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Animations: You can use the animations that run from page 11 to 65 and from page 64 to 10 to explore the relationship between contour lines and relief. Use animations 2 to 10 to see how three-dimensional features are represented on maps by contour lines. You will also see the link between an overhead view and a horizontal view of a feature as you follow the progression from a vertical to a horizontal view of it. See pages 64 and 65 for a description of each animation feature.

About this book

Mapwork skills and techniques are an important part of the Geography curriculum. The final Grade 12 Geography Paper 2 exam consists of: Basic mapwork skills (20%), and Application of mapping skills to content (80%). The same applies to Grades 10 and 11. Learners must also be able to apply their map skills to the theoretical content of Geography. In order for learners to master these important skills, they require many opportunities for practice. Focus on Map Skills Grades 10–12 is a learning resource that focuses specifically on map skills in order to provide essential mapwork practice, thus enabling learners to increase their chances of success in Geography.

Focus on Map Skills consists of appropriately sequenced and paced content, and a variety of activities. It includes advice and tips to make it easier for learners to read and analyse maps.

Focus on Map Skills consists of a learner’s book and teacher’s guide. The learner’s book includes the following features:

- Key concepts and terms are clearly defined in the Key points boxes.
- Tips are given to help learners work through the activities more effectively.
- A selection of the most recent maps and aerial photographs available are included. Learners will be working with up-to-date material.
- There is at least one topographic map extract from each of South Africa’s nine provinces, and a spread of rural and urban map areas is provided.
- A glossary of the geographical terms used in map reading is given on pages 6 and 7. An explanation of units and abbreviations is also included.
- A glossary of exam instruction words is provided on page 63. They are highlighted in bold type in the assignments in Chapter 4.

This book has four chapters, all with activities to initiate and develop map skills:

- The first three chapters introduce learners to aerial photographs, orthophoto maps, satellite images and topographic maps. The illustrated text and activities will enable them to read, analyse and interpret all of these.
- Chapter 4 presents exam-style assignments on the reading and interpretation of topographic maps, aerial photographs, orthophoto maps, satellite images and other kinds of maps. Assignment activities in this chapter are structured in a way similar to NSC exams, so they may be used to sharpen skills and to develop exam familiarity and competence.
- All the assignments in Chapter 4 open with general activities that apply to all three FET grades; they continue with map and photo activities related to the theoretical content specific to Grades 11 and 12 (a requirement in exams). Mark allocations based on the NSC exams can be used as a guide to the amount of detail required for each answer.

This book focuses on Learning Outcome 1: Geographical skills and techniques. However, Learning Outcome 2 is extensively covered, as learners must apply knowledge and understanding in the assignments. Learning Outcome 3 is also covered, as learners must apply their knowledge and skills to various phenomena and environmental issues, and must reflect on values and attitudes to recommend possible solutions and strategies.

Tables of the Learning Outcomes and Assessment Standards for the activities and assignments in Focus on Map Skills Grades 10–12 are provided on pages 108 to 110.

Animation is a technique used to film successive drawings, photographs, maps or models to create the illusion of movement. Animation has been used in this book from pages 11 to 65 (Animations 1–5) and from pages 10 to 64 (Animations 6–10) to assist in illustrating concepts such as relief and the creation of maps from aerial photographs.
GLOSSARY OF TERMS USED IN MAPPING

aerial (pronounced AIR-ree-al) — of or from the air, for example from an aircraft
aerial photograph — photograph taken part of the Earth from an aeroplane:
  • vertical: taken from overhead, i.e. at 90° to the
    vertical (therefore at 90° to the horizon)
  • oblique (pronounced OWK-ee-blak): taken at an angle to the vertical
  • low oblique: taken at a small angle to the vertical: the horizon will not be in the photo
  • high oblique: taken at a large angle to the vertical: the horizon is visible (although this
    may have been trimmed away)
altitude — height above sea level; elevation (measured in metres)
annotate — add explanatory notes to a map, photo or text
asymmetrical — not symmetrical; not the same on both sides
bearing — the compass bearing from one point to another. It is measured as a horizontal angle from the (north-south) meridian of the observer to the line of direction of an object. It is always measured clockwise from north in degrees (between 0° and 360°). Magnetic bearings are measured from the magnetic north
bench mark — a mark, usually at the roadside, used by land surveyors to fix the position and altitude of other points
compass — an instrument used to find direction
curve — curved inwards; the opposite of convex
contour (line) — a line on a map that connects points that are the same height above sea level
contour interval — the vertical spacing between contours (20 m on topographic maps; 5 m on orthophoto maps)
contour spacing — the horizontal spacing between contours
covex — curved upwards or outwards; the opposite of concave
coordinate (pronounced: KOH-OR-din-ate) — the point at which a line of latitude and a line of longitude cross each other
cross-section (or profile) — a drawing of the side view you would see if you cut down through something, for example a mountain
direction — the line along which someone or something is pointing. Direction is described using the compass points north, east, south and west, or combinations of these
elevation — height above sea level; altitude (measured in metres)
gradiant (pronounced GRAY-dee-ant) — the steepness of a slope; it may be measured:
  • as a ratio of the number of metres one would move forward on a slope when going up by 1 m
    (for example 1:15 or 1 in 15)
  • in degrees measured above or below the horizontal
  • as a percentage
Greenwich meridian (pronounced GREN-itch) or prime meridian — the 0° meridian; the line of longitude (meridian) that passes through an observatory at Greenwich, London, from which all other meridians are numbered
grid — a framework of lines — as drawn on maps and cross-sections
horizontal — parallel to the horizon; level
index contour — a contour drawn with a thicker line and bold header label; every 100 m contour on 1:50 000 topographic maps is an index contour
intervisibility — the ability of one point to be seen from another point
intervisible — one point can be seen from the other
landscape — the general appearance of an area; the physical landscape is the result of relationships between landforms, vegetation, soils, rivers and lakes; the cultural (or human) landscape includes all features constructed by humans, for example farms, plantations, settlements, communications and mines
latitude — the distance south and north of the equator measured in degrees as if measured from the centre of the Earth
line of latitude — a line drawn on a map joining all points that are the same distance south or the same distance north of the equator
line of longitude — a line on a map joining all points that are the same distance east or west of the Greenwich meridian (0°) measured in degrees as if measured from the centre of the Earth
magnetic bearing — the compass bearing from one point to another, measured from the direction of the magnetic north pole to the line of direction of the distant point. It is always measured clockwise from magnetic north in degrees (between 0° and 360°)
magnetic declination — the angle between true north and magnetic north
magnetic north pole — the point on the Earth to which magnetic compasses point; it is different from the true north pole
meridian — a line of longitude
oblique (pronounced OWK-ee-blak) — slanting
ortorate — line up a map or a person to face north
orthophoto map — accurate large-scale (1:10 000) vertical aerial photograph with contours, power lines and some place names and route numbers added
parallels — lines of latitude (north and south of the equator)

relief — the shape of the Earth’s surface, for example mountains, hills, valleys and plains
river profile — a longitudinal cross-section of a riverbed from its source to its mouth
route distance — the distance between two points along a road, path, railway, river, shoreline or other twisting or bending route; also known as the curved-line distance
saddle — a flatish ridge between two higher hills or mountain peaks; sometimes called a pass or a notch
satellite — a spacecraft that travels in an orbit around the Earth
satellite image — a photograph that is taken by remote sensors on an Earth-orbiting satellite and transmitted to ground stations. They are especially useful in land use analysis, weather forecasting and map making
scale — the proportion between distances on a map and the corresponding distances on the ground
spot height — a small dot on a map showing the position of a ground point of known altitude
spur — a ridge of land, usually narrower and lower at one end
symbol — an icon on a map used to represent an object on the ground
terrain — a tract of land with distinctive characteristics of landforms, soil and vegetation
topo map — short for topographic(a) map
topographic(a) map — a map showing the surface features of an area. These include relief features (such as mountains, hills, valleys and spurs) and terrain features (such as rivers, lakes and vegetation), as well as constructed features (such as roads, railways, built-up areas and power lines)
topography — the physical features of a place
trigonometrical station (previously called a trig (trigonometrical) beacon) — a white concrete pillar topped by black metal vanes set up on a hilltop, mountain or even on a building. Their exact position and altitude are known. Surveyors use them to find the position and altitude of other points
true north pole — the point at the northern extremity of the Earth; it is equidistant from all points along the equator
valley — a long, narrow stretch of land lying between two areas of higher land, often containing a stream
vertical — at right angles to the horizon
vertical exaggeration — the upward stretching of a cross-section. Vertical exaggeration (VE) is the ratio of the vertical scale to the horizontal scale used on the cross-section. The vertical scale is deliberately exaggerated to emphasise relief details
vertical interval — see contour interval
woodlot — a piece of land used entirely for growing timber

Notation used
mm — millimetre(s)
 cm — centimetre(s)
 m — metre(s)
 km — kilometre(s) (not Km)
 / per (as in km/h)
: — represents
km/h — kilometres per hour
ha — hectare(s) (10 000 m²)

A space should be used between a number and a unit, e.g. 2.1 cm, 10 km
Note: Do not add 's' for a plural to these units;
'm' means 'metre' or 'meters', e.g. 5 m = 5 metres

Conversions
10 mm = 1 cm
100 cm = 1 m
1 000 m = 1 km
10 000 m² = 1 hectare
100 ha = 1 km²

Pronunciation
metre — MEE-ter
millimetre — MILL-ee-MEE-ter
kilometre — KIL-lee-MEE-ter
hectare — HEK-tehr

Quick conversions from 1:50 000 maps
On the map: On the ground
1 cm: 500 m (or 0.5 km)
2 cm: 1 000 m (or 1 km)
4 mm² (e.g. 2 mm × 2 mm): 1 ha
4 cm² (e.g. 4 cm × 4 cm): 1 km²
Chapter 1: Aerial photographs

1.1 Different kinds of aerial photographs

In this chapter, you will become skilled at reading and using aerial photographs, orthophoto maps and satellite images, and you will discover how aerial photographs are produced, annotated and indexed.

Figure 1.1 This is an oblique aerial photograph of part of the town of Hanover, Northern Cape. The photograph was taken through a window on the side of an airplane.

**ACTIVITY 1**

1. Three of the features in Figure 1.1 are marked A, B and C respectively.
   a. Identify each feature.
   b. In which grid squares are these features shown in Figure 1.2?
2. The following are two important features in Hanover:
   - a large place of worship (a church) at D
   - a cemetery at E
   a. In which grid squares do they occur in Figure 1.1?
   b. In which grid squares are they in Figure 1.2?
3. An area in Figure 1.1 is marked X. From clues in the photographs (Figures 1.1 and 1.2), say for what purpose you think this area is used.
4. In which grid squares of Figure 1.1 do you think that the main shopping area of Hanover is found?
   (Clue: Find a street with most of the biggest buildings facing onto it.)
Photographs are useful geographical tools because:

- they are easier to read than maps
- they show details that may not be shown on maps
- they are a record of landscape details at a particular point in time
- they enable geographers to observe surface changes over time.

Vertical aerial photographs are used to make maps. They are also useful for planning. Maps and aerial photographs, when used together, become powerful tools for understanding landscapes and for planning future developments.

Photographs from different angles
Geographers often use photographs when studying processes on the Earth’s surface. The four types used most often are as follows:

- **Ground-level photos** are taken horizontally to show features as they are normally seen on the ground. There is an example on page 12.

- **Oblique aerial photos** are taken from an aeroplane with a camera aimed at an angle oblique to the ground. An example is provided on page 9.

- **Vertical aerial photographs** are taken from an aeroplane with a camera pointing straight down onto the feature being photographed. An example is provided on page 10.

- **Satellite images** are views of large areas of the Earth. They are obtained from satellites orbiting hundreds of kilometres above the ground. Some satellite images look like vertical aerial photographs. An example is provided on page 21.

ACTIVITY 2

Compare the vertical aerial photograph (Figure 1.2) with the map (Figure 1.3).

1. Find three pieces of information that are shown on the vertical aerial photograph but not on the map.
2. Find three pieces of information on the map that are not given on the aerial photograph.

**Figure 1.2** The same town, Hanover, shown on a vertical aerial photograph. The vertical photograph was taken with a camera facing straight down to the ground.

**Figure 1.3** A vertical aerial photograph like the one in Figure 1.2 was used to make this map of Hanover.

You can see how a vertical aerial photograph is used to make up a map by referring Animation 1 from page 11 to page 15.

**Figure 1.4** A ground-level, or horizontal, photograph (90° from vertical)

**Figure 1.5** Oblique aerial photographs

**Figure 1.6** A vertical aerial photograph

**Figure 1.7** Satellite images are obtained from satellites orbiting high above the Earth.
1.2 How to interpret ground-level and oblique aerial photographs

1. Make an initial statement
   a. Is this an oblique aerial photograph or a ground-level photograph?
   b. Describe the extent of the area: you can estimate this from the size of features you are familiar with (for example the railway, power-line pylons, farm houses, trees and vineyards in the above photograph).

2. Identify the major pattern or patterns
   a. Is this mostly an urban or a rural environment?
   b. What features or patterns of landforms, rivers or vegetation are shown?
   c. What settlement patterns are shown?
   d. How have people used the natural resources of the area?

3. Identify and group the features
   - Note the main features in the photograph:
     - natural environment: landforms, drainage, climate, natural vegetation
     - built environment: land use, settlement, transport, communications.

4. Make a sketch of the area
   a. Start by drawing a large frame with the same proportions as the photograph.
   b. Imagine that the photograph is divided into three areas:

<table>
<thead>
<tr>
<th>Left</th>
<th>Middle ground</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td>Middle ground</td>
<td>Foreground</td>
</tr>
</tbody>
</table>

   c. Find the features in the background of the photograph. In your frame, sketch a pencil outline of these. Label them. Repeat this process for the features in the middle ground and the foreground. Use the checklist in 3. above, to be sure you have identified all the important features.
   (Note: The Hex River is visible in the left middle ground.)

5. Explain relationships between features
   - The patterns in the photograph are the result of the interaction of natural and human factors.
   a. How have landforms influenced the vegetation pattern?
   b. What clues are given about the kind of climate here?
   c. How have people changed the natural environment?
   d. How have landforms influenced human activities and transport routes?

1.3 How to interpret vertical aerial photographs

The whole of South Africa has been photographed vertically from the air several times.

Vertical aerial photographs are valuable tools for:
- geographers in understanding human and physical landscapes
- geologists researching rock structures and mineral resources
- engineers and planners designing new suburbs, bridges and airports
- businesses and other professions planning marketing campaigns.

