International Labour Office Training Programmes
Occupational Safety & Health for the Construction Industry

Construction OS&H

For construction companies ('contractors')

PROJECT

PURPOSE, AIMS AND OBJECTIVES

A modular programme gives great flexibility in the ways in which a course can be presented and updated, but one of the difficulties created is that the information is presented in a series of distinct blocks, whereas in real life many issues and facts have to be taken into account together. Therefore, this project is a concluding assignment which aims to integrate some of the main aspects of the course, while at the same time allowing course participants to apply the knowledge that they have gained in the course to a realistic project. This should also provoke some good discussion between the participants and the Tutor.

In addition, the participants' work can serve as an indication of the effectiveness of the course.

DESCRIPTION OF THE CONSTRUCTION PROJECT

LUFBRA RESERVOIR

Introduction to the project

The reservoir to be constructed is shown in Drawings R/01/36/1 to R/01/36/4 It is a rectangular reinforced concrete box, with a central dividing wall to facilitate cleaning and repairs while in use. It will be constructed on Beacon Hill, near the market and university town of Lufbra. The estimator's report of his site visit is reproduced below, and an extract from the instructions to tenderers on the following page.

WINDMILL CONSTRUCTION

INTERNAL MEMORANDUM

ESTIMATOR'S REPORT ON LUFBRA RESERVOIR

Lufbra Reservoir is described in Drawings R/01/36/1 (Location Plan); R/01=36/2 (Site Plan); and R/01/36/3 (General Arrangement). The client is the Burleigh Brook Water Authority, whose engineer is well-known for his strict enforcement of the contract documents, and the R.E. is expected to be Mr. E.R. Stephenson, who is known to us as a hard but fair man.

The site is at Beacon Hill, in attractive countryside. The existing access track is adequate for most forms of transport, but large or heavy vehicles may have some difficulties. Water and electricity supplies may be easily obtained. The first two metres of excavation (below top soil) will be in boulder clay, the remainder in weathered and heavily fissured granite. The contractors who built a neighbouring reservoir found that "the rock could be loosened by powerful ripping equipment - just", according to the engineer. All excavated material may be incorporated into the site landscaping. The underfloor drain is a simple 150 mm dia. drainage pipe surrounded by no-fines concrete.

The walls are of constant height, both floor and roof having a similar plan shape. Details of the valve chamber are given in Drawing R/01/36/4. There are no restrictions on the dimensions or volumes of concrete pours, although the engineer has indicated possible pours, as a guide only.

Construction methods are shown on our drawings WC/90/16/1 - and useful production information has been obtained from the records of Woodhouse and Thorpe Acre Reservoirs.

Site investigation shows that there are no water problems on this site.

The power line across the site can be isolated for a period not exceeding 6 months.

There is a reasonable supply of labour in Lufbra, five miles away.

The contract duration is 12 months, starting on 1st April 1990; I think we can complete this project in 9 months, so saving 3 months' overheads.

