Irrigation Manual
Module 6

# Guidelines for the Preparation of Technical Drawings

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# Contents

# List of figures



# List of tables

# Chapter 1
# Introduction

Technical drawings should be prepared for every design, whether it refers to a scheme layout, a structure or a longitudinal profile of a canal. They are essential for completing the engineering design, for estimating the quantities of materials and relative costs and for implementing the project.

Technical drawings also communicate to the contractor all the information that the designer or client has developed. Contractors, on their part, are always required to provide the client with so-called Working drawings and As built or Record drawings (see Module 12). These drawings should incorporate any modifications made to the originals provided by the client during construction.

Technical drawings also serve as future reference for anyone who wants to obtain information about the scheme, for example for operation, maintenance, repairs and rehabilitation purposes.

Simple freehand sketches are convenient forerunners to the final working, and are frequently used for preliminary studies or to illustrate an explanation during a discussion. They are also a logical way for the designer to convey their ideas to the draftsperson. Freehand sketches may be used for developing plans by testing a number of alternative designs, or for evolving detail drawings of complex project elements. They are particularly useful in recording details and dimensions from existing structures or prefabricated units.

Once the final drawing has been chosen from the sketches, it is re-drawn with instruments on tracing paper so that prints may be readily made. Relatively light paper, 70-75 g/m$^2$ paper, can generally be used. However, if many prints have to be made heavier paper should be used. Plastic tracing film is a more durable material than tracing paper, especially for handling and storage, and it has the advantage that ink can be removed with a moist eraser. It is however more expensive than tracing paper and requires the use of special lead and drawing pens, since its surface is much harder.

Technical drawings should be easily understood, and comprehensive and detailed enough for the purpose. They should be a good record of the designer's intentions. In this module standardization of drawings and guidelines to be adhered to by designers and to be used in the drawing office will be discussed.

# Chapter 2
# Drawing equipment

It is important to have a permanent workplace, a drawing office, for the preparation of drawings. The layout of the drawing office should provide an efficient and comfortable environment for the draftsperson. This includes a good chair (stool) of convenient height, a good tiltable drawing board, sufficient light and sufficient space for the drawing equipment (Table 1).

A good drawing board should be large enough to hold the size of the paper selected (see Chapter 3). While a sheet of hardboard or blockboard may be used as a drawing board, it is advisable to install a hardwood edge such as ebony. It may be necessary to saw longitudinal grooves 75-100 mm apart in the back of the board to prevent warping. The board may be placed on a table or on trestles and should be covered with thick white paper or special plastic to give a smooth surface. Drafting tape should be used to affix the tracing paper or film to the table, as the low adhesion allows for easy removal without damage.

**Table 1**
**Minimum equipment requirements for a reasonable drawing office**

| | | |
|---|---|---|
| **Furniture** | : | Table<br>Chair<br>Light<br>Drawing board<br>Cutting board |
| **Curves** | : | Circles template<br>Ellipse template<br>Lettering template or stencil<br>French curve<br>Flexible curve<br>Compass plus bar |
| **Fixing** | : | Drawing tape<br>Masking tape<br>Drawing pins<br>Weights |
| **Erasing** | : | Rubber (vinyl)<br>Ink rubber<br>Razor blade<br>Erasing shield |
| **Lines** | : | T-square<br>Set squares<br>Adjustable set square<br>Scale rule<br>Protractor<br>Hangers<br>Metal ruler |
| **Filing** | : | Files<br>Fling cabinet or drawer |
| **Pens/pencils** | : | Cedarwood pencil<br>Clutch pencil 2mm<br>Clutch pencil 0.3-0.9mm<br>Leads (2H, HB, 2B)<br>Ink-pen 0.25, 0.35, 0.50, 0.70<br>Fibre-tip pens |
| **Sharpeners** | : | Pen knife<br>Mechanical sharpeners<br>Sand paper |
| **Cutting** | : | Scissors<br>Knife<br>Scalpel |
| **Paper** | : | Sketching A4 transparent<br>Tracing A1 transparent<br>Scratch pad A4<br>Card board<br>Sketch book<br>Grid paper |
| **Handling** | : | Storage shelf<br>Tubes<br>Case for instruments |
| **Other** | : | Cleaning cloth |

# Chapter 3
# Sizes and scales of drawings

For technical drawings normal A-size papers are usually used, for which there is a fixed relation of $\sqrt{2}$:1 between the length and width of the paper (Figure 1 and Table 2). In simple terms, this relation means that the length is 1.41 times the width. The width of one paper size is equal to the length of the next smaller size and the length of one size is equal to two times the width of the next smaller size (Table 2). This means that the area of the next smaller size is half the area of the preceding size. The fixed relation between length and width allows reductions and enlargements of drawings to be made.

**Figure 1**
**Relationship between the different normal A-size papers**

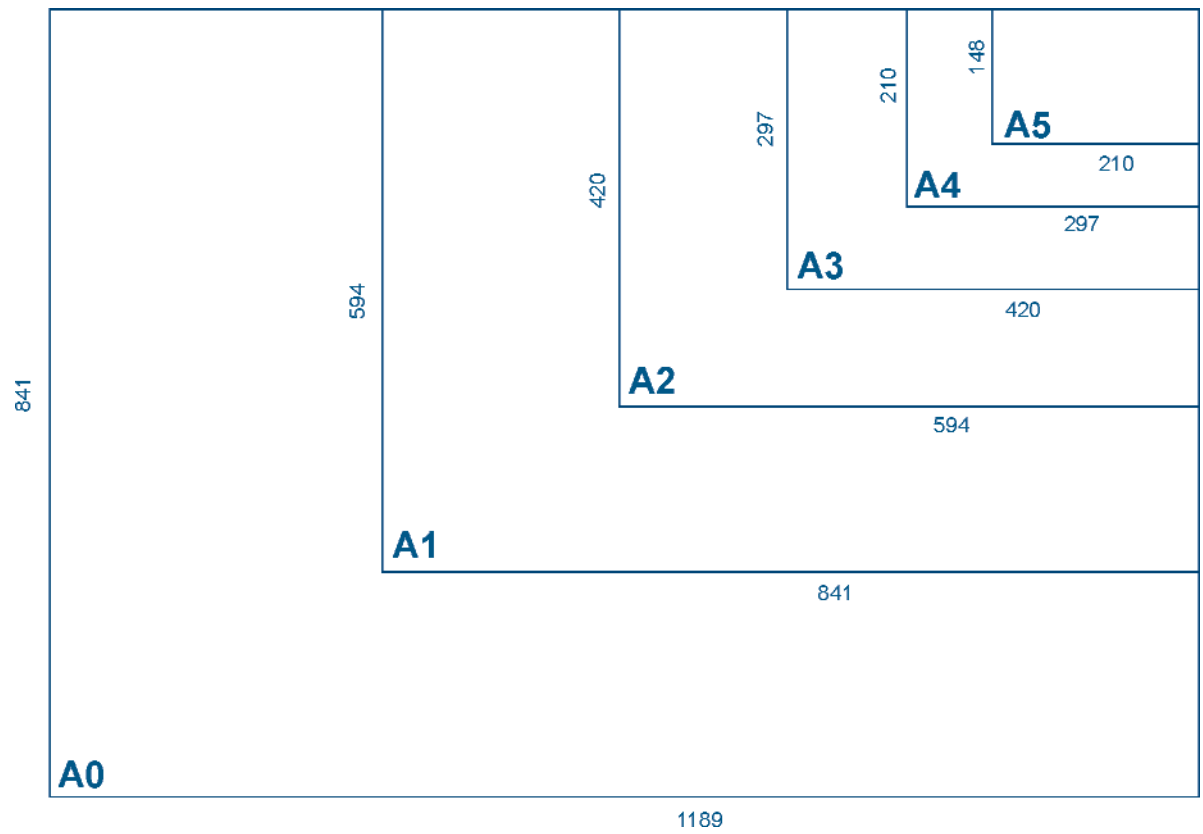



**Table 2**
**Nominal sizes and areas of normal A-size papers**

| Format | Nominal size: width (mm) x length (mm) | Area ($m^2$) |
|---|---|---|
| A0 | 841 x 1189 | 1.00 |
| A1 | 594 x 841 | 0.50 |
| A2 | 420 x 594 | 0.25 |
| A3 | 297 x 420 | 0.125 |
| A4 | 210 x 297 | 0.0625 |
| A5 | 148 x 210 | 0.0312 |

