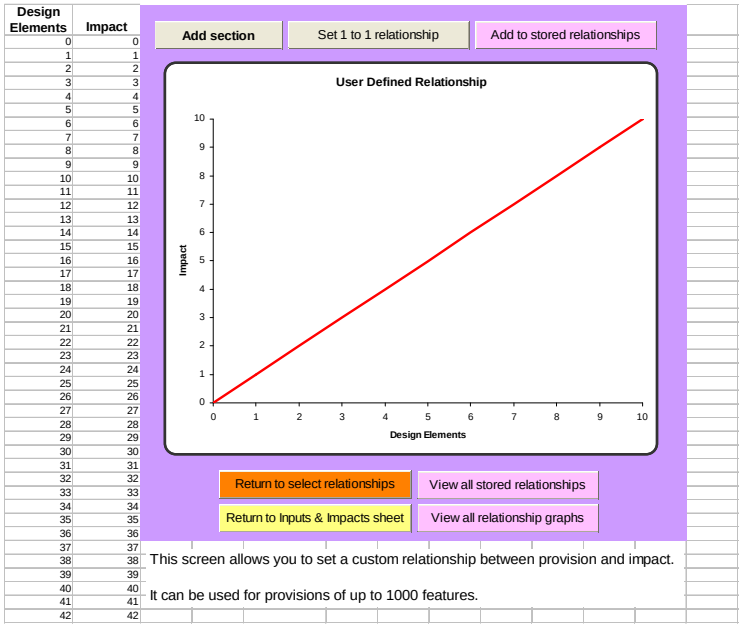


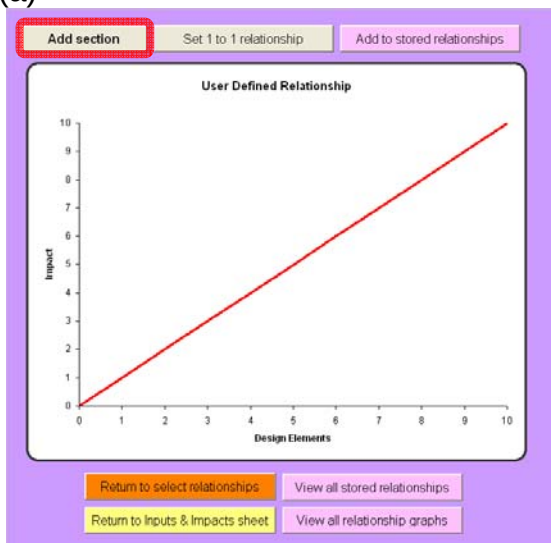
Figure B2: The *EditRel* sheet

This default relationship can be altered by adding straight sections, curved sections and a cut off point. Clicking on the *Add Section* button, highlighted in Figure B3(a) below, opens the *Add Section* dialog box, shown in Figure B3(b).

Adding a straight section

A straight section is added by defining a start point, an end point and setting a gradient. This adds the desired gradient between the start and end points specified. Figure B3(b) shows how to add a gradient of 5 between 5 and 10 design elements.

(a)



(b)

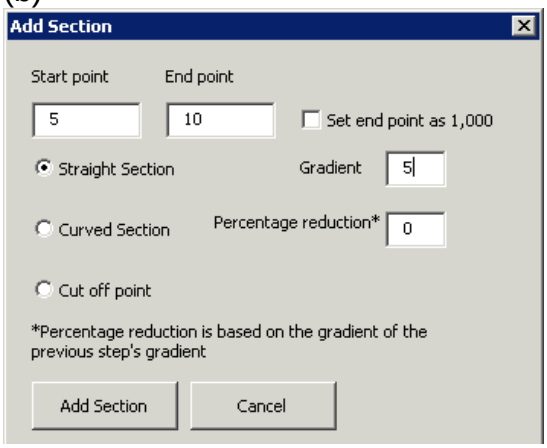


Figure B3: (a) The *Add Section* dialog box is opened by clicking the *Add section* button. (b) Adding a straight section using the *Add Section* dialog box.

Figure B4 shows the result of clicking the *Add Section* button in the *Add Section* dialog box. The gradient returns to 1 after the end point, in this case 10. The *Set end point as 1,000* checkbox easily allows a straight line section to be extended to the final point.

