

COMMUNICATING data with

COLOUR

A DPCD GUIDE TO PRODUCING
COLOUR ACCESSIBLE MAPS
AND VISUAL DATA

ACCESSIBILITY

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The painting, "Bank Place Dancing" on Page 3 is copyright and is replicated with permission by the artist Samantha Lord [0409 997 776] www.inkartworks.com.au

'Bank Place Dancing' 214 x 188 cm oil on 15 oz premium canvas hand stretched on heavy weight bars, 2011.

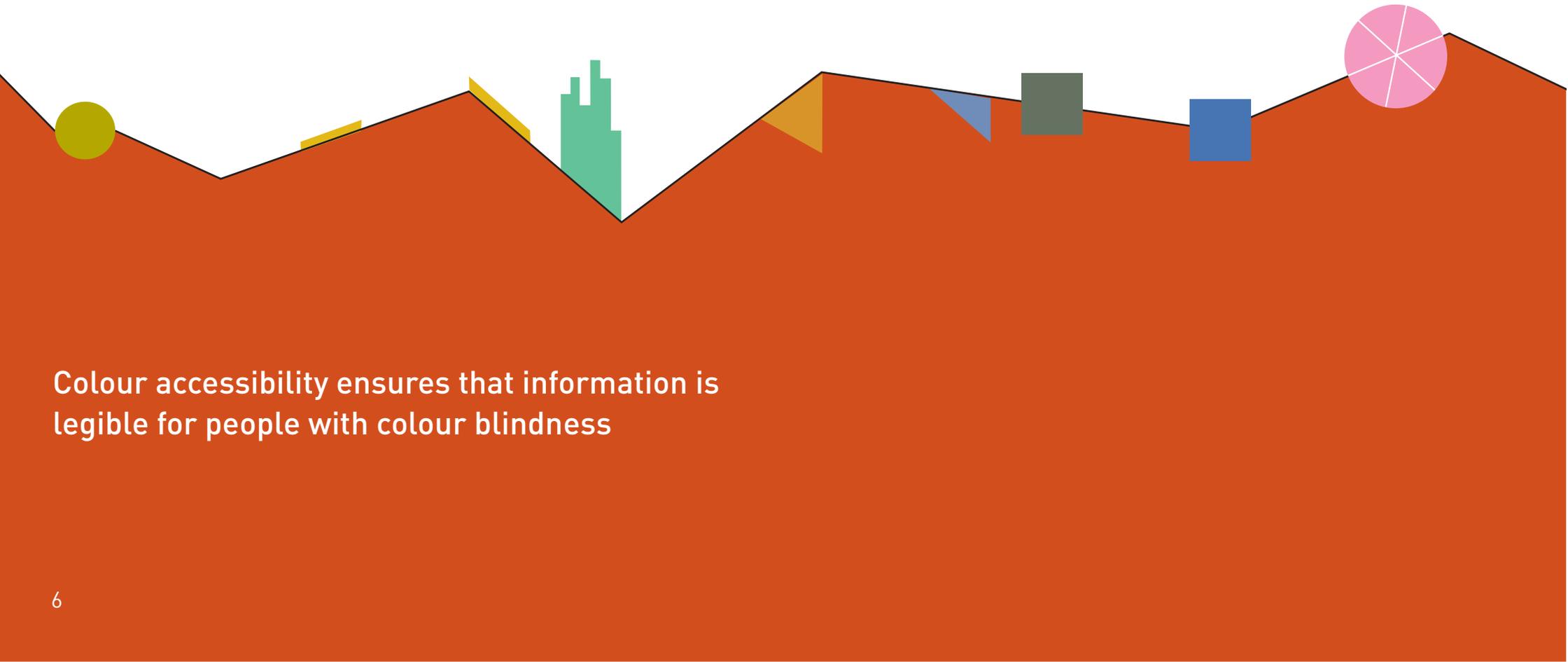
Standard vision





Experience of a person
who is colour blind

SECTION 1 : INTRODUCTION



Colour accessibility ensures that information is legible for people with colour blindness

COLOUR ACCESSIBILITY

Colour accessibility policy

From May 2011, maps and visual data created for public distribution by graphic designers, urban designers, cartographers, researchers, publishers and intranet/internet content managers should be made colour accessible.

Colour accessibility ensures that information is legible for people with colour blindness.

In cases where the complexity of the map or visual data prevents it from being fully colour accessible, an equivalent, accessible alternative needs to be created in a similar format. This should be included in the same publication or website.

This policy applies to all published or externally commissioned material in all file types including documents, presentations or online materials.

Staff may need to use historical material in their publications that may not meet the colour accessibility requirements. In this event, the publication should carry the disclaimer that 'historical material used in this publication may not be colour accessible. The general accessibility policy will then apply and the reader would be encouraged to contact DPCD where staff would assist further.

To successfully implement this policy, staff should:

- Read this *Communicating Data with Colour* guide;
- Consider how to implement colour accessibility at the design stage of the project;
- Be familiar with strategies to implement colour accessibility in publications;
- Test their work to ensure it is colour accessible, using a range of tools and processes;
- Ensure that all external parties who produce maps and visual data on behalf of the department comply with this policy.

ABOUT THE GUIDE

The Role of the Guide

This guide highlights the issues confronting people who are colour blind when accessing information, introduces the policy of colour accessibility and outlines practical methods for achieving colour accessibility in publications and online.

Who is the Guide for?

This guide is for graphic designers, researchers, cartographers, publishers, intranet/internet content managers and authors who produce maps or visual data either printed or digital for or on behalf of DPCD.

Structure of the Guide

Part 1: Introduction to the guide.

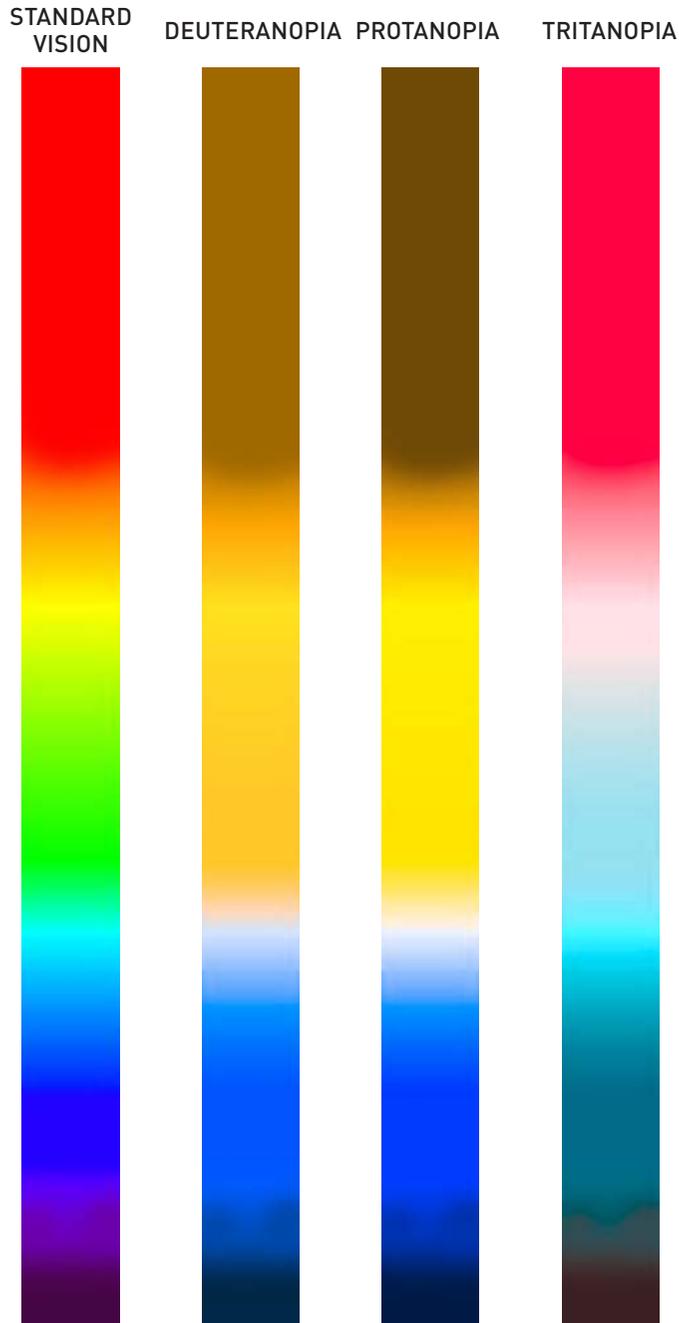
Part 2 : Visual Data section illustrates how annotation, style and colour can be used on graphs and diagrams.

Part 3: Maps section gives examples of how the same principals discussed in Part 2 can be applied to maps.

Part 4: Resources section provides links to essential tools, reading and resources.



COLOUR BLINDNESS



People perceive colour differently

The severity of colour blindness varies from person to person

People with colour blindness have difficulties distinguishing between certain colours and may confuse colours that the majority of people see readily.

This is not a rare condition with colour blindness counted among the worlds most common genetic disorders. Colour Blindness affects 8 per cent of males worldwide, or 1 in 12 males. However it affects less than 1 per cent of females.