**Table 3**
**Nominal sizes and areas of alternative A-size papers**

| Format | Nominal size: width (mm) x length (mm) | Area ($m^2$) |
|---|---|---|
| A10 | 594 x 1189 | 0.70 |
| A20 | 420 x 1189 | 0.50 |
| A21 | 420 x 841 | 0.35 |
| A31 | 297 x 841 | 0.25 |
| A32 | 297 x 594 | 0.18 |

If the project plans tend to be very long, as can be the case when drawing a longitudinal profile of a canal for example, alternative A-sizes may be useful (Table 3).

The formats A0, A10 and A20 are difficult to handle and should be avoided, if possible. Instead, try to use a smaller scale or divide the figure into more drawings. If possible, only one format should be used for all drawings in a project or alternatively all drawings should have the same height.

A number of sheets of each size of paper should be sourced in advance and kept in the drawing office. Then, whenever a drawing is brought into the drawing office for tracing, the best paper size can be chosen. The designer should select the scale of the drawings such that they fit onto the selected paper size and enough detail can be seen.

For contour maps prepared for irrigation purposes and for irrigation layouts, common scales vary from 1:500 to 1:2 000 depending on the size of area. It is not recommended to use scales larger than 1:2 000. If the scheme area cannot fit within one drawing, it is recommended to divide the area into appropriate blocks and make more drawings. For structures, the scales normally vary from 1:5 to 1:100. Sufficient cross-sections and details should be included.

Before starting to draw, one should estimate how large the figure will be and centre it on the page. A worthwhile aid to include is a small figure, identifying the location of a detail drawing in relation to the master plan.

The scale of a drawing should be shown on a line scale form, so that it remains valid when reducing or enlarging the drawing through photocopying.

# Chapter 4
# Drawing lines and characters

## 4.1. Lines and line work

Principal lines are first sketched by pencil using a number of short strokes. Once the joining points have been established and lines are satisfactorily straight, they may be traced by ink-pen and darkened as needed to give emphasis and easy reading. All lines should be uniformly black.

Thick continuous lines define visible edges and outlines, while thin continuous lines are for dimensioning and leader lines.

Dashed lines indicate hidden outlines and edges while thin, mixed broken and dotted lines are mostly used for centre lines. Dashed lines should start and end with dashes in contact with the hidden or visible lines from which they originate. If a dashed line meets a curved line tangentially, it should be so marked using a solid portion of dashed line. All chain lines should start and finish with a long dash.

Centre lines show the centre of a structure, such as a road or part of it, or they indicate at what place in the structure a designed cross-section is taken. When centre lines define centre points, they should cross one another at long dash portions of the line. Centre lines should extend only a short distance beyond the feature or view to which they apply, and they should not touch a line off the drawing (for example the lines indicating the dimensions).

The drawings presented in this module provide illustrations of all these lines.

## 4.2. Lettering and numerals

Ideally, in technical drawings letters and numbers of a straight upright type (sans serif) are used, as shown in the example in the box below.

Clarity, style, spacing and size are very important in a technical drawing. Using the correct techniques, clear lettering can be produced as easily and as swiftly as scratchy letters. Suggested heights for letters are:

- 3 mm or 0.3 cm for the text in figures, measurements and descriptive techniques
- 5 mm or 0.5 cm and 7 mm or 0.7 cm for headings and for drawings that will be reduced

Lettering should normally run from left to right and be parallel to the edge of the sheet. When it becomes necessary for lettering to run vertically it should always run from the bottom upwards.

Notes and captions should be placed in such a way that they can be read in the same direction as the title block. The underlining of notes and captions is not recommended. Instead, larger characters should be used to draw attention to a note or a caption.

For an unskilled draftsperson, guiding lines may be essential. They may be drawn lightly in pencil for subsequent erasure when lettering is done in ink; or they may take the form of a closely-gridded sheet laid underneath the transparent tracing paper.

Letters and words are spaced by eye rather than by measuring. If the proportion, form and spacing of the letters are done properly, the result will be pleasing to the eye.

Figure 2 shows the different stencils, ink-pen sizes and letter heights that can be used in lettering.

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z** – bold
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z – regular
**a b c d e f g h i j k l m n o p q r s t u v w x y z** – bold
a b c d e f g h i j k l m n o p q r s t u v w x y z – regular
**1 2 3 4 5 6 7 8 9 0** – bold
1 2 3 4 5 6 7 8 9 0 – regular