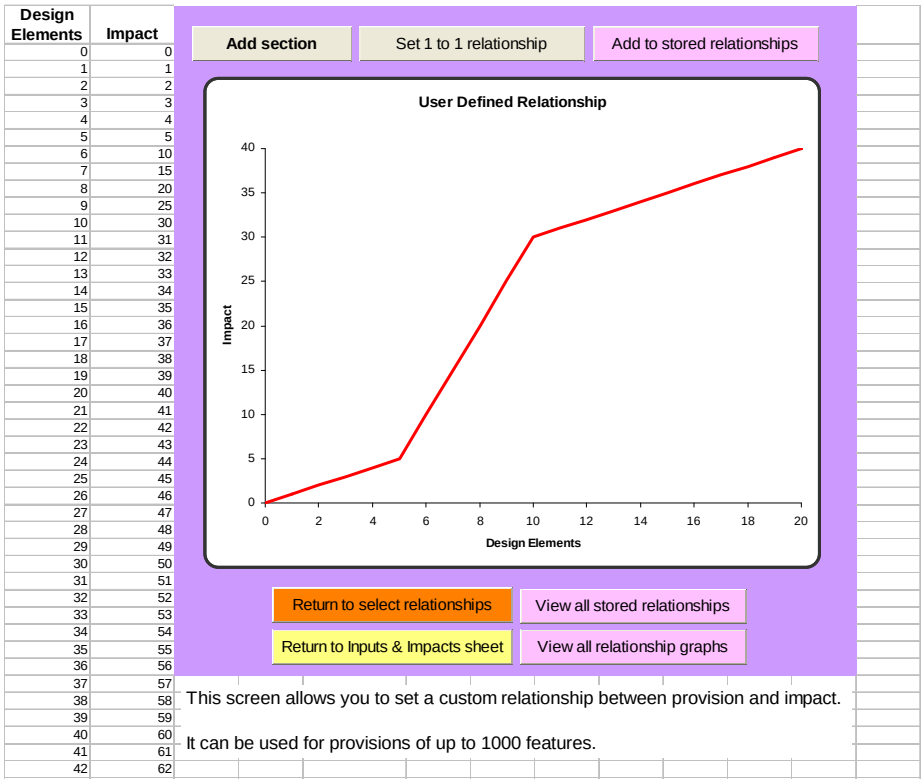


Figure B4: Result of adding a straight section

Adding a curved section

A curved section is added using the same *Add Section* dialog box used for the straight section. To add a curved section a start point, end point and percentage reduction need to be specified. In the example in Figure B5 below a 20% reduction is added for provision between 10 and 15 bays.

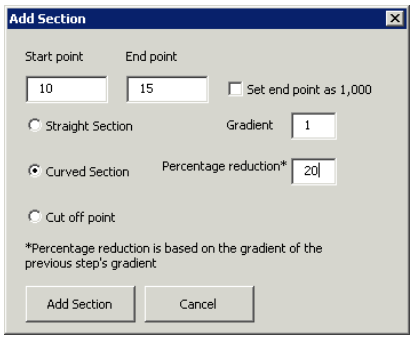


Figure B5: Adding a curved section

N.B. Using a negative value for percentage reduction will lead to a percentage increase.

Figure B6 shows the result of adding this curved section. The function returns to a straight line beyond the curve. Rather than returning to a gradient of 1 after the end section, the line has the gradient of the last section of the curve. If a different gradient is required this can be added as a straight section immediately following the curve.