Learn how to interpret vertical aerial photographs by studying the aerial photo of Hanover on page 15.

1. Gather introductory information
   a. From the top and bottom margins, find the date and the time of the photograph (as shown on page 15). Knowing the date tells you the season (this is useful for understanding vegetation, crops and drainage) and how old the information is. Knowing the time of the photo helps you to determine the north edge of the photo. Photos taken in the morning will
have shadows falling to the west, but on afternoon photos the shadows will fall to the east. Most of South Africa is south of the Tropic of Capricorn, and aerial photos are usually taken between 10:30 and 14:30, so shadows usually fall to the south.

b. Determine the approximate scale of the original photograph.

2. Identify the important patterns
   a. Is the area mostly a natural environment or mostly a built environment?
   b. What information can you see concerning the topography? Look for clues from landforms, stream drainage and vegetation.
   c. What settlement patterns are shown? (There are two contrasting ones in the Hanover photo in Figure 1.11.)
   d. How have people used natural resources in the area?

3. Identify and group the features
   a. Orientate the photograph with north at the top (as described in 1.a., or by using a map).
   b. Draw a frame to the same proportions as the photograph – and bigger if possible. Using faint lines, divide the frame into squares 1 or 2 cm wide.
   c. In each square of the frame, draw a series of simple sketch maps of features you have noted in the corresponding section of the photograph. (All aerial photographs will have different features. Use the checklist on page 16 to guide you in interpreting the landscapes they show.)

3.1 The physical landscape
Mark the following on your sketch map:
   a. hills and higher ground
   b. any streams, rivers or reservoirs
   c. areas of distinct vegetation.

3.2 The cultural (built) landscape
   i. Transport
      Mark the following on your sketch map:
      a. major roads (for example national roads)
      b. minor roads (excluding roads in the town)
      c. aerodrome runways.
   ii. Settlements
      Mark the following on your sketch map:
      a. the town and its newer suburbs (‘townships’)
      b. recreation areas (find a golf course, playing fields and a track).
   iii. Relationships
      a. There is a natural spring (called the Eye) in Hanover, a town in the semi-arid Karoo. It supplies over 200 000 litres of water a day. What evidence is there in the aerial photograph (Figure 1.11) of this resource?
      b. There are four hills on the western side of Hanover. The second-most northerly of these (Trappieskop) was the site of South Africa’s first astronomical observatory (since removed to Sutherland). In what ways were this location and this site suitable for an observatory?
      c. Hanover is said to be the most central town in South Africa. It is about midway between Johannesburg and Cape Town and between Port Elizabeth and Upington. How does this help to explain that there are 50 hotel and bed-and-breakfast establishments in this small town?
      d. In what ways has the dry karoo climate influenced people’s activities?
      e. What changes have people made to the natural environment?

How to recognise objects in aerial photographs
   Shape: Features such as airports, sports fields and road interchanges have characteristic shapes.

---

**Figure 1.11** Vertical aerial photograph of Hanover, Northern Cape

Size: A highway looks, and is, wider than a rural road.

Tone: Objects of different colour will show up lighter or darker; uniforms cropland is darker than mature cropland.

Pattern: The linear arrangement of trees, crops and vines indicates land under orchards, plantations or vineyards.

Shadow: Long shadows indicate tall buildings and trees. Shadow shape differentiates windpumps, water towers and other similar objects.

Texture: The coarseness or smoothness of an area is different for sports fields, forests, cropland and karoo scrub.

Location: Clues from nearby objects help identify features. Trees along rivers may be willows; a rectangle near a wind pump could be a water trough.

**Figure 1.12** Sketch map based on the vertical aerial photograph of Hanover
Checklist for identifying features in aerial photographs

Use this checklist to help you interpret the photos on pages 90 to 102.

A. Natural landscapes
1. Topographic features and landforms
   a. Does the area appear:
      • flat: could it be a plateau, a plain or a wide valley?
      • hilly: is there evidence of river erosion?
      • mountainous: is there evidence of folds or faults?
   b. Is this a coastal area?
      • Are there erosional features, such as cliffs, platforms or stacks?
      • Are there depositional features, such as beaches, dunes or sand spits?
      • Is there evidence of resort development or of tourism?
   c. Is this area influenced by fluvial action?
      • Identify the stream pattern/s and stream divides.
      • Find landforms such as valleys, meanders, flood plains, terraces and waterfalls.
2. Vegetation features
   a. Is the vegetation made up of trees, shrubs, grasses or other flora?
   b. How is the vegetation distributed? (For example trees on hillsides only.)
   c. Has human activity (for example farming, urban settlement) affected the vegetation?

B. Landscapes altered by human action
1. Rural areas
   a. What type of settlement pattern is there? (isolated farms, villages, town(s). Where are these located?
   b. How has the land been subdivided?
   c. What information can be obtained from specific buildings (for example cattle kraals, chicken houses, clusters of African villages)?
   d. Any terracing, erosion walls, irrigation furrows or contour ploughing?
   e. What kinds of cultivation are visible (for example orchards, field crops, vineyards, meadows)?
   f. Is there any evidence of livestock farming?
   g. Are there any woodlands or plantations of trees?
2. Urban areas
   a. Are there residential areas?
      • Look for high- and low-density housing and where these are situated.
      • Is there evidence of apartment blocks or flats?
   b. Are there any schools (these often have playing fields), hospitals, places of worship, caravan parks, military establishments?
   c. Can you find a neighbourhood shopping area?
   d. Are there industrial areas, mines, power stations?
3. Business districts
   a. Can you find the central business district or minor business districts?
   b. Is there a shopping mall (with a large parking area)?
4. Recreational areas
   a. Can you find any recreational areas? Can you identify their use (for example football, tennis, golf, athletics, parks)?
   b. Do some homes have swimming pools and/or tennis courts?
5. Engineering structures
   a. Can you see any dams and reservoirs, furrows, bridges, cuttings, water tanks, land reclamation, harbour works?
6. Transport and communication
   a. Can you discern major roads and minor roads?
   b. Is there a railway line to this town?
   c. Can you find an airfield, aerodrome or airport?
   d. What evidence is there of the importance/unimportance of any of these?

How vertical aerial photographs are taken

Aerial photographs are taken with large specialised cameras mounted inside the bodies of aeroplanes. Loaded with long rolls of photographic film, these cameras take photographs at regular intervals. The film takes photographs that are 23 cm x 23 cm.

How to choose an aerial photograph

You may want an aerial photograph of a specific area – for example your school, your farm, a holiday resort, a suburb that is about to be developed, an industrial area or a landfill on which you are doing a portfolio project. How do you set about getting the right photograph?

1. Determine the area
   Find its latitude and longitude. (You will also need this for finding the matching topographic map.)

2. Look at the flight plan of the area
   You can get flight plans (cost R7,00) from Surveys and Mapping, Private Bag X31, Mowbray, 7005, or from their website: http://www.saimp.gov.za.

3. Identify the photograph
   A flight plan is made of every aerial photographic survey (called a 'job'). It shows the aircraft's course and the sequence of photos taken as it travelled along each flight path, flying west to east, then east to west over the survey area. Along each strip, individual photographs are numbered. Find the number of the photograph that you need.

Figure 1.13 Each aerial photograph overlaps the preceding one by 80 percent. Aerial photographs are taken in west-east strips that overlap adjacent strips by 20 to 30 percent.

Figure 1.14 An extract of the flight plan of job 1101. Dots mark the centre of each photograph. Follow along strip D to find the centre of photograph 0388, which shows Hanover.
How to order aerial photographs
You can place your order on the website listed on the previous page. If you order by mail, be sure to specify the numbers of the job, strip and photograph. In 2006, a contact print (23 cm × 23 cm) cost only R6.00; an enlargement up to twice contact scale (up to 46 cm × 46 cm) cost R25.00; up to three times enlargements cost R33.00. Postage is extra.

Here is a scaled-down version of the contact print of the aerial photograph 0389 of Hanover – which is in the Middelburg district.

<table>
<thead>
<tr>
<th>scale of contact print (1:50 000)</th>
<th>job number (1101)</th>
<th>job area (Middelburg)</th>
<th>strip number (002)</th>
<th>date of photo (27/11/2005)</th>
<th>photo number (0389)</th>
</tr>
</thead>
</table>

Figure 1.5 A scaled-down version of the aerial photograph 0389

ACTIVITY 3
On the black frame around the photograph in Figure 1.15, find:
1. the date on which the photograph was taken
2. the time at which the photograph was taken
3. the aerial photograph job number
4. the approximate scale of the original photograph
5. the photograph strip number in that job
6. the number of the photograph
7. the altitude at which the aeroplane was flying.

1.4 Orthophoto maps
An orthophoto map is a special kind of vertical aerial photograph. Look at this extract from the orthophoto map of Hanover.

Figure 1.16 This orthophoto map shows part of the town of Hanover.
An orthophoto map is really a vertical aerial photograph that has had contour lines and some other information added to it. All orthophoto maps are at a scale of 1:10 000. This means that 1 cm on the orthophoto map represents 100 m on the ground. It follows that 1 km on the ground is represented by 10 cm on the orthophoto map.

Eight ways an orthophoto map is more useful than an aerial photo:
1. It has been adjusted so that the scale is correct throughout (unlike vertical aerial photographs).
2. The large scale of 1:10 000 means that features are large and easily identified.
3. Contour lines and spot heights enable readers to read off relief information.
4. Some landmarks and suburbs are named.
5. Railways and power lines are highlighted; important roads are identified by name or number.
6. Adjacent orthophoto maps can be joined together easily and exactly to show larger areas.
7. Coordinate grid marks enable exact site location.
8. It is cheaper than an aerial photo at the same scale.

One disadvantage is that many of the available orthophoto maps are old. It is expensive to keep all of the 47 000 orthophoto maps updated. (The extract of the Hanover orthophoto on page 19 was made in 1982. It is the latest available.) You will be able to find many differences between the orthophoto map (1982) and the aerial photograph (2005) on page 15.

How to read orthophoto maps
Use the same methods as those described on pages 13 to 16 for reading aerial photographs.
It is easier to identify natural features and artificial constructions on orthophoto maps than on aerial photographs.

Remember that:
• you are viewing the area from above
• 1 cm:100 m
• contour lines show height above sea level in metres
• the contour interval is 5 m
• shadows provide clues about the heights of buildings and the time of day.

ACTIVITY 4
Use Figure 1.16 to answer the following questions:
1. How long is Burg Street (Burgstraat) in metres?
2. In which grid squares are the following shown?
   a. a school (with the letter S)
   b. a post office (with the letter P)
   c. a police station (with the letters PS)
3. How many places of worship (with the letter W) are shown?
4. What suggests that Darling Street is an important shopping street?
5. a. Compare the sizes of the houses in squares H4 and H9.
   b. What does this suggest about the incomes of people living in each area?
6. a. What kind of feature is Trappieskop?
   b. What is its height above sea level? (Use Figures 1.16 and 1.17.)
7. From place names and street names, suggest the origin of the people who founded (started) the town of Hanover.

1.5 Satellite images
The modern way of collecting images and information about the Earth’s surface is by using remote sensors in satellites. The digital data they transmit to ground stations is easily processed to produce accurate images that can be used to produce maps. Satellite images are replacing aerial photographs.

Figure 1.17 A satellite image of greater Johannesburg. On a computer, this image can easily be enlarged to show fine details. Find Ellis Park Stadium on this image.
Scale 1:250 000 (1 cm:2.5 km)

Figure 1.18 An enlarged detail of a satellite image of Johannesburg showing Ellis Park Stadium and some of the surrounding buildings.
Scale 1:50 000 (1 cm:966.7 m)

Some satellite images are in ‘true colour’, showing various land uses in their real colours. Others are ‘false colour’ images, where different colours have been used to highlight specific kinds of land use. See page 67 for an example of a true-colour and a false-colour image. When reading satellite images, consult the colour code being used by referring to the key (if one is provided).
Chapter 2: Map reading and analysis

2.1 How to find the map you need

The maps most widely used for hiking, adventure trips and local planning are the 1:50 000 topographic maps. The skills of reading and interpreting 1:50 000 topographic map sheets are also an important part of the NSC course and examination. For these reasons, this book is designed to help you to use this kind of map easily and well.

The main supplier of South Africa’s maps and orthophoto maps is the Directorate of Surveys and Mapping. When you need a map for recreation or study, you need to know how to specify which sheet you want to order.

Imagine if there were just one topographic map of the whole of South Africa at a scale of 1:50 000 (i.e. 2 cm representing 1 km). It would be a huge map 33 m wide and 30 m long! Instead, it is divided into 1 913 sheets, each showing only about 660 km². Figure 2.4 shows how South Africa’s 1:50 000 topographic map sheets are arranged and numbered.

South Africa’s map is divided up into squares that are one degree by one degree (1° x 1°). Each degree square is defined by a four-digit number giving the latitude and longitude of its top left (NW) corner. Each degree square is divided into sixteen quarter-degree squares. Look at Figure 2.4 on page 24.

Polokwane’s map sheet is numbered 2329CD.

<table>
<thead>
<tr>
<th>3°S</th>
<th>29°E</th>
</tr>
</thead>
<tbody>
<tr>
<td>23°S</td>
<td>30°E</td>
</tr>
<tr>
<td>24°S</td>
<td>31°E</td>
</tr>
</tbody>
</table>

**Figure 2.1** 23°S is the degree square Polokwane is in.

**Figure 2.2** The C indicates which 1° square Polokwane is in.

**Figure 2.3** The D’ tells which 1° square Polokwane is in.

### Activity 1

1. Which map sheet covers these towns?

2. Which two map sheets would you need for these towns?

3. Which four map sheets cover these towns?

### Activity 2

1. Although Figure 1.17 is not in colour, use it to apply the steps outlined above.
2. Use the steps above to interpret the Hermanus photo on page 67.

**Interpreting satellite images**

Modern satellites can now show fine detail. Some satellites are set to show large areas and to collect information that would not be shown in aerial photographs. Satellites do this by sensing specific wavelengths reflected from the Earth. For example, satellite images may show sea-surface temperatures, recent use of irrigation water, the distribution of citrus trees, the presence of plant diseases and the extent of built-up areas.

You apply different skills when reading satellite images of different kinds and at different scales. Reading large-scale images, like that in Figure 1.18, will be much like reading a vertical aerial photograph.

To read and interpret a satellite image, follow these steps.