**Figure 2**

**An example of the different stencils and letter heights used in lettering**

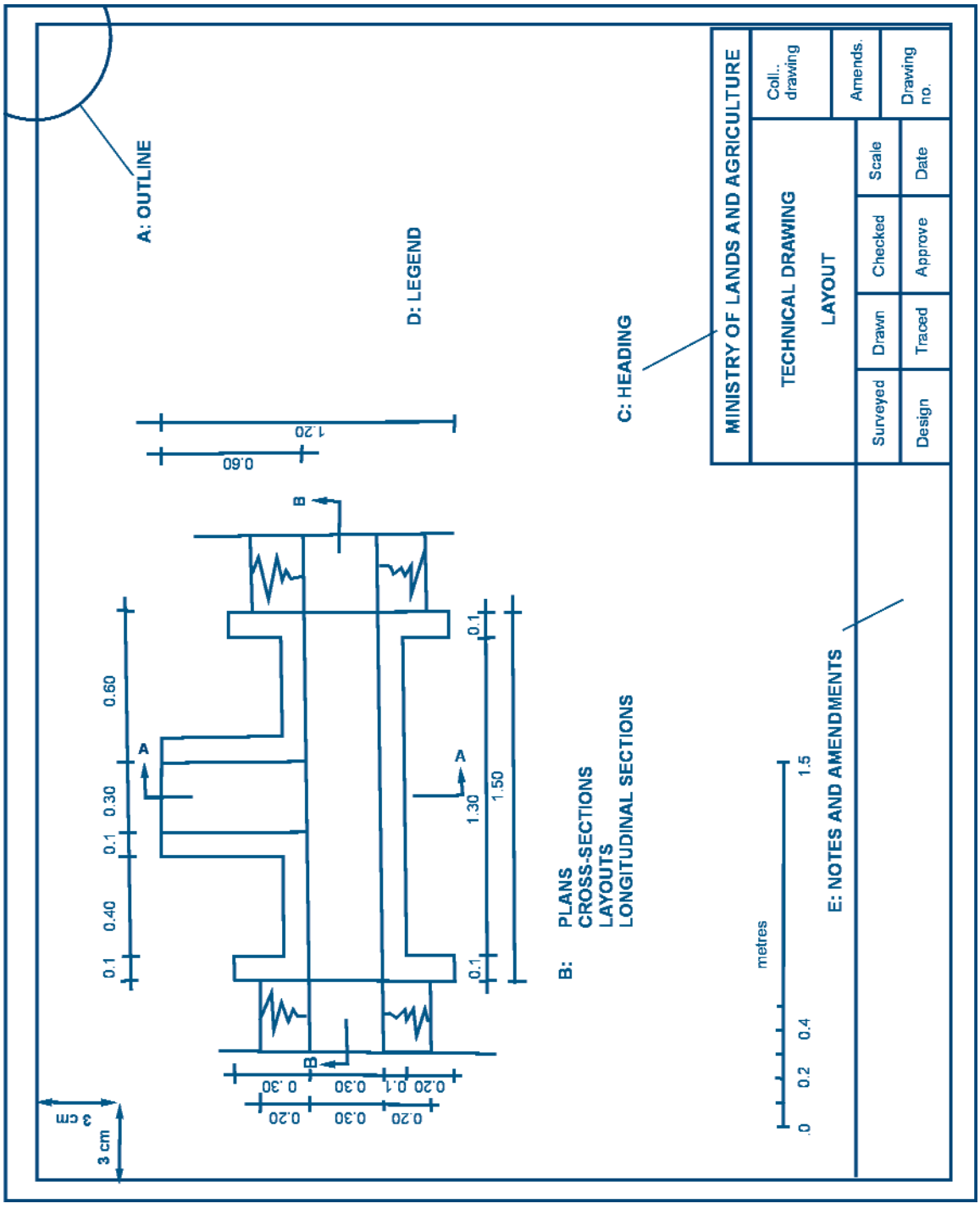
| STENCIL SIZE | | Letter height mm |
|---|---|---|
| 40 | | 1 |
| 50 | | 1.2 |
| 60 | A A B C | 1.5 |
| 80 | A A B C D | 2 |
| 100 | A B C D E | 2.5 |
| 120 | A B C D E | 3 |
| 140 | A B C D E F | 3.5 |
| 175 | A B C D E F G | 4.5 |
| 200 | A B C D E F G H | 5 |
| 240 | A B C D E F G H | 6 |
| 290 | B C D E F G H K | 7.5 |
| 350 | B C D E F G H K | 9 |
| 425 | BCDEFGHK | 10.5 |
| 500 | BCDEFGHKL | 12 |

Stencil means template

# Chapter 5
# Layout of drawings

Figure 3 gives a schematic layout of a technical drawing. The details (A, B, C and D) will be explained in the next sections, and the most commonly used ink-pen size or thickness of 0.50, 0.35 and 0.25 mm will be indicated in italics.

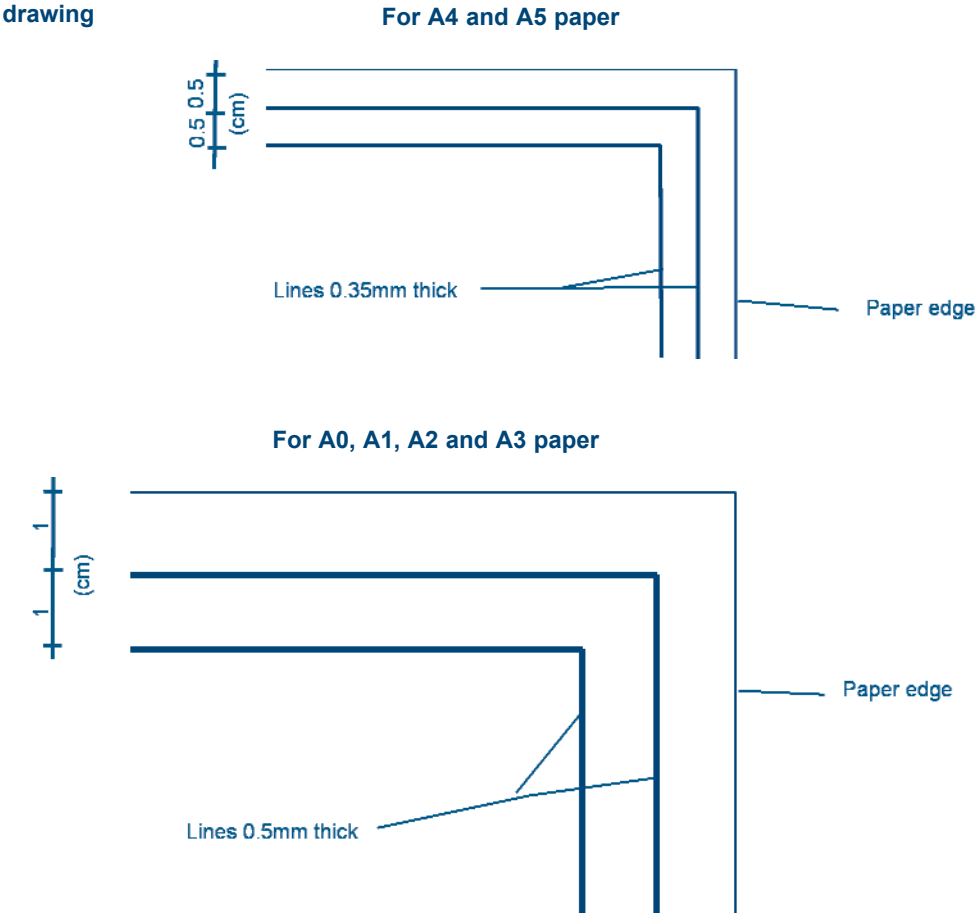
**Figure 3**
**Schematic layout of a technical drawing**



## 5.1. Outline

For A0, A1, A2 and A3 size paper, an outline is made by tracing two lines at the edge of the paper at 1 cm spacing (Figure 4). The line thickness to be used is 0.50 mm. For A4 and A5 size paper, it is 0.5 cm spacing and 0.35 mm line thickness.

**Figure 4**
**Outline of a drawing**




## 5.2. Plan, cross-section, scheme layout, longitudinal profile and contour map

### 5.2.1. Plans and cross-sections of structures

For every structure, a clear plan (top view) and a sufficient number of cross-sections should be made so that the drawing is clear. The drawing should be clear enough that the structure can be constructed on site by reading the drawing. Figures 5 and 6 give an example of a top view and a cross-section respectively.

There should always be at least 3 cm spacing between the outline and the drawing, depending on the size of the paper. By doing so, one avoids squeezing in the dimensions of the structure. It is recommended to trace the structure itself with the 0.5 mm ink-pen size. Less important aspects of the drawing, such as the canal in Figure 5, should be traced with the 0.35 mm pen. All dimension and centre lines should be traced with the 0.25 mm pen. The cutoff lines are also broken and dotted using a thickness of 0.25 mm.

The recommended ink-pen sizes for the different lines, letters and numbers are indicated in the Figures 5-11.

The parts of the structure through which one should cut in order to get a view of its section could be shaded, as with the concrete floor in Figure 6. This is usually done by drawing lines across the section at an angle of 45° to the edges of the structure, as is done at the middle of the concrete floor in Figure 6. Alternatively, dots could be used, as shown at the edges of the concrete floor of Figure 6.

### 5.2.2. Layout of a sprinkler irrigation scheme

Figure 7 shows an example of lines, lettering and numerals used in the drawing of a layout of a sprinkler irrigation system.