According to the World Wide Web Consortium 'Colour blindness is a lack of sensitivity to certain colours. Common forms of colour blindness include difficulty distinguishing between red and green, or between yellow and blue. Sometimes colour blindness results in the inability to perceive any colour'.

We see colour thanks to the cone and rod cells found in our eyes. Cones are responsible for colour vision while rod cells distinguish between light and dark shades. Where these do not function correctly, then a person will likely experience some degree of colour blindness.

Historically, the term colour blindness has widely been used to describe people

with any form of colour vision deficiency. However, total colour blindness, where a person is only able to perceive black, white and shades of grey, is extremely rare with estimates indicating it affects only one in 33,000 people worldwide.

Types of Colour Blindness

The severity of colour blindness varies from person to person, the most common form is where people find it difficult to distinguish between red and green (ie. 'red/green' colour blindness).

Deuteranopia – difficulty in perceiving green (most common)

Protanopia – difficulty in perceiving red (less common)

A third type of colour blindness is **Tritanopia**, which is difficulty in perceiving blue. Tritanopia is very rare.

DESIGNING FOR COLOUR ACCESSIBILITY

The primary purpose of graphs, maps and diagrams, is to communicate information in a visual and hopefully interesting way.

Frequently colour is relied upon as one of the primary means for differentiating information within a graphic or map. However, this can be problematic for people with colour blindness.

A number of techniques and design principles can be employed to enhance the clarity of visual data and maps aiding all readers to understand the information. A wide range of tools are available to assist staff to develop colour accessible material. For example, numerous tools can simulate the experience of colour blindness and should be used throughout the production of your publication, particularly at the design/development stage.

Each graph, map or diagram is different and the most appropriate method or methods you apply will largely depend upon the unique characteristics of your information, the time available for design and also individual author preferences. There is no 'one size fits all' solution and it is up to individual authors/designers to ensure that their outputs comply with the *DPCD Colour Accessibility Policy*.

This guide focuses on three strategies to improve the colour accessibility of visual data – the use of Annotation, Style and Colour.

3 strategies to ensure accessibility

1. Annotation

Direct annotation or labelling of information can help your audience interpret the data on your graphic or map and help minimise ambiguity between elements.

2. Style

The use of different visual variables such as shape, size and pattern can be used as an alternative means to colour for differentiating between elements on your graphic or map.

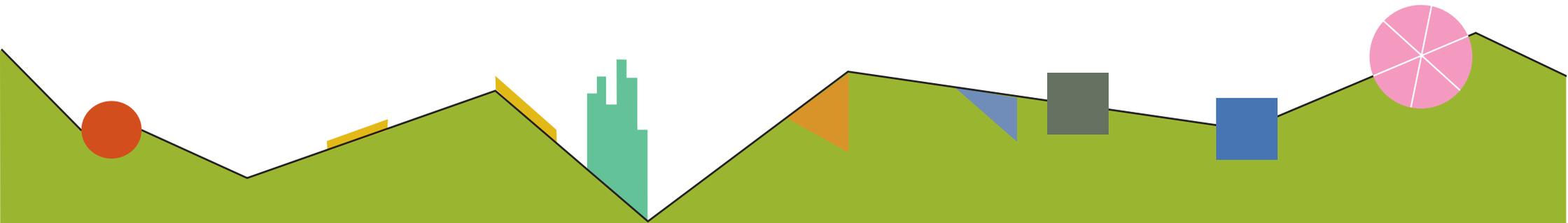
3. Colour

The selection of non-ambiguous colour combinations can greatly reduce the likelihood of confusion between different elements on your graphic or map by people with colour blindness.

“Designers, and especially cartographers, should ensure that their work is clear to the colour impaired as well as to the viewer with full colour vision. Such barrier-free ‘universal’ design is especially important when readers have very limited time to read maps and information graphics.”

BERNHARD AND KELSO

SECTION 2 : VISUAL DATA



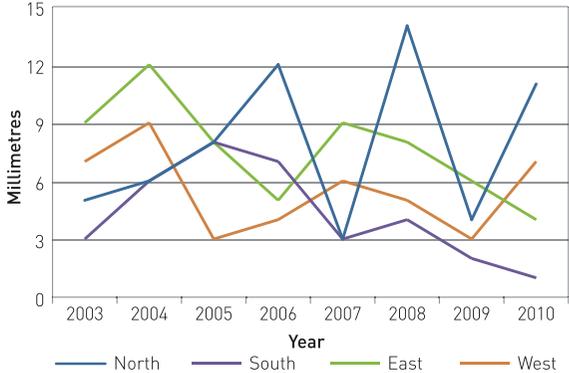
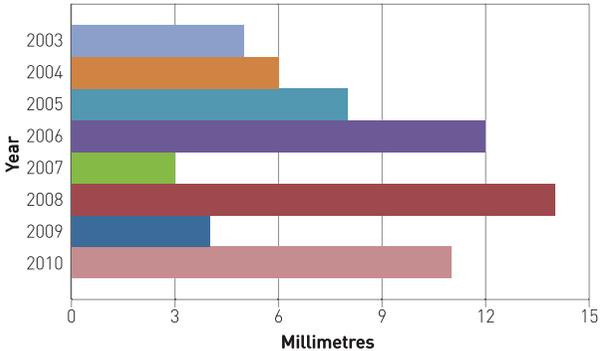
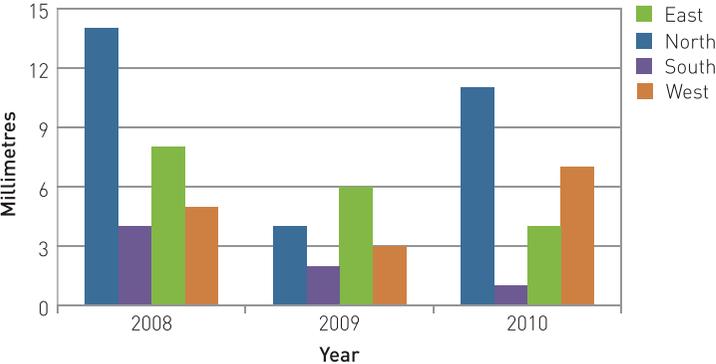
DPCD uses a wide range of visual data.

This section illustrates how commonly used graphs appear to people with colour blindness and introduces practical ways to improve their colour accessibility.

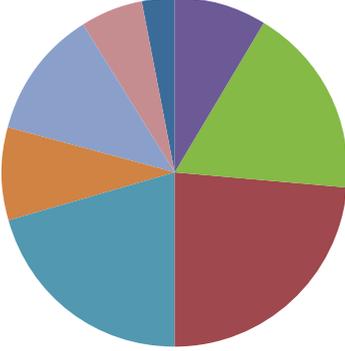
COMMON GRAPHS AND VISUAL DATA

Graphs in standard vision

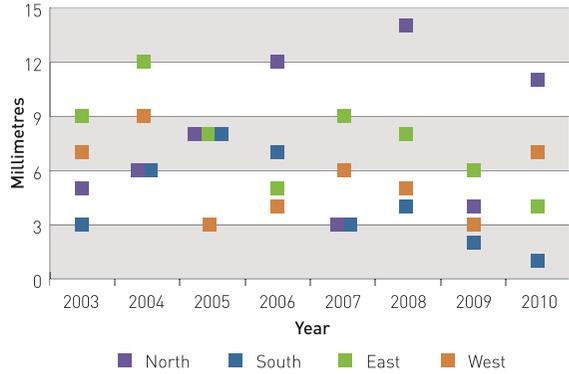
(developed in Microsoft Excel)



- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010



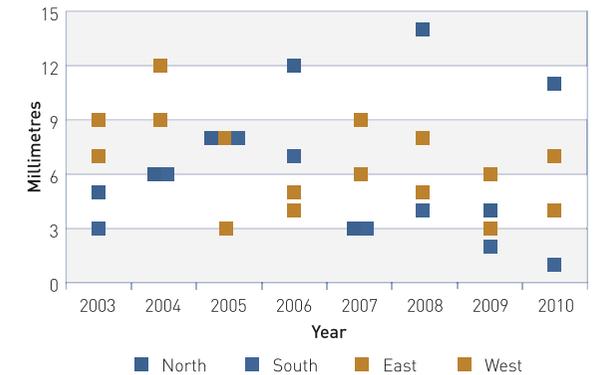
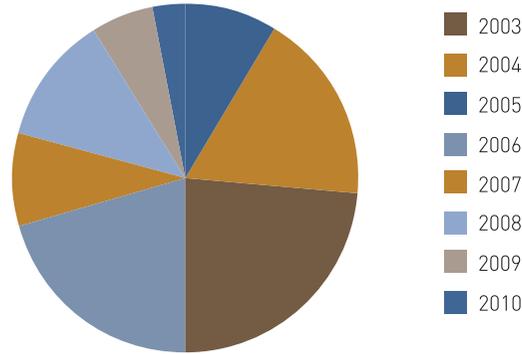
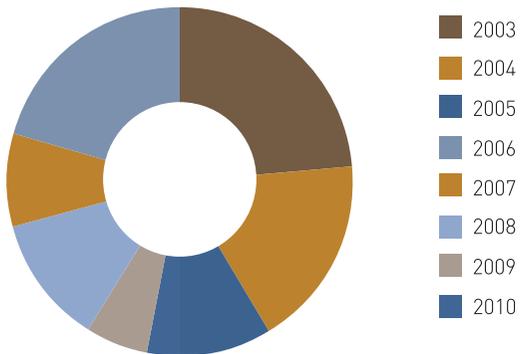
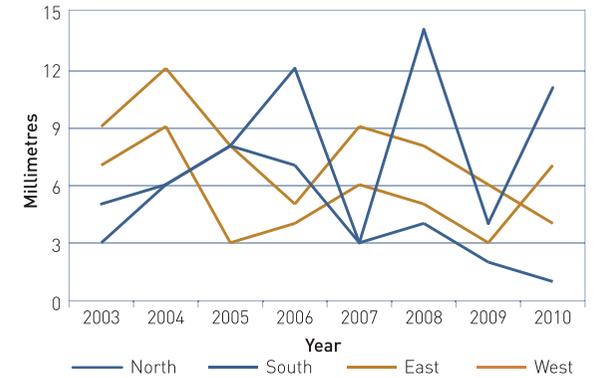
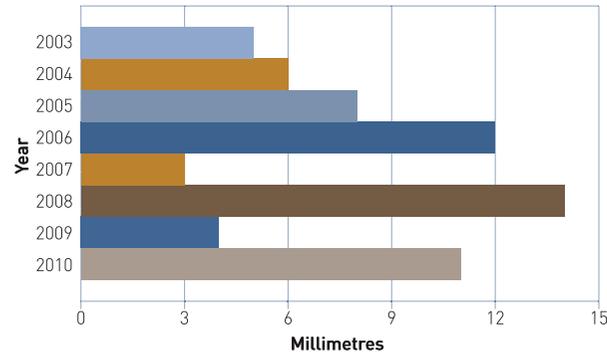
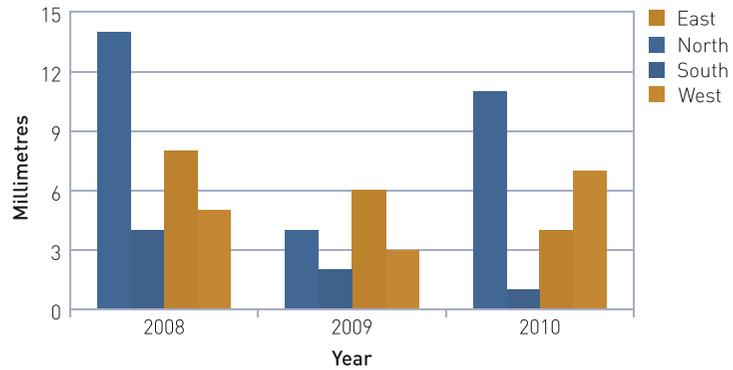
- 2003
- 2004
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- 2007
- 2008
- 2009
- 2010



COMMON GRAPHS AND VISUAL DATA

Graphs in deuteranope vision

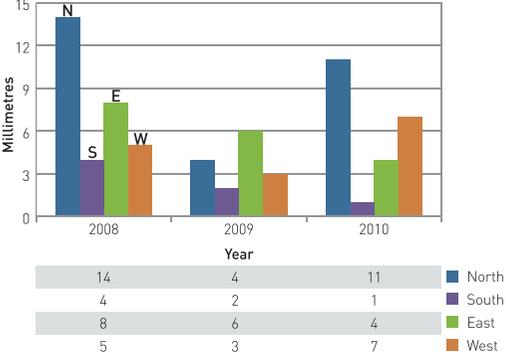
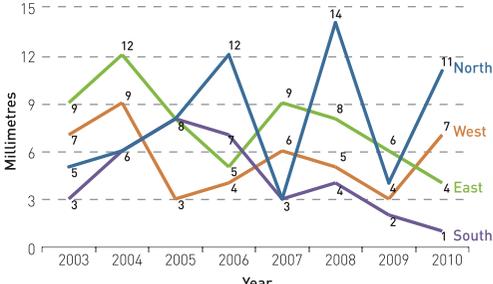
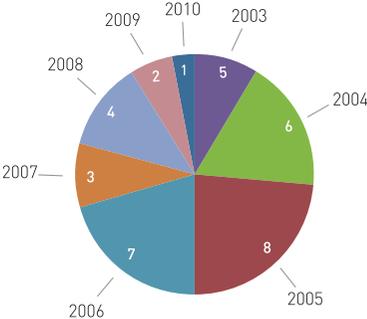
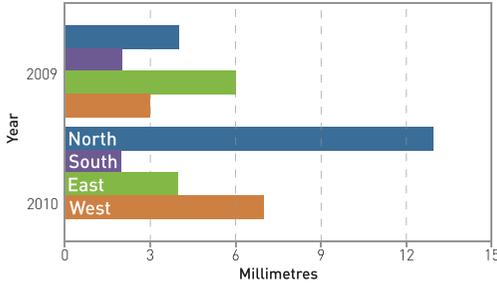
[5% of the male population will see the graphs on page 12 like this]



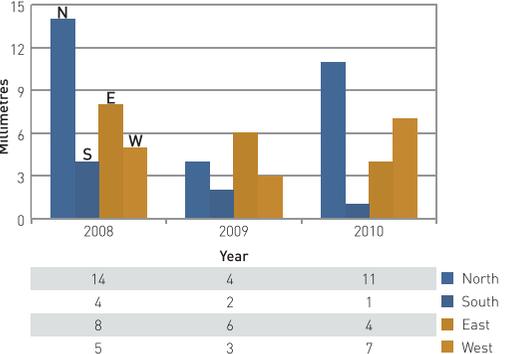
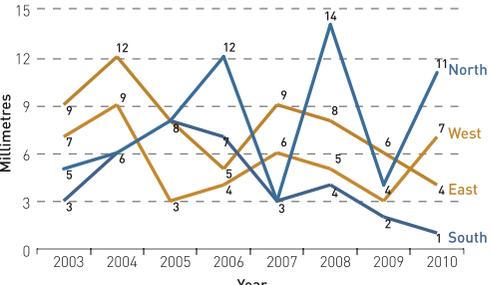
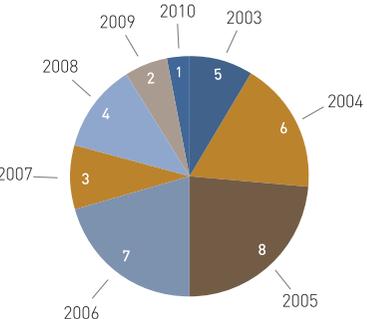
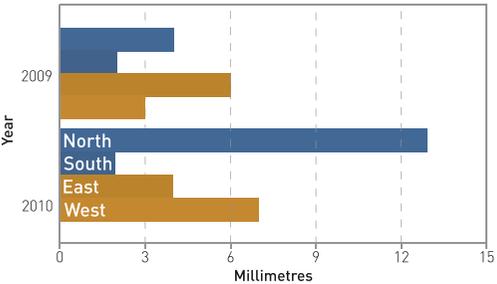
SOLUTIONS: ADD ANNOTATION

- The best method to improve colour accessibility is to apply labels
- Labels should show category name and can include values or percentages
- Labels can be placed within or outside the element
- A data table can be useful
- Include a legend below the data and ensure values appear in the same order as the chart.

STANDARD VISION

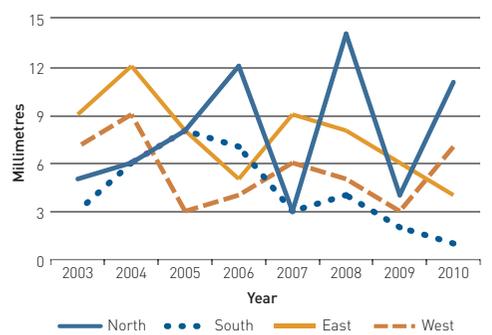
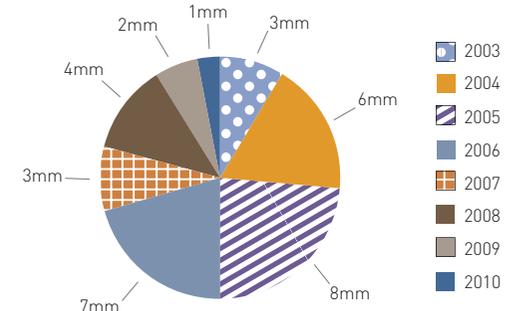
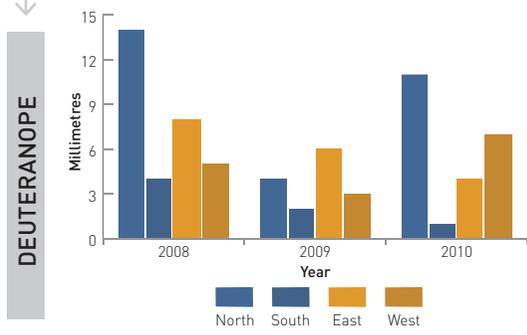
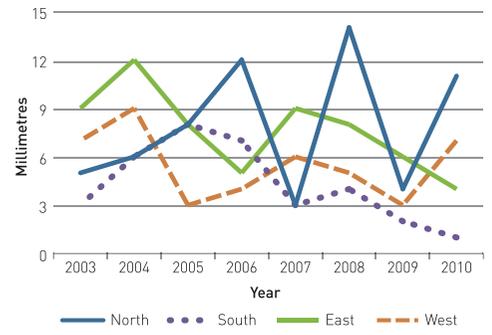
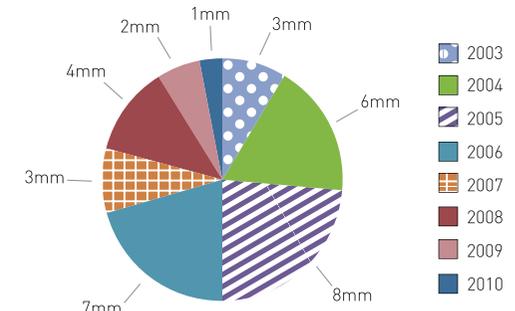
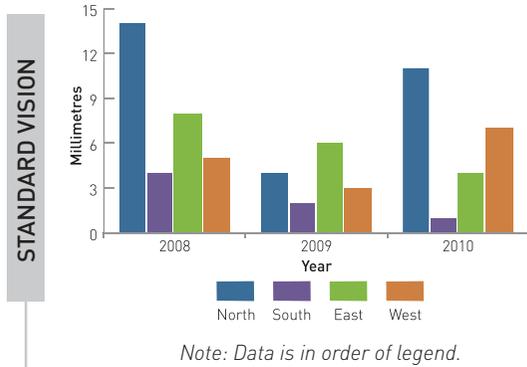