1. **Determine the basics**
   a. Determine the size of the area. Find the scale of the image. If the scale is not given, compare the image with an atlas map to find the distance between two identifiable features and calculate the scale (see page 55).
   b. Determine the main land uses. Is this a natural environment or a built-up environment? What are the distribution patterns of relief and landforms, of drainage and of vegetation? Can you see a pattern in the distribution of settlements, or a pattern of land use within a settlement?
   c. Identify the natural resources. What clues are there about how people are using resources?

2. **Read the image**
   If necessary, make a sketch map of the image area. Use the method outlined under heading 3 on page 14. On your map, locate and sketch in these features where they occur:
   a. rivers, coastlines, lakes or dam reservoirs (these are often shown in dark blue on false-colour images)  
   b. natural vegetation (shown in natural colours on true-colour images, and often as shades of red-brown on false-colour images)
   c. settlements or areas of urban land use (these will be reddish or light grey on true-colour images, but may be light blue on false-colour images)
   d. farmland (shown in natural colours that will vary according to the crop and the season on true-colour images, but usually as pink or red on false-colour images)
   e. communications: look especially for main roads, railways, airports and harbours.

3. **Interpret the image**
   Here you apply your geographical knowledge. Use what you have learnt about landforms, climate, settlement, resource use and economic geography to explain:
   a. how the natural landscape has formed and been changed
   b. how these changes have affected other features. For example,
   - how has settlement influenced drainage (dry river courses, new dams, drained wetlands, silting of lakes and river courses)?
   - how has human occupancy changed vegetation (clearing of natural vegetation, new cropland, patterns of irrigation)?

In interpreting the landscape, you are looking for the causes and effects of some of the features. Remember that politics may play a role here.

### Activity 5

1. Although Figure 1.17 is not in colour, use it to apply the steps outlined above.
2. Use the steps above to interpret the Hermanus photo on page 67.
2.2 How to read topographic maps

1. Map symbols

Key points
A map symbol is a mark or sign on a map representing a feature or object on the ground.

When you read a story, you have to know the language that was used to write it. Map symbols are the language used to 'write' maps.

The map symbols that are used on the 1:50 000 topographic maps are shown on page 65.

Often, map symbols do not look exactly like the ground objects they represent. There are three kinds of map symbols.

- **Point symbols** show features that are found at a particular place, for example a school, a windpump or a trigonometrical station.

- **Line symbols** show long, narrow features, for example a road, a railway, a river or a power line.

- **Area symbols** show larger features, such as a city or a lake.

- **Symbolic shadings** represent different types of land use or natural features.

When you read a map, you need to know the symbols that are used to represent features on the ground.

Figure 2.4 Part of the map index of the map sheets of the 1:50 000 topographic map of South Africa. The map sheets marked with grey shading show most of the map extracts used on pages 70 to 88 of this book.
• Area symbols show features that are long and wide, for example cultivated farmland or a built-up area in a town.

ACTIVITY 2

Make illustrated lists of:
1. sixteen point symbols
2. eighteen line symbols
3. eighteen area symbols.
Either use the same colours as are used on maps or write the colour in brackets next to each symbol.

2. Position

Key points
1. Position is the exact location of a point on a map or on the ground.
2. You state the position of a point by giving the latitude and the longitude of that point. This is its coordinate position.

Latitude and longitude are shown on the borders of all 1:50 000 topographic maps. They are given in degrees and minutes. To determine position accurately, one can subdivide each minute either into seconds or into decimal parts of a minute.

How to find a coordinate position on a map
Find the coordinate position of the small dot marking spot height 1241 on map sheet 2429AD Zebediela on page 76. Follow these steps:

1. On the map, find the spot height 1241 (m) (see Figure 2.5).
2. Draw fine pencil lines from the symbol straight to the grid markings on the border. These lines must be at right angles to the border. Use a ruler and a set square (or the edges of a sheet of paper) to do this.
3. Where the pencil lines cross a minute bar, lightly divide that bar in half; then divide each half into three equal spaces. This will let you read the position in seconds. (If you need to give position in decimal parts of a minute, you should divide the minute bar in half; then divide each half into five equal spaces.)
4. Now estimate the latitude and longitude of spot height 1241.

Finding coordinates very quickly and accurately
You can find coordinates very quickly and accurately with a small home-made minute divider.
Follow these steps to make your own minute divider:
1. Cut a small rectangle of paper to the exact size of one minute (width and height) on the 1:50 000 map sheet you are using.
2. Figure 2.6a has the edges divided by ten-second and five-second intervals. Figure 2.6b shows how to mark divisions to find decimal parts of a minute.
3. Place your minute divider on the map with the bottom right corner exactly at the point whose position you want to find.
4. On your minute divider, read the seconds (or decimal parts of a minute) where the nearest meridian and parallel intersect it. (You will need to draw the meridians and parallels lightly in pencil on the map to do this.)

Locating an area
When you need to give the location of an area (for example a small farm, a CBD, an industrial area) you can name its grid square. This is the whole minute square it is in. Identify the grid square by giving the coordinate of its top left corner. For example, on page 76 the settlement Zobediela Estates is in grid square 24°19'S; 29°17'E.

ACTIVITY 3
1. In which grid squares are the following on the Zobediela map (page 76)?
   a. Hlakano; b. Motsereneng hospital; c. Sunningdale orchards
2. What recreation activity is shown in grid squares 24°17'S; 29°17'E and 24°17'S; 29°19'E?
3. What features are at these coordinates?
   a. 24°17'50"S; 29°18'08"E (24°17,83'S; 29°18,13'E)
   b. 24°19,73'S; 29°17,80'E
   c. 24°21,78'S; 29°19,73'E
   d. 24°17'50"S; 29°17,80'E
   e. 24°20'08"S; 29°17,12'E
4. Give the coordinate position of the following features:
   a. trigonometrical station No. 98 in grid square 24°17'S; 29°17'E (A3)
   b. the road bridge over the Doring River in square 24°18'S; 29°21'E (B7).

3. Direction

   We use the points of the compass to describe the general direction from one point to another. Often, the four cardinal directions (north, south, east and west) are adequate for describing direction. For finer descriptions we also use sub-cardinal directions (for example northeast, southwest and east-southeast).

   ![Diagram of the compass points]

   Figure 2.7 Direction is named using the points of the compass.

4. Bearing

   **Key points**

   1. Bearing is the direction from one place to another as measured in degrees.
   2. Bearing is given in degrees of arc measured clockwise from north.
   3. There are 360° of arc.

   True bearings from one point on the Earth to another point are measured in degrees from the true north–south line.

   ![Diagram of true bearings]

   Figure 2.8 True bearings are measured in degrees clockwise from true north.

   On a map, you use a protractor to find bearings.

   ![Diagram of using a protractor to find bearings]

   Figure 2.9 How to find a true bearing on a map

   **Tips**

   1. True north is on a bearing of 0°. True south is on a bearing of 180°.
   2. True bearing is the angle between the true north-south line and the line joining the point from which the bearing is being taken to a distant point.
   3. Bearings are measured clockwise in degrees from true north (0°).
**ACTIVITY 4**

1. Use a protractor to find the true bearings from the beacon (r) to points X, Y, and Z in Figure 2.10. Always measure from the centre of the triangle. (Hint: Draw faint pencil lines from the centre of the beacon through each of the points.)

2. Turn to the map of Zebediela on page 76. You need to find the true bearing from Zebediela railway station to trig station 82 (AS). This is how to do it:

   Step 1. Measure the distance from the centre of the station to the left edge of the map. Be exact: do this very carefully. In pencil, mark at least three points on the map that are the same distance as the station from the left edge of the map.

   Step 2. Draw a faint pencil line through the pencil marks and through the railway station. Because the edge of the map is a true north–south line, the line you have drawn parallel to it will be the true north–south line passing through the station.

   Step 3. Draw a pencil line from the railway station through the centre of the triangle marking trig station 82.

   Step 4. With a protractor, measure the angle between the true north–south line and the line joining the railway station and trig station 82. Take care to have the centre point of the protractor in the middle of the railway station symbol. Check that the 0° line and the 180° line of the protractor are both on the north–south line you drew.

   Did you find the true bearing from the station to trig station 82 to be 48°?

3. What is the general direction:
   a. from Zebediela railway station to Majaneng
   b. from the railway station to the golf course
   c. from trig station 88 to trig station 82
   d. followed by the railway from the station to the lower edge of the map?

4. Find the bearing from Zebediela railway station to:
   a. the school in Moletlane
   b. the buildings on Sunningdale farm
   c. trigonometrical station 88
   d. the road bridge over the river in grid square 24°18'S; 29°21'E (B7).

**Tips:**

1. If you are using a semi-circular protractor to measure a bearing greater than 180°, remember to include the first 180° in your measurement.
2. Having a 360° protractor will make your work easier and more accurate.

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**5. Magnetic bearing (Grades 11 and 12)**

**Key points**

A magnetic bearing is the angle between the direction of the magnetic north pole and the direction of a distant point.

On a hike, or in geography fieldwork, you would use a magnetic compass to find the bearing from where you are standing to another point.

**Figure 2.11 Using a magnetic compass to find magnetic bearing**

**Figure 2.12 A magnetic compass is used to find bearing outdoors.**

Magnetic compasses point in the general direction of the Earth’s magnetic north pole, but they are also strongly influenced by local variations in the Earth’s magnetism at the place of observation. (In 2007, the magnetic north pole was more than 1 000 km from the true north pole.)

On the ground, you would use a magnetic compass to find the magnetic bearing to a distant point. You could then make an adjustment for the Earth’s magnetism to find the true bearing.

**Figure 2.13 The angle between the directions of true north and magnetic north at any one place is called the magnetic declination. It is shown with the letter ‘d’ on this map.**

**Figure 2.14 How magnetic declination is shown on maps**

Magnetic declination is the angle between the direction of true north and the direction of magnetic north.

**Figure 2.14 shows how the mean magnetic declination of the map area is shown on topographic maps.**
Most parts of South Africa have a magnetic declination of between 16° and 25° west of true north. The declination changes continuously, either a little to the east or a little further to the west every year.

The rate of change varies — and may suddenly reverse direction! As a result, any detailed calculation of the amount of change in the local magnetic declination is likely to be incorrect.

We can use the map information as a guide to the current magnetic declination, however.

Example: Using the information in Figure 2.14 to find the approximate magnetic declination for the map area in December 2008.

Difference in time = December 2008 - June 2002 = 6.5 years
Annual change = 12° westwards
Total change in 6.5 years = 6.5 × 12° westwards = 78° westwards = 1°18' westwards
Magnetic declination in Dec 2008 = 22°36' west + 1°18' westwards = 23°54' west

Tips:
If the change in magnetic declination is westwards, add the calculated change to the original declination. If the change in magnetic declination is eastwards, subtract the calculated change from the original declination.

How to apply magnetic declination
If you are using a magnetic compass on a hike or on a fieldwork task, you must take into consideration the difference between true north (as measured on a map) and magnetic north (as obtained from your compass).

In the above example, the magnetic declination in December 2008 was found to be 23°54'W (i.e. nearly 24°). Figure 2.15 shows what this means.

It follows that in South Africa (where the magnetic declination is always westwards):
• true bearing + magnetic bearing = magnetic declination
• magnetic bearing + true bearing = magnetic declination.

ACTIVITY 5  (Grades 11 and 12)
1. Calculate the magnetic declination for July of this year for the map area on:
   a. page 88 (Hermanus)
   b. page 60 (Richmond).

2. Before you set out on a hike, you would first find from a map the true bearings you should follow. But once you have set out, you would use a magnetic compass to determine your direction; so now you would need to know the magnetic bearings to follow.

Round off the magnetic declination in 1.9 to the nearest degree, and calculate the magnetic bearings where the true bearings on the map are:
   a. 10°; b. 90°; c. 176°; d. 355°.

Tips:
Hand-held compasses give magnetic bearings that are accurate to within one or two degrees. So, for most field uses one need not calculate the precise magnetic declination in order to convert true bearings to magnetic bearings.

6. Scale

Key points
Scale is the ratio of map distance to actual ground distance.

Maps are always smaller than the area of ground they represent. How greatly distances on the ground have been shrunk to fit them onto a map is known as the scale of that map. There are three ways of expressing a map scale.

1. A representative fraction is a numerical way of showing how greatly ground distances have been reduced. It is the ratio between distance on a map and the actual distance on the ground, both expressed in the same units. So, a scale of 1:50 000 means that 1 cm on the map represents 50 000 cm on the ground. Follow what this means on the table below.

<table>
<thead>
<tr>
<th>distance on the map</th>
<th>distance on the ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cm</td>
<td>50 000 cm</td>
</tr>
<tr>
<td>1 cm</td>
<td>500 m</td>
</tr>
<tr>
<td>1 cm</td>
<td>0.5 km</td>
</tr>
<tr>
<td>2 cm</td>
<td>1.0 km</td>
</tr>
</tbody>
</table>

   So, when measuring distances on a 1:50 000 map, you can always divide the centimetre distance on the map by two to find the ground distance in kilometres. For example, if the map distance = 4 cm, the ground distance would = 2 km.

2. A word scale is a statement. For the 1:50 000 map, the word scale would be: 1 cm represents 500 metres, or 2 centimetres represent 1 kilometre (or simply, 2 cm to a kilometre).

3. A line scale is a line showing the map distances that represent specific real ground distances. All maps have a line scale. Using a line scale is the simplest way to find distances on a map. It is accurate, and no calculations are needed!

4. A line scale is a line showing the map distances that represent specific real ground distances. All maps have a line scale. Using a line scale is the simplest way to find distances on a map. It is accurate, and no calculations are needed!
**ACTIVITY 6**

On the map on page 76, find the distance (in km) around 1. the Zebediela golf course and 2. the dam southeast of the golf course.

**8. Area**

**Key points**

Area is the measure of the size of a surface.

Small surface areas (for example a housing plot) can be measured in square metres (m²); medium-sized areas (for example a field or a suburb) can be measured in hectares (ha); very large areas (for example a town or an extensive sheep farm) are measured in square kilometres (km²).

Be clear about how big these areas are:

a. One square metre (1 m²) is equivalent to an area 1 m long and 1 m wide, although it may not be a tidy square shape.

b. One hectare (1 ha) is equivalent to an area 100 m long and 100 m wide. Because a football field is 100 m long and 50 m wide, it follows that one hectare is the size of two football fields (or hockey fields).

c. One square kilometre (1 km²) is equivalent to an area that is 1 km long and 1 km wide. Note that 1 km² may not be an exact square: it could be any shape.
You can learn to visualise the size of areas on 1:50 000 maps by using Figure 2.20 to help you.