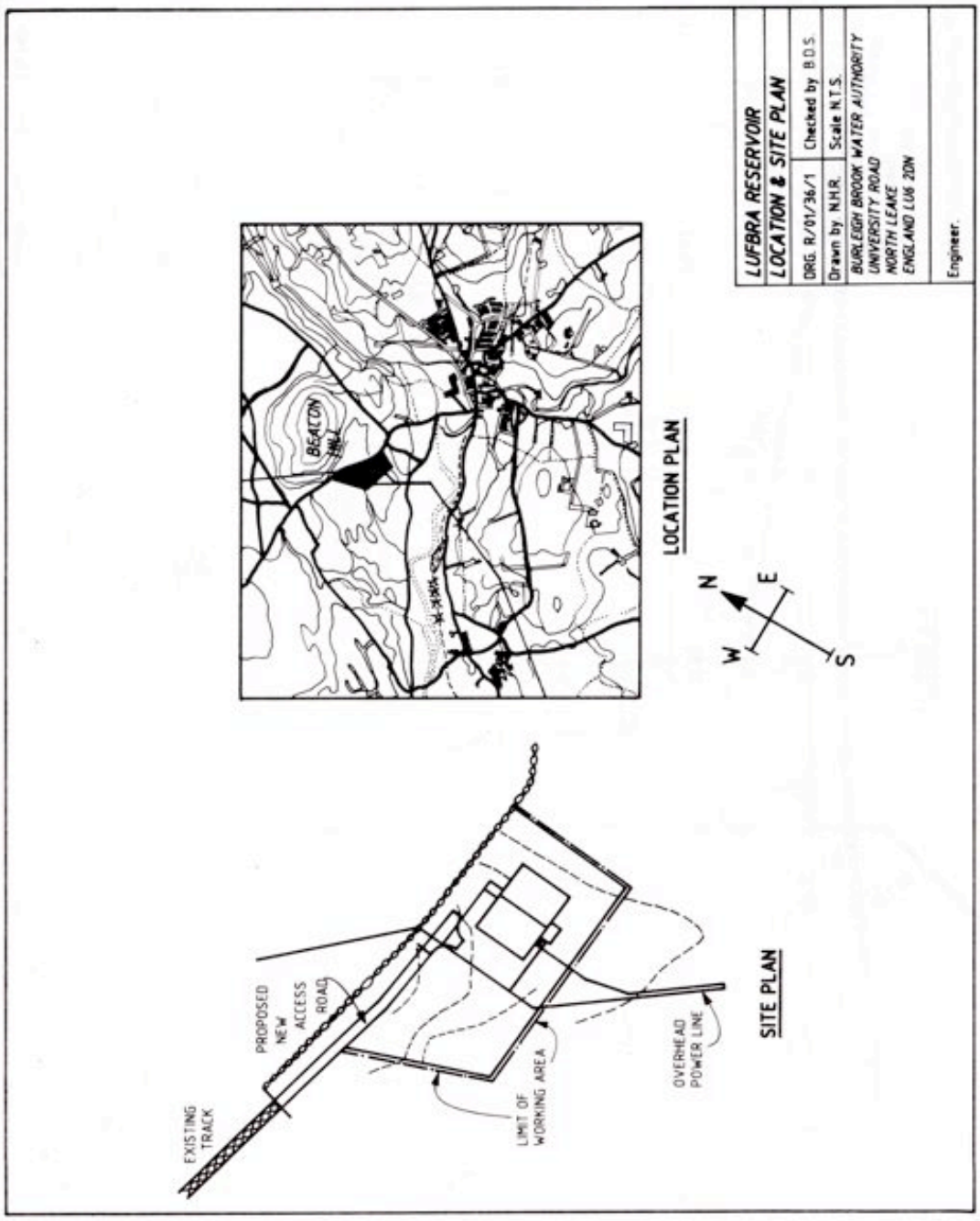
F.M. Phillipson

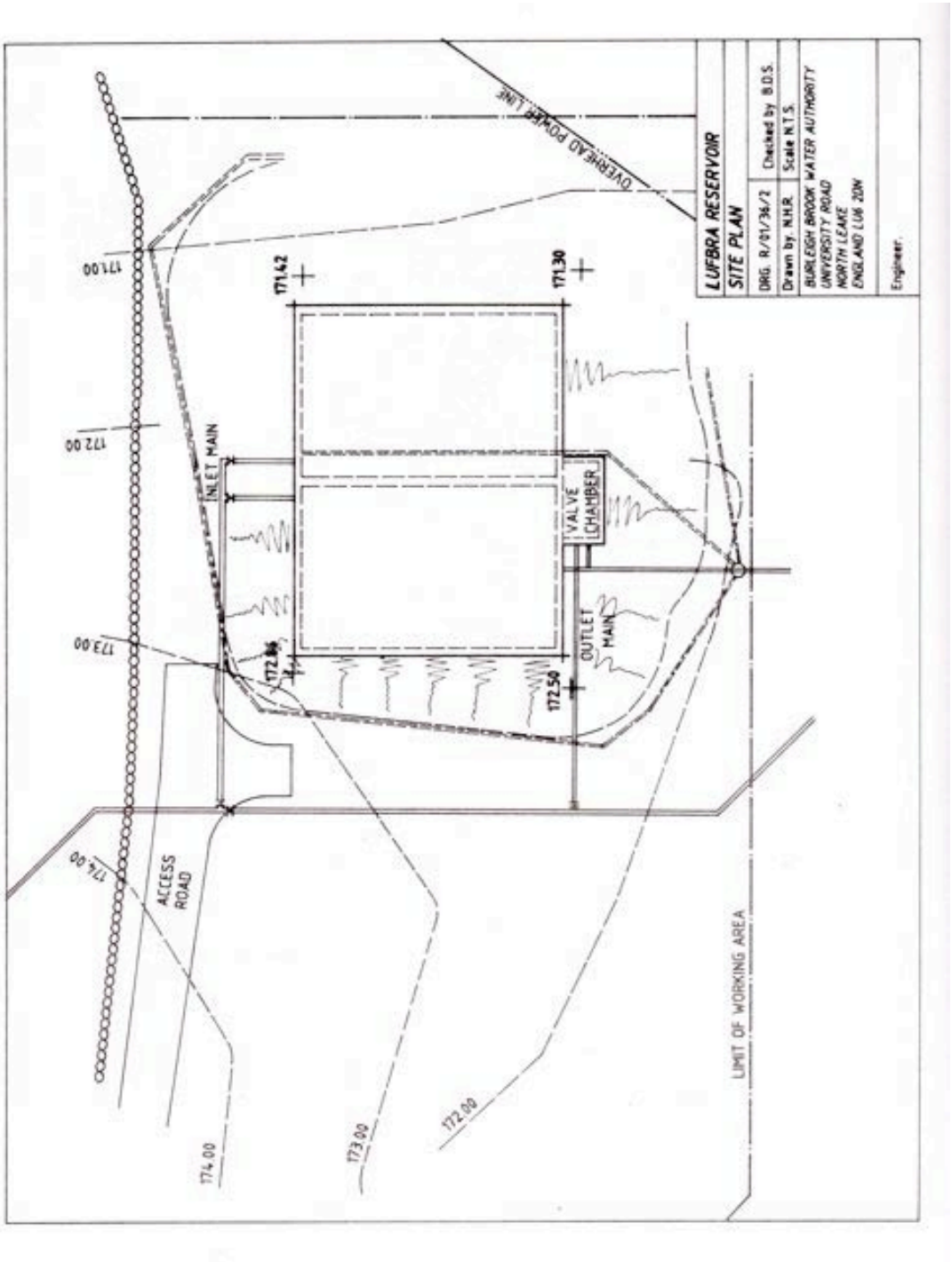
F.M. Phillipson
Chief Estimator 2nd February 1990

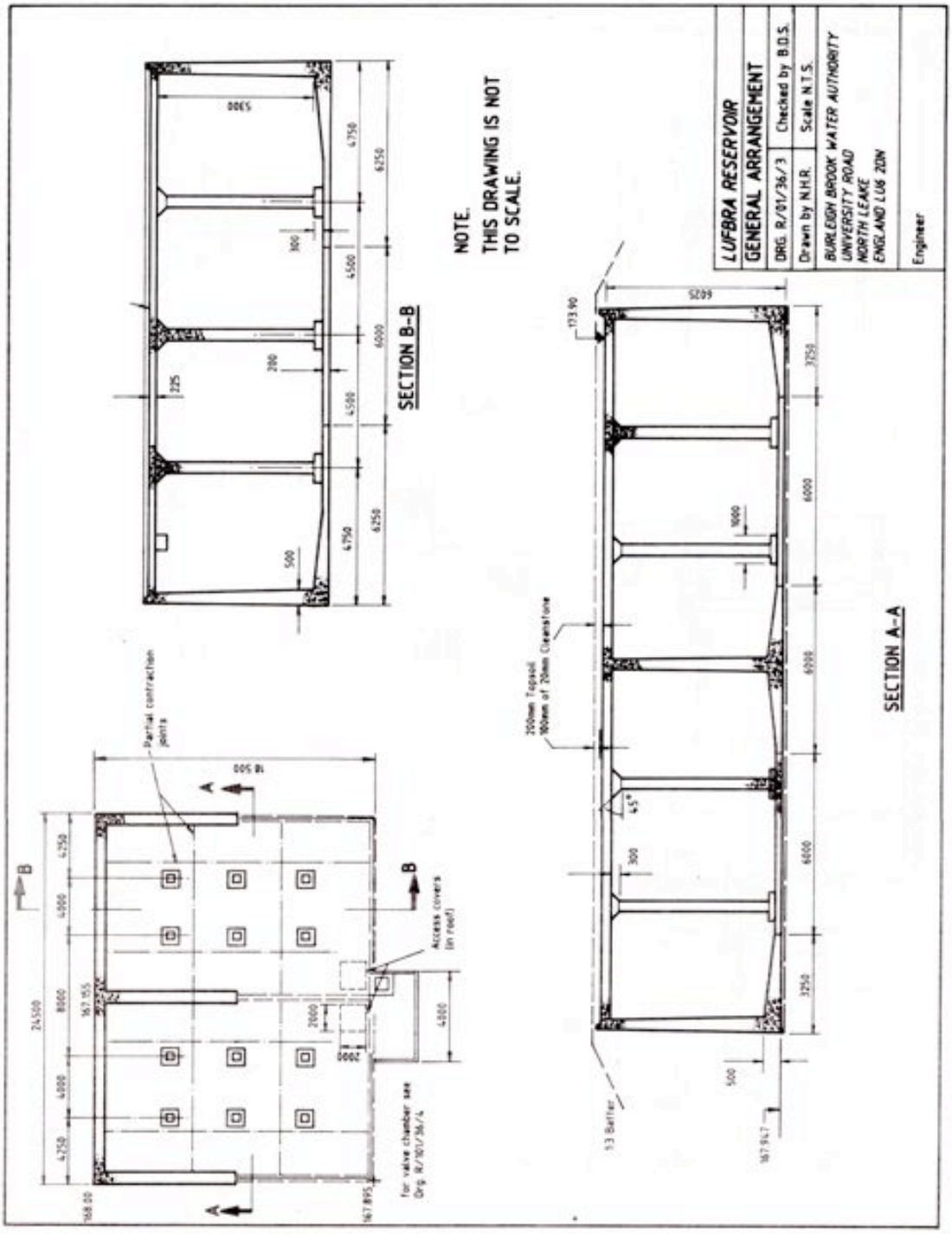
Author's note:

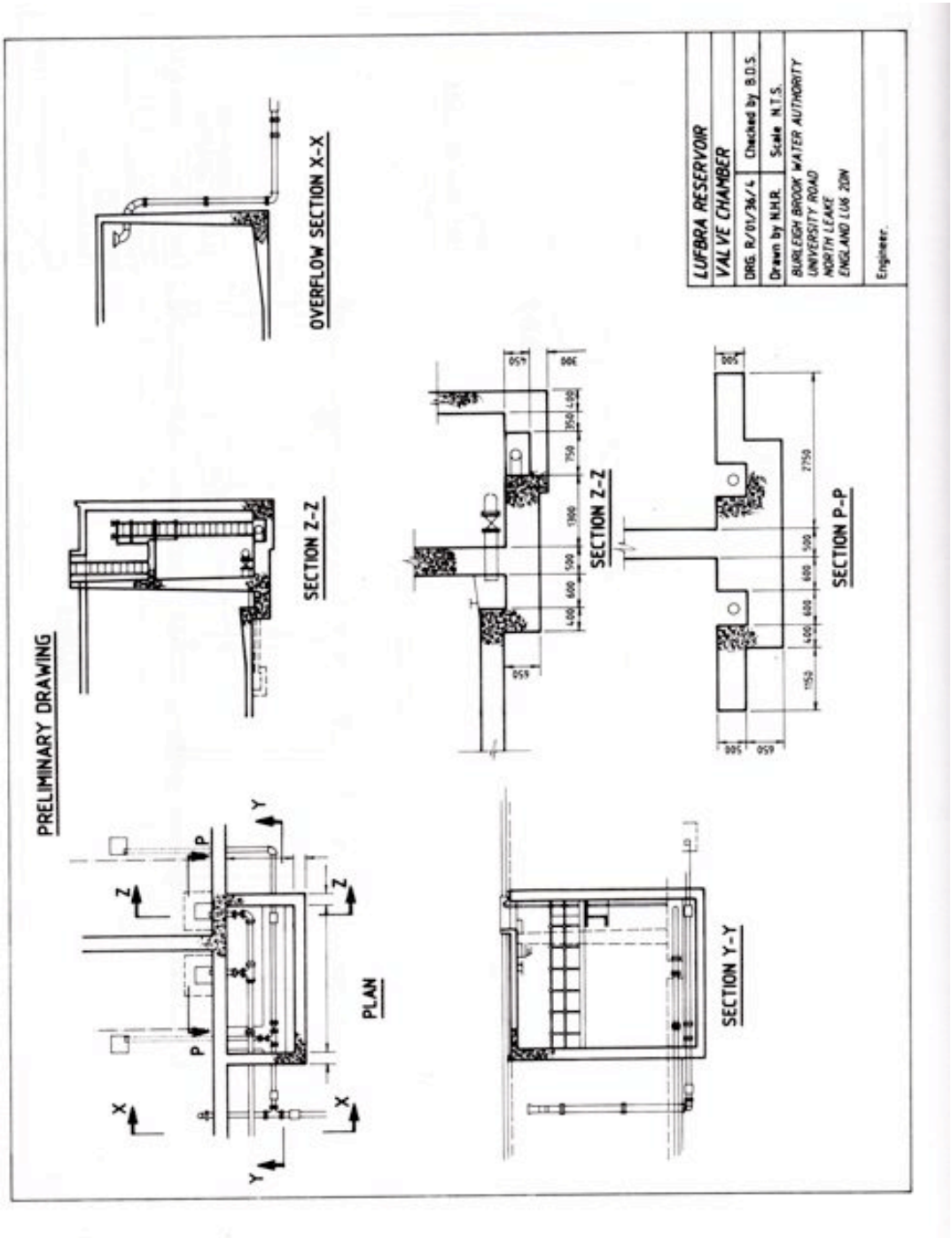
RE: "In the form of contract used for this project, an 'Engineer' was appointed by the client to have overall responsibility for the investigation and design of the project, and to supervise its construction. The Resident Engineer represents the Engineer on the site of the works."

No fines concrete: "This is a form of lightweight concrete obtained when fine aggregate is omitted, i.e. consisting of cement, water and coarse aggregate only" (A. M. Neville: *Properties of concrete*, p. 544. Pitman, London, 1977).