**Figure 5**

**Example of lines, lettering and numerals used in the drawing of the plan of a diversion structure**

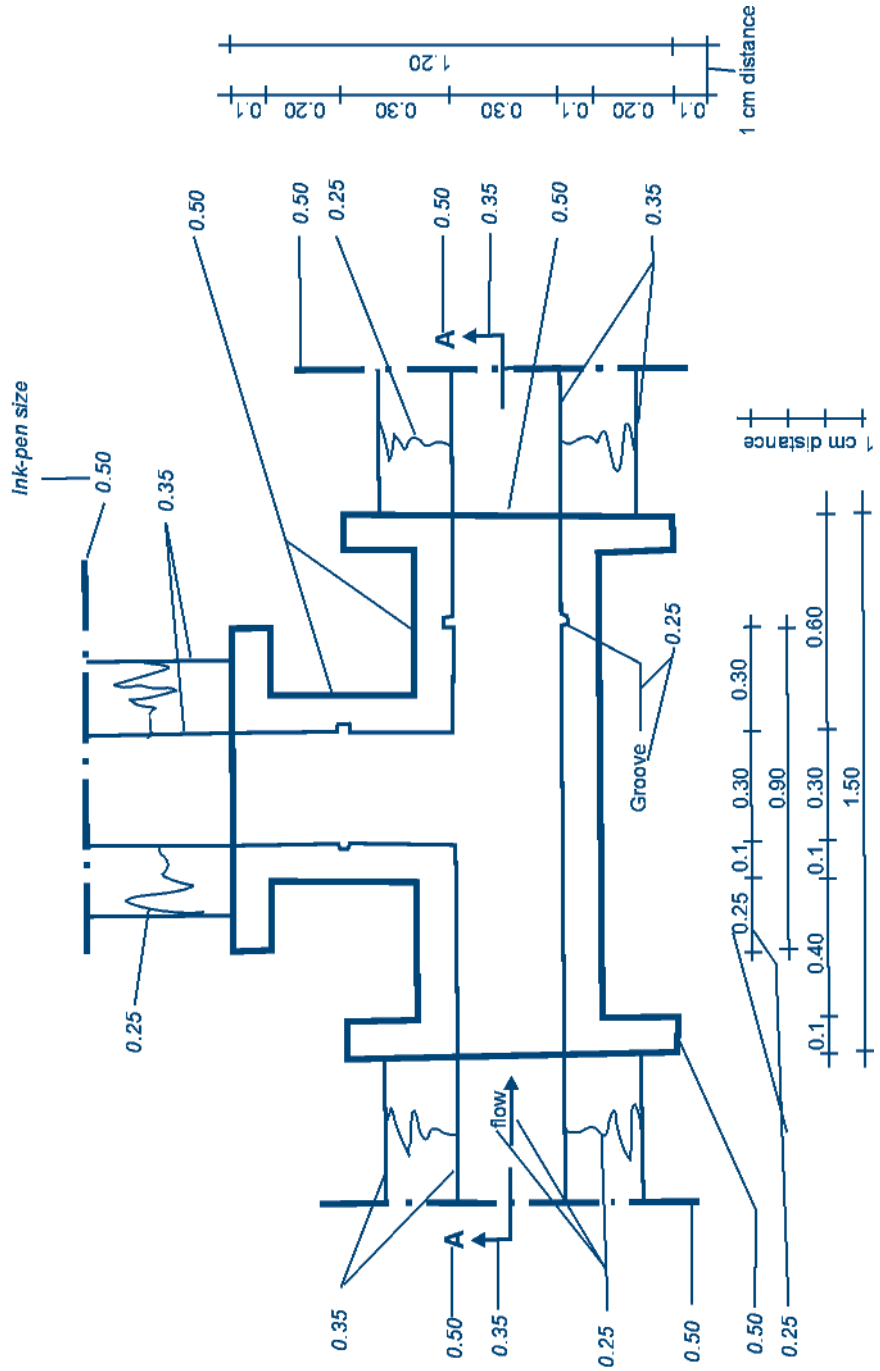


**Figure 6**

**Example of lines and numerals used in the drawing of a cross-section (A-A in Figure 5) of a diversion structure**

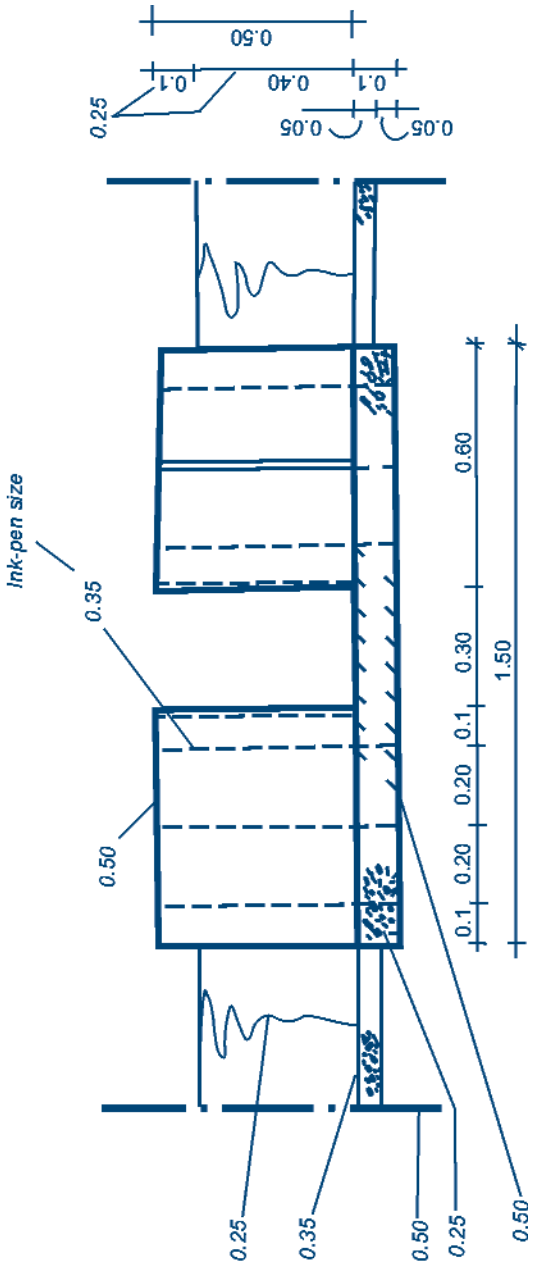
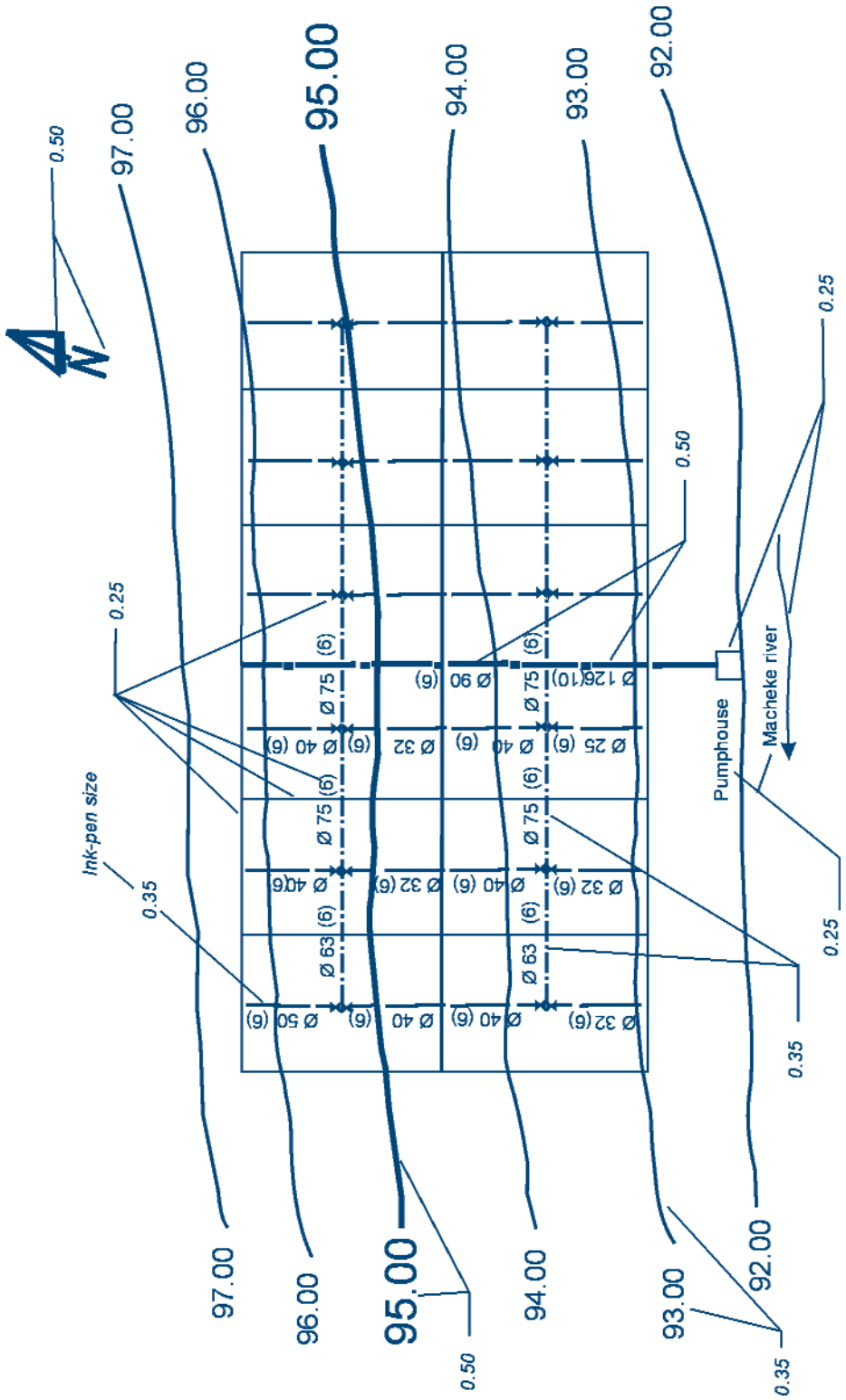