DEUTERANOPE



SOLUTIONS: STYLE

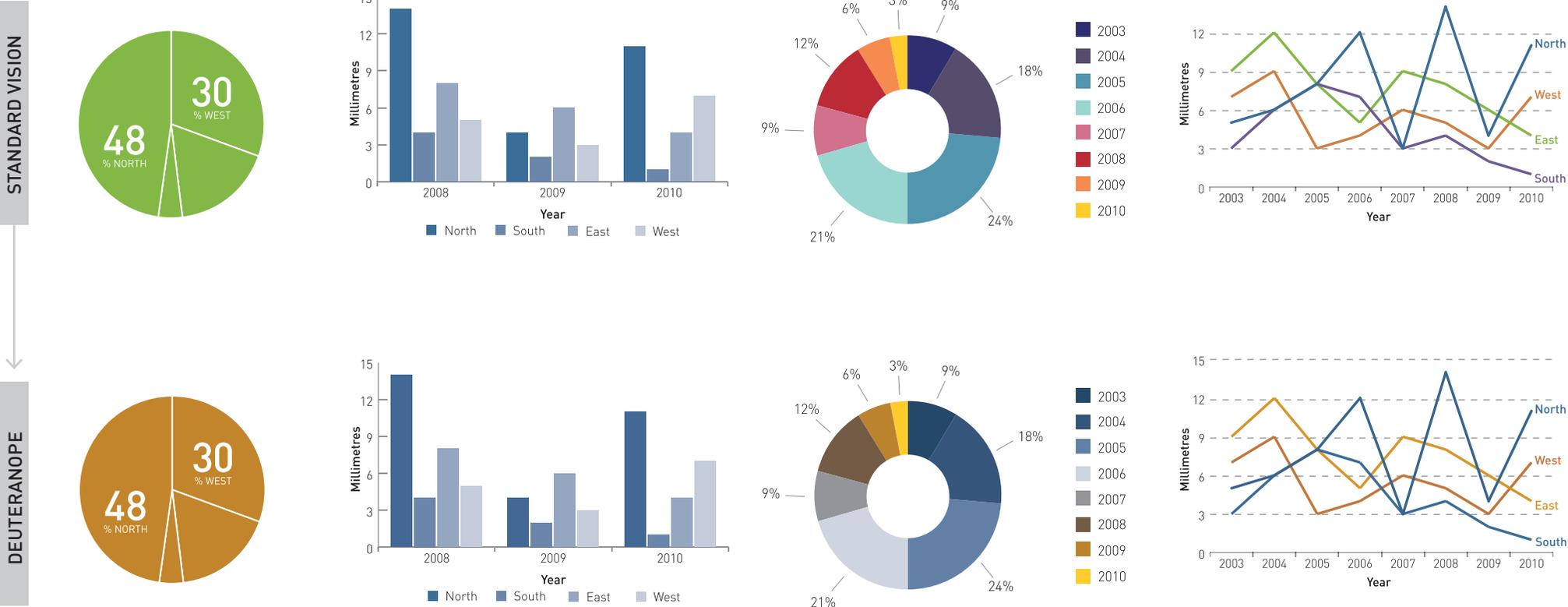
- Style changes can help to distinguish visual elements
- Include a legend below the data and ensure values appear in the same order
- Include borders or space between elements helps prevent colour blending
- Use different points or line styles
- Shade or introduce a pattern on conflicting colours
- Judge whether both style improvements and annotation are required



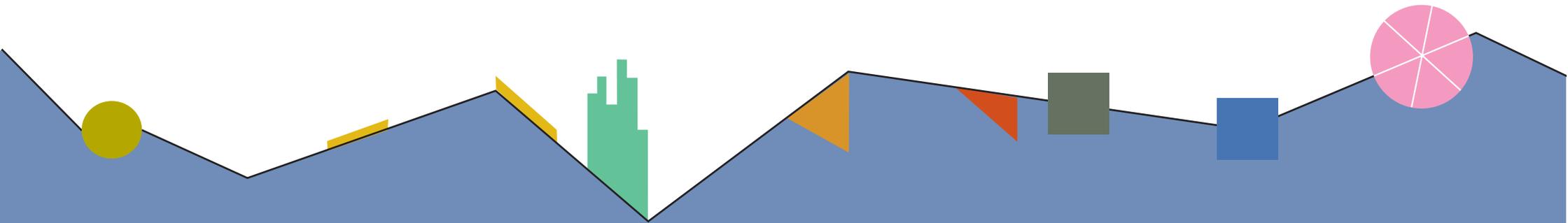
SOLUTIONS: COLOUR

- Use shades of a single colour
- Select non-ambiguous colours and test (greyscale, Deuteranopia, Protanopia, Tritanopia)
- Use one colour and include annotation

Note: Colour calibration differs between screens, software programs, printers, proofs and final products.



SECTION 3 : MAPS



This section focuses on simple, easy to apply suggestions for improving map clarity whilst achieving colour accessibility.

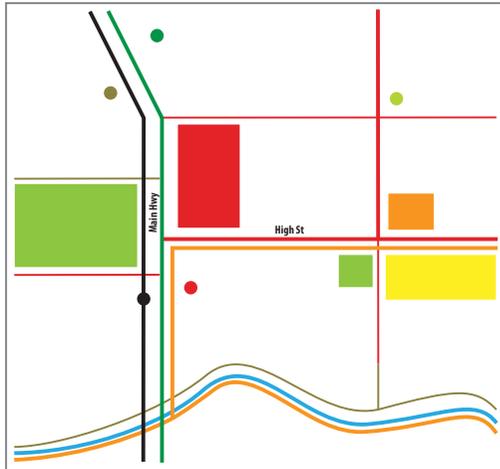
CARTOGRAPHIC CONVENTIONS

Cartographic conventions have developed over time to assist map designers when creating maps which includes guidance on issues such as label placement, use of styles, colour and layouts. A comprehensive overview of cartographic conventions is readily available in cartographic and GIS reference books, and on a number of on-line websites.

SOLUTIONS: ADD ANNOTATION

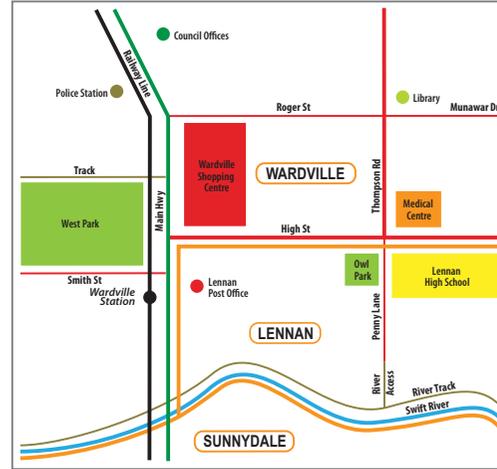
STANDARD VISION

WITHOUT ANNOTATION



- | | | |
|-------------------|-------------------|-------------------|
| — Train Line | ● Train Station | ■ Shopping Centre |
| — Highway | ● Post Office | ■ School |
| — Major Road | ● Police Station | ■ Park |
| — Minor Road | ● Council Offices | ■ Medical Centre |
| — Walking Track | ● Library | |
| — Suburb Boundary | — River | |

WITH ANNOTATION



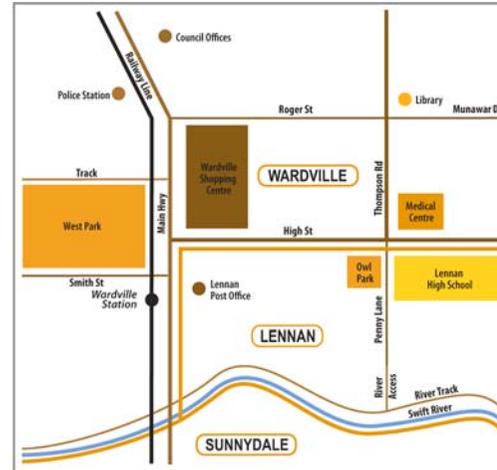
- | | | |
|-------------------|-------------------|-------------------|
| — Train Line | ● Train Station | ■ Shopping Centre |
| — Highway | ● Post Office | ■ School |
| — Major Road | ● Police Station | ■ Park |
| — Minor Road | ● Council Offices | ■ Medical Centre |
| — Walking Track | ● Library | |
| — Suburb Boundary | — River | |

One of the simplest methods to improve accessibility of maps is to annotate or label features ensuring that everything is clearly identified.

