SSIGL 29

NATIONAL GUIDELINES

For Small Scale Irrigation Development in Ethiopia

Construction of Irrigation Infrastructures

November 2018

Addis Ababa

MINISTRY OF AGRICULTURE

National Guidelines for Small Scale Irrigation Development in Ethiopia

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DISCLAIMER

Ministry of Agriculture through the Consultant and core reviewers from all relevant stakeholders included the information to provide the contemporary approach about the subject matter. The information contained in the guidelines is obtained from sources believed tested and reliable and are augmented based on practical experiences. While it is believed that the guideline is enriched with professional advice, for it to be successful, needs services of competent professionals from all respective disciplines. It is believed, the guidelines presented herein are sound and to the expected standard. However, we hereby disclaim any liability, loss or risk taken by individuals, groups, or organization who does not act on the information contained herein as appropriate to the specific SSI site condition.

FORWARD

Ministry of Agriculture, based on the national strategic directions is striving to meet its commitments in which modernizing agriculture is on top of its highest priorities to sustain the rapid, broad-based and fair economic growth and development of the country. To date, major efforts have been made to remodel several important strategies and national guidelines by its major programs and projects.

While efforts have been made to create access to irrigation water and promoting sustainable irrigation development, several barriers are still hindering the implementation process and the performance of the schemes. The major technical constrains starts from poor planning and identification, study, design, construction, operation, and maintenance. One of the main reasons behind this outstanding challenge, in addition to the capacity limitations, is that SSIPs have been studied and designed using many ad-hoc procedures and technical guidelines developed by various local and international institutions.

Despite having several guidelines and manuals developed by different entities such as MoA (IDD)-1986, ESRDF-1997, MoWIE-2002 and JICA/OIDA-2014, still the irrigation professionals follow their own public sources and expertise to fill some important gaps. A number of disparities, constraints and outstanding issues in the study and design procedures, criteria and assumptions have been causing huge variations in all vital aspects of SSI study, design and implementation from region to region and among professionals within the same region and institutions due mainly to the lack of agreed standard technical guidelines. Hence, the SSI Directorate with AGP financial support, led by Generation consultant (GIRDC) and with active involvement of national and regional stakeholders and international development partners, these new and comprehensive national guidelines have been developed.

The SSID guidelines have been developed by addressing all key features in a comprehensive and participatory manner at all levels. The guidelines are believed to be responsive to the prevalent study and design contentious issues; and efforts have been made to make the guidelines simple, flexible and adaptable to almost all regional contexts including concerned partner institution interests. The outlines of the guidelines cover all aspects of irrigation development including project initiation, planning, organizations, site identification and prioritization, feasibility studies and detail designs, contract administration and management, scheme operation, maintenance and management.

Enforceability, standardization, social and environmental safeguard mechanisms are well mainstreamed in the guidelines, hence they shall be used as a guiding framework for engineers and other experts engaged in all SSI development phases. The views and actual procedures of all relevant diverse government bodies, research and higher learning institutions, private companies and development partners has been immensely and thoroughly considered to ensure that all stakeholders are aligned and can work together towards a common goal. Appropriately, the guidelines will be familiarized to the entire stakeholders working in the irrigation development. Besides, significant number of experts in the corresponding subject matter will be effectively trained nationwide; and the guidelines will be tested practically on actual new and developing projects for due consideration of possible improvement. Hence, hereinafter, all involved stakeholders including government & non-governmental organizations, development partners, enterprises, institutions, consultants and individuals in Ethiopia have to adhere to these comprehensive national guidelines in all cases and at all level whilst if any overlooked components are found, it should be documented and communicated to MOA to bring them up-to-date.

Therefore, I congratulate all parties involved in the success of this effort, and urge partners and stakeholders to show a similar level of engagement in the implementation and stick to the guidelines over the coming years.

H.E. Dr. Kaba Urgessa
State Minister, Ministry of Agriculture

SMALL SCALE IRRIGATION DEVELOPMENT VISION

Transforming agricultural production from its dependence on rain-fed practices by creating reliable irrigation system in which smallholder farmers have access to at least one option of water source to increase production and productivity as well as enhance resilience to climate change and thereby ensure food security, maintain increasing income and sustain economic growth.

ACKNOWLEDGEMENTS

The preparation of SSIGLs required extensive inputs from all stakeholders and development partners. Accordingly many professionals from government and development partners have contributed to the realization of the guidelines. To this end MOA would like to extend sincere acknowledgement to all institutions and individuals who have been involved in the review of these SSIGLs for their comprehensive participation, invaluable inputs and encouragement to the completion of the guidelines. There are just too many collaborators involved to name exhaustively and congratulate individually, as many experts from Federal, regional states and development partners have been involved in one way or another in the preparation of the guidelines. The contribution of all of them who actively involved in the development of these SSIGLs is gratefully acknowledged. The Ministry believes that their contributions will be truly appreciated by the users for many years to come.

The Ministry would like to extend its appreciation and gratitude to the following contributors:

- Agriculture Growth Program (AGP) of the MoA for financing the development and publication of the guidelines.
- The National Agriculture Water Management Platform (NAWMP) for overseeing, guidance and playing key supervisory and quality control roles in the overall preparation process and for the devotion of its members in reviewing and providing invaluable technical inputs to enrich the guidelines.
- Federal Government and Regional States organizations and their staff for their untiring effort in reviewing the guidelines and providing constructive suggestions, recommendations and comments.
- National and international development partners for their unreserved efforts in reviewing the guidelines and providing constructive comments which invaluably improved the quality of the guidelines.
- Small-scale and Micro Irrigation Support Project (SMIS) and its team for making all efforts to have quality GLs developed as envisioned by the Ministry.

The MOA would also like to extend its high gratitude and sincere thanks to AGP's multi development partners including the International Development Association (IDA)/World Bank, the Canada Department of Foreign Affairs, Trade and Development (DFATD), the United States Agency for International Development (USAID), the Netherlands, the European Commission (EC), the Spanish Agency for International Development (AECID), the Global Agriculture and Food Security Program (GAFSP), the Italy International Development Cooperation, the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP).

Moreover, the Ministry would like to express its gratitude to Generation Integrated Rural Development Consultant (GIRDC) and its staff whose determined efforts to the development of these SSIGLs have been invaluable. GIRDC and its team drafted and finalized all the contents of the SSIGLs as per stakeholder suggestions, recommendations and concerns. The MoA recognizes the patience, diligence, tireless, extensive and selfless dedication of the GIRDC and its staff who made this assignment possible.

Finally, we owe courtesy to all national and International source materials cited and referred but unintentionally not cited.

Ministry of Agriculture

DEDICATIONS

The National Guidelines for Small Scale Irrigation Development are dedicated to Ethiopian smallholder farmers, agro-pastoralists, pastoralists, to equip them with appropriate irrigation technology as we envision them empowered and transformed.