LUFBRA RESERVOIR
LOCATION & SITE PLAN
DRG. R/01/36/1
Checked by B.D.S
Drawn by N.H.R.
Scale N.T.S.
BURLEIGH BROOK WATER AUTHORITY
UNIVERSITY ROAD
NORTH LEAKE
ENGLAND LU6 2DN
Engineer.
LOCATION PLAN
BEACON HILL
N
E
W
S
SITE PLAN
EXISTING TRACK
PROPOSED NEW ACCESS ROAD
LIMIT OF WORKING AREA
OVERHEAD POWER LINE


LUFBRA RESERVOIR
SITE PLAN
DRG. R/91/34/2
Checked by B.D.S.
Drawn by N.H.R.
Scale N.T.S.
BURLEIGH BROOK WATER AUTHORITY
UNIVERSITY ROAD
NORTH LEAKE
ENGLAND LU6 2DN
Engineer.
OVERHEAD POWER LINE
171.42
171.30
172.50
INLET MAIN
VALVE CHAMBER
OUTLET MAIN
ACCESS ROAD
LIMIT OF WORKING AREA
171.00
172.00
173.00
174.00
172.00
173.00
174.00


LUFBRA RESERVOIR
GENERAL ARRANGEMENT
DRG. R/91/36/3
Checked by B.D.S.
Drawn by N.H.R.
Scale N.T.S.
BURLEIGH BROOK WATER AUTHORITY
UNIVERSITY ROAD
NORTH LEAKE
ENGLAND LU6 2DN
Engineer
NOTE.
THIS DRAWING IS NOT
TO SCALE.
SECTION B-B
SECTION A-A
Partial contraction joints
Access covers (in roof)
For valve chamber see Drg R/901/36/4
200mm Topsoil
100mm of 20mm Clarestone
13 Batter
45°


PRELIMINARY DRAWING
OVERFLOW SECTION X-X
SECTION Z-Z
SECTION Z-Z
SECTION P-P
PLAN
SECTION Y-Y
LUFBRA RESERVOIR
VALVE CHAMBER
DRG. R/01/36/4
Checked by B.D.S.
Drawn by N.H.R.
Scale N.T.S.
BURLEIGH BROOK WATER AUTHORITY
UNIVERSITY ROAD
NORTH LEAKE
ENGLAND LU6 2DN
Engineer.

Construction strategy

The joint layout and pour design for the floor, walls and roof are shown by sketches on the following pages. The contractor chose to use crawler-mounted mobile cranes and to leave out some floor and wall panels to allow the crane to be used within the reservoir. Wall formwork is illustrated.
Using this information, strategies can be developed for the sequence of construction of the floor, walls and roof.

The strategy is summarized tersely in boxes below.

Access to excavation

Must have a ramp for access of people, small equipment, etc., also for removal of spoil from rock-ripping.

Can make ramp

through valve chamber, which goes to base of reservoir

or

through drains, which is nearer to access road but not as deep as valve chamber.

Spoil from rock excavation can be used to make a good roadway around excavation, so that whole reservoir can be easily served by a crane from top of bank.

Floor

Column base reinforcement details enable the floor to be kept clear until columns have to be erected.

May start floor before bringing any cranes to site. Direct discharge from ready-mixed concrete trucks recommended.

Floor reinforcement details do not impose a sequence of pours. The detailing is very good for "constructability".

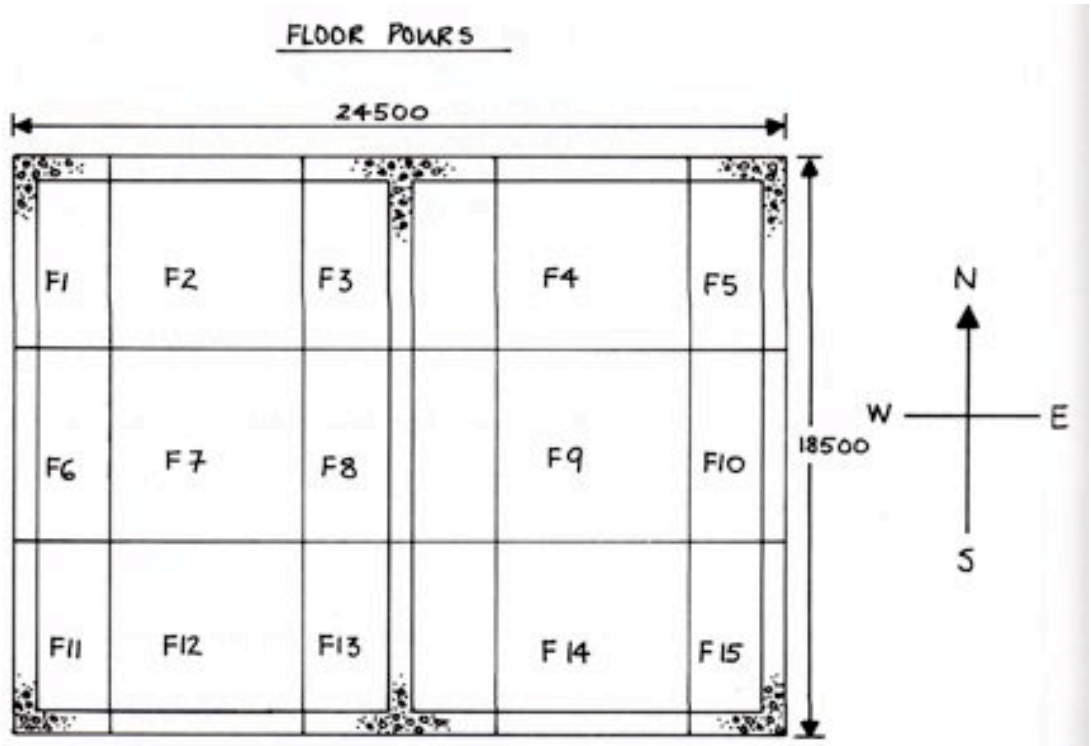
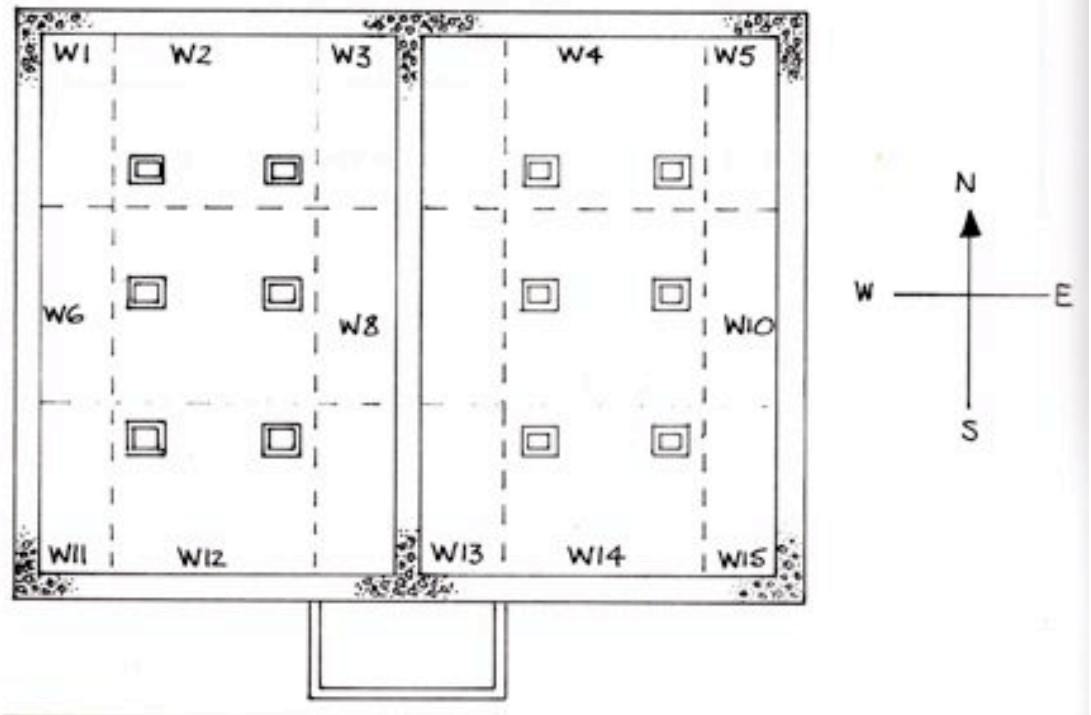