**Figure 7**

**Example of lines, lettering and numerals used in the drawing of the layout of a sprinkler irrigation scheme**

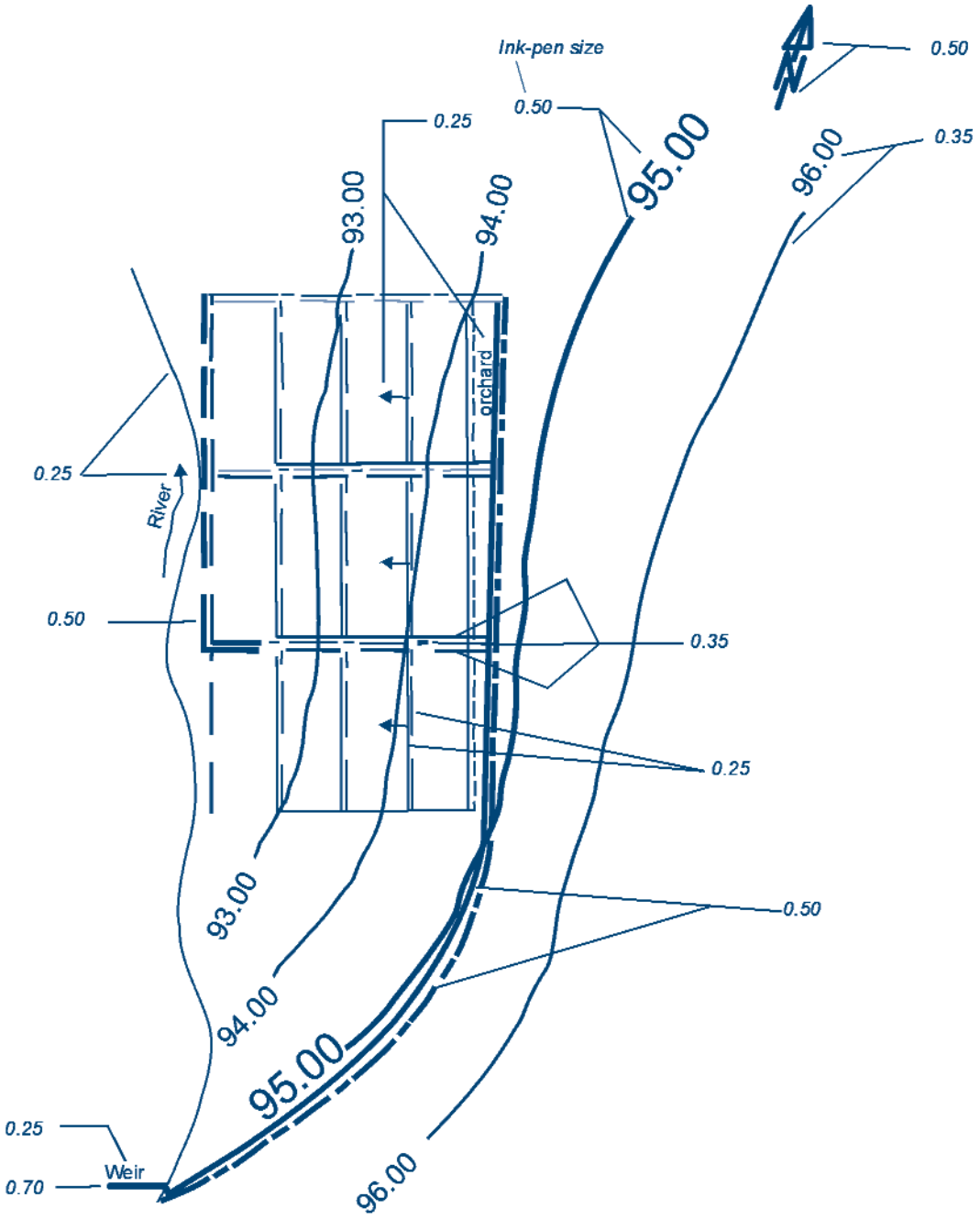


The tracing should be done such that the biggest size pipe is indicated with a 0.50 mm pen. For smaller size pipes subsequently smaller size ink-pens are used. As there are usually more pipe sizes than there are available ink-pen sizes, it is important to clearly indicate the diameter and the class of the pipe, as is done in Figure 7. For example, Ø 63 refers to the pipe diameter and the number 6 between brackets refers to the pipe class. All pipelines should be indicated with a broken line (see the 25, 32, 40 and 50 mm pipes) or a mixed broken and dotted line (see the 63, 75, 90 and 126 mm pipes). All segments of a same pipe size should have the same ink-pen thickness and also the same segment length.

### 5.2.3. Layout of a surface irrigation scheme

The layout of a surface scheme should be traced in the same way as a sprinkler scheme. Figure 8 shows an example of lines, lettering and numerals used in the drawing of a layout of a surface irrigation system.