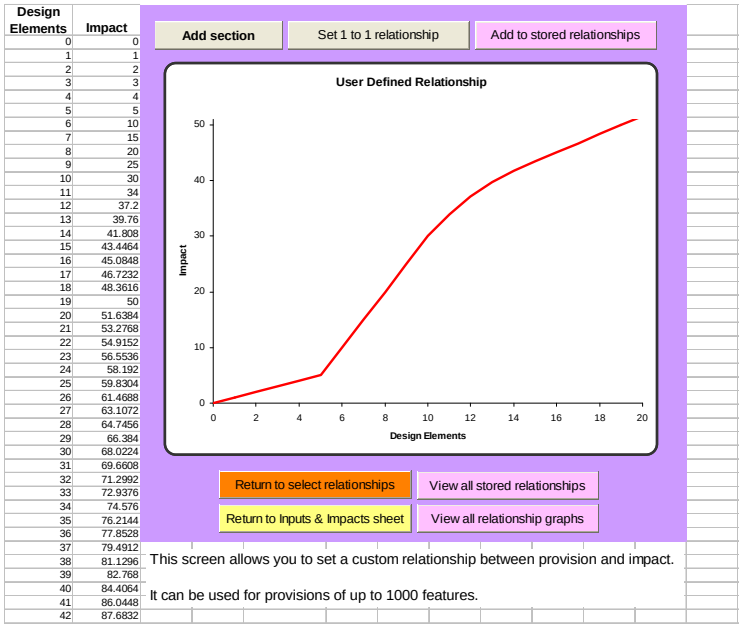


Figure B6: Result of adding a curved section

Adding a cut off point

A cut off point is also added using the *Add Section* dialog box. For a cut off point only the start point is required. In the example below (Figure B7) the cut off point has been set at 20, the result of this can be seen in Figure B8.

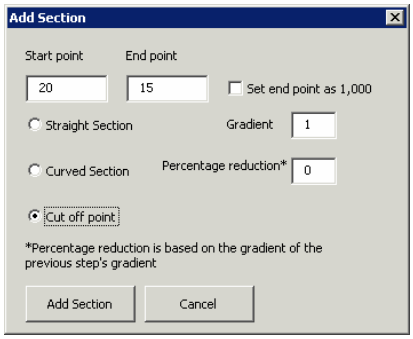


Figure B7: Adding a cut off point using the *Add Section* dialog box

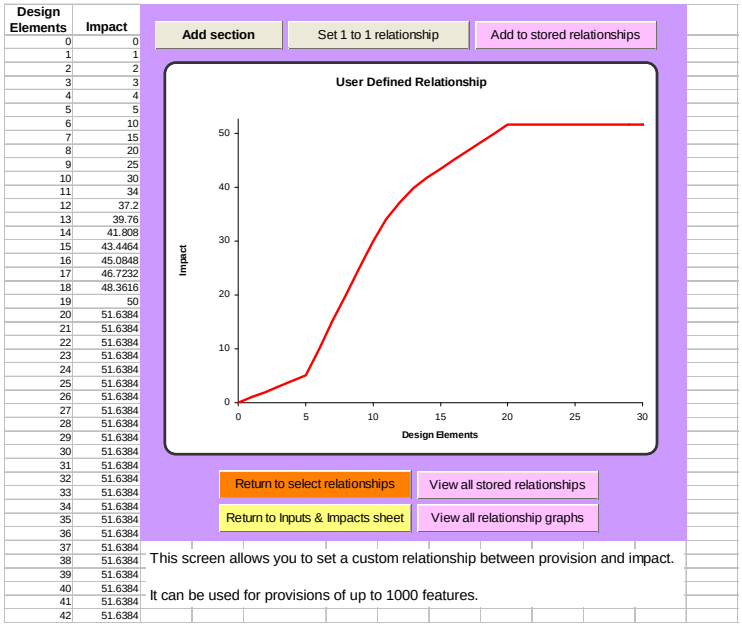


Figure B8: Graph showing the result of adding a cut off point at 20

It can be seen from the graph in Figure B8 that increasing the design elements beyond 20 does not increase the impact.

Resetting relationships and defining new relationships

The relationship shown in B8 demonstrates the different parts available to the user, but it is probably not representative of the kind of relationship that will generally be used. Before we deal with using custom relationships we will define a general s-curve, and before we can do this we must reset the *EditRel* sheet. Clicking the *Set 1 to 1 relationship* button resets the custom function to the original 1 to 1 relationship, as shown in Figure B9.