Figure 38. Joint layout and concrete pours for reservoir walls



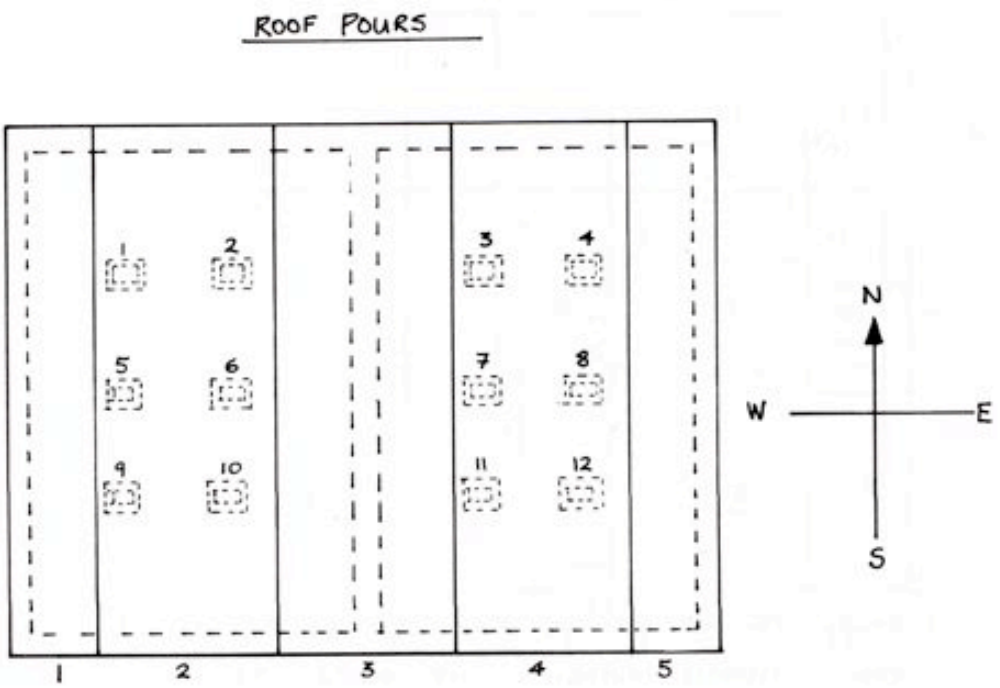
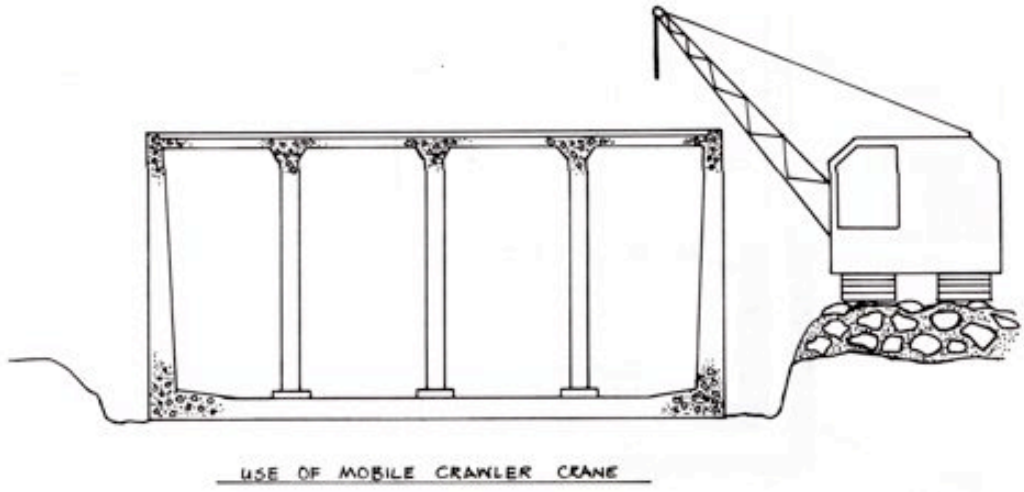
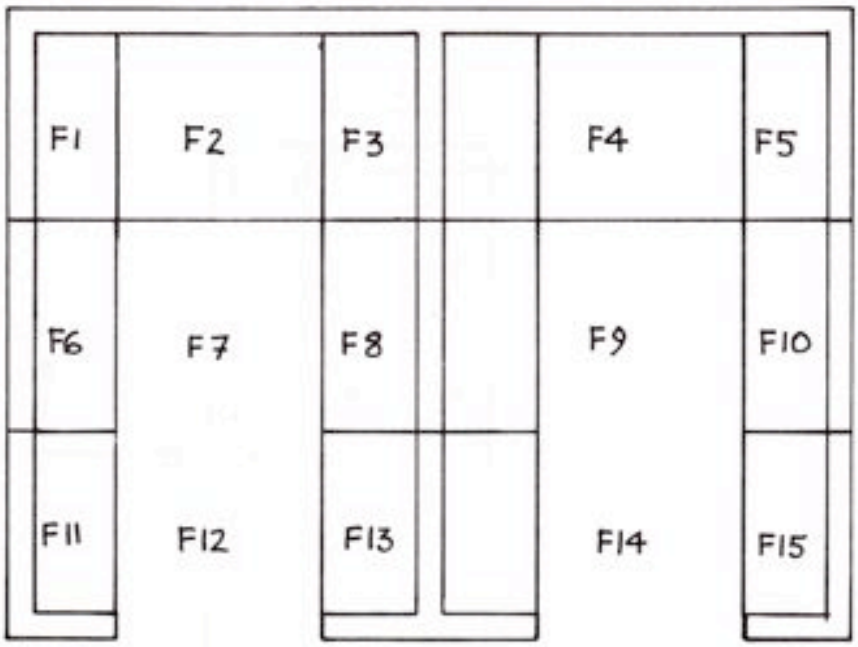