**Figure 8**
**Example of lines, lettering and numerals used in the drawing of the layout of a surface irrigation scheme**

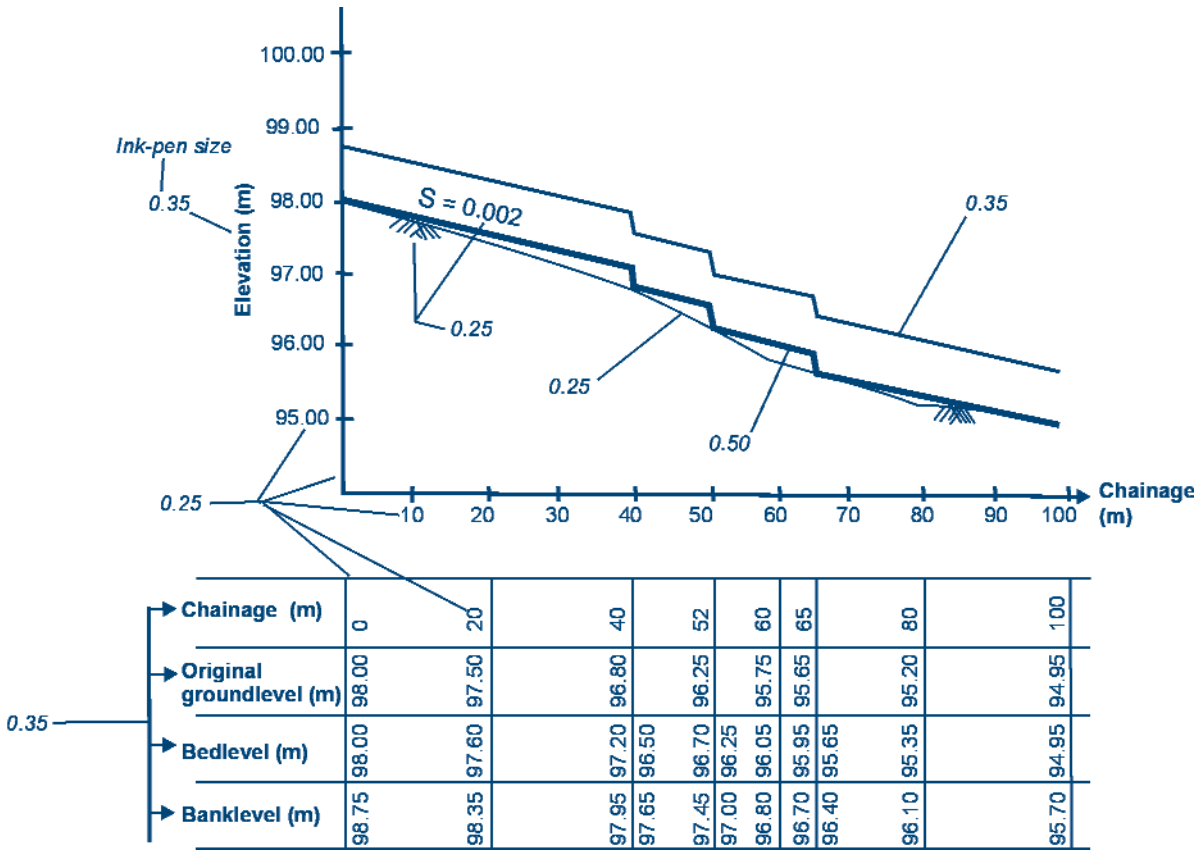


The larger canal sizes should be traced with the largest size ink-pen (0.50 mm). Irrigation canals should be indicated with continuous lines, drainage channels should be indicated with broken lines. In Figure 8, some drainage channels are perpendicular to the direction of the irrigation water flow over the field (and at the bottom of the field). The arrows starting from field canals indicate the direction of the irrigation water flow. Other drains, which are parallel to the infield roads (shown by dashed lines with long and short segments), are parallel to the arrows showing flow direction. Surface irrigation schemes usually have many different kinds of structures, for example diversion and drop structures, bridges and culverts. These should all be explained in the legend (see Section 5.4 and Figure 12).

### 5.2.4. Longitudinal profiles

Drawings showing longitudinal profiles of canals are not only prepared to calculate required earthworks but also to facilitate their setting out during construction. One should select an appropriate vertical and horizontal scale, such that the figure fits on the paper size and enough detail can be read. Figure 9 shows an example of a longitudinal profile. The recommended ink-pen sizes to be used are again indicated.

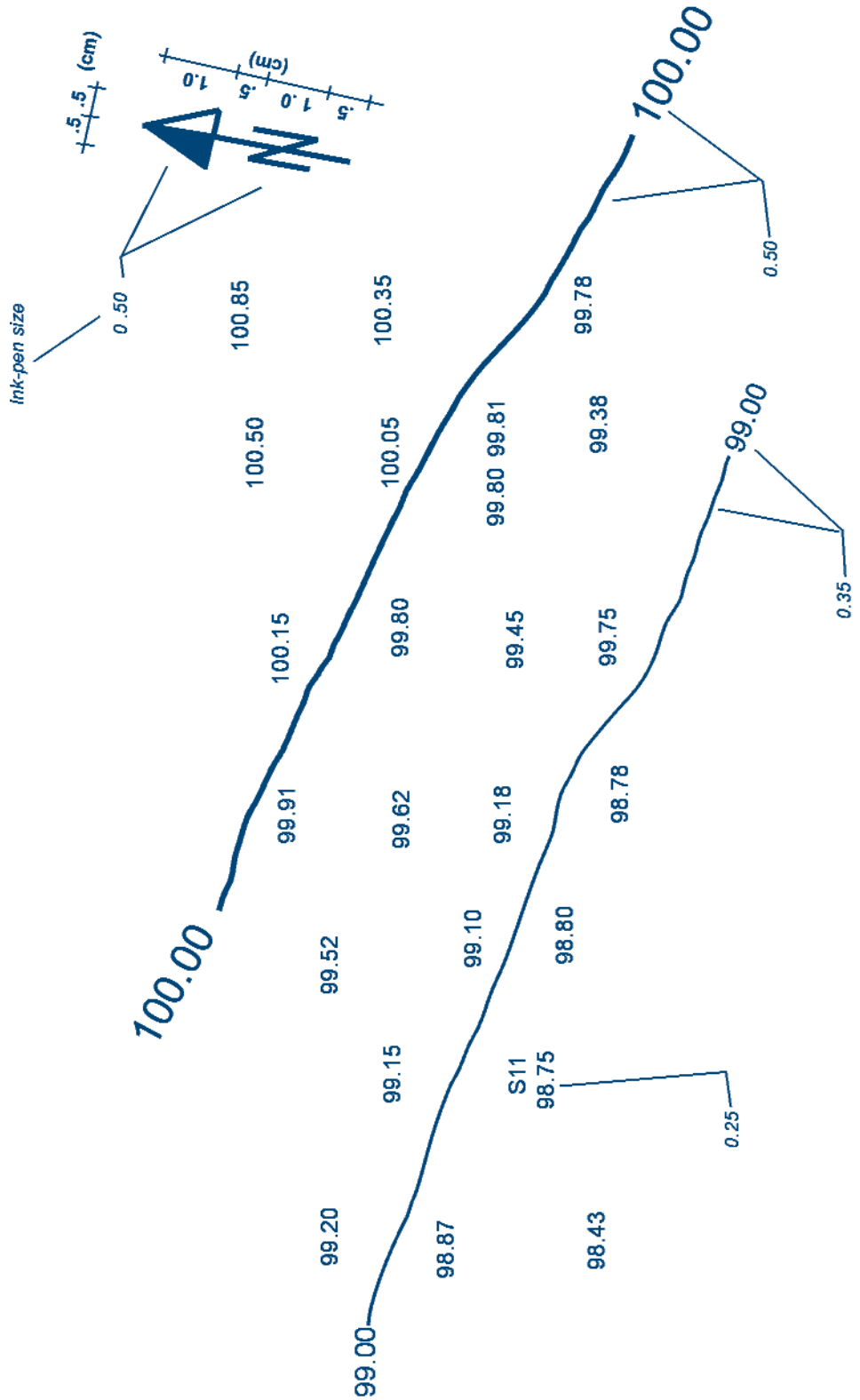
**Figure 9**
**Drawing showing the longitudinal profile of a canal**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Chainage (m) | 0 | 20 | 40 | 52 | 60 | 65 | 80 | 100 | |
| Original groundlevel (m) | 98.00 | 97.50 | 96.80 | 96.25 | 95.75 | 95.65 | 95.20 | 94.95 | |
| Bedlevel (m) | 98.00 | 97.60 | 97.20 | 96.50 | 96.70 | 96.25 | 96.05 | 95.95 | 95.65 | 95.35 | 94.95 |
| Banklevel (m) | 98.75 | 98.35 | 97.95 | 97.65 | 97.45 | 97.00 | 96.80 | 96.70 | 96.40 | 96.10 | 95.70 |