Figure 2.20 An area scale for 1:50 000 maps. Copy or trace this scale to help you to determine areas (in ha) on 1:50 000 maps.

On the map, 2 cm represent 1 km. So, on a map, a square that is 2 cm long on all sides will represent 1 km². That is the size of the big square in Figure 2.20.

1 square kilometre = 100 hectares
1 km² = 100 ha

On Figure 2.20, find one hectare. On a map, it is a square only 2 mm x 2 mm in size.

How to measure areas on a map
Find the area of Zwelihle (excluding the sewage disposal works). This map is part of the 1:50 000 Hermanus extract on page 88.

Use any of these four easy methods:
1. Use an area scale like the one in Figure 2.20. This is useful for estimating how many hectares there are in medium-sized areas. This method suggests the area of Zwelihle is about 55 ha, or just over 0,55 km².
2. Use the average dimensions of the area. Draw a rectangle that includes as much of the area around Zwelihle as it excludes from the area of Zwelihle. Then multiply real length x real width to find area.

Area = length x width
= 800 m x 680 m
= 544 000 m²
= 54,4 ha
= 0,54 km²

3. Use several simple shapes to cover the area to be measured. Then, find the total area of those shapes.

Area of rectangle = 800 m x 570 m = 456 000 m²
Area of triangle = 800 m x 220 m = 2 x 88 000 m²
Total area of Zwelihle = 544 000 m² = 54,4 ha

4. Use graph paper. Trace the outline of the area onto graph paper. You already know that 1 ha = 100 m x 100 m. On a 1:50 000 map that would be a square of 2 mm x 2 mm. So, try to use graph paper with 2 mm squares. Otherwise, adapt the 1 mm graph paper that you may already have, or draw a grid of fine pencil lines at 2 mm intervals on a tracing of the area (as in Figure 2.24).

Count all the 2 mm squares. Count only the squares that are at least half covered; ignore all the squares that are less than half covered. In the example in Figure 2.24 there are 55 covered and half-covered squares, each 2 mm x 2 mm. This represents 55 ha. That is the same as 0,55 km².

If you use this method for large areas, remember that a square 2 cm x 2 cm represents 1 km² (or 100 ha). That will speed up your calculation.

Note:
• Method 1 (the area scale) is quick and useful for small- to medium-sized areas.
• Methods 2 and 3 (measuring dimensions and calculating) are slow, but they are the best methods for determining large areas of several square kilometres.
• Method 4 (graph paper) is quite quick, fairly accurate and easy to understand.

Tips:
1. Always convert the distances you measure on the map into real ground distance before using them to calculate area.
2. Remember to express area with the correct units: use km² or ha or m².

ACTIVITY 7
Find the area in hectares and in square kilometres of the following locations:
1. the suburb of Wilgerpark in grid square 28°17’S; 29°06’E (C2) (page 82)
2. the round irrigated cultivated land in square 28°07’S; 24°54’E (D5) near Warrenton (page 72)
3. the area of the Zebediele golf course (24°17’S; 29°17’E on page 78)
4. the area of the whole dam, most of which is in square 24°17’S; 29°18’E (A4) on page 76.

9. Altitude and relief

Key points
Altitude refers to the height of land above sea level. It is the same as elevation.

The way 1:50 000 topographic maps show altitude is of enormous value, because these maps show where there are valleys and plains, where the slopes are steep or gentle and where there are hills and mountains. And, they give exact heights of hilltops, mountains and other points. This information is essential for understanding landscapes and for planning such features as settlements, roads, dams, irrigation schemes, boundaries and cell-phone transmitters.
Key points

Relief is the shape of the solid surface of the Earth.

A relief map shows the features of the landscape – for example, mountains, hills, valleys of different kinds, flat plains and steep cliffs. In giving a lot of altitude information, the 1:50 000 map gives us a detailed picture of the solid shape of small areas. Reading the relief of an area from a map is an important map skill.

You can see how contour lines show relief by fanning through Animations 2–5 (from page 11–65) and Animations 6–10 (from page 64–10).

How altitude and relief are shown on the 1:50 000 map

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Contour lines are brown lines on a map joining points at the same height above sea level.</td>
<td>By request, 1:50 000 map sheets can have hill shading added.</td>
<td>• Spot heights are precise points, not always marked on the ground, whose altitudes are shown on maps.</td>
<td>Hachures are short black or brown lines running in the direction of a steep slope.</td>
</tr>
<tr>
<td>Contours at 20 m intervals</td>
<td></td>
<td>• Bench marks are fixed points of a specific height above sea level that are marked on the ground.</td>
<td>Cutting — (black)</td>
</tr>
<tr>
<td>Index contours, a thicker line at 100 m intervals</td>
<td></td>
<td>• Trigonometrical stations are survey points whose location and altitude (height above sea level) have been precisely recorded.</td>
<td>Embankment — (black)</td>
</tr>
<tr>
<td>Depression contours</td>
<td></td>
<td>The beacon number is shown like this: 195. The altitude (in metres) is shown like this: 1284.6</td>
<td>Eroded area — (brown)</td>
</tr>
<tr>
<td>Contours are always numbered facing downslope</td>
<td></td>
<td></td>
<td>Excavation — (black)</td>
</tr>
<tr>
<td>3. Spot heights, bench marks and trigonometrical stations</td>
<td></td>
<td></td>
<td>Digging — (black)</td>
</tr>
<tr>
<td>4. Hachures</td>
<td></td>
<td></td>
<td>Mine dump — (black)</td>
</tr>
</tbody>
</table>

5. Symbols

Brown symbols show rock outcrops and sand dunes.

Prominent rock outcrops
Sand dunes
Mudflats
Beaches and sand

6. Facts about contours on 1:50 000 maps

• Contours are brown lines on maps.
• Contours join points of the same altitude.
• Contour numbers face downslope.
• The contour interval is 20 m.
• Thicker index contours are used every 100 m.
• Widely-spaced contours show a gentle slope.
• Close-spaced contours show a steep slope.
• Contours may merge into a single line to show a steep cliff.
• Evenly-spaced contours show a uniform (even) slope.

Figure 2.26 Gentle, steep and even slopes

ACTIVITY 8

Study the table on page 38 very closely. Then, do these activities based on the Hermansrus map on page 88.

1. a. What is the altitude of the highest point on the map?
   b. Is it marked as a beacon or as a spot height?
2. Find the R43 road in grid square 34°24’S; 19°09’E (D3).
   a. Does the land north of the road slope upwards or downwards?
   b. Give two reasons for your answer.
3. Find the Onrusberg (Onrus Mountains).
   a. Which slope is steeper – the north-facing slope or the south-facing slope?
   b. How can you tell? (This calls for an important skill. Work on it until you can 'see' the difference in the slopes.)
4. What is the altitude, and what is the altitude indicator at these points?
   a. 34°23’55”S; 19°08’55”E (C2)
   b. 34°24’55”S; 19°08’11”E (D2)
   c. 34°21’57”S; 19°06’25”E (D3)
5. To determine the altitudes of the features below, find a numbered contour nearby, then apply these two map rules:
   • the contour interval is 20 m
   • contour numbers face downslope.
   a. the reservoirs in grid square 34°24’S; 19°09’E (D3)
   b. the dam wall of the Klip Dam in grid square 34°21’S; 19°12’E (A6)
   c. the round dam on Vredehoek farm (34°22’S; 19°14’E (B8). The dam lies between two contour lines, so you must estimate.
6. If you walked from Volmoed (34°22’S; 19°14’E (B8) northward to De Bos Dam, would you be walking uphill, downhill or on the level?

How contours show relief

Contours show more than just altitude. They also show types of slopes. You can see this illustrated by fanning through the animations on the edges of these pages.
A changing pattern of contours tells us even more about slopes. Figure 2.26 shows a convex and a concave slope. Notes below the diagram explain the contour pattern.

The presence of different types of slope in a landscape:
- affects possible land use
- gives clues to underlying rock structures
- is relevant in designing roads and in laying out suburbs
- influences property values.

Spurs and valleys are characteristic of fluvial (river) landscapes.

**Facts about contours in river valleys**
- The contours have a V-shaped pattern.
- The V-shape points upstream (towards the river's source).
- The V is sharply pointed in the upper (mountain) stage of the river.
- Where contours meet at the tip of the V there may be a waterfall.
- Contours are closer together near the river's source where the valley is steep and narrow.
- The contours are further apart and have a wide-open V pattern in the river's middle and plain stages.

Contours showing a spur are more rounded and U-shaped; they point downhill.

**Activity 9**

Turn to the Hermanus map extract on page 88. Look at the patterns of spurs and valleys on the north and south side of the Onrusberge. How many of the "Facts about contours in river valleys" could you find on this map?

**Activity 10**

1. Use Figure 2.28 and the definitions in the box on the next page. Which letter represents these features:
   a. the highest peak
   b. the lowest peak
   c. a pass
   d. a saddle?
2. How would you describe the slope between the 1 200 m and 1 600 m contour lines south of F?
3. South of which letter is the slope concave?
4. South of which letter is a valley shown?

**Figure 2.28** A simple contour map of a mountain ridge with a saddle and a pass

**Figure 2.29** A flat-topped Karoo koppie

5. In Figure 2.29, in which square(s) is the slope
   a. steepest
   b. stepped (alternately steep and gentle)
   c. very gentle
   d. more concave: B4 or D4
   e. more uniform: E4 or C3?
6. Compare the koppie in Figure 2.29 with Koffeibus on the Teebus map extract on page 74. Which of the two is higher?
7. Run animations 2, 3 and 4 several times until you can see clearly how contours represent slopes and the landforms of which they are a part.
Definitions

mountain ridge – a long, narrow upland with steep sides; it is long in comparison with its width
pass – a low passable notch or gap in a mountain ridge where a routeway can be made; it connects one valley to another valley
peak – a more or less pointed mountain top
saddle – a high, flattish ridge between the summits of two higher hills or mountain peaks

10. Gradient

Key points

Gradient is the measure of steepness of a slope.

We can describe the steepness of a slope by comparing the change in vertical height up or down the slope in relation to the horizontal distance travelled along that slope. Look at the six slopes in Figure 2.30. Notice how each of the slopes goes up vertically by only one block unit; but the slopes become steeper as the horizontal distance travelled becomes less and less.

Figure 2.30 Different degrees of slope

Travelling up the gentle slope in Figure 2.30, a person would move forward by 20 m while rising by only 1 m. This slope has a gradient of 1 m in 20 m.
Expressed more simply, the gradient is 1 in 20 or 1:20.
A gradient of 1 in 2 (1:2) is very steep. Find it in Figure 2.30. Can cars drive up a 1:2 slope?

Determining gradient from a 1:50 000 map

There are two ways to find the gradient of a slope from a map.
1. A gradient scale
The lower part of Figure 2.31 has a gradient scale. It shows the contour density for different gradients. So, if you want to know the gradient of a slope, simply mark all of the contours on that slope on the edge of a paper strip and match them with the contours on the scale. It’s as easy as that.

Try the gradient scale on a particular slope. On the Hermanus map extract on page 88, find spot height 228 (34°24'S, 19°14'E). What is the gradient for the first 300 m of slope downhill from that spot height?

On the edge of a paper strip, mark all the contours over a distance of 6 mm southeast from the spot height (6 mm represents 300 m). Now match those marks against the gradient scale in Figure 2.31. You should find that the gradient of that slope is 1:2 – very steep, a difficult climb: be careful there.

Figure 2.31 Slopes, their gradients and a gradient scale

2. Calculation of gradient

Figure 2.32a is a 1:50 000 map of an island. What is the average gradient from the shore at X to the peak at Y?

Figure 2.32b is a cross-section through the island showing the average slope from X to Y.

Figure 2.32c

You need not draw Figure 2.32b to find gradient, but you should always draw a simple diagram like that in Figure 2.32c.
Figure 2.32c contains all the information taken from the map in Figure 2.32a that you need to calculate the average gradient:
- the altitudes of points X and Y
- the vertical difference in altitude between points X and Y
- the horizontal distance between points X and Y.

Use this formula, and substitute the information in Figure 2.32c:
Gradient of slope = \( \frac{\text{vertical rise}}{\text{horizontal distance}} \)

Gradient of slope = \( \frac{146}{200} = \frac{1}{1.5} \)
or 1 in 15, 1 or 1:15, 1

**Tips:**
The calculation method is slower, but gives more exact results. For example, it shows that the 300 m slope below spot height 228 in Hermanus has a gradient of 1:2, 2.

**ACTIVITY 11**

1. Using method 2 above, find, on the Hermanus map extract (page 88), the average slope gradients for the following slopes:
   a. from trig station 31 (at 481, 2 m) southward to the R43 road
   b. from spot height 238 (square: 24°22'S; 19°45'E) northward to the buildings at Karwyderskraal.

2. You plan a hike from the south bank of the Klei Dam (34°21'S; 19°12'E) (A&B) in a straight line southward to spot height 507 (C&D).
   a. What is the straight-line distance?
   b. What is the difference in altitude?
   c. Using the method in Figure 2.32, find the average gradient.
   d. Use Figure 2.31 to find the degree of slope (in words) of:
      i. the first half of the hike
      ii. the second half of the hike.

**11. Cross-sections**

**Key points**
A cross-section is a drawing of the side view you would see if you cut down through a land feature such as a hill or a mountain.

**Drawing a cross-section**

1. Prepare a grid for the cross-section (Figure 2.33)
   - Draw it or use graph paper.
   - Make it as wide as the section length.
   - Space the grid lines to match the vertical scale.
   - Include one grid line beyond the highest and lowest points on the section.

2. Gather data from the map (Figure 2.34)
   - Use a paper strip.
   - Mark every contour, and its height, crossed by the section line.
   - Note streams, valleys and roads on the section line.
   - Mark the ends 'A' and 'B' respectively.

3. Transfer data to the section grid (Figure 2.35)
   - Figure 2.35 shows the best method (using a ruler and set square).
   - You can also move the paper strip up and down, while keeping A and B on the grid frame.

4. Complete the cross-section (Figure 2.36)
   - Label heights and end points of the section line.
   - Add a descriptive title.
   - Give the horizontal and vertical scales used.
   - State the vertical exaggeration (see page 47).
   - Shade the land.
A learner was asked to draw a cross-section to meet these instructions: 'Using the map extract on page 88, draw a S-N cross-section through trigonometrical station 207 (in grid square 34’23’S; 19’11’E). The section starts 100 m out to sea and goes to a point 3 km north of trig station 207. On your section, show the position of the rocky coast, Sandbaai settlement, Onrus River, a caravan park, the R43 road, trigonometrical station 207 and a hiking trail or track.' The completed cross-section is shown below.