Figure 40. Access for mobile crawler crane around the reservoir

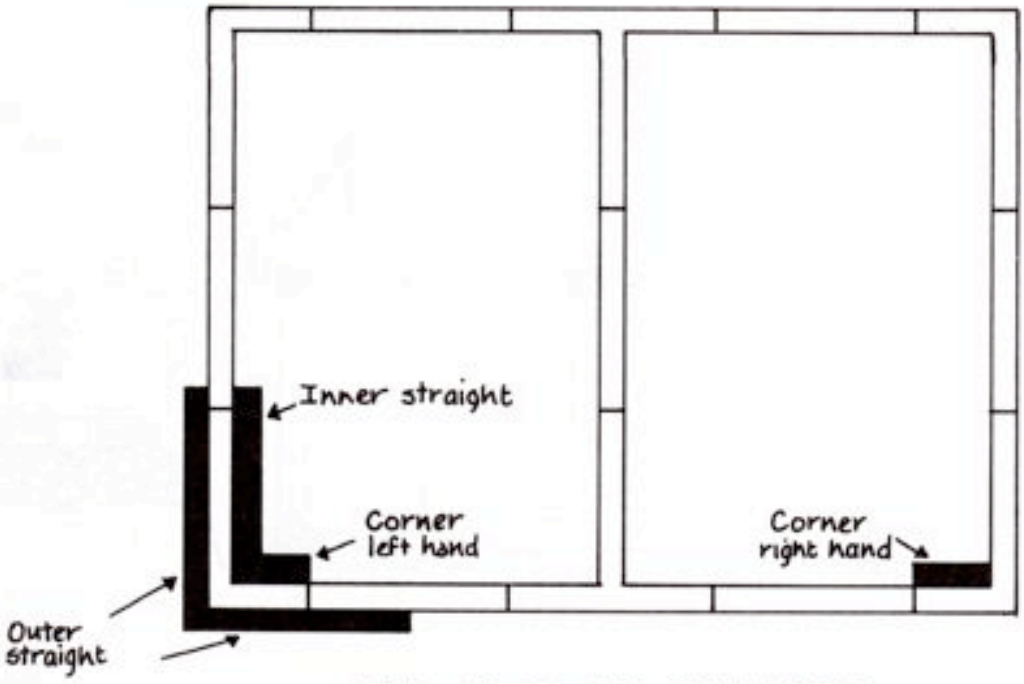


Access to centre of reservoir



Pours F7, F9, F12 and F14 concreted last, to enable concrete trucks to drive into the reservoir

Wall formwork



WALL POURS AND WALL FORMS
2 "Inner straights" required for tees

Walls

There are three types of pour:

straight walls;

corners, which are handed because of the internal wall taper;

tee-shaped-junctions between the cross wall and the side walls.

The easiest way is to make corner forms – right- and left-hand – which also form the inside of the wall on the shortest sides of the corners and tees. Each such form could be used for two tees and two corners, according to the handling. To form a tee requires a pair of such sections, plus three straight panels for the remaining, longer faces. This is the minimum number of panels required. (Note that these longer straight sections will also be used on the straight sections of wall.)

Valve chamber

Forming the section of reservoir adjacent to the valve chamber will damage the forms, because of the provision of starter bars for the valve chamber walls. Therefore, this should be in the last reservoir wall pour.

A special form should be made for the base of this section of wall, enabling the pipes to be built in easily. The main wall form then sits on this in the same way as for the previous wall bases.

Columns and roof

Columns may be most easily erected before the main soffit falsework and formwork is erected, using small and independent scaffolds. This gives more flexibility when planning.

A variety of pours and sequences is possible. Note that all support material has to be removed through the access hatch.

One of the key factors is the striking time of the falsework, as required by the specification; this is dependant on the air temperature during the curing period, but we have assumed two weeks.