0.35

**Figure 10**
**An example of the drawing of a contour map**



#### 5.2.5. Contour map

An example of part of a contour map is shown in Figure 10. The recommended ink-pen sizes are again indicated. All contour lines were traced with a 0.35 mm ink-pen size, except those at 5 m intervals, like 100.00 and 95.00, for which a 0.50 mm ink-pen was used.

## 5.3. Heading

Figure 11 shows the heading that could be used for all drawings on A1 and A0 paper sizes. For smaller paper sizes, a reduced heading size should be used, otherwise too much space will be taken from the paper. The heading should clearly indicate the title of the drawing, the persons responsible for survey, design, checking and approval, as well as the scale and the date. Each drawing should be numbered. Drawings related to each other, for example a layout drawing and longitudinal canal sections, should be indicated as collateral drawings. Dates of any amendments should be indicated and explained in the box containing notes and amendments.

## 5.4. Legend

In general, many symbols are used in irrigation and drainage layouts. The most important symbols are given in Figure 12. All explanations in the legend, such as main drain or drop structure, should be written in small letters using a 0.35 mm ink-pen.

## 5.5. Notes and amendments

At the bottom of each drawing, a space of 4 cm in height is left for notes and amendments (see E in Figure 3).

Examples of notes are:

- Concrete mix is 1:2:3
- All brick walls to be plastered on both sides
- Soil refill to be well compacted in layers of 15 cm at the correct soil moisture

Any amendments made after the original design should also be explained in this section. As an example, when an extra tertiary canal is added in the field it should be indicated and explained on the drawing.

**Figure 11**
**An example of a heading or title block used for drawings of A1 and A0 sizes**

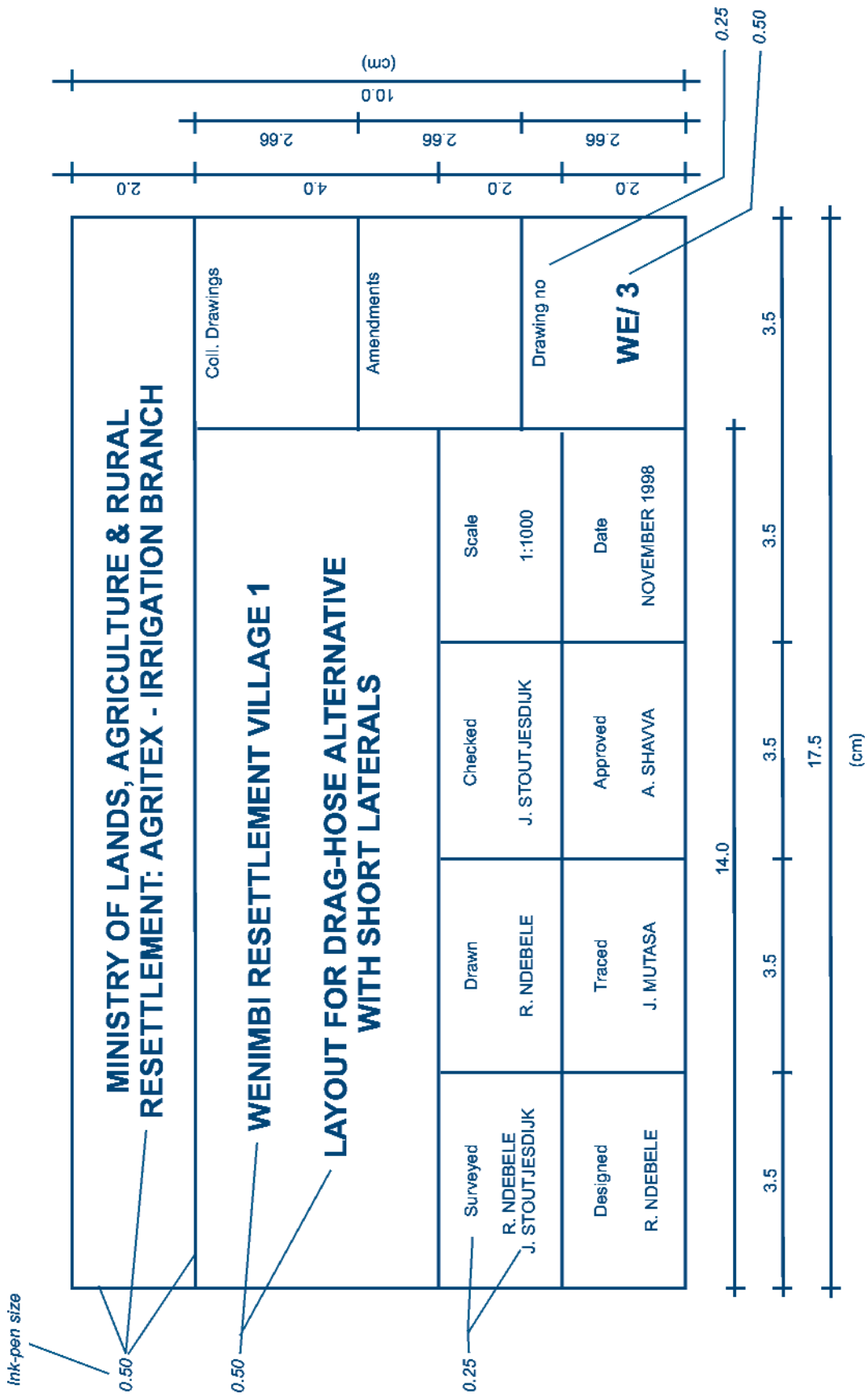
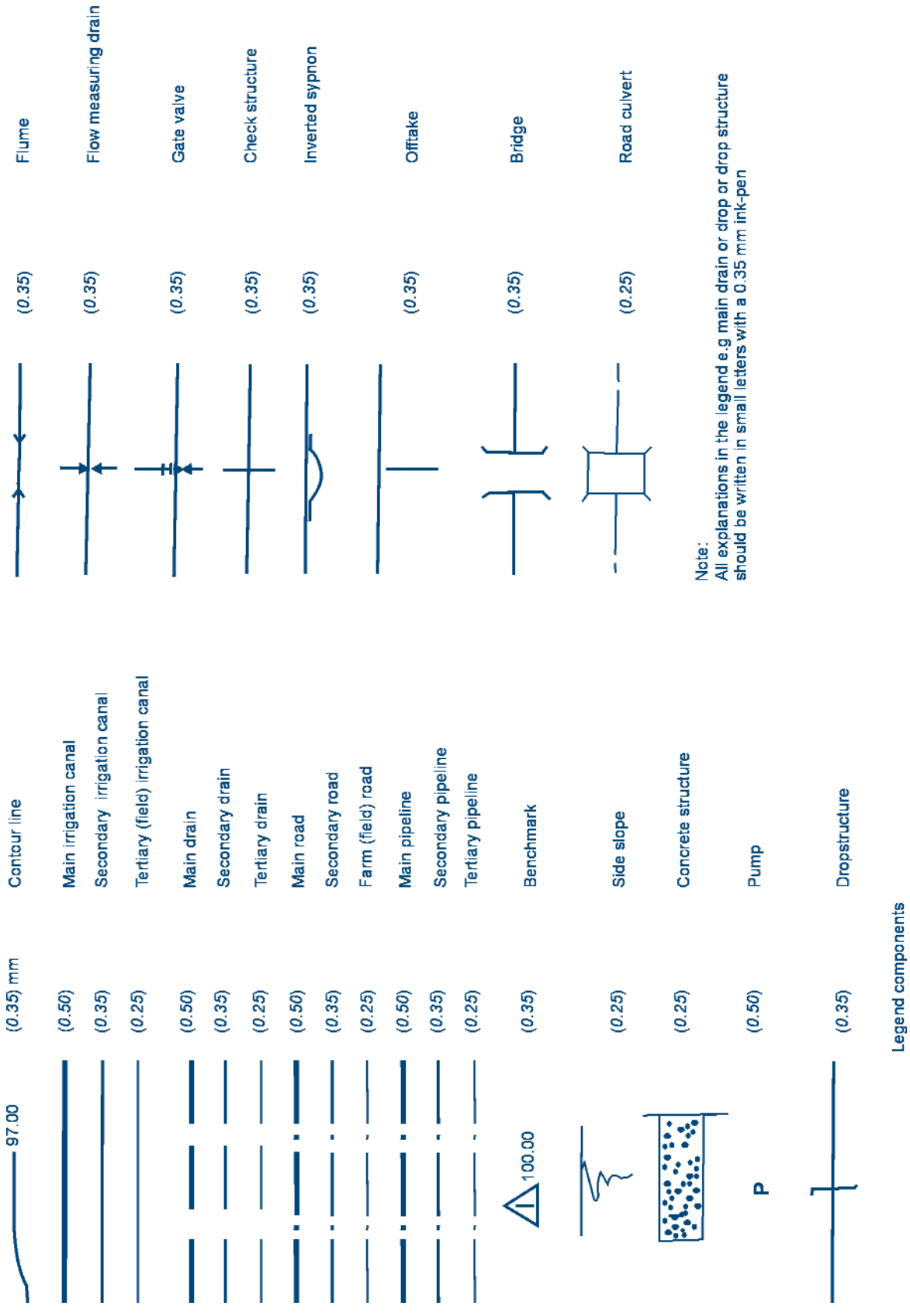