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ACRONYMS

ACV	Aggregate Crushing Value
AGP	Agricultural Growth Project
ASAE EP	American Society of Agricultural Engineering
AutoCAD	Automatic Computer-Aided Design
BOQ	Bill of Quantities
cm	Centimeter
ConMIS	Construction management Information System
CST	Construction Supervision Team
DN	Nominal Diameter
EMP	Environmental Management Plan
Es	Modules of elasticity
ESMF	Environmental and Social Management Frame
ETB	Ethiopian Birr
fs	Yield points stress
g	Specific Gravity
GCC	General Condition of Contract
GIRDC	Generation Integrated Rural Development Consultant
GL	Guideline
HCB	Hallow Concrete Block
HDP	High Density Pipe
HFL	High Flood Level
kg	Kilogram
m	Meter
m2	Square Meter
m3	Cubic Meters
mm	Millimeter
MoANR	Ministry of Agriculture and Natural Resources
MOWIE	Ministry of Water, Irrigation and Electricity
Mpa	Mega Pascal
MS-Project	Micro Soft Project

N	Newton
PBOQ	Priced Bill of Quantities
PN	Nominal Pressure
PPE	Personal Protective Equipment
PSGMs	Permanent Survey Ground Markers
PVC	Poly Venile Chloride
RE	Resident Engineer
ROW	Right of Way
s	Second
SCC	Specific Condition of Contract
SSID	Small Scale Irrigation Development
SSIGL	Small Scale Irrigation Guideline
SSIP	Small Scale Irrigation Project
TS	Tensile strength
uPVC	Un-plasticized Polyvinyl Chloride
VAT	Value Added Tax
VO	Variation Order
ys	yield strength

PREFACE

While irrigation development is at the top of the government's priority agendas as it is key to boost production and improve food security as well as to provide inputs for industrial development. Accordingly, irrigated land in different scales has been aggressively expanding from time to time. To this end, to enhance quality delivery of small-scale irrigation development planning, implementation and management, it has been decided to develop standard SSI guidelines that must be nationally applied. In September 2017 the Ministry of Agriculture (MoA) had entrusted Generation Integrated Rural Development Consultant (GIRDC) to prepare the National Small-scale Irrigation Development Guidelines (SSIGLs).

Preparation of the SSIGLs for enhancing development of irrigated agriculture is recognized as one of the many core initiatives of the MoA to improve its delivery system and achieve the targets in irrigated agriculture and fulfill its mission for improving agricultural productivity and production. The core objective of developing SSIGLs is to summarize present thinking, knowledge and practices to enable irrigation practitioners to properly plan, implement and manage community managed SSI schemes to develop the full irrigation potential in a sustainable manner.

As the SSIGLs are prepared based on national and international knowledge, experiences and practices, and describe current and recommended practice and set out the national standard guides and procedures for SSI development, they serve as a source of information and provide guidance. Hence, it is believed that the SSIGLs will contribute to ensuring the quality and timely delivery, operation and maintenance of SSI schemes in the country. The SSIGLs attempt to explain and illustrate the important concepts, considerations and procedures in SSI planning, implementation and management; and shall be used as a guiding framework for professionals engaged in SSI development. Illustrative examples from within the country have been added to enable the users understand the contents, methodologies presented in the SSIGLs.

The intended audiences of the SSIGLs are government organizations, NGOs, CSOs and the private sector involved in SSI development. Professionally, the SSIGLs will be beneficial for experienced and junior planners, experts, contractors, consultants, suppliers, investors, operators and managers of SSI schemes. The SSIGLs will also serve as a useful reference for academia and researchers involved and interested in SSI development. The SSIGLs will guide to ensure that; planning, implementation and management of SSI projects is formalized and set procedures and processes to be followed. As the SSIGLs provide information and guides they must be always fully considered and applied by adapting them to the local specific requirements.

In cognizance with the need for quality SSIGLs, the MoA has duly considered quality assurance and control during preparation of the guidelines. Accordingly, the outlines, contents and scope of the SSIGLs were thoroughly discussed, reviewed and modified by NAWMP members (senior professionals from public, national and international stakeholder) with key stakeholders in many consultative meetings and workshops. Moreover, at each milestone of SSIGL preparation, resource persons from all stakeholders reviewed and confirmed that SSIGLs have met the demands and expectations of users.

Moreover, the Ministry has mobilized resource persons from key Federal, National Regional States level stakeholders and international development partners for review, validation and endorsement of the SSIGLs.

Several hundreds of experienced professionals (who are very qualified experts in their respective fields) from government institutions, relevant private sector and international development partners have significantly contributed to the preparation of the SSIGLs. They have been involved in all aspects of the development of SSIGLs throughout the preparation process. The preparation process included a number of consultation meetings and workshops: (i) workshop to review inception report, (ii) workshop on findings of review of existing guidelines/manuals and proposed contents of the SSIGLs, (iii) meetings to review zero draft SSI GLs, (iv) review workshop on draft SSI GLs, (v) small group review meetings on thematic areas, (vi) small group consultation meetings on its final presentation of contents and layout, (vii) consultation mini-workshops in the National States on semi-final versions of the SSIGLs, and (viii) final write-shop for the appraisal and approval of the final versions of SSIGLs.

The deliberations, concerns, suggestions and comments received from professionals have been duly considered and incorporated by the GIRD Consultant in the final SSIGLs.

There are 34 separate guidelines which are categorized into the following five parts concurrent to SSI development phases:

Part-I. Project Initiation, Planning and Organization Guideline which deals with key considerations and procedures on planning and organization of SSI development projects.

Part-II. Site Identification and Prioritization Guideline which treats physical potential identification and prioritization of investment projects. It presents SSI site selection process and prioritization criteria.

Part-III. Feasibility Study and Detail Design Guidelines for SSID dealing with feasibility study and design concepts, approaches, considerations, requirements and procedures in the study and design of SSI systems.

Part-IV. Contract Administration and Construction Management Guidelines for SSI development presents the considerations, requirements, and procedures involved in construction of works, construction supervision and contract administration.

Part-V. SSI Scheme Management, Operation and Maintenance Guidelines which covers SSI Scheme management and operation.

Moreover, Tools for Small Scale Irrigation development are also prepared as part of SSIGLs.

It is strongly believed and expected that; the SSIGLs will be quickly applied by all stakeholders involved in SSI development and others as appropriate following the dissemination and familiarization process of the guidelines in order to ensure efficient, productive and sustainable irrigation development.

The SSIGLs are envisioned to be updated by incorporating new technologies and experiences including research findings. Therefore, any suggestions, concerns, recommendations and comments on the SSIGLs are highly appreciated and welcome for future updates as per the attached format below. Furthermore, despite efforts in making all types of editorial works, there may still errors, which similarly shall be handled in future undated versions.

UPDATING AND REVISIONS OF GUIDELINES

The GLs are intended as an up-to-date or a live document enabling revisions, to be updated periodically to incorporate improvements, when and where necessary; may be due to evolving demands, technological changes and changing policies, and regulatory frameworks. Planning, study and design of SSI development interventions is a dynamic process. Advancements in these aspects are necessary to cope up with the changing environment and advancing techniques. Also, based on observation feedbacks and experiences gained during application and implementation of the guidelines, there might be a need to update the requirements, provisions and procedures, as appropriate. Besides, day-by-day, water is becoming more and more valuable. Hence, for efficient water development, utilization and management will have to be designed, planned and constructed with a new set up of mind to keep pace with the changing needs of the time. It may, therefore, be necessary to take up the work of further revision of these GLs.

This current version of the GLs has particular reference to the prevailing conditions in Ethiopia and reflects the experience gained through activities within the sub-sector during subsequent years. This is the first version of the SSI development GLs. This version shall be used as a starting point for future update, revision and improvement. Future updating and revisions to the GLs are anticipated as part of the process of strengthening the standards for planning, study, design, construction, operation and management SSI development in the country.

Completion of the review and updating of the GLs shall be undertaken in close consultation with the federal and regional irrigation institutions and other stakeholders in the irrigation sub-sector including the contracting and consulting industry.

In summary, significant changes to criteria, procedures or any other relevant issues related to technological changes, new policies or revised laws should be incorporated into the GLs from their date of effectiveness. Other minor changes that will not significantly affect the whole nature of the GLs may be accumulated and made periodically. When changes are made and approved, new page(s) incorporating the revision, together with the revision date, will be issued and inserted into the relevant GL section.