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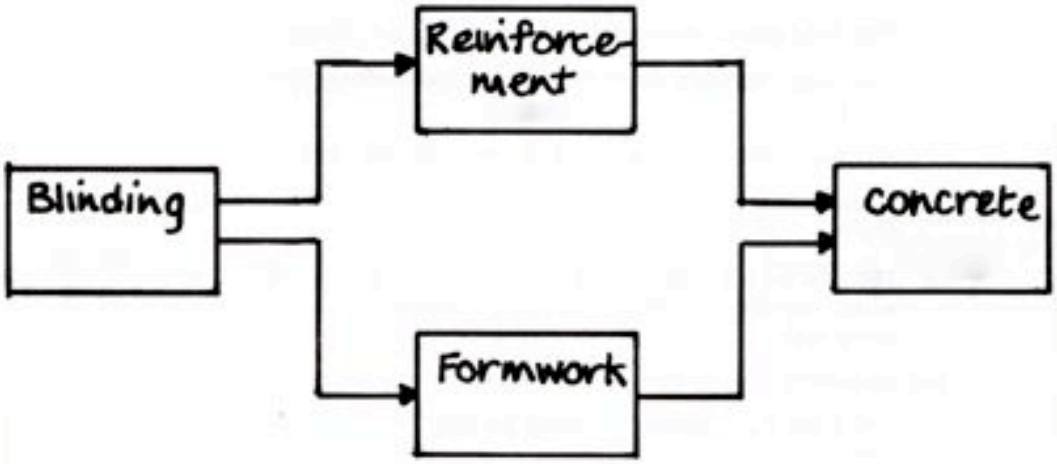
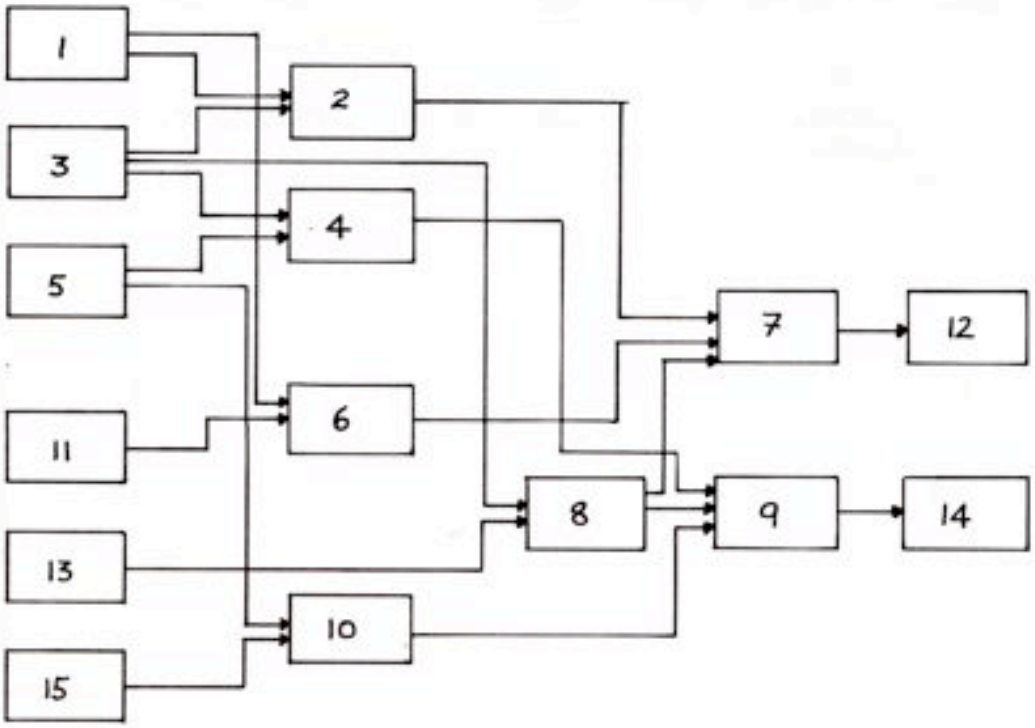
Activities that represent the construction of one floor panel



Sequence for the construction of floor panels F1 to F15, leaving panels omitted for access until last (note that these are dependent upon other activities also)



Walls

The walls will follow a similar pattern to the floor. The rules are:

The floor panel under the wall must be completed.

Tees and corners must be completed before infilling with straight walls.

Walls 12 and 14 are used for access, so are done last.

Formwork must be manufactured before the wall formwork may be started.

The starter bars for the valve chamber walls will damage the forms when panels 13 and 12 are cast. Therefore these panels should be done last.

The sequence of events for each of the panels is quite straightforward:

Once the floor panel has been concreted, the reinforcement can be fixed.

The formwork can then be erected.

The panel can finally be concreted.

(With the walls it is not possible to fix the steel and erect the formwork at the same time.)

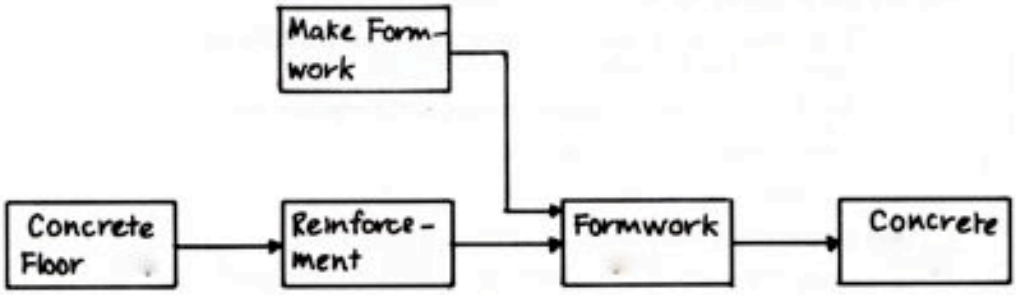
Columns

To simplify the plan, the columns are paired to give six activities, according to the floor panels they occupy. The construction rules are:

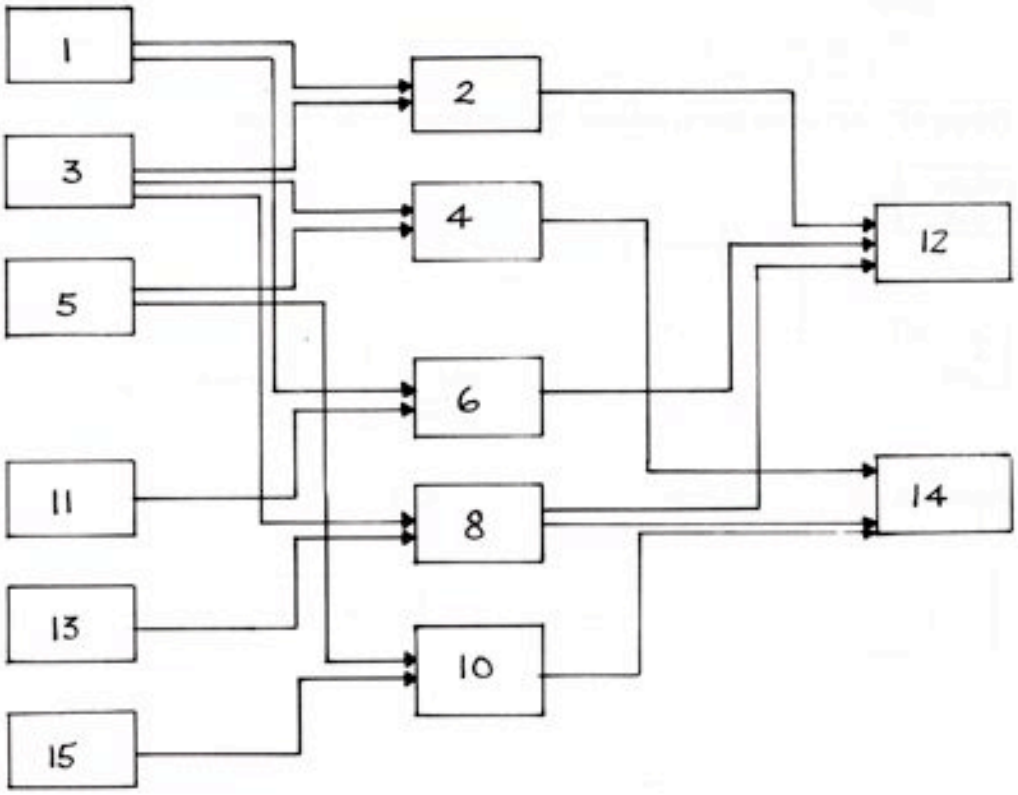
the floor under the column must be complete before the column can be started;