![Cross-section](image)

**Figure 2.37** A learner’s cross-section drawn to meet the above instructions

Figure 2.37 shows the kind of cross-section you can draw from a 1:50 000 topographic map. With practice, it is quite easy to do — but it takes time to draw a really neat cross-section. In examinations you are often given a section that has been started, and you need only to complete it and identify certain features. An example of a section-completion activity can be found on page 85.

### Tips:
- Drawing cross-sections is a complex skill. To improve your skill, come back every few weeks to do one of the cross-sections below.

### ACTIVITY 12

You should do the first of these cross-sections now to develop the skill.

1. **Hermanus extract** (page 88): from Nuwebaai (D1) through trig station 31 (C2) to Huiswaterkloof (C4).
2. **Teebus extract** (page 74): a 5-km-long cross-section passing W–E through trig stations 10 and 137, with Koffiebus at its centre.
3. **Peebus extract** (page 74): an 8 km N–S section from the top of the map through trig station 137 on Koffiebus and spot height 1578 on Teebus. On your section, mark in the railway and cultivated lands.
4. **Harrismith extract** (page 82): an 8.6 km cross-section from the N3 through trig station 229 (C4) and spot height 2346 (A8) to the edge of the map. Mark in Quean’s Hill, Franz von Daring Dam, and the Platberg.
5. **Mafatelese extract** (page 78): an 8 km cross-section from the map’s top edge through trig stations 201 and 180. Mark in Mpule, Motsete, Malubelube, the river Botiso, the Mapaneng settlement and all cultivated land.
6. **Zebedie (east) extract** (page 76): an 8 km W–E cross-section through trig stations 98 and 82. It starts 1 km west of trig station 98 and ends 2.3 km east of trig station 82. Mark route 518, Nkumpi Dam and the Strydpoortberge.

### ACTIVITY 13

1. Draw cross-section 1 of Activity 12 (on page 46) twice; first with a vertical scale of 1:20 000 (1 cm:200 m), then with a vertical scale of 1:10 000 (1 cm:100 m).
2. Calculate the VE of both of your cross-sections.

### Key points

**Vertical exaggeration** is the deliberate upward stretching of a cross-section to emphasise the heights of physical features such as mountains, hills and valleys.

Cross-sections are always drawn with some vertical exaggeration. Without vertical exaggeration, hills and mountains would be very flat, and it would be hard to see landscape details. Vertical exaggeration is abbreviated as VE.

### Tips:
- It is usual to choose a VE of between four times and ten times when drawing cross-sections from 1:50 000 maps.

### Tips:
- The scale is the ratio of the map to the real terrain. The vertical exaggeration is the ratio of the map to the vertical scale.

**Figure 2.38** Different vertical exaggerations in three simple sections through an island like the one in Figure 2.34

We achieve VE in a cross-section by choosing a larger vertical scale than the horizontal scale. In Figure 2.37, the vertical scale was 1:10 000, while the horizontal scale was only 1:50 000.

Understand it this way:

\[
\text{vertical scale} = \frac{1 \text{ cm}}{100 \text{ m}}, \quad \frac{1}{10000}, \\
\text{horizontal scale} = \frac{1 \text{ cm}}{500 \text{ m}}, \quad \frac{1}{50000}, \\
\text{vertical exaggeration} = \frac{\text{vertical scale}}{\text{horizontal scale}}
\]

This means that the height of a hill will be stretched upwards, or exaggerated, by five times compared with its length; valleys will be shown five times deeper.
13. **Intervisibility**

**Key points**
- Intervisibility is the ability of one point to be seen from another point.
- Points are intervisible when they can be seen from each other.

To find whether two points on the ground are intervisible, one looks at a cross-section passing through both points. Look at Figure 2.39.

**Figure 2.39** Can point C be seen from points A and B?

It is useful to know how to determine intervisibility when choosing a site with a broad view and when placing advertising, light signals or certain kinds of radio transmitters.

**ACTIVITY 14**

Here is an example from the Hermanus cross-section in Figure 2.40.

Can a person walking around trigonometrical station 207 on a peak on the Onrus Mountains see:
1. route R43 to the south
2. the hiking trail to the north?

**Figure 2.40** A S-N section through the Onrus Mountains near Hermanus

---

14. **Speed, distance and time**

When you see a traffic sign saying ‘60 km per hour’ you are reminded that there is a link between speed, distance and time.

Here are three formulas:

<table>
<thead>
<tr>
<th>Formula</th>
<th>Calculation</th>
<th>Tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed = Distance</td>
<td>Speed = ( \frac{\text{Distance}}{\text{Time}} )</td>
<td>And here is a triangle to help you remember the formulas without having to learn them. <strong>Don’t Stop Trying!</strong></td>
</tr>
<tr>
<td>Time = Distance</td>
<td>Time = ( \frac{\text{Distance}}{\text{Speed}} )</td>
<td></td>
</tr>
<tr>
<td>Distance = Speed</td>
<td>Distance = ( \text{Speed} \times \text{Time} )</td>
<td></td>
</tr>
</tbody>
</table>

Use the Hermanus extract (page 88) for the following example.

Example: At 09:00 two cyclists set out by bike from benchmark 34,9 (in A2) near Fisherhaven to go to the Otto du Plessis Bridge (grid square D6). They keep up a steady speed of 20 km/h. How long will they take to reach the bridge? At what time should they reach the bridge?

First, measure the distance the cyclists must ride (see pages 34 and 35). The distance on the map is 23,4 cm - representing 11,7 km.

Second, apply the formula:

- Time = \( \frac{\text{Distance}}{\text{Speed}} \)  
- = \( \frac{11.7 \text{ km}}{20 \text{ km/h}} \)  
- = 0.585 h  
- = 35 min 1 s

Finally, add the travel time to the starting time to find the arrival time: 09:35.

**ACTIVITY 15**

**How long will the school hike take?**

This is the planned route (see page 58):
1. Start from the school in Mount Pleasant (grid square 34°25'S; 19°12'E (E61)).
2. Walk 0.5 km to the R43 and turn left (westwards).
3. After just over 1 km, turn right (northeast) up the Hemel en Aarde valley.
4. Stay on the road up the valley all the way to the wall of the De Bos Dam.
5. After a 30-minute rest at the dam, return some of the way along the road.
6. At the turn-off to Glen-Melsetter turn left (southeast) and follow the hiking trail across Patryskloof down to Rotary Way.
7. Follow Rotary Way back to the R43.
8. Cross the R43 and return to the school.

Measure the distance carefully. Hint: It is easier to divide the whole route into three or four parts and to measure each part separately; then add all the distances together. A school group will hike at about 4 km/h.
15. Orientating a map

When you orientate a map, you turn the map around so that features on the map are in the same relative position as the features they represent on the ground. When a map has been orientated, roads, rivers, coastlines and mountains will run in the same direction on the map as they do on the ground. (You have to do this outdoors!)

Once you have orientated the map it is easier to determine directions, unfamiliar features and place names. If you are doing fieldwork using maps, orientation is the first thing you need to do.

**ACTIVITY 16**

Take the 1:50 000 map sheet of your school area outside and orientate it using one or both methods of orientating a map.

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**Chapter 3: Interpreting topographic maps**

So far, you have learnt the skills needed to read individual items of information from a map. Because maps often show complex landscapes, geographers must develop other map skills so they can interpret those maps.

When reading a map, you are obtaining information answering “What?” and “Where?” questions. But when you interpret a map, you are finding reasons or explanations for the nature of some of the real ground features shown on the map. You are asking and answering “Why?” and “How?” questions. To do this, you need to use your understanding of geographical processes, along with basic map-reading skills.

In this chapter you will gain experience in interpreting the following:
- how map features are distributed (for example landforms and drainage)
- why those features are distributed in such a way
- relationships between features (for example how landforms influence patterns of rural or urban settlement).

**Start by getting a general impression of the map area**

Before you start any detailed map interpretation, spend a little time becoming familiar with the map area.

**Tips:**

Look for the following when familiarising yourself with the map area:
1. The size of the area: find the length and breadth of the area in kilometres.
2. The general nature of the area: look at:
   - relief: is it mountainous, hilly or flat in places?
   - general elevation: how high above sea level is it?
   - drainage features: in which direction do rivers flow?
   - climate: is the area obviously wet or dry, hot or mild?
   - settlement: is the area urban or rural? What kinds of land use are there? Are there any clues to the reason for this settlement?
3. The date of publication on the map. (If this is not given, you can use the date in the note on magnetic declination as a clue.)

You need not write any notes on these matters, because at this stage you are only getting a general mental picture of the area. Compare these two areas.
3.1 Interpreting physical features

Physical features are the natural components of a landscape: the hills, valleys, landforms and vegetation found in an area. Here is a guide to what to look for when starting to interpret the physical features of a map.

1. Relief
   - Focus your attention on the contours. Look for the higher ground.
   - Determine what range of height is shown between hills and valley bottoms.
   - Consider drawing a small sketch map (and even a cross-section) of the map to show the main relief features (such as ‘mountain’ and ‘plain’).
   - Estimate the percentage of the map area that is higher land.
   - Identify in which part of the map area the higher land is found, and in which part of the map the lower land is found.

2. Landforms
   - Can you see evidence of specific landforms? For example, do the contour patterns show a plateau, a mesa, a butte (koppie), a cuesta, a ridge, valleys, convex slopes, uniform slopes or concave slopes? (Some of these are shown in Animations 2–10.)
   - Do any of the landforms provide evidence of the underlying rock structures?
   - Try to identify what erosion agents have shaped the landforms.

Later, you may use what you have read from the map to explain patterns of drainage, settlement, agriculture and transport links. Use the points given in 1. and 2. above to interpret physical features on the Mataiele and Harrissmith maps (pages 78 and 82 respectively).

3. Drainage

![Diagram of drainage](example)

Figure 3.3 Six ways to interpret the direction of stream flow

- In which general direction are the streams or rivers flowing? Figure 3.3 shows six ways of working out the direction of stream flow.
- Where are the watersheds?
- What is the drainage pattern? (Grade 12 Geography addresses dendritic, trellis, rectangular, radial, centripetal and deranged patterns. Make sure you are familiar with what these look like.)
- Are the streams perennial (i.e. permanent) or non-perennial (i.e. intermittent, seasonal or episodic)?
- Is the drainage density high or low? This can be a clue to rainfall received and soil permeability (high soil permeability means fewer river channels).
- What are the valleys like? Are there clues to the present stage in the river valley's development?
- Does the drainage pattern suggest river capture, rejuvenation, superimposed drainage or antecedent drainage?
- Look for lakes and waterfalls in the river's course. What do they tell you?

Later, you may link what you have read about physical features from the map to settlement, communications and agriculture. Apply the procedures for interpreting drainage patterns that are suggested above to the Mataiele map on page 78.

4. Climate

You can make some assumptions about the climate of an area shown on a topographic map if you know where in South Africa it is.

**Tips:**

Remember that the first four digits in a topographic map’s title tell you the area’s latitude and longitude. The map borders often have information about road and rail distances to other towns. This is a useful clue in deducing the climate and vegetation of a map area.

- Latitude is a guide: lower latitudes (in the northern parts of South Africa) are generally warmer (see Figure 3.4).
- Longitude: the western regions of South Africa are drier, while the eastern parts are often wetter (see Figure 3.5).
- Mountainous areas have higher rainfall levels (see Figure 3.5).
- Distance from the ocean: Inland places usually have a higher temperature range than do coastal places (see Figure 3.6).
2. Land use

The ways in which land is used differ very greatly not only between rural and urban settlements but also within each of these categories of settlement.

Rural land use

On any map of a rural area that you are studying, distinguish which forms of farming are being practised. Figure 3.8 shows the main kinds of farming and the symbols associated with them. The figure is a guide: do not assume that no traditional subsistence farming community has a windpump or a dam — or that all commercial farms will have them.

FARMING

<table>
<thead>
<tr>
<th>TRADITIONAL SUBSISTENCE</th>
<th>COMMERCIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>crops and stock</td>
<td>stock</td>
</tr>
<tr>
<td>kraal turtles</td>
<td>stock</td>
</tr>
<tr>
<td>walls</td>
<td>stock</td>
</tr>
<tr>
<td>huts</td>
<td>stock</td>
</tr>
<tr>
<td>windpump</td>
<td>stock</td>
</tr>
<tr>
<td>fences</td>
<td>stock</td>
</tr>
<tr>
<td>kxenungu</td>
<td>stock</td>
</tr>
<tr>
<td>dam</td>
<td>stock</td>
</tr>
<tr>
<td>reservoir</td>
<td>stock</td>
</tr>
<tr>
<td>(green)</td>
<td>(green)</td>
</tr>
<tr>
<td>(green)</td>
<td>(green)</td>
</tr>
</tbody>
</table>

Figure 3.8 Different kinds of farming — and the map symbols associated with them

On topographic maps, look for the following:

- subsistence and commercial farming
- types of farming, whether crop farming or stock farming
- the crops being produced. Sometimes there are clues nearby in the form of labels, such as "Wine Cellar", "Sawmills", "Poultry", "Silos", "Nurseries", "Forest Station", "Lookout Tower" and "Sugar Mill". Older maps show "Dairy" labels too. You can also apply your geographical knowledge here. For example, you know that:
  - sugar is grown in KwaZulu-Natal and southern Mpumalanga
  - deciduous orchards and vineyards are more common in the Western Cape
  - maize and sunflowers are most common in the Highveld.
- the influence of terrain (relief, landforms, soil and vegetation) on the location of the farmland: is it on a valley floor? a north-facing slope? Why there?

Urban land use

The built-up area of a town or city is shown on maps with grey tones. If there is a town or city in the map area, you should identify the main land uses there.

The central business district (CBD) is usually at or near the centre of an urban area. Here's how you can usually find the CBD:

- Find the centre of a grid pattern of roads. Most of the South African settlements that have grown into towns and cities were originally laid out with a rectangular grid pattern of roads. You will usually find the CBD near the middle of this grid pattern.
- The CBD will often have a post office (P), a police station (PS) and a place of worship (W).
- Main roads pass through or near the CBD; major routes may cross here too.
- For towns with several suburbs, the biggest place name label will be placed quite close to the CBD.

irrigation. Are there dams linked to cultivated areas by canals, furrows or aqueducts? Are there pumps on or near the fields? Are the areas of cultivated land circular (a sign of centre-pivot irrigation)? You can trace irrigation canals from their sources to the fields they irrigate on the Teebus, Zebediea and Loskop Dam map extracts on pages 74, 76 and 84 respectively.