DEUTERANOPE



- | | | |
|-------------------|-------------------|-------------------|
| — Train Line | ● Train Station | ■ Shopping Centre |
| — Highway | ● Post Office | ■ School |
| — Major Road | ● Police Station | ■ Park |
| — Minor Road | ● Council Offices | ■ Medical Centre |
| — Walking Track | ● Library | |
| — Suburb Boundary | — River | |



- | | | |
|-------------------|-------------------|-------------------|
| — Train Line | ● Train Station | ■ Shopping Centre |
| — Highway | ● Post Office | ■ School |
| — Major Road | ● Police Station | ■ Park |
| — Minor Road | ● Council Offices | ■ Medical Centre |
| — Walking Track | ● Library | |
| — Suburb Boundary | — River | |

SOLUTIONS: ENHANCING ANNOTATION

Different fonts, sizes and text effects can be augmented with different colour and alignment of annotations to differentiate between data categories and also to differentiate hierarchy within a category such as different sizes of towns/cities on a reference map of a whole state.

Font

Select different fonts, particularly those which are serif/sans serif, however avoid too many different types on the one map.

Size

Use different size text to reinforce hierarchy within a category or between categories of data.

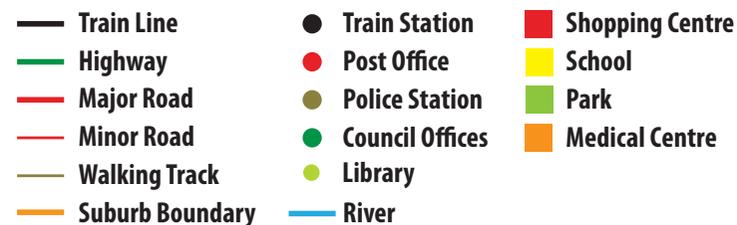
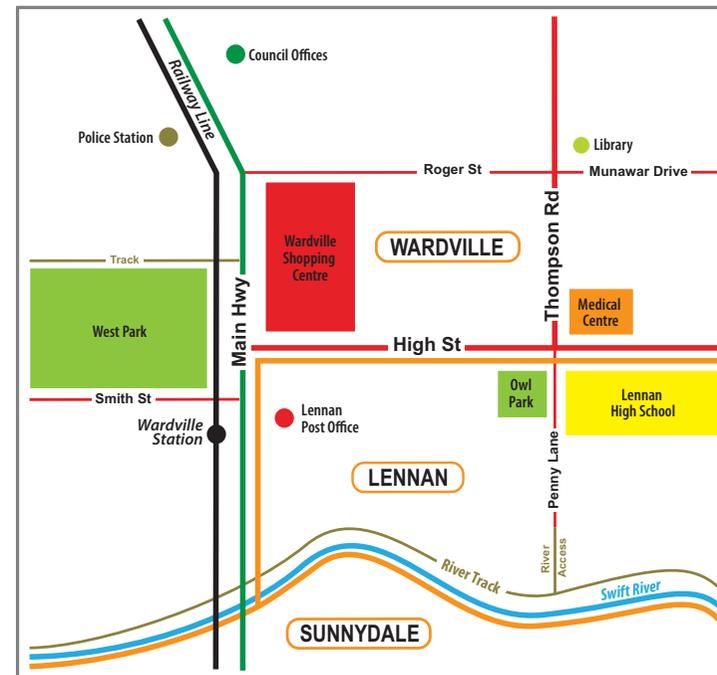
Text Effects

Font style - Using font styles, such as bold, underline, italics and capitalisation, can be used to differentiate text further.

Colour - Using the same colour as the feature, such as blue for water-bodies, creates an instant connection between the text and the feature.

Alignment - Aligning text with a features orientation, such as a north-south running road or contoured along a river, creates a connection between the label and the feature.

The same map from the previous page using enhanced annotation styles to improve the readability of the map.



SOLUTIONS: STYLE

Cartographic software provides a myriad of styles for representing the points, lines and polygon features of your map. The use of different visual variables, such as varying the size, width and pattern of elements, will help make your map colour accessible from the point of design.

The examples below illustrate how these principles can be applied to cartographic features.

STANDARD VISION

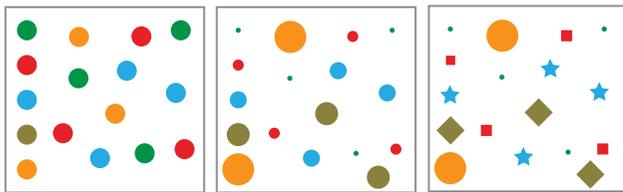
DEUTERANOPE

POINTS

Original

Vary Size

Vary Pattern

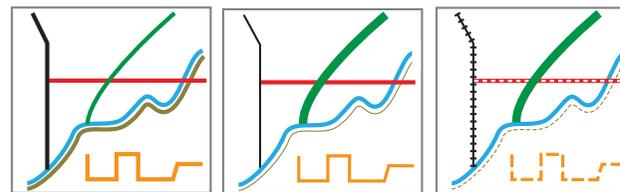


LINES

Original

Vary Size

Vary Pattern

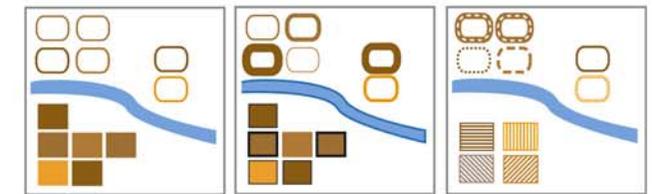
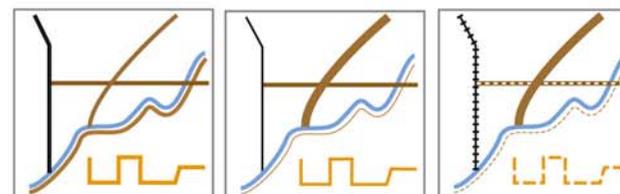
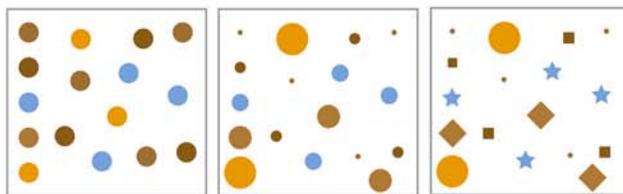
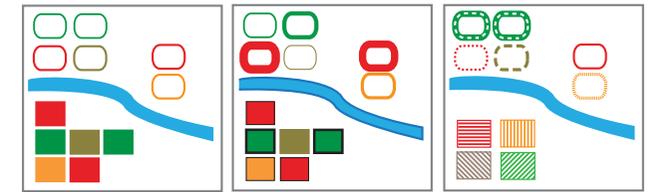


POLYGONS

Original

Vary Size

Vary Pattern



SOLUTIONS: COLOUR

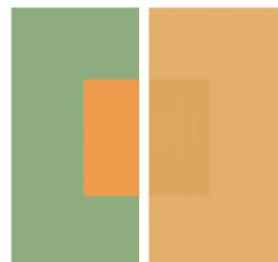
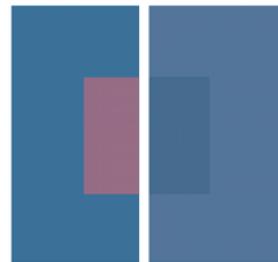
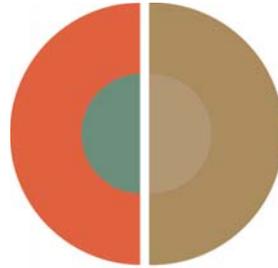
The appropriate use of colour can be used to enhance and clarify a presentation and poor colour use can greatly disadvantage or confuse your audience if they are colour blind.

It is commonly understood that colours such as red/green and blue/purple are easily confused by people with colour blindness. However, this diagram demonstrates that there are some surprising combinations which can also cause confusion such as pink/grey.

Note: Colour calibration differs between screens, software programs, printers, proofs and final products.