**Figure 12**

**Some of the commonly-used legend symbols in irrigation and drainage layout drawings**



# Chapter 6
# Registering and filing of drawings

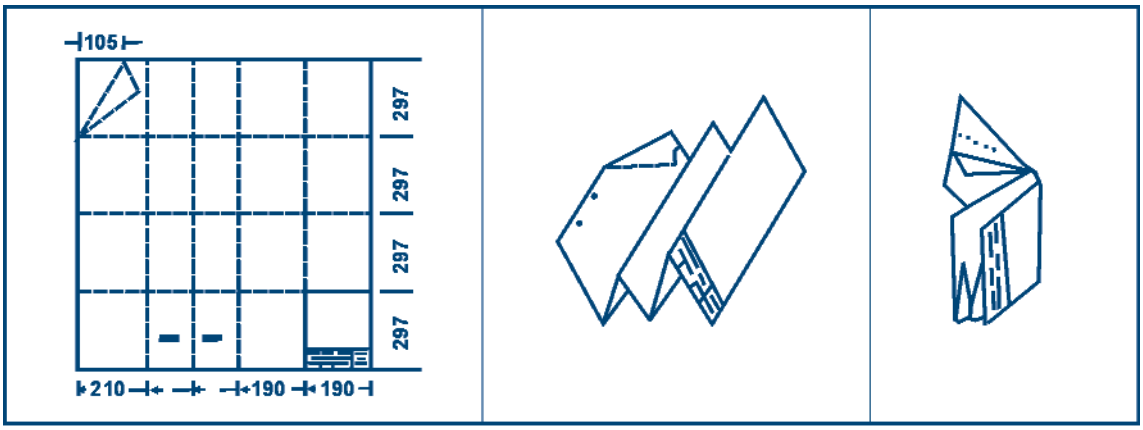
As a rule, the engineers prepare their drawings with pencil on bond paper. These drawings or sketches are brought to the drawing office for tracing. Once the drawing is brought to the drawing office, the entry date, name of designer and title of drawing should be entered in a register. The supervisor of the drawing office should allocate one of the technical officers or draftspersons to do the tracing. Their name should also be entered in the register, as shown in Table 4. Once the tracing of the drawing is completed, the date should be indicated in the register. Drawings that are completed and returned for filing should be kept in filing cabinets. Drawings that are pending should be kept flat, either in a drawer or on top of a large table.

Usually, prints are made of the traced original drawing. For storage of the originals, the drawings should be rolled with the printed side facing outwards and kept in a dark place. For storage of copies in a binder or for inclusion in documents, the copies (not originals) should be folded in such a way that the title block is visible and that it can be unfolded without being taken out of the binder (Figure 13).

**Table 4**
**Example of a register for drawing office**

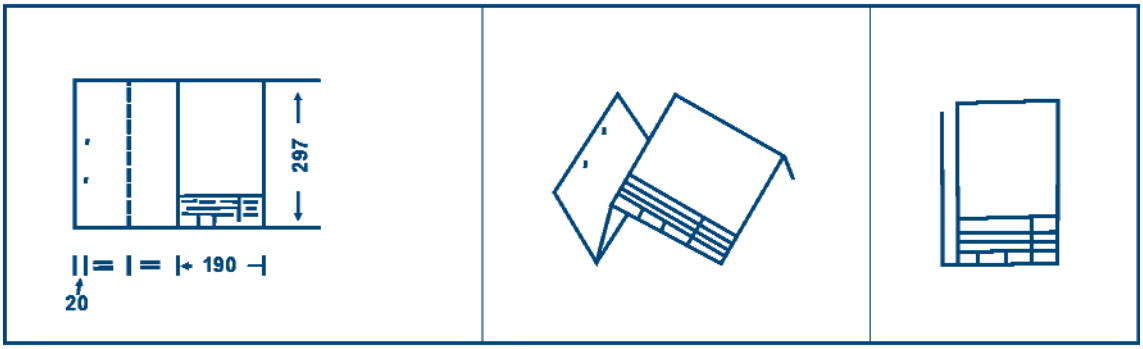
| Date in | Designer | Drawing title | Draftsperson | Date completed |
|---|---|---|---|---|
| 17.01.87 | Stoutjesdijk | Nabusenga layout | Mabwe | 23.01.87 |
| 21.02.97 | Madyiwa | Tikwiri land levelling map | Mutasa | 10.03.97 |
| 22.02.97 | Chirwa | Nyatate main canal | Maina | 28.02.97 |

**Figure 13**
**Examples of folding of different A-size papers in order to fit in an A4 document**




FOLDING OF A0


FOLDING OF A1 & A2




FOLDING OF A3