columns must be completed before the scaffold for the roof is started.

Activities that represent the construction of one wall panel



Sequence of wall pours W1 – W6, W8, W10 – W15



Roof

The roof will be poured in five strips, moving from east to west; the first and last pours being half width. The following rules will be adopted:

Supporting walls and columns must be completed before any scaffolding is erected.

Scaffold must be completed before soffit erection starts.

Reinforcement can follow closely behind the soffit formwork.

The sequence of panels will be 1, 2, 3, 4 and 5.

The sequence of activities is, therefore, as follows:

when the walls and columns are complete, the scaffolding can be erected;

the roof soffit and reinforcement are worked on simultaneously, with a lead of one day to ensure the reinforcement will have a form to lay on;

the panel is concreted;

curing and striking follows on.

Notes:

Curing and striking have been combined in one activity. A more accurate representation would be to use separate activities, where the curing activity is given a seven-day-week calendar.

The scaffolding cannot be erected for the next panel until it has been struck from the previous panel.

Activities that represent the construction of one roof panel

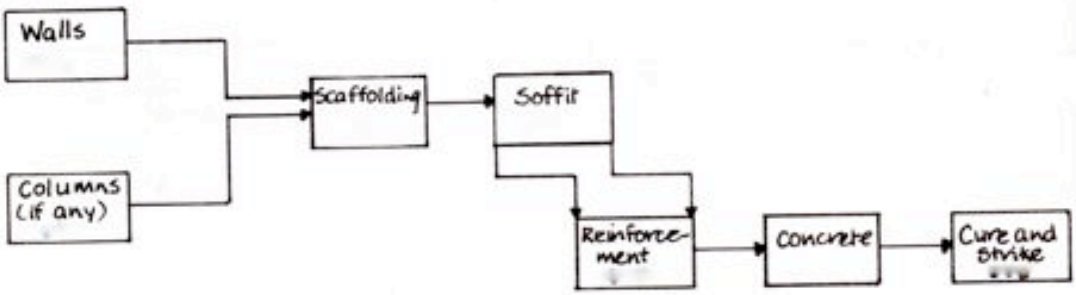
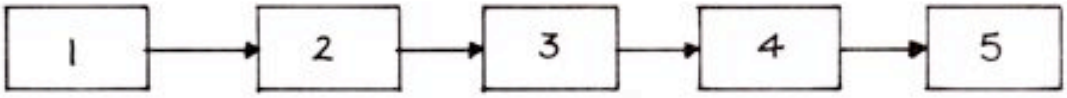


Figure 48. Sequence for the construction of roof pours P1 – P5



CONSTRUCTION PROJECT AND CONTRACT ORGANISATION

Client
The Burleigh Brook Water Company is a regional water company based entirely in the catchment of a major river. It serves 6 million people.

Contract
A 'traditional' contract, in which the Client engaged a Designer and let the contract to a main contractor on a fixed price but re-measured for the actual work done.

Contractor
Ilobwi Construction is a medium sized construction company that specialises in high quality concrete work. It is based in the same region as the Client. It employs 40 people in its Head Office and about 40 project management staff on its various sites. Almost all the work is sub-contracted but because Ilobwi is a specialist in high quality concrete work it employs 30 highly skilled concrete workers directly on permanent contracts.

Sub-contractors for this project
These include:

- Diversion of the electricity line by the authorised authority
- Site facilities, including catering and welfare
- Permanent and temporary fencing
- Excavation, general groundwork and landscaping
- Roadworks
- Pipework and drainage
- Steel reinforcement
- Concrete formwork
- Control equipment

Employment of the workforce
Apart from the project management team and the specialist concrete workers, all the workforce will be employed by the sub-contractors, most of whom will in turn employ most of their workers on a contract basis rather than by direct employment.

Suppliers for this project
These include:

- Pipework, from a company nominated by the Client
- Control equipment, from a company nominated by the Client
- All plant and equipment used by the main contractor will be hired
- The sub-contractors will supply their own materials, plant and equipment

COURSE PARTICIPANTS' TASKS

Assignment

Course participants will work in groups of three or four during the periods shown in the course timetable. Their tasks are described below:

- Write an OS&H Policy for Ilobwi, the main contractor on this project
- Identify the major hazards and risks that my arise from this project
- Advise Ilobwi on worker participation and engagement with the Trades Unions
- Write a specific OS&H Policy for Ilobwi for this project
- Draft an outline OS&H plan for Ilobwi for this project
- Write clauses for the main sub-contracts for effective OH&S for the project
- Make a draft, outline plan for the site layout and welfare facilities
- Draft a list of the items of personal protective equipment that Ilobwi will require for the first three months of this project
- Identify THREE major items of plant that will be required on this project and explain what steps you would take to make sure that these are used safely
- Identify THREE major construction operations required during the construction of this reservoir and explain how they will be managed safely

Reporting and recording

- Each group will write a succinct, illustrated report on their work, which will be copied for all participants and retained by the Tutor.
- Each group will nominate a reporter who will present the work of the group.
- The presentations will be followed by discussion leading to clear conclusions and recommendations.
- The Tutor will summarise the conclusions and recommendations and provide each participant with a copy.

The reporting and recording documents from the above will be used by the Tutor to assess the learning of the participants against the information taught during the course and this will form an element of the evaluation of its effectiveness.