All suggestions to improve the GLs should be made in accordance with the following procedures:

I. Users of the GLs must register on the MOA website: Website: www.moa.gov.et
II. Proposed changes should be outlined on the GLs Change Form and forwarded with a covering letter or email of its need and purpose to the Ministry.
III. Agreed changes will be approved by the Ministry on recommendation from the Small-scale Irrigation Directorate and/or other responsible government body.
IV. The release date of the new version will be notified to all registered users and authorities.

Users are kindly requested to present their concerns, suggestions, recommendations and comments for future updates including any omissions and/or obvious errors by completing the following revisions form and submitting it to the Ministry. The Ministry shall appraise such requests for revision and will determine if an update to the guide is justified and necessary; and when such updates will be published. Revisions may take the form of replacement or additional pages. Upon receipt, revision pages are to be incorporated in the GLs and all superseded pages removed.

Suggested Revisions Request Form (Official Letter or Email)

To: ----------
From: ----------
Date: ----------
Description of suggested updates/changes: Include GL code and title, section title and # (heading/subheading #), and page #.

GL Code and Title	Date	Sections/ Heading/Subheading/ Pages/Table/Figure	Explanation	Comments (proposed change)

Note that be specific and include suggested language if possible and include additional sheets for comments, reference materials, charts or graphics.

GLs Change Action

Suggested Change	Recommended Action	Authorized by	Date

Director for SSI Directorate**: _____Date: _____**

The following table helps to track initial issuance of the guidelines and subsequent Updates/Versions and Revisions (Registration of Amendments/Updates).

Revision Register

Version/Issue/Revision No	Reference/Revised Sections/Pages/topics	Description of revision (Comments)	Authorized by	Date

1 INTRODUCTION

1.1 SCOPE OF THE GUIDELINE

This comprehensive technical guideline is developed for improving the knowledge and capacity of the sector to scale up the effectiveness and efficiency of small scale irrigation implementation so as to accelerate irrigation development of the country at large.

It aims to assist field construction personnel by giving outline of activities to be performed routinely in the construction of Small Scale Irrigation Projects; standardize the presentation of information that is necessarily required for the proper coordination of the work; provide construction management techniques; bear in mind that time scheduling or programming of activities for construction shows how the works should be organized and what resources mobilized in order to meet the targeted objectives in the implementation of the project; and discuss construction control focusing on (1) control of physical progress, (2) control of labour inputs, (3) control of equipment inputs, and (4) construction material control.

It also aims to support the existence of an effective project management system at the operational level on the site in order to accomplish the job as per the contract.

1.2 SETTING OF THE GUIDELINE

Construction guideline for small scale irrigation development addressed the issues in detail chapter by chapter. There are twelve chapters having the following its own contents: -

Chapter one presents introduction of the guideline and deals with the scope and setting out of the guideline. Chapter two deals with works contract management focusing on the day to day and periodical contract administration task within the members of construction crew.

Chapter three discusses construction planning and scheduling. Chapter four deal with construction personnel and their responsibilities. Chapter five describes activities in construction of small scale projects. Chapter six discusses type and use of construction materials associating with technical specification that forms the contract. Chapter seven deals with construction equipment, plants and instruments required in the course of small scale irrigation implementation.

Chapter eight discusses construction methodology for small scale irrigation project. Chapter nine deal with construction control underlining quality, time and cost that are the three areas of equal importance in a construction project to be controlled progressively. Chapter ten deal with construction safety issues by describing steps to be followed at site level to ensure safety at construction site and very important safety issues and measures.

Chapter eleven presents construction procedure for preparatory works, excavation and fill works of earthworks, masonry works, concrete works, pipe installation and testing works, pump installation and testing works, and gate fixing works using work flowchart. Finally, construction management software's that are currently applied by the engineers assigned in construction industry are discussed on chapter twelve.

2 WORKS CONTRACT MANAGEMENT

Works contract is a legally binding agreement entered into between the employer and the contractor for the execution of the works desired by the employer. Here, it is an expression of the willingness of the employer to pay the contractor and of the contractor to do the work as per the agreement.

Irrigation projects are capital projects that need to follow general contract management procedures during their implementation. In order to accomplish the job as per the contract, the contractor needs an effective project management system at the organizational level as well as at the operational level on the site.

Both parties must now make arrangements to fulfill their obligations and protect their interests under the contract. Some of the respective obligations and interests of client and contractor are as tabulated here under.

CLIENT	CONTRACTOR
Obligation Efficient project and contract management ▪ Ensure contactor's access to the site ▪ Secure adequate cash flow and payment procedures ▪ Promptly communicate decisions and information pertaining to the contract	**Interests** Realize the profit from the contract ▪ be able to work as planned ▪ Be paid on time ▪ Be informed of decisions and conditions pertaining to the contract
Interests Fulfillment of project objectives ▪ Be informed on progress and actions taken by the contractor ▪ Good quality of the Works ▪ Delivery on time ▪ Delivery at contract price	**Obligation** Efficient construction and contract management ▪ Adhering to specifications ▪ Effective planning and site management ▪ Promptly act on decisions and other information received ▪ Provide adequate warning on technical and other problems pertaining to the contract

The day to day and periodical contract administration tasks within the members of construction crew is described and discussed in sequential order as follows.

2.1 ADVANCE PAYMENT REQUEST AND COLLECTION

After signing a new contract agreement, the contractor can request the advance payment as specified in the contract attaching disbursement schedule which shows for what purpose the advance payment will be used and advance guarantee bond. The contractor should follow that the advance payment approved by the client/consult to be sent to the client for further approval and also that the responsible experts approve the payment and transfer to their finance to be effected. Finally, the contractor delegate should collect the approved advance payment.

2.2 CONSTRUCTION SITE HANDOVER

The contractor should arrange the way site hand over will be conducted in the presence of the client's, supervisor's, contractor's, and beneficiaries' representatives to locate the exact position of the works and the format prepared for this purpose should be signed by the three parties (Appendix Part IV/GL 29/I-1 SSI Project Site Handover to Commence Construction Format). The contractor shall set out the works in relation to original points, lines and levels of reference specified in the contract or notified by the engineer during the site hand over and approved by Engineer.

2.3 PROJECT LAUNCHING AND JOB ORDER

The contractor should arrange a meeting for the concerned bodies and present the overall content of the agreement signed. The contractor should give job order to the respective construction crew along with agreement documents and working drawings. The job order letter and agreement document should also be copied for other supporting teams and Archive. The code/job order number given indicates the project type, project office/zone and number of agreement in a particular year.

2.4 MOBILIZATION

The contractor should mobilize to the site within the period specified in SCC forming the contract. The project contractor must utilize the mobilization period to finalize arrangements, which could not be completed before signing of the contract or are still outstanding. The following checklist provides an overview of the mobilization task to be carried out by the contractor.

MOBILISATION TASKS BY THE CONTRACTOR		
Task	**Purpose**	**Checks and Requirements**
Provide Advance Payment Bond	Enable mobilization	Insurance policies, dedicated bank account
Provide Insurance Policies	Enable mobilization	Information to insurance company, money for payment
Finalize cash flow analysis and financing arrangements	Enable mobilization and construction	All requirements taken into account: Overheads, staff, labour, materials, tools, equipment, transport, interest payments, equipment lease/hire etc.
Take possession of site	Enable site establishment	Ensure that client has fulfilled his obligations
Mobilize office and site staff	Project and site management	Qualifications, terms of employment, housing, transport
Recruit laborers	Contract execution	Information to local leaders
Open dedicated Project Bank Account	Control of contract proceeding	Provide authorized signatories
Review or set up accounting system	Control of contract proceedings and payments	System must capture all costs and enable cost breakdown on bill items and costs components
Set up filing system	Accessibility and safekeeping of all contract related correspondence, documents	One file number per contract divided in sections as required. To be kept in locked steel cabinet.