ColorBrewer is a web tool for selecting colour schemes for maps and is available online at www.colorbrewer2.org

Standard Vision Deuteranope



MAP EXAMPLES

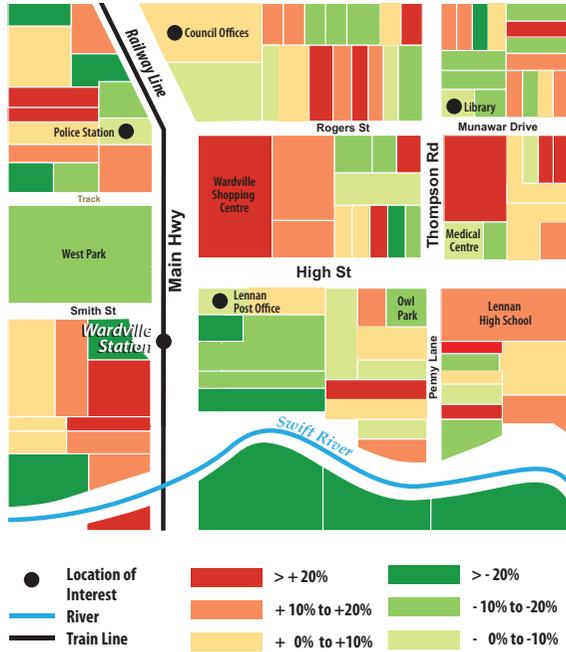
Thematic Map

Thematic maps using colour ranges are a commonly used mapping technique and can prove particularly problematic for people with colour blindness as the map relies heavily on colour to relay the information. The selection of a non ambiguous colour scheme can largely overcome this issue.

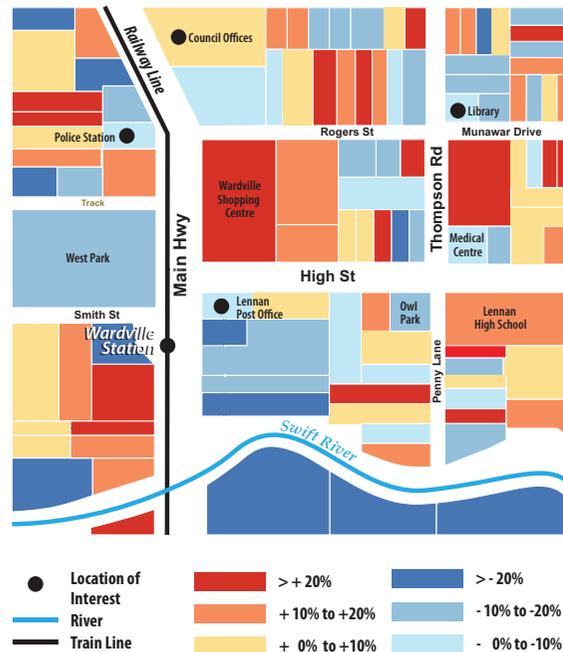
Two diverging colour ramps are demonstrated, however, only the one on the right is designated to be coloursafe, with colours chosen via *ColorBrewer*.

STANDARD VISION
↓
DEUTERANOPE

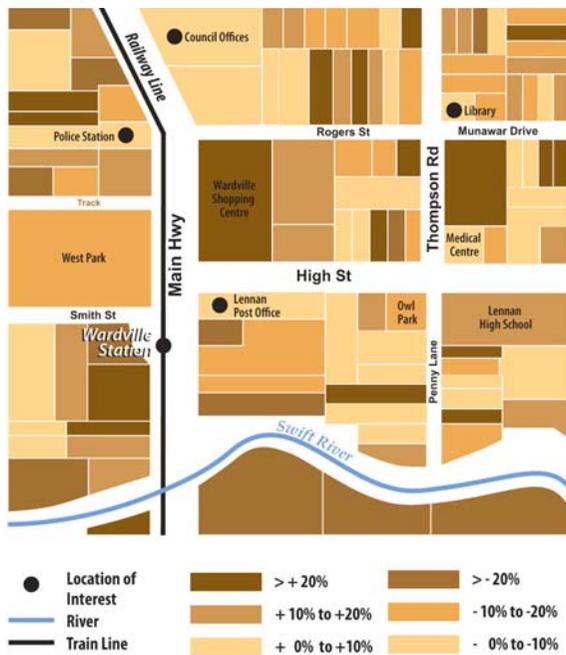
STANDARD COLOURS



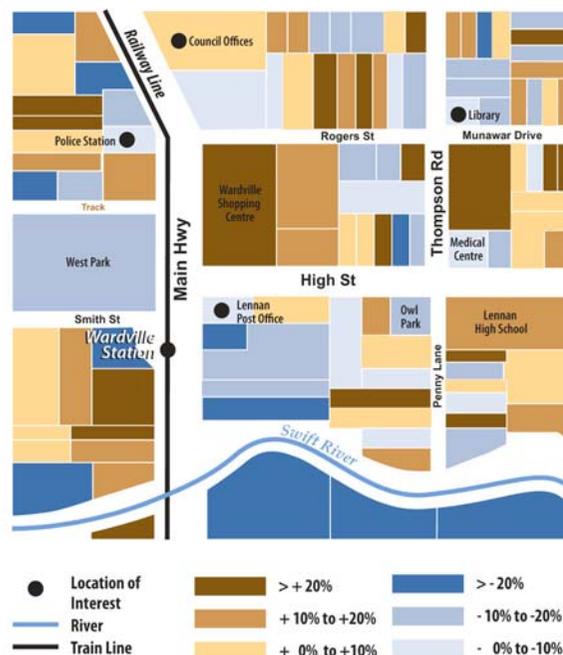
COLOUR BREWER



STANDARD COLOURS



COLOUR BREWER



MAP EXAMPLES

Aerial Photographs

It can be difficult to choose colour schemes for different backgrounds such as aerial photographs or street directories. Options for overcoming this include changing the background to greyscale or using effects such as fading to increase the contrast between the background and the foreground colours.

STANDARD VISION

DEUTERANOPE

ORIGINAL



- Station precinct
- LGA boundary
- Proposed multi-story car park
- Potential development site

CHANGE STYLE/COLOUR



- - - Station precinct
- LGA boundary
- ... Proposed multi-story car park
- Potential development site

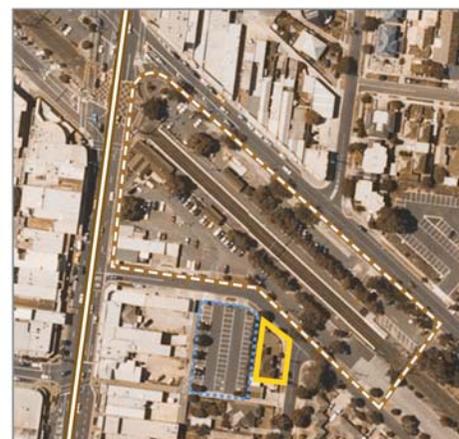
CHANGE BACKGROUND



- Station precinct
- LGA boundary
- Proposed multi-story car park
- Potential development site



- Station precinct
- LGA boundary
- Proposed multi-story car park
- Potential development site



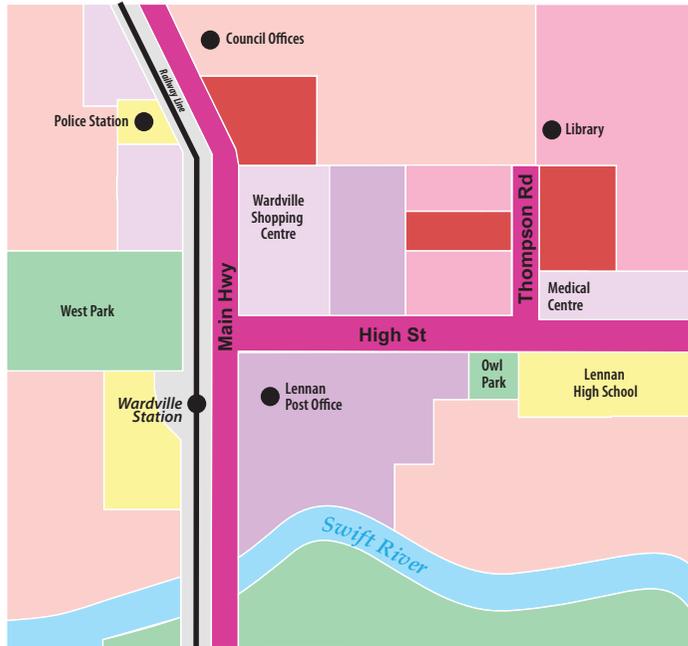
- - - Station precinct
- LGA boundary
- ... Proposed multi-story car park
- Potential development site



- Station precinct
- LGA boundary
- Proposed multi-story car park
- Potential development site