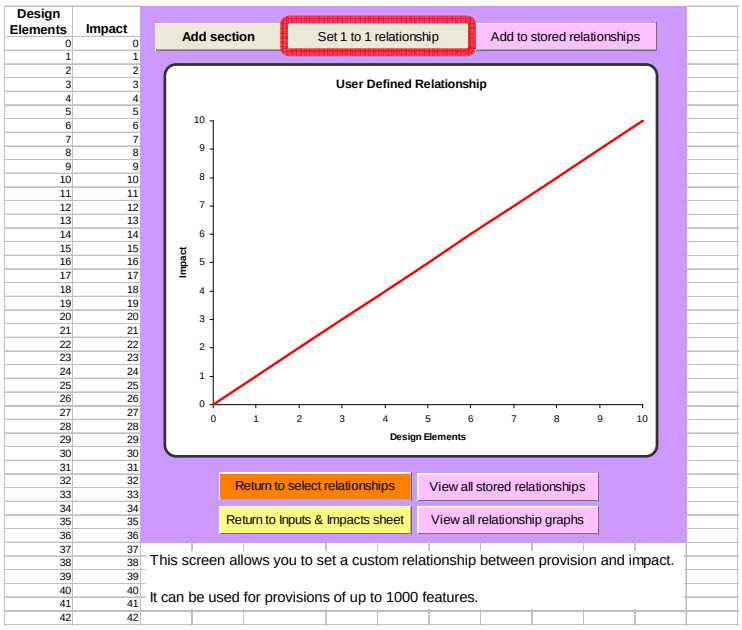


Figure B9: Resetting the relationship

The s-curve graph of shown in Figure B10 is made up of two curved sections. The first section is a percentage increase (a negative value for percentage decrease), between 5 and 10 bays. The second section is a standard percentage decrease between 10 and 15 bays.

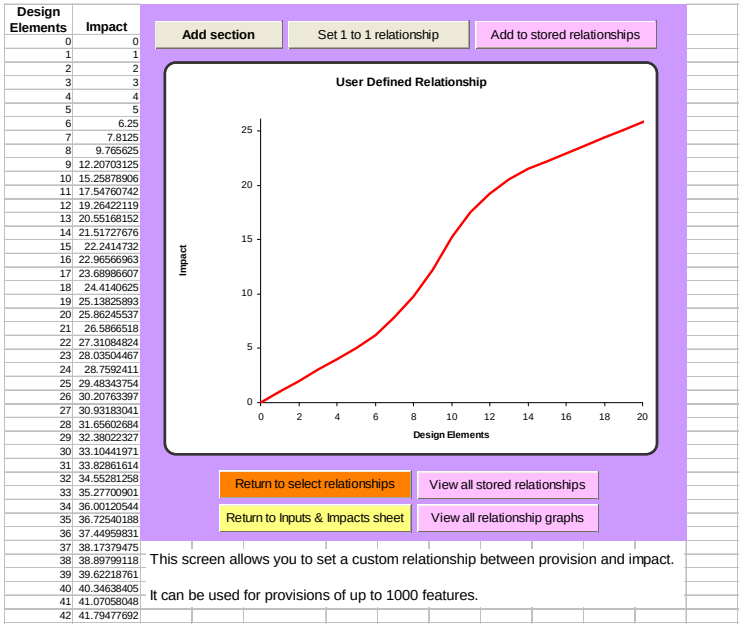


Figure B10: Defining an s-curve

Storing and using a user defined relationship

Before a user defined relationship can be used to represent a particular street design element, it must be assigned to one of the user defined relationship 'slots'. These slots store relationships and make them available for selection elsewhere in the spreadsheet: the *SelectRel* and *BenefitsMatrix* sheets. All stored relationships are saved with the spreadsheet when it is saved. The spreadsheet currently has space for 50 user defined relationships labelled Rel1 to Rel50. The user defined relationship that is displayed on the *EditRel* sheet (in our example the s-curve defined in the previous section) can be set to one of the slots by clicking the *Add to stored relationships* button shown in Figure B11.

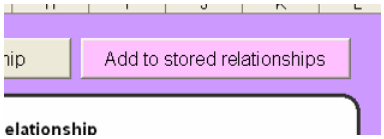


Figure B11: The *Add to stored relationship* button

Figure B12 shows the *Set user relationship* dialog box and drop down menu; this is used to select which slot the relationship will be assigned to. Slot Rel1 is identified as *User1* in the drop down box, other slots are similarly named up to *User50*. Each time a relationship is added the default slot shown in the dialog box is increased by 1 – this is to avoid accidentally overwriting previously stored relationships.

A memorable name can be given to the relationship at this point, we have called our relationship "s-curve" (see Figure B12). The relationship name is stored with the relationships on the *SummRel* screen. It is advisable to keep the relationship name to below about 17 characters otherwise the full name might not be visible in the cells and drop down menus elsewhere in the spreadsheet.