MOBILISATION TASKS BY THE CONTRACTOR		
Task	**Purpose**	**Checks and Requirements**
	and records.	
Reporting and Monitoring System	Control of project management and contract execution	Internal and external reporting and monitoring to capture all aspects of project.
Schedule of meetings	Dissemination of information, discussion and resolution of problems	Project co-ordination meetings, site meetings, staff meetings,
Quality control procedures	Control of contract execution	Acquire equipment and recruit staff, arrange for testing at laboratory as required.
Roles and functions of staff	Efficient contract management	Draft and approve job descriptions
Acquire equipment, transport	Contract execution and supervision	Finalize arrangements for procurement, lease or hire
Purchase tools, materials	Contract execution and supervision	Finalize arrangements for supply
Office space	Contract management	Standard office inventory, communications, PC(s), copier, stationary
Site facilities	Contract execution and supervision	Site camp, office, store

2.5 PROJECT FOLLOW - UP AND SUPERVISION

Continuous project supervision should be conducted by the contractor delegate supervisor to follow whether the construction works are ongoing as per the contract agreement & the intended planed schedule or not. Utilization of construction materials, machineries and person power should also be investigated based on the cost break down.

Variation works should be clearly identified and clear contractual procedures should be set prior to execution of any variation work. (Both item or quantity variation). Contractual claims should be raised for every unforeseen problem like design changes, price escalations, time extension, weather and force majeure conditions and site related problems.
Contractor delegated supervise should also play an important role in settling any contractual disputes and disagreements between the contractor and the resident engineer during supervision. The activities (check lists) which should be performed during supervision are:

- Whether or not construction is on progress as per the contract agreement (i.e. cost wise, time wise and quality wise)
- Identifying variation works and informing the project office the contractual procedures or the way these works will be requested and approved on payment.
- Identifying the difference between report and payment and assessing the causes of this difference by observing the executed works. The difference is may be because of:
  - Works executed but not approved since it was executed without permission of the resident engineer.
  - Reporting error (Report uncertainty).
  - Works executed but payment not requested (Expected payment).

- Incomplete works.

- Settling any contractual disputes and disagreements between the project office and the resident engineer
- Identifying the problems and reasons for construction delays and suggest possible solutions.
- Assessing the utilization of construction materials:
  - Materials supplied purchased,
  - Received at projects,
  - Issued from store,
  - Utilized for construction, and
  - Materials on site or at stock/stock balance.
- Finally, the detail report, problems observed and suggestions given shall be reported for the concerned bodies for their immediate action.

2.6 PERFORMANCE & CONSTRUCTION MATERIALS UTILIZATION ANALYSIS

All the necessary data like the materials supplied to project, cash transferred from offices which are used as inputs for analysis to be made both at office and at project site during supervision should be regularly collected and various analyses should be made based on this data by supervise.

i. Construction materials data

Store keeper should give the report of each construction material, equipment and other inputs supplied for all the projects and feedback of the materials received at projects. This data will be used for analysis of materials supplied, revived at project, issues from store and utilized for construction.

ii. Weekly, monthly, quarterly and annual plan & report of project

- Revised project(s) annual and monthly construction plan or schedule to follow their performances.
- The detail physical report of projects should be collected by supervise for comparison between payment and report for executed activities monthly.

iii. Analysis

Based on the above data, the following analyses should be made periodically and the result should be reported each time to the concerned bodies.

a. Construction materials analysis by comparing materials supplied, received at projects, issued from store, the stock balance and those utilized for construction. This analysis is made both at head office and also at projects during supervision by physically observing the executed works, materials on site and those at store.
b. The detail physical report of projects should be compared with payment requested and physically executed activities and the reasons for the gap observed should be identified during supervision.
c. Monthly analysis of the difference between payment and report shall be presented so that special attention will be given.

2.7 INTERIM PAYMENT REQUEST AND FOLLOW UP

Monthly payments of projects shall be submitted by site construction crew to head office on the specified day of the month.

i. Monthly payments approved by the supervisor engineer shall be submitted to Contract Engineer via site construction crew on the specified day of the month.
ii. Contract Engineer records the payment on the payment attendance sheet, checks that all the quantities on take-off sheet are correctly taken to the measurement sheet and also check any arithmetic errors.
iii. If the take-off quantities are not correctly taken to the measurement sheet, the correct measurement sheet should be done at head office by Contract Engineer.
iv. After thoroughly checking the payment, making the above corrections and preparing payment certificate and request letter, the payment shall be copied and the original one shall be sent to the client/supervisor for approval by Contract Engineer.
v. Contract Engineer should daily follow the approval of the payment by client/supervisor.
vi. The payment sent to the client/supervisor for approval should be taken back by Contract Engineer so that the required number documents will be copied, bound and sent back if there is no any correction given by the client/supervisor. If there are corrections given by client/supervisor, the payments shall be corrected and the required number of copies shall be sent back similarly.
vii. Contract Engineer should follow that the payment approved by the consultant is sent to the client for further approval and also that the responsible experts approve the payment and transfer to their finance to be effected.
viii. Contract Engineer should give feedback copy of the approved payment certificate to construction team, so that project offices shall use it as feedback for the next interim payment.
ix. Contract Engineer should give the necessary approved documents to the Financer for their collection.
x. Contract Engineer should regularly check that payments due to price adjustment are regularly requested and should also follow the approval for those materials, labor or other inputs listed in the special condition of the contract.

2.8 VARIATION WORKS

Construction team should follow that any variation (item or quantity variation) should be ordered by the resident engineer in written form prior to execution. Execution of variation works prior to written order and approval of supervisor delays the payment and also makes the client not to adjust its budget beforehand.

Site construction crew should analyze the variation works, fix the unit rate for new activities and sent to the client/supervisor for approval. The contractor should follow that the variation approved by supervisor is sent to the client for further approval according to the GCC “Engineer’s Decisions” Clause forming the contract document. After the variation is approved by the client, the contractor should act accordingly.

Case 1Variation Order, Engineer Decision Restriction and Employer Approval

Project A is an irrigation dam construction project. The works include: (i) foundation excavation; (ii) construction of dam; and (iii) construction of 5 km irrigation canal. The Particular Conditions of contract restricts the Engineer's authority to issue variation order of more than ETB 250,000.00.

While reviewing the design of the dam, the Engineer noticed errors and reviewed the design accordingly. According to the review, the volume of works has been increased by ETB 0.5 million. The Engineer has issued a variation order to the Contractor in line with the revised design.

If you are assigned as the Contractor's Project Manager on site and noted that the VO has not been copied to the Employer. What would you do upon receipt of such instruction?

Response

Extraction of existing matters with respect to GCC

1. There is a variation work due to increase of volume of works as the result of dam design error rectification that amount ETB 500,000.
2. There is restriction by the client for the engineer in accordance to GCC "Engineer's Decisions" Clause that is stated in the particular conditions of contract that restricts the Engineer's authority to issue variation order of more than ETB 250,000.00.
3. There is variation order by the engineer to the contractor in accordance to GCC "Instructions" Clause but not copied to the employer.
4. The Engineer didn't obtain approval from the employer before ordering the variation work to the contractor according to the restriction laid up on her/him based on the particular conditions of contract. S/he failed to notify the variation occurred, due to the dam design error rectification, for approval.

Having this understanding the contractor has to communicate with the engineer to get approval from the employer or directly communicate the employer for its consent prior to commencing the variation work ordered.