MAP EXAMPLES

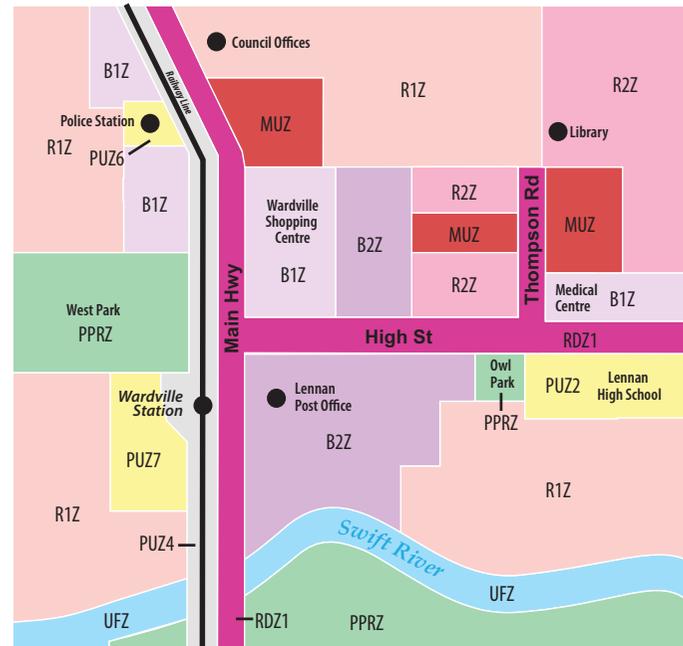
WITHOUT PLANNING ZONE ANNOTATION



Planning Scheme Zones



WITH PLANNING ZONE ANNOTATION



Planning Scheme Zones



Fixed Colour Scheme Planning Map

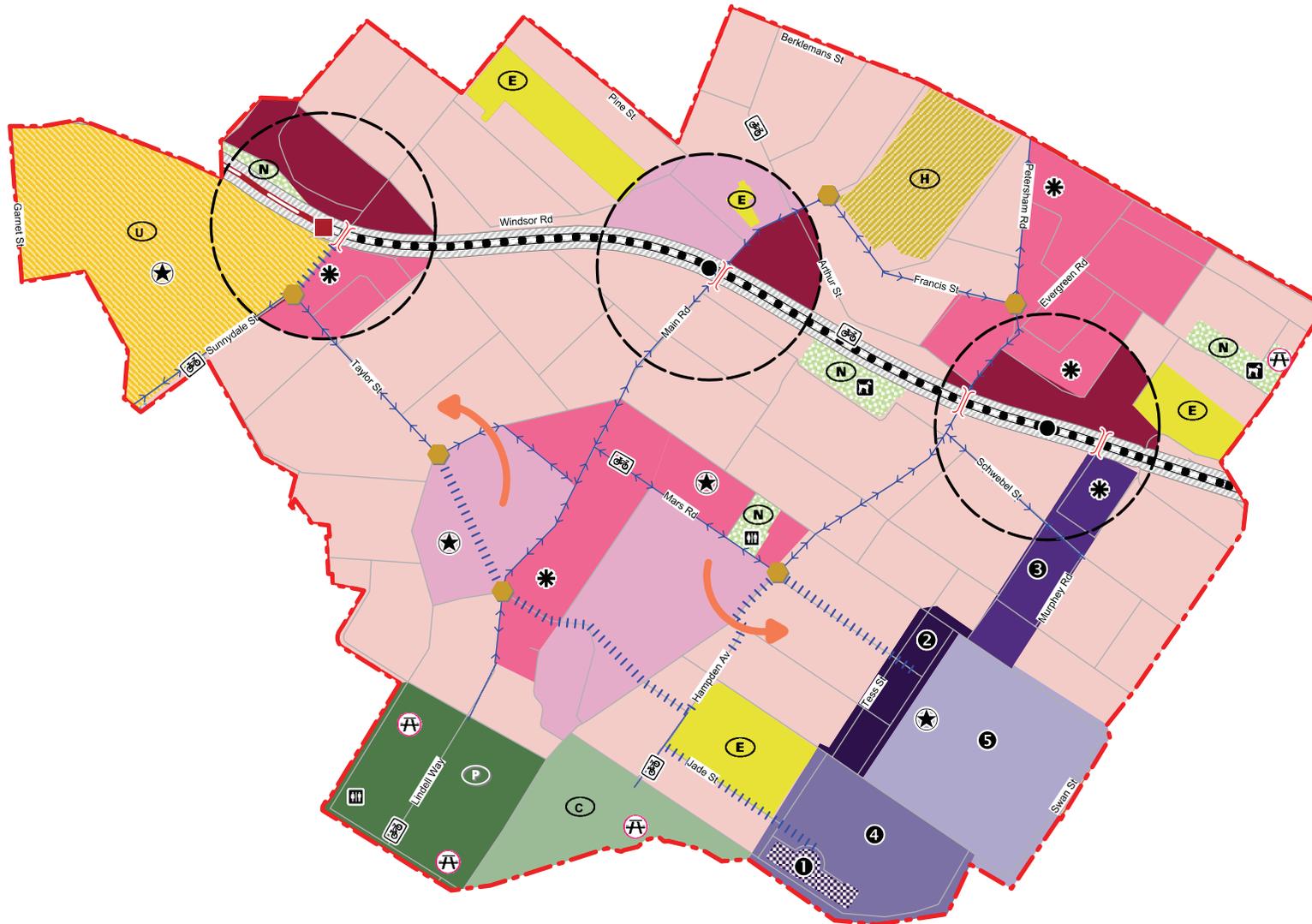
In some circumstances you may be unable to change a colour scheme, such as the *Victorian Planning Scheme*, which uses a large number of pre-defined colours for each zone category. In these instances, additional techniques such as use of transparent paper, annotation or the clever use of technology such as layered pdfs can be used to great effect for overcoming colour accessibility issues.

MAP EXAMPLES

STANDARD VISION

Strategic Map

Complex maps will require a combination of techniques. This map contains different types of annotation and a range of colours and styles.



Legend

Sunnysdale Precinct Boundary

Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Residential/Commercial Areas
- High Density Residential Areas
- Future expansion to Medium/High Density Area (10+ yrs)
- University
- Hospital
- Education Centres
- Public Open Space
- Habitat conservation area
- New Parks
- Rail Corridor Conservation Area

Targeted Funding Precincts

- Heritage Precinct
- Community Precinct
- Shopping Precinct
- Riverway Precinct
- Sports Precinct

Movement Network

- Main Bike Path
- Traffic & Pedestrian Lights Crossings
- Roads
- Existing Pedestrian Links
- New Pedestrian Links
- Rail Line & Station
- 400m Buffer of Train Station
- Proposed New Train Station
- Rail Line Extension
- Bridges

Built Form

- Key Development Sites
- Landmark Buildings

Community Facilities

- Picnic Facilities
- Facilities
- Off-Leash Dog Area

Legend

Sunnysdale Precinct Boundary

Land Use

- Low Density Residential
- Medium Density Residential
- Mixed Residential/Commercial Areas
- High Density Residential Areas
- Future expansion to Medium/High Density Area (10+ yrs)
- University
- Hospital
- Education Centres
- Public Open Space
- Habitat conservation area
- New Parks
- Rail Corridor Conservation Area

Targeted Funding Precincts

- 1 Heritage Precinct
- 2 Community Precinct
- 3 Shopping Precinct
- 4 Riverway Precinct
- 5 Sports Precinct

Movement Network

- Main Bike Path
- Traffic & Pedestrian Lights Crossings
- Roads
- Existing Pedestrian Links
- New Pedestrian Links
- Rail Line & Station
- 400m Buffer of Train Station
- Proposed New Train Station
- Rail Line Extension
- Bridges

Built Form

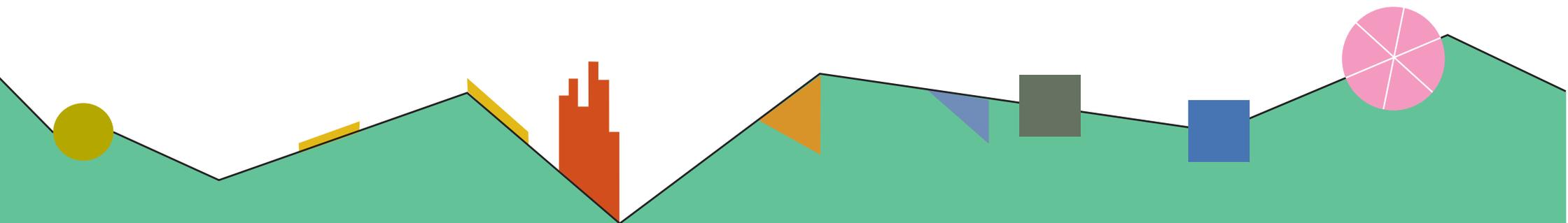
- Key Development Sites
- Landmark Buildings

Community Facilities

- Picnic Facilities
- Facilities
- Off-Leash Dog Area



SECTION 4 : RESOURCES



The following is a list of tools, tips and resources available to assist staff to develop colour accessible visual data.

STEPS TO ENSURE COLOUR ACCESSIBILITY

- > think about the information and the story you want to tell
- > download a colour blindness simulation tool eg. *color oracle*
- > start the design process and test your work using a simulation tool - view your work in deuteranope, protanope and tritanope
- > add annotation or use style or colour to differentiate items
- > consult *colorbrewer* to find alternative colour palettes
- > as your design or map is developed, run occasional colour blindness checks
- > if your map is too detailed or confusing, consider creating a series of maps
- > run a greyscale test and see if the elements are clear
- > test your work in the intended medium (eg. PowerPoint on a data projector)
- > provide the colour accessibility policy/guide to your designer

The Greyscale Test

A quick test for determining if a map can be read by people with colour blindness is to see if the map can be read in greyscale or black and white. Most software programs will allow you to print in greyscale or alternatively you can photocopy a map using the black and white settings on your photocopier. Whilst this is not always accurate it provides an indication when other methods or resources are unavailable such as when you only have a hard copy version of a map.