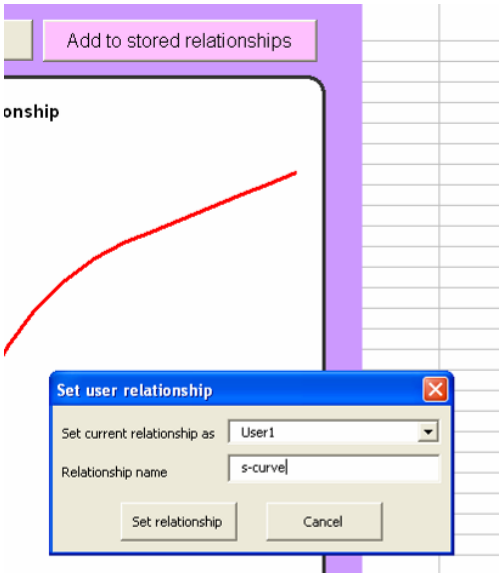


Figure B12: The *Set user relationship* dialog box

Clicking the *View all stored relationships* button shown in Figure B13 takes the user to *SummRel* sheet, where all the relationships are stored.

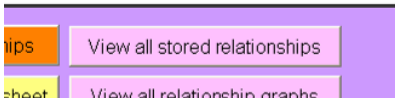


Figure B13: The *View all stored relationships* button

Figure B14 below shows a screenshot of the *SummRel* sheet. The left hand side of the *SummRel* sheet shows the names that have been assigned to each of the relationships. Users can return to the previous screen by clicking the *Go to Edit Relationships sheet* button above the relationship names. There is also a *Reset all* button which will clear all the user relationships (resetting them all to a linear 1 to 1 relationship and clearing the stored names) together with an *Undo reset* button if the reset button is clicked by mistake.

A graph for each relationship can be accessed by clicking the one of the *Graph* buttons at the top of the screen below the headings Rel1 to Rel50.

Reset all / Undo reset / Go to Edit Relationships sheet	Design Elements	Rel1	Rel2	Rel3	Rel4	Rel5	Rel6	Rel7	Rel8	Rel9
		Graph	Graph	Graph	Graph	Graph	Graph	Graph	Graph	Graph
Rel1 Name	0	0	0	0	0	0	0	0	0	0
s-curve	1	1	1	1	1	1	1	1	1	1
Rel2 Name	2	2	2	2	2	2	2	2	2	2
User Defined 2	3	3	3	3	3	3	3	3	3	3
Rel3 Name	4	4	4	4	4	4	4	4	4	4
User Defined 3	5	5	5	5	5	5	5	5	5	5
Rel4 Name	6	6.25	6	6	6	6	6	6	6	6
User Defined 4	7	7.8125	7	7	7	7	7	7	7	7
Rel5 Name	8	9.765625	8	8	8	8	8	8	8	8
User Defined 5	9	12.20703	9	9	9	9	9	9	9	9
Rel6 Name	10	15.25879	10	10	10	10	10	10	10	10
User Defined 6	11	17.54761	11	11	11	11	11	11	11	11

Figure B14: The *SummRel* sheet which shows all the user defined relationships on one screen

Figure B15 shows the result of clicking one of the *Graph* buttons, in this case for relationship Rel1, the slot we assigned our s-curve to. Our memorable name, "s-curve" is displayed on the graph (see Figure B15) and on the left hand side of the summary sheet (see Figure B14).

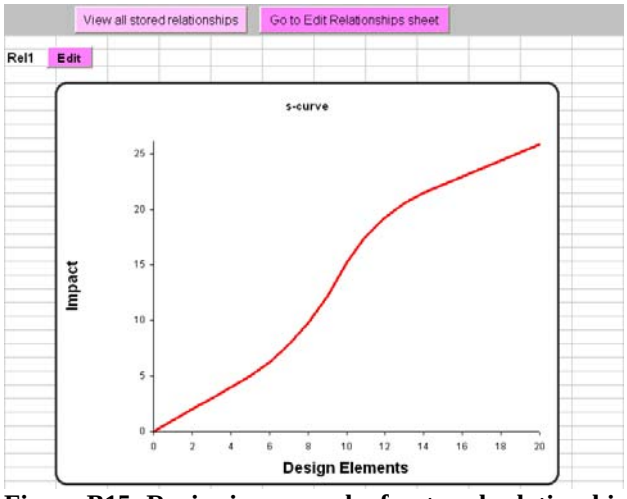


Figure B15: Reviewing a graph of a stored relationship

Navigation buttons are included above the graphs to move the user back to the *EditRel* sheet or the *SummRel* sheet.

Also included is an *Edit* button. Clicking the *Edit* button for a graph returns the user to the *EditRel* sheet which will be displaying the relationship shown in the graph. This allows a relationship to be re-edited, it can then be stored in a new slot. Alternatively the user can overwrite the original relationship by selecting the same slot as the original.