2.9 TIME EXTENSION

The contractor organizes and examines time extension data approved by the resident engineer. The data which should be collected and approved are types of activities delayed, justifiable reasons approved by third party, number of delayed days for each activity, and total number of delayed days. Finally, the contractor should check the time extension and send it to the client/supervisor for approval. After the time extension is approved by the client, the contractor should act accordingly.

2.10 REPORT PREPARATION

Accomplishment reports of contractor should be prepared weekly, monthly, quarterly and annually and submitted to the concerned bodies. Similarly, all the necessary data, information and different analyses should be ready at any time to be given for the concerned bodies.

Weekly report: The contractor should perform preparation of the overall weekly report and submit to the concerned bodies, Preparation of weekly payment attendance, and updating payment follow up once in a week.

Monthly report: The contractor should prepare the overall monthly report and submit to the concerned bodies.

Annual report: The contractor should prepare the overall annual report and submit to the concerned bodies.

Construction completion report: As a part of report the contractor should prepare construction completion report, as built drawings and operation & maintenance manual and submit to the supervisor for approval.

2.11 PROJECT PROVISIONAL HANDOVER

Having completed all essential tasks, the contractor will request the client/supervisor to undertake the inspection for substantial completion. Substantial Completion means that the Client can make use of the works in accordance with the objectives and that there are no significant defects or essential parts of the works missing. During this inspection all defects and outstanding works are noted and time limits given for the contractor to correct or carry them out.

Contractor should submit the following to the supervisor to notify the substantial completion of the project activities and initiating provisional handover.

- The completion report approved by the supervisor engineer shows that construction is completed as per the agreement,
- As built drawings prepared by construction engineer and approved by the supervisor engineer, and
- Operation & maintenance manual prepared by construction engineer and approved by the supervisor engineer.

Then the contractor requests the client/supervisor by letter to conduct provisional hand over. Provisional project handover shall be conducted in the presence of the three parties signing on the format/certificate prepared for this purpose (*Appendix Part IV/GL 29/I-2 Constructed Project Handover Format*).

2.12 REQUEST AND COLLECTION OF THE FIRST RETENTION MONEY

When the Substantial Completion Certificate has been issued, the contractor can apply for the release of the first retention money, which is meant to cover the Client's costs for completion of outstanding works or rectification of works not done according to specifications. The Retention Money is specified in the Contract Data as a percentage to be deducted from the value of the works approved for payment and as a maximum of total money that can be retained. It is usually 5% in small scale irrigation infrastructures construction which is deducted from each interim payment certificate.

Up on issuance of Substantial Completion Certificate the first 50% of retained payment (2.5% of the total contract amount) is request by the contractor and effect by the client accordingly.

2.13 DEMOBILIZATION OF THE CONTRACTOR

An orderly scaling down of activities and demobilization from site, require good planning and supervision by the site staff, as there are many diverse activities, usually spread over the whole project location, to be undertaken. The demobilization tasks come in addition to the finishing activities of the works and include:

- Giving notice to labourers as the labour force is scaled down for termination of the temporary employment in accordance with labour regulations;
- Settling accounts for suppliers and utility services;
- Taking down temporary works used in the construction activities and for the camp and site facilities;
- Re-instating areas used as close as possible to their original condition;
- Collection and stocktaking of tools and equipment;
- Maintenance, repair and removal of construction equipment from site;
- Planning and preparations, including training, for operation and maintenance during the Defect Liability Period.

2.14 PROJECT FINAL HANDOVER

Project final handover shall be effect during the period specified on the provisional handover format of the project at the end of the defect liability period (usually 365 colander days). The contractor should check the site during defect liability period and correct the defected works if any. At a time, the site is ready for final handover the contractor requests the supervisor/client to undertake the final inspection.

During the final inspection, representatives from the Client and other stakeholders should be present for the formal handing over of the works and signing on the format/certificate prepared for this purpose (*Appendix Part IV/GL 29/I-2 Constructed Project Handover Format*). Provided that all outstanding works and correction of defects as noted on the Substantial Completion Certificate have been carried out to the satisfaction of the Supervisor Engineer and the project has been well completed, the Client/Supervisor will issue the signed and stamped Final Completion Certificate to this effect.

2.15 REQUEST AND COLLECTION OF THE FINAL RETENTION MONEY

Up on issuance of the Final Completion Certificate, the contractor requests the final retention money and the client release the remaining portion of the Retention Money usually 50% retained payment (2.5% of the total contract amount).

2.16 REQUEST AND COLLECTION OF FINAL PAYMENT

After receiving the Final Taking-Over Certificate for the Works, the Contractor shall submit to the Engineer a Statement at completion with supporting documents.

After receiving the Performance Certificate, the Contractor shall submit, to the Engineer a draft final statement with supporting documents showing in detail in a form approved by the Engineer:

a) the value of all work done in accordance with the Contract, and
b) any further sums which the Contractor considers to be due to s/him under the Contract or otherwise.

Documents required for final payment to be obtained (refer to contract) may include the following, but are not limited to:

i. As-built drawings (CAD Format) and specifications on the specified days before final inspection. The as-built drawings are the original contract drawings adjusted to reflect all the changes that occurred,
ii. Maintenance/Operations Manuals – specified days after approval of submittal,
iii. Spare Parts List – specified days after approval of submittal, and
iv. Construction completion report

Finally, the contractor should collect the Final Payment Certificate which shall state:

a. the amount which is finally due, and
b. after giving credit to the Employer for all amounts previously paid by the Employer and for all sums to which the Employer is entitled, the balance (if any) due from the employer to the Contractor or from the Contractor to the Employer, as the case may be.

2.17 CONTRACT CLOSEOUT

Contract closeout is an important aspect of contract administration. Contract closeout begins when the contract has been physically complete, i.e., all services have been performed and products delivered. Closeout is completed when all administrative actions have been completed, all disputes settled, and final payment has been made. The process can be simple or complex depending on the contract type for cost-reimbursement contracts. This process requires close coordination between the contracting office, the finance office, the program office, and the contractor.

The contractor shall coordinate and plan for closeout submittals (if any) and closeout conference with contracting officer and customer. Assessment of the project team's performance is crucial in this stage for avoiding mistakes in the future. Actual activity costs and durations should be recorded and compared with that was planned. This updated costs and durations will serve as the basis for the estimating and scheduling of future projects. Some of contract closeout best practices for the considered concerns are tabulated hereunder as an example.

CONCERNS	BEST PRACTICES
Lack of management attention to contract closeout.	Establishing a separate closeout function within the contracting organization emphasizes the importance of contract closeout. The best time to concentrate on contract closeout is during the October to February timeframe when the contract placements workload may be less. Using contractor support may be an efficient way to accomplish contract closeout when in-house resources are limited. Such administrative functions as creating the closeout file, soliciting required closeout forms from internal organizations, obtaining the contractor's release are duties that can be performed through contractor support as long as the forms are executed and approved by the contracting official. Although the contract specialist continues to work with the contractor

CONCERNS	BEST PRACTICES
	through physical completion under "cradle-to-grave" contract administration, this does not prohibit a separate group from performing the closeout function. Rewarding employees through incentive awards (i.e., on-the-spot cash awards) for the highest number of closeouts completed is a good motivation factor. Using measurements standards such as those prescribed in the FAR for closing various types of contracts helps to keep the focus on the closeout effort. Cross-training in contract closeout is good for contract specialists as it helps them to understand the importance of writing good contracts.
Poor Management Information Systems to monitor the contract closeout process.	Consider using a management information system with milestones to track contract closeout from physical completion through final payment. Integrating the closeout system with a word processing capability allows for automatic generation of closeouts letters which speeds up the closeout process. Using contractor support for data entry services may be an alternative when in-house resources are limited.
Avoiding Disputes in Contract Closeout.	In construction, claims sometimes cause closeout problems. An alternative dispute resolution technique known as "partnering" should be considered. Creating a partnership agreement with the contractor helps to avoid disputes. Having the partnership agreement signed by all parties and the contractor creates a buy-in to the overall goal: "Completion on time, within budget, and without claims."
Closeout documentation.	Always use a checklist and include it in the contract file when closing contracts. This helps to assure that all actions have been completed.