Figure 3.12 Subsistence farmers are increasing their use of pipe and furrow irrigation.

Figure 3.13 Many commercial farms use centre-pivot irrigation. (See maps on pages 70, 72, 74 and 84.)
Look at the maps of Christiana (page 70), Warrenton (page 72), Matatiele (page 78), Richmond (page 80), Harrismith (page 82) and Hermanus (page 88), and identify how many of the characteristics described above apply to the CBDs of these towns.

On aerial photographs, a CBD is indicated by the presence of larger buildings. The shadows of these buildings may show them to be taller than those elsewhere in the town.

Residential areas are those parts of a town where people live. South African cities still show the influence of racial inequality, although this has been changing slowly.

- The former racial discrimination of the defunct Group Areas Act resulted in there being separate residential areas for black, white, coloured and Indian people.
- Higher-income areas have larger properties, so the street pattern is more widely spaced (as in Figure 3.15). Often, these were 'white' suburbs.
- Lower-income areas have smaller homes and properties; the street pattern is finer (as in Figure 3.16). Often, these were 'black' suburbs.
- Sometimes the names of the residential suburbs indicate the racial group that was once required to live there.
- In some towns, the residential areas for black people were built some distance from the 'white' town and residential areas (these areas are known as dormitory towns, for example Soweto and Langa).

Test how many of these characteristics apply to the residential areas of the following towns. Note the names of the suburbs, too. Look at map extracts of Christiana (page 70), Warrenton (page 72), Harrismith (page 82), Roodepoort (page 86) and Hermanus (page 88).

Figure 3.14 The CBD has taller buildings than the rest of the town or city, and a concentration of high-order services.

Figure 3.15 Higher-income residential areas have larger properties and less dense housing.

Figure 3.16 Lower-income residential areas have smaller properties and denser housing.

Now turn to the Roodepoort map extract (page 86), and find what appear to be the high-income, middle-income and lower-income residential areas there.

Some towns have informal settlements in or near them. These are high-density housing areas lacking formal roads and basic services. These characteristics often show up clearly on the 1:50 000 map. For example, on the Matatiele map extract on page 78, find the built-up dormitory areas of Moreneg, Madimonga and Zwelitsha, and notice how different the street plan is from that of Matatiele town. Some of those informal settlements are labelled with a special font on 1:50 000 topo maps because they are recent settlements whose names have not yet been officially recognised. For example, the settlement Mahangu on the Matatiele map is labelled using this font — it looks like this: Mahangu.

Industrial areas are those parts of a town that have factories, commercial workshops and wholesale warehouses. The buildings are often big enough to be shown individually as black squares and rectangles.

Figure 3.17 Most towns and cities have industrial areas.

Find the industrial areas on the southwest side of Harrismith (page 82), east of Roodepoort (page 86) and also in grid squares 26°11'S; 27°55'E and 26°12'S; 27°56'E of the Roodepoort map.

What is the name of the industrial area in grid square 26°11'S; 27°58'E on page 86?

Notice how both of these maps (2829AC Harrismith and 2627BB Roodepoort) show that their industrial areas have some of the key site requirements of manufacturing industries: flat land, road and rail transport links, availability of electrical power and accessibility to high- and low-income workers.

Recreation areas are the sports grounds, or areas, of a settlement, they are:
- coloured green
- marked either 'hec' or with the name of the sport played there
- sometimes part of the grounds of a school (8)
- often near the outer fringes of a town where land is or was cheaper. This is especially true of golf courses, which require more land than other sports generally do.

See how many of these general characteristics apply to the recreation areas around the towns of Richmond (page 80), Harrismith (page 85), Matatiele (page 78) and Roodepoort (page 86).

3. Transport routes

Transport routes are the links by which people and goods can move between places. These include roads, railways and airways.

When reading and interpreting a topographic map, ask the following questions:
- What means of transport are shown?
- What purpose do they serve?
- What landforms have affected transport routes, and how?
- How have transport routes influenced other human (or cultural) features?
On topographic maps, intercity national routes and railways show up clearly, as bold lines. On maps, it is usually clear that transport routes often follow flatter ground. River valleys have been the routes of human migration and trade for thousands of years. Railways and main roads need to follow lower gradients, so they are often routed along valleys.

Note that very low-lying or marshy areas are prone to flooding; transport routes will avoid them. Railways need even lower gradients than roads do. For this reason, they may take gentler, winding routes over steep mountains. They will also make more frequent use of tunnels than roads do.

Once roads and railways have been built, they tend to attract settlements to them. On maps, this relationship between transport routes and settlements shows up clearly. The Roodepoort and Hermanus map extracts (pages 86 and 88 respectively) show this phenomenon well.

### 3.3 Explaining relationships between features

Topographic maps are so full of information that it is sometimes difficult to see how one feature influences another. Look at the Harrismith map extract on page 82. With basic map-reading skills, it is quite easy to read what is on the map; it is not as easy to understand how relief, landforms, drainage, climate, vegetation, transport, settlement, and land uses interact with each other.

Here’s how to start to see the links:

- **Draw a few small rectangles, each in proportion to the map shape.** In the rectangles, draw small précis maps of some of the following aspects:
  - the relief, landforms and drainage
  - any available information on natural vegetation
  - transport links (including airports, harbours and railway yards)
  - main settlements (for example towns, villages, farmsteads)
  - rural land use
  - significant urban land use (for example conspicuous (highly visible) industrial areas and extensive informal settlements).

These small maps are called précis maps because they summarise the essential elements of a landscape. To draw a précis map, you can use the method explained under heading 3 on page 14.

- **Draw cross-sections through areas that attract your curiosity (for example across the town, through an airport or industrial area or along a road).**

Figure 3.20 shows a cross-section through the main urban areas of Harrismith, as depicted on the map extract on page 82.

- **Inspect the small précis maps you drew; combine (put together) any that show linkages or related patterns.**

- **On small maps, show how two or more features show related patterns, for example cultivated crop land and flat land, or informal settlements and higher ground.**

- **On a small map, show how human (cultural) features relate to natural features.**
Section 2: Using maps and images

**INSTRUCTION WORDS USED IN THIS BOOK AND IN EXAMINATIONS**

account for – explain the cause of; give reasons for
annotate – add explanatory notes to a sketch, map or drawing
calculate – work out (using maths or arithmetic) to arrive at an answer.
(Sometimes you are instructed to show the steps of your calculation)
classify – arrange according to type; sort
comment – write generally about; give further ideas on (see also ‘describe and comment on’)
compare – point by point, show both similarities and differences. Simply giving two separate accounts, definitions or descriptions is not a comparison
define (also explain the meaning of ..., outline ..., what is meant by ...) – give the precise meaning of the term in a short answer – usually two or three sentences. An example will clarify your answer. Use mark allocation to guide you on the length of the answer
describe – list the main characteristics of a feature, concept or process; give an account of. The description should be factual without an attempt to explain.
The description could include a diagram or a map
describe and comment on – after giving a description (as outlined above), you should make some judgment on the item or issue described. This may be an explanation, your (or other people’s) opinions on the matter, a value judgement or a suggestion on the possible causes or results of the item you described
determine – find out; decide
discuss – you should construct an argument about an issue, and you should give evidence and examples in your verbal debate. You may conclude with your own opinion after considering both (or all) sides of the matter
distinguish between – present a definition of the two (or more) items named, clearly highlighting a significant point of difference between them
explain (also suggest reasons for ...) – show the meaning of; give reasons for something; clarify, interpret or put into plain terms something that you have written or drawn; analyse the causes of
give (also identify ..., name ..., state ...) – write a short answer to a simple task, for example: write a named example of an item; provide a value or date from a graph; identify by name a landform on a map or photo; offer a significant fact
indicate – show or point out
justify – for a short answer of few marks: prove the truth of; give reasons for; (for a longer answer for many marks):
- for each of the options that are rejected, outline their positive and negative points, and end with a brief statement of why the negatives outweigh the positives
- for the chosen option, outline the positive and negative points, and end with a brief statement of why the positives outweigh the negatives
label – insert a name for a feature on a diagram or map
list – write an itemised series of short statements
name – identify; say what an item is; list
propose – give your ideas on (see also ‘suggest’)
provide evidence – give reasons for; prove
suggest – propose (a possible plan, an explanation or a solution)

**Your low-cost DIY map measuring kit**
Photocopy page 62 onto transparency film or tracing paper. Cut out each item as shown by the red line. The 360° protractor should be cut out exactly along its outer edge. You now have your own set of easy-to-use tools for measuring distance, area, bearing and gradient on 1:50 000 topographic maps.

Area: Lay 2 mm graph paper over the area to be measured. Count squares at least half-filled to find area in hectares. (Divide by 100 to convert hectares to square kilometres.)

Gradient: Match the lower edge of the gradient scale to 20 m contour spaces on 1:50 000 topographic maps.
Chapter 4: Assignments

This chapter has a selection of satellite images, thematic maps, topographic map extracts, aerial photographs and orthophoto map extracts for you to use in order to sharpen your skills of map reading, analysis and interpretation. The assignments are set out in the same way as some Grade 12 examinations so that you can use them in working towards your National Senior Certificate. To save space, our assignments do not often make use of multiple-choice questions and do not provide spaces for answers.

All assignments in this chapter start with questions designed to test the basic skills of map reading and simple analysis. The second part of each assignment has activities in more advanced map analysis and interpretation that apply to the content covered in Grade 11 and 12 Geography.

In the final Grade 12 NSC exam on geographical skills and techniques, questions on basic mapwork skills will count for 20 percent, while the application of map skills to theory will count 80 percent. The assignments in this book have many exercises in basic map reading to help you to retain your skills. At any stage, you can refer back to chapters 2 and 3 to refresh your memory of how to do a map task.

All of the map extracts, unlike their parent map sheets, have grid lines on them. This will make it easier for you to find map features. In examinations, the maps often have grid lines added to help you to work quickly and accurately. Many activities will give map references as coordinates (so you can find an exact point), but will also give a grid square (for example D7) to make the job easier.

A translation of words used on topographic maps is given on page 104. This will be of value if you are studying a 1:50 000 map sheet of your own area. The maps in this book were all published after 2000 so, following current practice, the labels are all in English. Most place names, however, remain in their original or correct language, for example ‘Swartberge’, ‘Zwelitsha’, ‘Fisherhaven’ and ‘Utvane’.

In this chapter, there is a map extract of an area from each of South Africa’s nine provinces. The five aerial photographs (on pages 90, 92, 94, 96 and 98) and two orthophoto map extracts (on pages 100 and 102) are linked to the topographic map extracts.
4.1 Satellite images

Satellites high above the Earth are sending continuous streams of data back to ground stations (see page 21). Computers process some of that data to produce maps and pictures known as satellite images.

Satellite images offer the following advantages over aerial photographs:
- Remote sensors in the satellites can detect radiation that is invisible to photographic cameras.
- Satellites transmit data continuously, day and night, in all weather.
- Satellites operate over all parts of the Earth – even those parts where it would be risky to fly aeroplanes.

The images on these pages are samples of a huge resource of many thousands of satellite images.

1. **NASA's Terra satellite tracks global pollution**
   Satellite images like this add to our understanding of the sources of global pollution and of how it spreads around the Earth. For each season, the computer averaged out four years of observations of invisible carbon monoxide (CO) at altitudes of about 1 500 m. The highest values are shown in red. This summer image shows the result of deforestation and veld burning. (The winter image shows high levels of pollution over cities.)
   a. **Name** three countries suffering the highest CO pollution in summer.
   b. **Suggest** three causes of increased atmospheric pollution over cities in winter.

2. **Aura satellite shows Europe's ground-level pollution**
   Dutch scientists used data from the Aura satellite to make this perspective-map image of NO2 pollution. New data comes in every day from Aura, so the map changes daily in order to show how the polluted air moves and where it settles.
   a. **Name** three countries whose air seems to be the most seriously polluted.
   b. Knowing that the prevailing winds here are westerlies, **identify** two countries that will receive polluted air from their neighbours.
   c. Which region in Italy is most polluted?
   d. The southern half of Switzerland is less polluted than the north. In an atlas, **find** why this is so.

3. **The Antarctic ozone hole**
   Ozone gas in the upper atmosphere shields us from dangerous solar radiation frequencies. The use of CFCs (chlorofluorocarbons) has destroyed part of the ozone layer over the poles, placing the Earth at risk. On the satellite image, dark blue indicates 'the hole', an area with 20 percent less ozone than normal. In the space of a year, the ozone hole shrank; shifted and split into two. This was caused by a season of stronger and warmer winds – not because of the decrease in the use of CFCs.
   a. On which two dates were these images made?
   b. Why does the second ozone hole seem less threatening?
   c. Why would it be incorrect to assume that the shrinking of the ozone hole continued after the date of the second image?

4. **Gauteng: true-colour and false-colour satellite images**
   NASA's Multi-angle Imaging SpectroRadiometer (MISR) observes all of the day-lit Earth every nine days. These two views are from it show some of the land use, vegetation and geological features of Gauteng province. In the false-colour image (right) vegetation is shown in red hues. Use an atlas map to **find** the following features on the image:
   a. the Vaal Dam in the southeast corner
   b. the ancient round volcanic complex of the Pilanesberg in the northwest corner
   c. the leafy northern suburbs of Johannesburg, which are just to the right of the centre
   d. the farmland on both sides of the Magaliesberg range, which loops west–east just above the middle of the image
   e. the urban areas, which are shown in grey pixels in the true-colour view, although they show signs of vegetation, too.

5. **A terrain model of Hermanus**
   This model of Hermanus is not a satellite image, but it was made by computer procedures similar to those used to process satellite data. The basic shape, or model, was made from the orthoimage map contours digitised to their x, y and z values. This is called a digital elevation model (DEM). Following this procedure, a colour vertical aerial photograph was draped over the DEM to produce this terrain model. Compare it with the map on page 88:
   a. **Find** the sewage disposal works on the terrain model.
   b. What is the name of the suburb to the east of the sewage works?
   c. **Name** the farm whose cultivated lands are on the top of the mountain.
   d. **Name** the road that comes in at the far northeast corner and runs southwestwards along the top of the mountain.
   e. **Name** the cape nearest the lower left corner.
   f. **What kind of observatory** is very close to the centre point of this model?
4.2 A world of maps

Maps are sources of information. Sometimes the information is simple, showing only the location of specific features.