Selecting a user defined relationship

Clicking *Return to select relationships* button on the *EditRel* sheet returns the user to the *SelectRel* sheet, shown in figure B16. On this sheet the required user defined relationship can be selected from the drop down box beside a street design element. The drop down box shows the slot number for the user defined relationship as *User1 to User50*, also included is the name given to the relationship when it was stored.

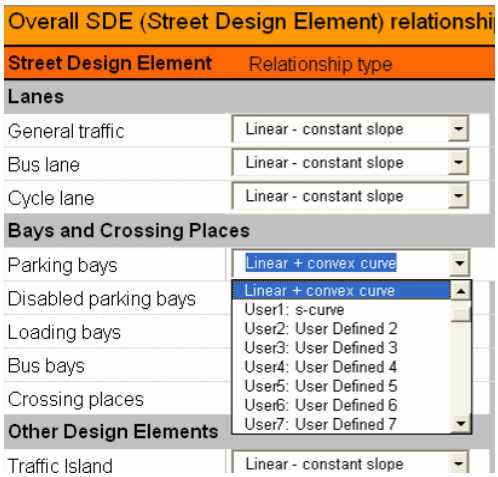


Figure B16: The select relationship drop down menu on the *SelectRel* sheet

Once the settings have been altered the user can return to the *Inputs&Impacts* sheet by clicking the *Return to Inputs & Impacts sheet* button below the relationship table. Figure B17 gives an example of how the changes to the relationship are reflected on the *Inputs&Impacts* sheet.

Returning to the Inputs&Impacts sheet

Once the customised relationship has been selected for a particular street design element on the *SelectRel* sheet, the *Inputs&Impacts* sheet will automatically be updated to reflect this change. Figure B17 shows how *User1: s-curve* is shown on the *Inputs&Impacts* sheet: *UD1* stands for **U**ser **D**efined Relationship **1**. The relationship name that was chosen when the relationship was stored is also shown here, if the name is longer than about 17 characters only the first part of the name will be visible.

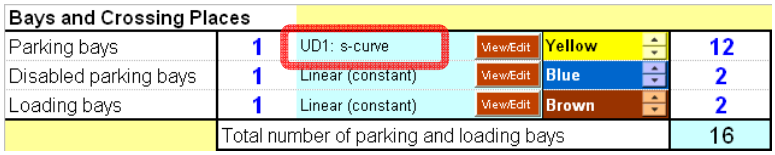


Figure B17: The *Inputs&Impacts* sheet updates to reflect relationships selected in the SelectRel sheet

With the user defined relationship selected the increases or decreases in impact (depending on the Benefits Matrix) will follow the shape of the relationship. Figure B18 shows an example of using our s-curve relationship to represent the impact from *Crossing Places*. Where the Benefits Matrix specifies a positive relationship (*Pedestrians* and *Pedestrians with mobility difficulties*) the impact of adding 6 places is positive, where the matrix specifies a negative relationship (*Those using the street as a link*) the impact is negative to the same degree.

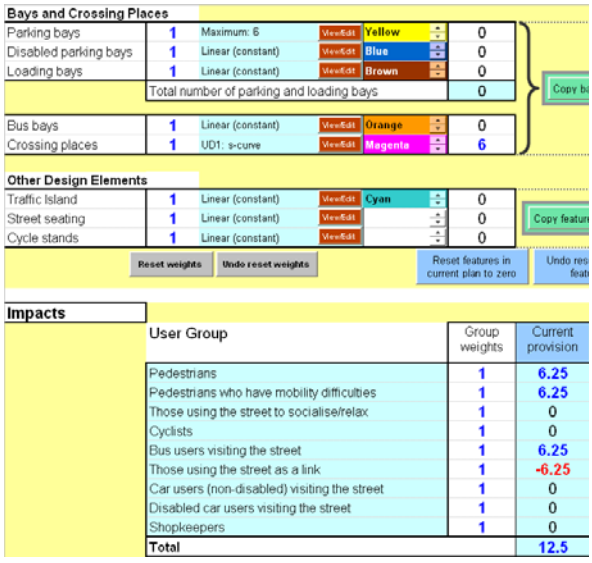


Figure B18: Using a custom relationship to represent the impact of *Crossing places*

Using a user defined relationship in the Benefits Matrix

Section 6.6 described how relationships can be selected for individual pairs of street design element and user group. Once stored a user defined relationship will be available for use on this screen, Figure 21 in Section 6.6 shows a screenshot of the dialog box used to select relationships in the Benefits Matrix.