3 CONSTRUCTION PLANNING AND SCHEDULING

3.1 CONSTRUCTION PLANNING

Construction planning & scheduling is an application of common sense and a logical analysis of construction activities using a thorough knowledge of construction methods, materials & practices.

Construction planning process is simply an application of the thoughts and process that must be entered into before detail scheduling is done. It requires the following to be considered. Planning serves as a foundation for several related functions, such as cost estimating, scheduling, project control, quality control, safety management, and others. It also answers the questions.

- What is going to be done?
- How?
- Where?
- By whom? and
- When (in general terms, the project's start and end)?

The efficient and effective implementation of construction projects requires good management of relationships for and among resources, activities and stakeholders as applied to the context where such projects are implemented. Materials, Money, Person power and Machineries are usual resources recognized in most situations.

Equipment types used in a construction project is largely dependent on their: -

- Direct input to unit prices or not,
- Type of work or trades,
- Scope of work,
- Mobility,
- System of control, and
- Availability.

Construction planning should consider the following but not limited to:

- items that require purchase orders to be placed long in advance,
- mobilization of labour may need conferences and discussion with the direct & indirect beneficiaries,
- access to construction site are requirements prior to mobilizing equipment and other construction utilities,
- if there are tasks in the project that are dependent upon the completion of other activities due consideration has to be made,
- if special environmental controls are required, it has to be sorted out,
- the time allotted to complete the project should be adequate for the location and the seasons. Otherwise increment in construction unit size or premium time will be a necessary

3.2 CONSTRUCTION SCHEDULING

Scheduling is the determination of the timing and sequence of operations in the project and their assembly to give the overall completion time. Scheduling focuses on one part of the planning effort. It deals with *when* on a detailed level.

Contractors need project scheduling to (1) calculate the project completion date, (2) calculate the start or end of a specific activity, (3) coordinate among trades and subcontractors, and expose and adjust conflicts, (4) predict and calculate the cash flow, (5) improve work efficiency, (6) serve as an effective project control tool, (7) evaluate the effect of changes, and (8) prove delay claims.

Scheduling requires determination of the work activities, activities' durations, and logical relationships; drawing of the logic network; and performing of the total time required calculations.

The Critical Path Method (CPM) is a schedule network analysis technique currently used with the following advantages: -

- Offers a visual representation of the project activities,
- Presents the time to complete the tasks and the overall project, and
- Tracking of critical activities.

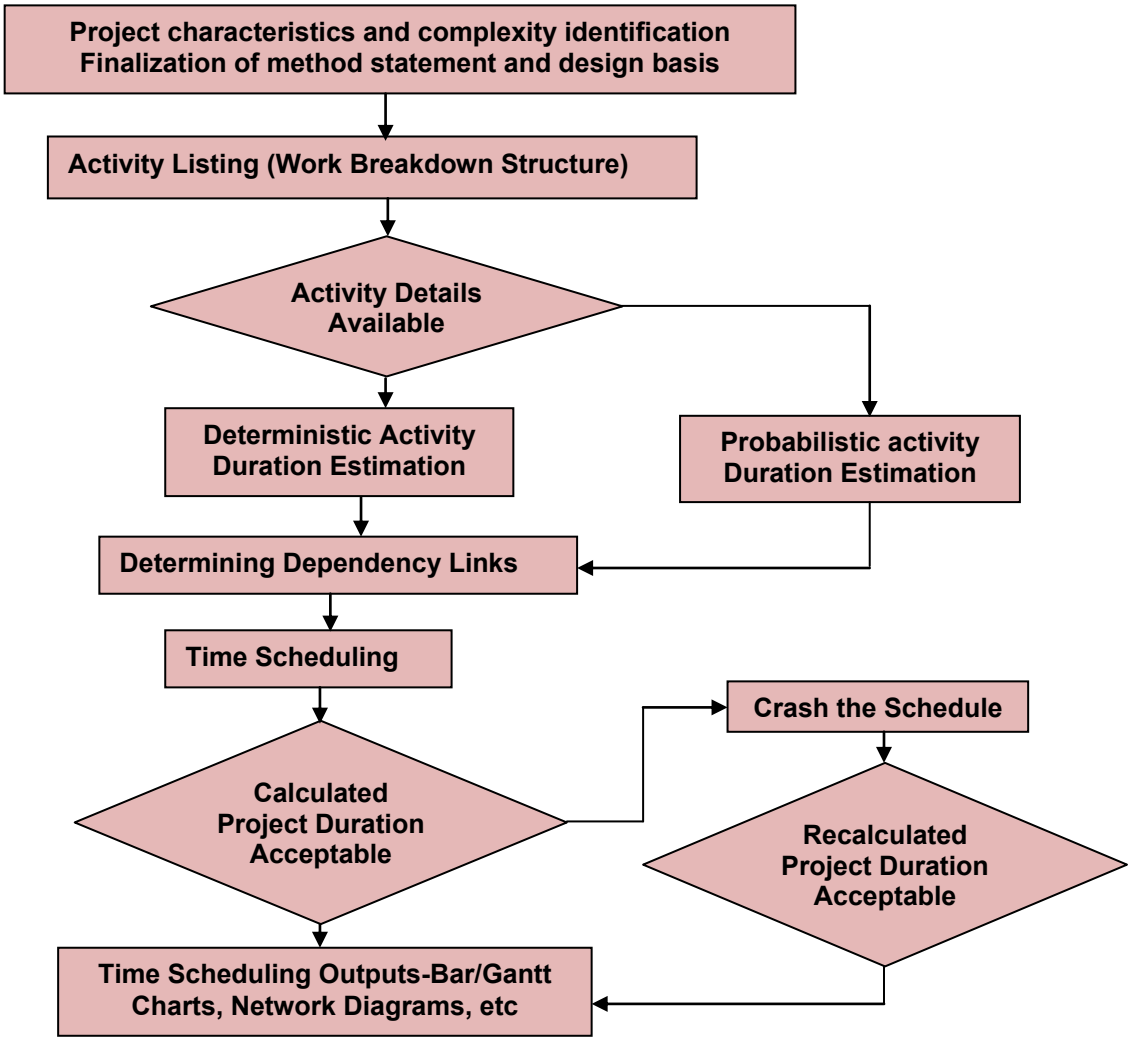


Figure 3-1: Typical time planning/scheduling process

While preparing construction schedule, it is necessary to draw up an optimum time frame keeping in view the following: -

a) Past experience of similar projects,
b) Location and weather conditions,
c) Time and other constraints lay down by the owner and other stakeholders,
d) Availability of resources such as personnel, funds, equipment, etc., and
e) Time required for proper execution of various activities without compromising quality and safety.

In its characteristics, SSIPs are infrastructure project by type of work, special short-term projects having less than one-year completion time, relatively small value projects, and normal pace projects.

During construction planning and scheduling use formats listed under Appendix Part IV/GL3/B Planning and Scheduling Format.

4 CONSTRUCTOR PERSONNEL AND THEIR RESPONSIBILITIES

Person power is the most influential element in construction industry. Construction team for a project can comprise a compliment of professional technical and administrative staff. In general, the following skilled/professionals, semi-skilled and unskilled person power as technical staffs together with other administrative staffs as per the demand have a paramount importance for construction of small scale irrigation projects at site level.