1. Figure 4.1 shows the location of schools without toilets in the year 2000. Some of the schools are small farm or village schools.
   a. Why is the date important?
   b. Which province shows the highest incidence of schools without toilets?
   c. Which province had the lowest incidence?
   d. What other information does one need in order to assess the seriousness of the problem shown here?

2. Figure 4.2 shows data relative to time: the average number of hail days a year. When the data are presented with the words 'per' or 'a' (as in 'per year' or 'a year') the map will be showing a rate of some kind.
   a. What part of southern Africa has hail most often?
   b. How often does hail fall there?
   c. Does hail fall with that frequency every year?
   d. How does this map show that it is more risky to grow peaches and tobacco in the eastern Free State than in the Western Cape? (Use numeric data in your reply.)

3. Figure 4.3 shows data relative to space for a particular census year: the number of people living in a square kilometre in 2001.
   a. In which province is population density highest?
   b. Name five cities in and around which there is a concentration of people.
   c. Which province has the lowest density of population?
   d. Explain why this is so.
   e. Why do the eastern parts of South Africa have high population densities?
   f. Suggest how the population density map for the year 1901 would have been different.

4. Figure 4.4 combines three kinds of information: soil loss in tons, per square kilometre, per year. Research suggests that 300 million tons of soil are lost by water and wind erosion every year.
   a. What colour on the map indicates the highest rate of loss?
   b. Define the rate of loss there. (Use the units '... tons per square kilometre per year'.)
   c. Suggest a reason for the rate of soil loss being relatively low in the northwestern regions.
   d. Which South African river delivers the most soil to the sea every year?
   e. Who is to blame for this soil loss?
   f. What attitudes and behaviours are the causes of this soil loss?
   g. Suggest three long-term consequences.

Cartograms are a powerful way of showing spatial information. They are a form of map that shows statistical data. The cartograms here have the sizes of the countries made bigger or smaller in order to show proportional data.

5. Figure 4.5 shows countries in proportion not to their ground area but to the number of people living there. Here, two of the world's biggest countries (Canada and Russia) almost disappear because their populations are relatively small.
   a. Find and name the five most populous countries.
   b. Name the continents of which they are a part.

6. Figure 4.6 indicates spending on healthcare. (Note: This cartogram closely matches the GDP cartogram.)
   a. Name the two countries spending most on healthcare.
   b. Using Figure 4.5, determine which of those two countries spends more per person.
   c. Which continent spends the least on healthcare?
   d. Which country on that continent spends the most?

7. The distribution of HIV/AIDS is shown in Figure 4.7.
   a. Which continent is most seriously infected by HIV/AIDS?
   b. Which two countries on that continent have the highest number of infected people?
   c. Identify a country in Asia with a large number of people infected with HIV/AIDS.
   d. Does this mean that a high percentage of people there have HIV/AIDS?
   e. Suggest a human value or attitude that lies behind this problem.

8. Child mortality is related to many factors other than HIV/AIDS. Figure 4.8 presents a serious image of global imbalance.
   a. Which country has the most child deaths?
   b. In which continent is child mortality most common?

Focus on Map Skills and Grades 10-12

Mean magnetic declination 19°16' West of True North (July 2002).

Mean annual change 7' Westwards (2000-2005).

Supplied by Hermanus Magnetic Observatory.
3. 3125BC Teebus, Eastern Cape

Teebus and Koffiebus (Afrikaans) for 'Tea pot' and 'Coffee pot') are buttes in the northern Karoo. The mean annual rainfall is only 400 mm, but ranges from 220 to 900 mm! The underlying sandstone layers are protected in places by hard dolerite caps, resulting in these buttes or koppies. Water from the Orange–Fish River has irrigated crops since 1975.

1. Basic Map Skills
(Grades 10, 11 and 12)
1.1 Name the higher of the two buttes on this map. (2)
1.2 State two ways in which one can see that the top of Koffiebus is flat. (4)
1.3 Draw a cross-section through Koffiebus.
   - Start from benchmark 1237.9 in C2, pass through trig stations 138 and 10, ending at the windpump on the 1 240 m contour in B4.

2. Hydrological systems
Almost all the streams in this arid area are non-perennial. They flow only after summer rains. Yet, the southern half of the map area has large areas of cultivated land similar to that found in wetter areas.
2.1 Name the water source for the cultivated land. (There is a clue in square E4.) (2)
2.2 Name the major contour below which most of the cultivated land is found. (2)
2.3 From the small map on this page, estimate how far the water used in this area has travelled as part of an inter-basin water transfer scheme. (The scale line represents 500 km.) (2)

3. Ecosystems
Explain how this area is an example of the 'people and the environment dilemma'. (4)

4. Development and sustainability
Forty years ago, this part of the Karoo was unproductive and thinly populated. Using specific items on the map extract, provide evidence for the case that the Orange–Fish River scheme has improved living standards locally and nationally. (8)

5. Fluvial processes
5.1 Describe the drainage pattern around Teebus (squares D3 and D4). (4)
5.2 State whether, in the area east of 25°39'E, the stream order increases or decreases southwards. (3)
5.3 Explain why the non-perennial stream of the Hongsloofrivier (squares G5, G6 and G7) becomes perennial in squares G4 and H4. (4)

6. Structural landforms
6.1 On the cross-section you drew in question 1.3, indicate these slope elements: a. talus, scree or debris slope b. crest c. pediment d. free face or scarps. (2 x 4 = 8)
6.2 Name the Teebus slope element upon which there is extensive erosion. (2)
6.3 Name the slope element which C5 and C6 are a part of. (2)
6.4 Explain how the map shows that the scarp retreat is occurring on the upper slopes of Teebus and Koffiebus. (See Animation 2 for further clues.) (4)

Mean magnetic declination 22°14' West of True North (July 2002). Mean annual change 10° Westwards (2000–2005).

Supplied by Northern Magnetic Observatory.

Grade 11

Grade 12

Section 2: Using maps and images
1. Christiana North West

Section 1: Using maps and images

4.4 Aerial photographs

Focus on Map Skills: Grades 10-12
**How to determine the scale of a vertical aerial photograph**

Compare this photo with the map of Matatiele on page 78.
- The photo, although almost as big as the map, is of only a small part of the map area.
- All of the land features are bigger in the photo than they are on the map.

It follows that the photo is at a larger scale than the map. But, what is the scale of the photo?

An easy way to calculate photo scale is from the relationship between a photo measurement and a map-derived ground measurement. Remember to use the same units for both measurements in the calculation.

\[
\text{Scale as a representative fraction} = \frac{\text{photo distance between two points (in metres)}}{\text{ground distance between same points (in metres)}}
\]

Obtain the ground distance from the topographic map.

Example (using the landing strip in squares J4 to M8 on the photo and D3 on the map):
- Measure them both in metres: photo distance = 4.6 cm, 0.046 m
- Map distance = 2.3 cm (representing 1 150 m)
- Use these measurements in the equation:

\[
\text{RF} = \frac{0.046 \text{ m}}{1 150 \text{ m}} = \frac{1}{25 000} \text{ or } 1:25 000
\]

Warning: Areas at the edges of a photograph are further from the camera than are areas in the middle of the photo. It follows that scale is not constant throughout a photo. For greater accuracy, measure distances across the centre of the photo.

**Tips:**

1. Always measure map and photo distances between two clearly identifiable points. Good points to choose include the intersection of two roads or of two fences, a spot height or a trig beacon.
2. Determine photo scale three or four times, and use the average of these (unless one calculation is obviously way-out wrong!).

**2. Matatiele, Eastern Cape**

1. **Calculate** the scale of the photograph by using the average scale determined from these two distances:
   - between the middle of the dam wall (H5 in the photo; C3 on the map) and the crossroads northwest of the hospital (V16-U16 in the photo; E5 on the map)
   - between the western corner of the woodland (P4 in the photo; D3-E3 on the map) and the northern corner of the woodland (Q18 in the photo; E5 on the map).

2. **Suggest** a risk in using distances between features such as woodland, cropland and built-up areas to determine scale.

3. **Identify** the feature shown in photo squares N2, N3 and N4.

4. Using information given with question 4 on page 78, **suggest** what is being built in the area around N2, N3 and N4.

5. **Identify** the purpose of each of these features in the photo squares named:
   - the rectangular feature in N7
   - the circular feature mostly in R10 and 11
   - the elongated feature in P8
   - the irregular area in I4
   - the long, dark feature in B1 to E1.

The topographic map of Matatiele on page 78 was published in 2000. The aerial photograph opposite was taken in May 2004. Even over a period of only four years, there were several changes in land use and in the size of the built-up areas.
(9) 6 x 7 = 42
(10) 2 x 3 = 6
(11) 1 x 9 = 9
(12) 3 x 7 = 21
(13) 5 x 8 = 40
(14) 2 x 7 = 14
(15) 3 x 3 = 9
(16) 4 x 7 = 28
(17) 5 x 5 = 25
(18) 6 x 5 = 30
(19) 7 x 5 = 35
(20) 8 x 5 = 40

(2) A key feature of the exposure is that it is
(3) The exposure is such that the features are
(4) The exposure is such that the features are
(5) The exposure is such that the features are

(2) The exposure is such that the features are
(3) The exposure is such that the features are
(4) The exposure is such that the features are
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(2) The exposure is such that the features are
(3) The exposure is such that the features are
(4) The exposure is such that the features are
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(2) The exposure is such that the features are
(3) The exposure is such that the features are
(4) The exposure is such that the features are
(5) The exposure is such that the features are
4.5 Orthophoto map extracts
Orthophoto maps are modified vertical aerial photographs. For short, we call them orthophotos.
- They are at a scale of 1:10 000 - so 1 cm represents 100 m, and 10 cm represent 1 km.
- The scale is so large that small buildings can be seen; it is even possible to distinguish a tennis court from a netball court!
- The scale is accurate throughout the orthophoto map (unlike on ordinary aerial photographs).
- Labelled contours, spot heights and trig stations have been added - so heights can be determined.
- The contour interval is 5 m.
- It takes 25 orthophoto maps to show the same area as one 1:50 000 topographic map sheet.
- The extract on the left is part of orthophoto 2829 AC 3 Harrismith, published in 1997.

1. 2829 AC 3 Harrismith, Free State
Circled numbers have been added to this orthophoto to direct attention to specific features. You will need to refer to the topographic map extract on page 82 to complete some of the activities.

1. Photo reading and analysis
1.1 Describe the direction in which the longer streets in Harrismith (such as Warden Street) run. (4)
1.2 Identify the features indicated with the numbers 1 to 7. (14)
1.3 State the altitude of feature 4. (2)
1.4 Name the activity carried out in building 8. (2) (22)

2. Interpretation
2.1 Draw cross-section A-B. Use a vertical scale of 1 cm to 20 m. (8)
   a. State as ratios:
      i. the horizontal scale
      ii. the vertical scale. (4)
   b. Calculate the vertical exaggeration of your cross-section. (2)
   c. Name the landform shown by your cross-section. (2)
   d. Explain how it was formed. (5) (22)

2.2 Take a trip. Start at the footbridge marked C. Walk 480 m northeast along Bester Street.
   a. State: Are you walking uphill, downhill or on the level? (2)
   b. Name the street you have reached and are about to cross. (2)
   Turn left and walk just over half a kilometre.
   c. Identify the sort of place you have reached. (4) [8]

2.3 Soil erosion
   a. Identify a place on this orthophoto that shows evidence of soil erosion. (2)
   b. Suggest how this specific example of soil erosion might have been caused here. (4) [6]

2.4 Settlement
   You are looking for a piece of land on which to build. The land should
   • be big enough for six homes with gardens
   • have a view
   • have limited exposure to severe temperature inversions in winter.
   a. State which of the sites D, E and F would best meet your needs.
   b. Name one additional disadvantage of each of the sites you have rejected. (4 x 2 = 8) [8] [66]
2.627BB 19 Florida, Gauteng

Reference to the 1:50 000 topographic map extract on page 86 will help in answering some of these questions. This orthophoto shows the area of square NS and the top third of CS on the topographic map.

1. Orthophoto reading and analysis

1.1 a. At what scale is this orthophoto map? (1)
   b. Is this scale ‘larger’ or ‘smaller’ than on a 1:50 000 topographic map? (1)
1.2 In which direction is the train travelling if it has left R17 and is going towards M17? (2)
1.3 On what true bearing is the wall of the Hennie Hugo Dam (T2 to W2) aligned? (2)
1.4 What is the west–east distance across this orthophoto map extract in kilometres? (2)
1.5 a. For what purpose is the light-coloured area in parts of grid squares G7, G8, H7 and H8 used? (2)
   b. Find its average width (NW–SE) in metres. (2)
   c. Find its average length (NE–SW) in metres. (2)
   d. Determine its area in hectares. (3)
   e. Express that area in square kilometres. (2)
   f. What is the altitude of the road on the northern side of this feature? (2)
1.6 You are travelling southwards along the N1 freeway from H12 to Y16.
   a. Is the freeway sloping downhill or uphill? (2)
   b. Explain your answer. (2) [25]

2. Interpretation

Most of these questions relate to Grade 12 Geography content.