General Principles

Consideration should be given to your intended product medium as this will have a direct impact upon how the colours are rendered on your final product. For instance, colours on-screen print differently on A4 handouts made by your office printer, glossy colour brochures printed at a professional printer and large-scale projections, such as Microsoft PowerPoint, in a board room. It is strongly advised that you test your output on your intended medium.

TOOLS

The following is a selection of resources that can be used to check whether your visual data or map is colour accessible

NAME	CATEGORY	DESCRIPTION	APPLICATION	LINK
Color Brewer	Point of Design	Provides colour safe combinations for people with red-green colour blindness	Use this tool to find colour safe palettes for qualitative, sequential or diverging colour schemes	www.colorbrewer2.org Online Tools Target User: Cartographers
ColorOracle	Simulation – Real Time	Applies a full screen colour filter, independently of the software in use. Simulates Deuteranopia, Protanopia and Tritanopia	Use in real time to check the accessibility of your work, regardless of the software you are using	http://colororacle.cartography.ch/ Free download for Windows, Mac and Linux Target User: General
Fujitsu Colour Doctor	Simulation – Real Time	Simulates display content according to greyscale and the three dichromatic colour vision deficiency types in real time	Use in real time to check the accessibility of your work, regardless of the software you are using	http://www.fujitsu.com/global/accessibility/assistance/cd/ Free download for Windows Target User: General
VisCheck plugin for photoshop	Simulation	Transforms the colours of an image into the colours that people with Deuteranopia, Protanopia or Tritanopia CVD may see	Use this tool to check if your design is colour accessible, can be used to check PDFs or Images (eg. bmp/jpg)	www.vischeck.com/downloads Free download for Windows and Mac Target User: Graphic Designers / Cartographers
Image J and Vischeck (non photoshop)	Simulation	Transforms the colours in the original image into the colours that people with Deuteranopia, Protanopia or Tritanopia CVD may see	Use this tool to check if your design is colour accessible, can be used to check PDFs or Images (eg. bmp/jpg)	Download Image J from: http://rsb.info.nih.gov/ij/ Download Vischeck to work with Image J from: www.vischeck.com/downloads Free download for Windows and Mac Target User: General
Adobe Illustrator Protonope and Deuteranope view	Simulation – Final Image	Transforms the colours of an image into the colours that people with Deuteranopia, Protanopia CVD may see	When working in Illustrator, this inbuilt tool is useful to quickly check if your design is meeting the colour accessibility criteria	Inbuilt tool in Adobe Illustrator Target User: Graphic Designers
ColorSelector 5.11	Simulation – Real Time	Checks the colour accessibility of combinations of background colours and text in real time against five different criteria: Regular, Cataract, Protanopia, Deuteranopia or Tritanopia	Use in real time to make sure the colour of your annotations is clearly visible against your chosen background	www.fujitsu.com/global/accessibility/assistance/cs/download.html Free download for Windows and Mac Target User: General
Sim Daltonism	Simulation – Real Time	Filters in real-time around the mouse pointer and displays the result in a floating palette	Use in real time to ensure your design work or web pages are accessible/usable to people with colour blindness	http://michelf.com/projects/sim-daltonism/ Free download for Mac Target User: Graphic Designers / Web Developers
Colour Contrast Analyser	Point of Design Simulation – Real Time	Analyses foreground and background colour combinations to determine if they provide good colour visibility	Additionally, allows for real time simulation with option to upload existing image	Primarily developed for web page design. www.visionaustralia.org/info.aspx?page=1571 Free download for Windows Target User: Web Page developers

READING

There are thousands of great websites dedicated to discussing colour blindness. Some of the leading contributors in this area are listed in the reading section.

Bernhard, J. and Kelson, N.V. (2007). *Mapping: Methods & Tips – Color Design for the Color Vision Impaired*. *Cartographic Perspectives* 58: 61–67.

Bernhard, J and Kelso, N. V. (2007). *Designing Maps for the Colour-Vision Impaired*. *SoC Bulletin* 14: 9–12.

Brewer, C.A. [2005]. *Designing Better Maps: A Guide for GIS Users*, ESRI Press

Coon, D and Mitterer, J.O. (2010). *Introduction to Psychology: Gateways to Mind and Behaviour*: 12th Edition. Wadsworth, Cengage Learning, USA.

Evans, K. (2003). *Color Is In The Eye Of The Beholder – A Guide To Color Vision Deficiency and Colorblindness*. USA.

Vision Australia

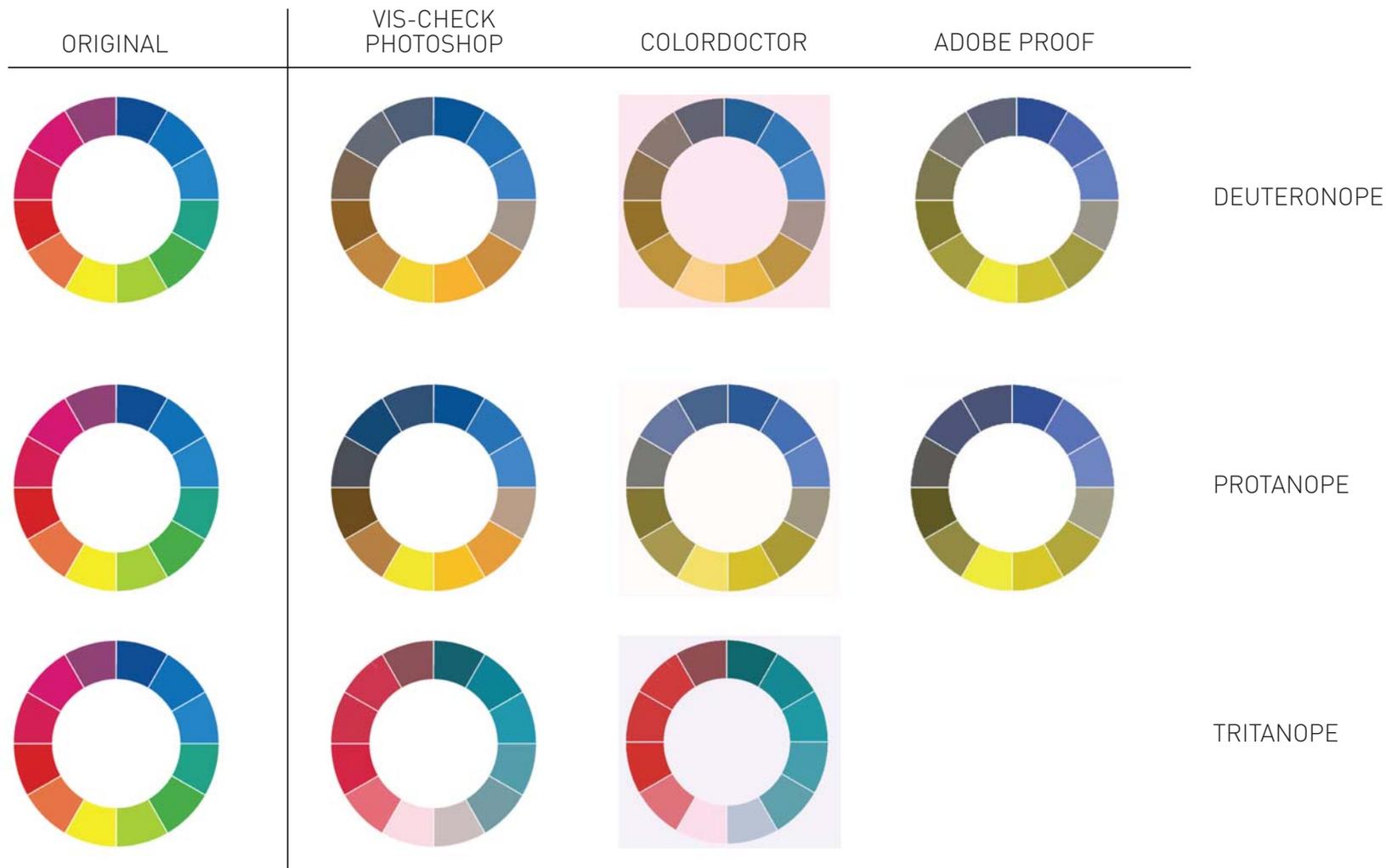
Vision Australia is the primary provider of blindness and low vision services in Australia. Its website contains many resources aimed at understanding and overcoming challenges faced by people who are blind or have low vision. It also has a great resource section geared towards web page accessibility.

<http://www.visionaustralia.org/>



TOOL COMPARISON

Each tool will show a slightly different result from another. Remember, these tools provide an indication only and other methods may be needed to ensure your work is accessible.



Note: Vischeck has been used as the simulator tool for all maps and visual data except for the image on Page 5 of this booklet. That image was produced using the default plugin for deuteranopia in Photoshop CS4.