No	Required Person Power	Number	Responsibility
A	**Technical Staffs**		
I	**Professionals/Skilled**		
1	Project Manager	As required	Responsible to manage the financial, technical and schedule requirements of the project in such a manner as to bring the project on-time, within budget and with a technical quality that meets or exceeds the contractual performance specifications. In general, all project activities are the responsibility of PM.
2	Site/Office Engineer/Others	As required	Responsible for coordinating and lead the site works, give clarification when ambiguity arises, draw technical recommendation if required, successful completion of the project as per technical specification and drawings forming the contract, etc. He/she is working under close supervision of Project Coordinator. To communicate local community.
3	Material Engineer/Lab. Technicians	As required	Responsible for: ➢ Provision of expert advice in the geotechnical aspects of the contractor's design; ➢ Ensuring the recommended foundation of structures; ➢ Establishment and management of materials testing laboratories and ensuring that materials and workmanship are in accordance with the specified requirements; and ➢ Testing the materials and work in accordance with the specified test methods. Responsible for the testing carried out by him/her ensuring that: - ➢ The proper test methods are followed; ➢ Only calibrated equipment is used; ➢ Work sheets and report forms are correctly completed; and ➢ All calculations are checked.
4	Safety Officer	As required	Responsible for monitoring that adequate safety measures are put in place at all times accordance to rule and regulation of the country.
5	Forman	As required	Responsible for the day-to-day distribution of plant and labour, supervision of flow of materials and upkeep of site communication systems. He is also the link between management and labour. He/she is working under close supervision of Site Engineer.
6	Surveyor	As required	Responsible for accurate measurements of land areas in order to determine boundaries, elevations, and dimensions of structures. He/she is working under close supervision of Construction Forman.

No	Required Person Power	Number	Responsibility
7	Machinery Operators	As required	Responsible for efficient operation of machinery.
8	Truck Drivers	As required	Responsible for driving a large vehicle for transporting construction materials to site.
9	Service Vehicle driver	As required	Responsible for driving service vehicle for transporting staffs and construction materials at site level.
II	**Semi-skilled**		
1	Carpenter	As required	Responsible for building of wooden objects or structures as specified in the specification and drawing forming the contract. He/she is working under close supervision of Construction Forman.
2	Mason	As required	Responsible for stone and brick works as specified in the specification and drawing forming the contract. He/she is working under close supervision of Construction Forman.
3	Plasterer	As required	Responsible for plastering structures as per specification forming the contract. He/she is working under close supervision of Construction Forman.
4	Chiseller	As required	Responsible for chiseling parts of the structures as recommended by the engineer. He/she is working under close supervision of Construction Forman.
5	Bar Bender	As required	Responsible for cut, bend and fix in a position of reinforcement bar as specified in the specification and drawing forming the contract. He/she is working under close supervision of Construction Forman.
6	Plumber	As required	Responsible for installing and fixing of pipe works as per specification and drawing forming the contract. He/she is working under close supervision of Construction Forman.
7	Welder	As required	Responsible for constructing or repairing metals works by welding separate pieces or parts together as specified in the specification and drawing forming the contract. He/she is working under close supervision of Construction Forman.
III	**Unskilled**		
1	Daily Labourer	As required	Daily laborers work at a job that requires physical strength and stamina under Semi-skilled laborers.
2	Guard	As required	Responsible to protect project resources against danger or loss by being vigilant and taking defensive measures.
B	**Administrative Staffs**		
1	Purchaser	As required	Responsible to buy the required construction materials keeping the quality as specified on the technical specification forming the contract and legal procurement process. He/she is working under close supervision of Project Coordinator.
2	Cashier	As required	Responsible for receiving and paying out money and keeping financial records in the project. He/she is working under close supervision of Project Coordinator.
3	Store Keeper	As required	Duties include checking in and out and safeguarding all materials at the construction site. He/she also receives and issue tools that will be used during construction.
4	Time Keeper	As required	Record labor force attendance and prepare pay-sheets to submit to the office manager. He/she needs to liaise closely with the foremen in order to keep track of attendance of the labor force.

5 ACTIVITIES IN CONSTRUCTION OF SMALL SCALE PROJECTS

The followings are major activities that should be well articulated and presented in the technical specification, drawings and bill of quantity of a given project. The existence and scope of the activities may vary project to project based on the site condition that determines the type of structure even.

5.1 SIT CLEARING

The work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of project and such other areas as may be indicated on the plans or required by the work.

5.2 EXCAVATION

This work shall consist of excavation, disposal, shaping, or compaction of all material encountered within the limits of the work. Broadly, excavation can be categorized as trench excavation, foundation excavation, and mass excavation. Excavation is required found structure foundation, canal, and ditches; to obtain material for small earth dams; to form the embankments of irrigation canals; to produce a level road formation platform in virgin terrain.

Figure 5-1: Trench for pipe laying

5.3 HARD-CORE

It is stone place over soil to form foundation of the main structure. It is usually 20cm to 25cm thick.

Figure 5-2: Hard core laying

5.4 MASONRY STRUCTURE

In most cases small scale irrigation infrastructures could be built out of stone masonry. It is relatively cheap and is easy to work with as compared to other construction materials. Shaped stone masonry is the commonly used stone masonry. The stones are shaped to a rectangular prism is easier to produce a wall with proper bonding and uniform surface.

Besides, hallow concrete block (HCB) masonry made from sand-cement can be used in irrigation construction for building of pump and generator houses.

Figure 5-3: Stone masonry

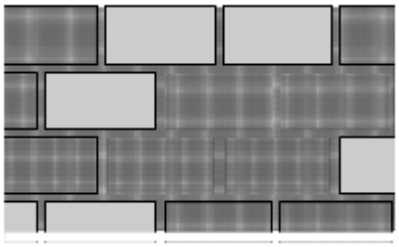


Figure 5-4: Hallow concrete block masonry

5.5 CONCRETE STRUCTURE

It is an activity of casting a structure with the specified cement, sand and gravel mix. It may be lean, mass or reinforced cement concrete depending on the quality of works as specified in the technical specification, drawings, and bill of quantity forming contract. In some description concrete works includes supply, cutting, placing and fixing in a position of reinforcement bar. But, mostly supply, cutting, placing and fixing in a position of reinforcement bar work treated separately.

5.6 PLASTERING

It is application of cement mortal to the internal and external walls of structures as specified in technical specification and drawing.

5.7 POINTING

It is an activity of application of cement mortal between building stones or the bricks leaving the latter undressed.

5.8 BACKFILL AND COMPACTION

It is an activity of refill a trench or other excavation around a structure with the specified back fill material and compact the fill to the recommended degree of compaction to make it firm. The fill material may be surplus native excavated or selected material from borrow area.

5.9 STONE RIPRAP

Stone riprap is an activity of a stabilizing foundation or embankment with stone placed in or along the edge of water.

5.10 PIPE LAYING

Pipe lying is an activity commonly used for construction of canal system and pressurized irrigation system.

Figure 5-5: Pipe lying

5.11 GABION STRUCTURE

Gabion structures are wire mesh boxes filled with stones and tied together to form basic structures. They are used principally for retaining walls, drifts and erosion protection. The standard size of gabion boxes is: 2m length, 1m width and 1m height.

Gabion boxes may be made from purpose made gabion cages, welded steel mesh sheets or galvanized chain link fencing.

Foundations must be excavated level. Unsuitable material has to be removed and replaced with good soil, stone or gravel and compacted.