2.1 Climatology

   a. Explain why winter frost is more likely at L5 than at L5. (2)
   b. Suggest two reasons for air pollution being more serious in area S16 than in area E16. (4) [6]

2.2 Fluvial processes

   a. Determine which of these squares best defines the watershed in this area:
      i. S2 and V2
      ii. M14 and S14
      iii. E7 and E17
      iv. E7 and V7. (4)
   b. Name the square that shows the lowest part of the watershed. (3)
   c. State in which direction water flows from the Hennie Hugo Dam (U2). (2)
   d. Explain your answer (two reasons). (4)
   e. In which square is the steepest slope shown? (2)
   f. Is the slope between G1 and L1 uniform, stepped, convex or concave? (2) [17]

2.3 Settlement

   a. Explain what ‘high housing density’ means. (4)
   b. Identify which of these two squares shows a higher housing density: B17 or O6. (2)
   c. Identify the street patterns in
      i. L9
      ii. A12 (2 × 2 × 4)
   d. Name two advantages of living in Q8 rather than Q14. (4)
   e. Match the relevant residential patterns in the grid squares in list A with residential styles selected from list B.

   f. Suggest two reasons for classing the residential area in C9 as a relatively recent development.
      i. Identify in squares B13 and D5 two human-made features that are related to water supply. (4)
      ii. Explain why this was a suitable location for these features. (4)
      iii. Identify two pieces of evidence to support the statement that when the N1 freeway was built, it cut through existing suburban structures. (4) [38]

2.4 People and their needs

   a. Arrange these squares in descending order, starting with the one with the highest electrical energy consumption: O6, B17, W4, H12, K10. (3)
   b. Identify the energy sources that are most commonly used in these squares:
      i. N16
      ii. T14
      iii. NR. (2 × 3 × 6) [9] [95]

   f. Suggest two reasons for classing the residential area in C9 as a relatively recent development.
      i. Identify in squares B13 and D5 two human-made features that are related to water supply. (4)
      ii. Explain why this was a suitable location for these features. (4)
      iii. Identify two pieces of evidence to support the statement that when the N1 freeway was built, it cut through existing suburban structures. (4) [38]

   b. Identify the energy sources that are most commonly used in these squares:
      i. N16
      ii. T14
      iii. NR. (2 × 3 × 6) [9] [95]
Translations: English–Afrikaans terms on maps

<table>
<thead>
<tr>
<th>Afrikaans</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baai</td>
<td>Bay</td>
</tr>
<tr>
<td>Begraafplaas</td>
<td>Cemetery</td>
</tr>
<tr>
<td>Bibliotheek</td>
<td>Library</td>
</tr>
<tr>
<td>Blokhuis</td>
<td>Blockhouse</td>
</tr>
<tr>
<td>Boodskanskoor</td>
<td>Forestry Office</td>
</tr>
<tr>
<td>Brug</td>
<td>Bridge</td>
</tr>
<tr>
<td>Fabriek</td>
<td>Factory</td>
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<tr>
<td>Fontein, -fontein</td>
<td>Fountain, Spring</td>
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<td>Fonteineleie</td>
<td>Small Fountain or Spring</td>
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<tr>
<td>Golfbaan</td>
<td>Golf Course</td>
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<td>Groot(te)</td>
<td>Cave(s)</td>
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<td>Hospitaal</td>
<td>Hospital</td>
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<td>Drive-in Cinema</td>
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<td>Caravan Park</td>
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<td>Clinic</td>
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<td>Landingsstrook</td>
<td>Landing Strip</td>
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<tr>
<td>Lousie</td>
<td>Location ('black' suburb)</td>
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<td>Oogbouwings</td>
<td>Diggings, Excavations</td>
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<td>Ou Plaaas</td>
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<td>Plantation</td>
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<td>Pump</td>
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<td>Sletbaan</td>
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<td>-vlei</td>
<td>Abandoned</td>
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<td>Swamp, Marsh, Lake</td>
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<td>Vooi</td>
<td>Aerodrome (Airfield)</td>
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<td>Voorbrand</td>
<td>Parrow</td>
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<td>Waterfilterwerke</td>
<td>Firebreak</td>
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<td>Water Filtration Works</td>
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Self-assessment checklist for mapwork

Name: ___________________________ Date: ___________________________

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<tr>
<th>I can</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. on maps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>use the map index system to locate a specific map sheet</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>identify most point, line and area symbols used on 1:50 000 topographic maps</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>locate points on a topographic map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>locate an area inside a grid square on a map using its coordinates</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>name direction using compass points</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>measure bearing accurately on a 1:50 000 map, using a protractor</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>use information to determine magnetic declination in a given month</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>calculate magnetic bearing on a map in a given month</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>accurately determine straight-line distances on a map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>accurately determine curved-line or route distances on a map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>calculate the size of ground areas shown on maps using different methods</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>find information about altitude from a topographic map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>use contours on a map to determine landforms (such as valleys, spurs, slopes)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>name different slope profiles from contour patterns on a map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>calculate the average gradient between two points on a map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>find the gradient of a section of slope using a gradient scale</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>draw cross-sections at least fairly well</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>draw cross-sections accurately</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>calculate the vertical exaggeration of a cross-section I have drawn</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>determine from map information whether two ground points are intervisible</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>use map data in speed, distance and time calculations</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>orientate a map of my school area</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>interpret information that could be inferred from topographic maps</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>identify general relief and drainage features</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>make reasoned statements about the climate in the map area</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>locate different land uses in the map area</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>describe settlement types and patterns on a map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>draw précis maps of key physical and cultural features on maps</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>explain relationships between some of these features</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>apply my knowledge of physical geography to understanding a topographic map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>apply my ability to read a topographic map to understanding physical geography</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>apply my ability to read a topographic map to the geography of settlements</td>
<td>Yes</td>
<td>No</td>
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2. on aerial photographs and orthophoto maps

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<tr>
<th>I can</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
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</thead>
<tbody>
<tr>
<td>distinguish between orthophotos and vertical and oblique aerial photographs</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<td>determine the size of the area shown</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>interpret information inferred from aerial photos and orthophotos</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>identify general relief and drainage features</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>identify some specific landforms</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>make reasoned statements about the climate and vegetation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>describe settlement types and patterns shown</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>locate different land uses</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>draw précis maps of key physical and cultural features</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>explain relationships between some of these features</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>read an aerial photograph in conjunction with a topographic map of the same area</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>apply my ability to read photos to other sections of geography</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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</table>

3. on satellite images

<table>
<thead>
<tr>
<th>I can</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>determine the size of the area shown</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>identify the key features or items shown</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>read the image in conjunction with an atlas or topographic map of the same area</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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</table>

4. on topical or thematic maps

<table>
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<tr>
<th>I can</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>identify the topic being illustrated on the map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>analyse the key message(s) of the map</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>identify differences in the spatial distribution of the data shown</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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</tbody>
</table>

Concept not examined/tested in this grade
Key formulas you need

Distance
Measure map distance in centimetres. Divide by 2 to find ground distance in kilometres.
Ground distance in kilometres × 1000 = ground distance in metres.

Area
Rectangular areas: \( a = l \times w \)
I.e., area (square metres \((\text{m}^2)\)) = length (metres) \( \times \) width (metres)
or area (square kilometres \((\text{km}^2)\)) = length (kilometres) \( \times \) width (kilometres)

Triangular areas: \( a = \frac{1}{2} \times l \times w \)
I.e., length (metres) \( \times \) width (metres) \( \div 2 \) = area (square metres \((\text{m}^2)\))
or length (kilometres) \( \times \) width (kilometres) \( \div 2 \) = area (square kilometres \((\text{km}^2)\))

Gradient
Gradient of a slope = \frac{\text{height}}{\text{distance}} = \frac{\text{up (metres)}}{\text{along (metres)}}

Vertical exaggeration
Vertical exaggeration = \frac{\text{vertical scale (on the cross-section)}}{\text{horizontal scale (on map and section)}}

Magnetic bearing
Magnetic bearing = true bearing + present magnetic declination
• Remember: Bearings are always given in degrees measured clockwise from north.

Speed, distance and time
Speed = \frac{\text{Distance}}{\text{Time}}
Time = \frac{\text{Distance}}{\text{Speed}}
Distance = \text{Speed} \times \text{Time}

Finding the scale of a vertical aerial photograph
Scale as a representative fraction = \frac{\text{photo distance between two points (in metres)}}{\text{ground distance between same points (in metres)}}

Conversions
Distance
10 mm = 1 cm
100 cm = 1 m
1000 m = 1 km

Area
10 000 m\(^2\) = 1 hectare
100 ha = 1 km\(^2\)

Photocopies of this page can be used for cross-section drawings and for finding areas.
<table>
<thead>
<tr>
<th>Learning Outcomes and Assessment Standards</th>
<th>Activities/Assignments in each chapter</th>
<th>Chap. 1</th>
<th>Chap. 2</th>
<th>Chap. 4</th>
<th>4.1 &amp; 4.2</th>
<th>4.3</th>
<th>4.4</th>
<th>4.5</th>
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<tbody>
<tr>
<td>Learning Outcome 1: Geographical Skills and Techniques</td>
<td>AS1: Identify issues and formulate questions for an investigation</td>
<td>1, 2, 3, 4</td>
<td>4.2</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>AS2: Acquire information from a variety of sources</td>
<td>1, 2, 6, 7, 8, 9, 11, 13</td>
<td>4.1, 4.2</td>
<td>4.2, 8, 6, 7, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<tr>
<td></td>
<td>AS3: Organize information graphically, pictorially and diagrammatically</td>
<td>5</td>
<td>12, 14, 16</td>
<td>4.1, 4.2</td>
<td>3.4, 5, 7, 8, 9</td>
<td>4.5</td>
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<tr>
<td></td>
<td>AS4: Analyse information obtained from a variety of sources</td>
<td>1, 4</td>
<td>3.7, 8, 9, 10, 15</td>
<td>4.1, 4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<tr>
<td></td>
<td>AS5: Report findings in oral and/or written form.</td>
<td>1.4, 5</td>
<td>2.4, 9, 11, 12, 13, 15</td>
<td>4.1, 4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<tr>
<td>Learning Outcome 2: Knowledge and Understanding</td>
<td>AS1: Describe processes and associated spatial patterns in places and regions</td>
<td>8, 9, 11, 12, 14, 15, 16</td>
<td>4.1, 4.2</td>
<td>2.3, 4, 6, 7</td>
<td>1.5</td>
<td>1.2</td>
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<tr>
<td></td>
<td>AS2: Identify similarities and differences in processes and spatial patterns between places or between regions</td>
<td>2, 4</td>
<td>8, 9, 10, 14</td>
<td>4.1</td>
<td>2.3, 6, 7, 8, 10</td>
<td>1.5</td>
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<tr>
<td></td>
<td>AS3: Describe the links between environmental problems and social injustices in a local and global context</td>
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<td>AS4: Describe the interdependence between humans and the environment at different scales.</td>
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<td>4.1</td>
<td>5, 6, 8, 10</td>
<td>1, 3, 4, 5</td>
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<tr>
<td>Learning Outcome 3: Application</td>
<td>AS1: Apply skills and knowledge to a range of phenomena, issues and challenges at a local and global scale</td>
<td>4.1</td>
<td>1, 3, 5, 6</td>
<td>4</td>
<td>1, 2</td>
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<tr>
<td></td>
<td>AS2: Identify different values and attitudes held by individuals and groups associated with processes, spatial patterns, and human-environment interactions on a local and global scale.</td>
<td>4.2</td>
<td>1, 3, 9</td>
<td>1, 2, 3, 4</td>
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<table>
<thead>
<tr>
<th>Learning Outcomes and Assessment Standards</th>
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<th>4.3</th>
<th>4.4</th>
<th>4.5</th>
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<tr>
<td>Learning Outcome 1: Geographical Skills and Techniques</td>
<td>AS1: Plan and structure a project or enquiry process</td>
<td>1, 2, 3, 4</td>
<td>1, 2, 5, 6, 7, 8, 9, 11, 13</td>
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<td></td>
<td>AS2: Acquire information from a variety of sources</td>
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<td>1, 2, 5, 6, 7, 8, 9, 11, 13</td>
<td>4.1, 4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<tr>
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<td>AS3: Classify the acquired information according to different categories</td>
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<td>1, 4, 9, 10, 16</td>
<td>4.1</td>
<td>3.4, 6</td>
<td>5</td>
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<tr>
<td></td>
<td>AS4: Analyse information obtained from a variety of sources – including fieldwork data, 1:50 000 topographic maps, orthophoto maps and statistics</td>
<td>1, 2, 4</td>
<td>3.10, 16</td>
<td>4.2</td>
<td>2.3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>AS5: Report findings in written, oral and/or illustrative form.</td>
<td>1, 4, 5</td>
<td>3.4, 9, 10, 11, 12, 13, 15</td>
<td>4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
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<tr>
<td>Learning Outcome 2: Knowledge and Understanding</td>
<td>AS1: Explain processes and associated spatial patterns in a range of places and regions</td>
<td>14</td>
<td>4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
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<td>1, 2</td>
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<td></td>
<td>AS2: Compare and contrast processes and spatial patterns between places and/or between regions</td>
<td>2</td>
<td>8, 9, 10, 14</td>
<td>4.1</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 5</td>
<td>1, 2</td>
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<td>AS3: Examine issues and challenges arising from human and environment interactions in a local/continental context</td>
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<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 4, 5</td>
<td>1, 2</td>
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<td>AS4: Explain different measures of conserving the environment while addressing human needs in a variety of contexts.</td>
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<td>2.3, 6, 10</td>
<td>4.5</td>
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<tr>
<td>Learning Outcome 3: Application</td>
<td>AS1: Apply skills and knowledge to a range of phenomena, issues and challenges at a local and continental scale</td>
<td>4.1</td>
<td>4, 5, 6, 7</td>
<td>4.5</td>
<td>1, 2</td>
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<tr>
<td></td>
<td>AS2: Examine the consequences of actions resulting from values and attitudes held by individuals and groups which influence processes, spatial patterns, and human-environment interactions on a local and continental scale.</td>
<td>4.2</td>
<td>1.2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>1, 2, 3, 4, 5</td>
<td></td>
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</tbody>
</table>
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### Learning Outcomes, Assessment Standards and activity references for Geography Grade 12

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#### Learning Outcome 1: Geographical Skills and Techniques

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#### Learning Outcome 2: Knowledge and Understanding

| AS1: Explain the influence of processes and associated spatial patterns in a range of places and regions | 4 | 8, 10 | 4.2 | 1.2, 3, 4.5, 6.7, 8.9, 10 |
|-----------------------------------------------|-----------------|-----------------|
| AS2: Account for the similarities and differences in processes and spatial patterns between places and between regions | 4 | 8 | 4.1 | 1.2, 3, 4.5, 6.7 |
| AS3: Explore possible responses to issues and challenges arising from human and environment interactions in a local/national context | 5 | 4.2 | 1.2, 4, 5.6, 8.9, 10 |
| AS4: Examine different approaches used to sustain the environment that take into account different knowledge systems in a variety of contexts | 4, 6, 10 | 5 |

#### Learning Outcome 3: Application

| AS1: Apply skills and knowledge to a range of phenomena, issues and challenges at a local and national scale | 4 | 4.1, 4.2 | 1.2, 3, 4.5, 6.7, 8.9, 10 |
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| AS2: Examine values and attitudes held by individuals and groups associated with processes, spatial patterns, and human-environment interactions on a local and national scale. | 5 | 4.2 | 1.3, 4, 5.7, 9.10 | 1.2, 3, 4.5 | 1 |
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