Cages have to be woven together using 3mm galvanized binding wire, securing all edges every 0.15m with a double loop. Tighten the binding wire with a pair of heavy-duty pliers and secure with multiple twists.

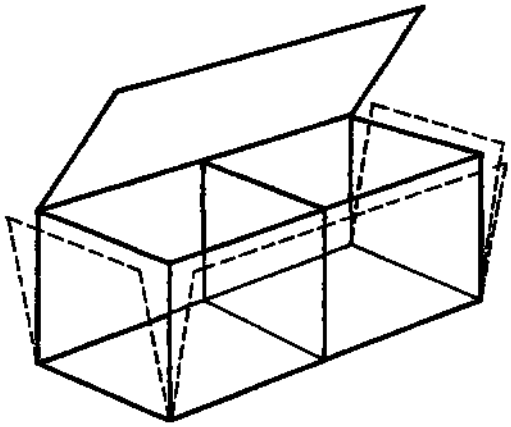
Stretch and stake the connected baskets with wires and pegs to achieve the required shape (all sides rectangular).

Fill baskets by hand using hard durable stones not larger than 250 mm and not smaller than the size of the mesh. The best size range is 125 - 200 mm. Place the stones as if for dry stone masonry.

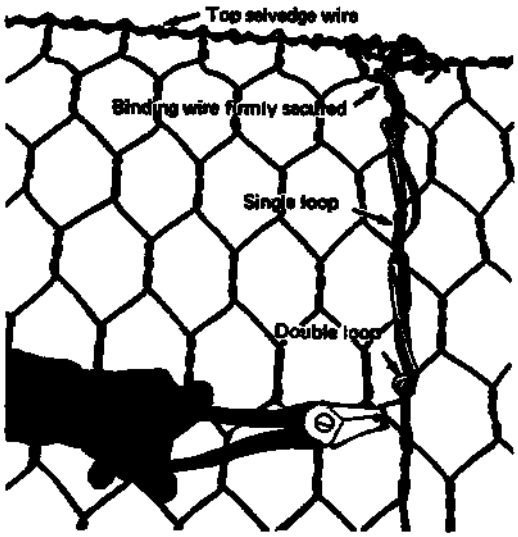
Fill the boxes to 1/3 of the height. Fit horizontal bracing wires and tension with a windlass to keep the vertical faces even and free of bulges. Further bracings should be fixed after filling to 1/3 of the height.

Lids are closed and stretched tightly over the stones, (carefully) using crowbars if necessary. The lid is securely woven to the tops of the walls using galvanized wire.

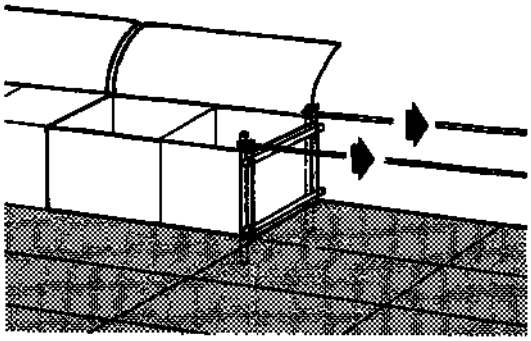
1. ASSEMBLE CAGE



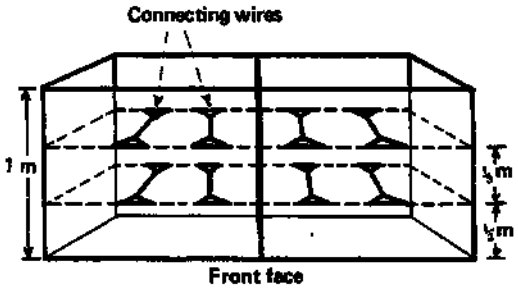
2. WEAVE BOXES SECURELY TOGETHER



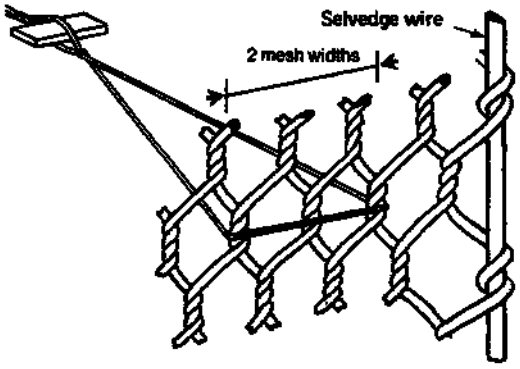
3. STAKE AND STRETCH CAGES TO REQUIRED SHAPE



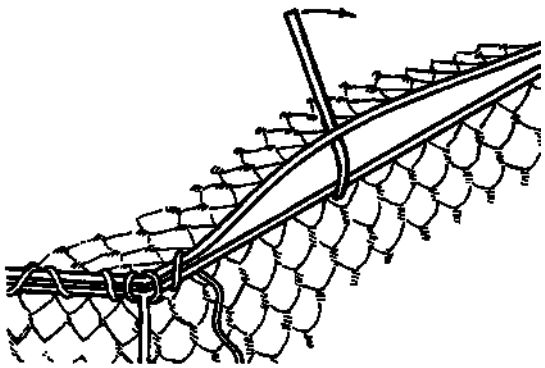
4. INTERMEDIATE BRACING



5. WINDLASS BRACING



6. CLOSE AND SECURE LID



5.12 DEWATERING

It is an activity to removing water from working area. The water may be from surface flood, sub surface or ground sources. It is mainly happening during diversion weir construction and spring eye capping.

5.13 COFFERDAM

Cofferdam is a temporary dam or barrier used to divert a stream or to enclose an area during construction of headwork structures such as Earth Dam and Diversion Weir. Cofferdams may be constructed of soil, sandbags or sheet piles depending to the complexity of the work. Generally, cofferdams are constructed of materials available at the site.

Figure 5-6: Sheet piles

Figure 5-7: Cofferdam made of soil and stone

6 TYPES AND USE OF CONSTRUCTION MATERIALS

Different construction materials are used for irrigation construction. Some of them and the respective unit of measurement are as tabulated under.

No.	Construction Materials	Unit of Measurement
1	Sand	m^3
2	Gravel	m^3
3	Stone	m^3
4	Selected Material	m^3
5	Timber	m^2
6	Cement	qt
7	RCC Bar	kg
8	Eucalyptus poles	pcs
9	CIS 32 Gauge	pcs
10	HCB	pcs
11	Plywood	pcs
12	Chip wood	pcs
13	Morale	pcs
14	Nail	kg
15	Roof Nail	kg
16	Soft Wire	kg
17	Gabion	kg
18	RCC Pipe, of different ø	pcs
19	PVC pipes of different ø	pcs
20	Geo-membrane	m^2
21	Red Ash	m^3

All materials to be used in the work shall be in conformity with the requirement laid down in the technical specification forming the contract. If any special material not covered in the technical specification is required to be used, it shall conform to the relevant Ethiopian Standard, or specified by the Engineer.

6.1 EMBANKMENT FILL MATERIAL

Selected Material are used for embankment fill from the borrow area recommended by the geologist and adapted by design engineer during design phase and specified in the technical specification forming the contract. Generally, borrow material shall be pit-run, granular, well graded material free from rocks larger than 100 mm in maximum dimensions and free from large roots, stumps, or other debris.

6.2 STRUCTURE BACK FILL MATERIAL

Soil materials used for back filling of structures may be native material excavated from foundation or trench and borrow materials as discussed above (Section 6.1). Back fill materials shall be as specified in the technical specification or recommended by the supervisor engineer.

6.3 STONE

The stone used for hard coring and masonry works is to be hard basaltic granite, gneiss or other hard, dense stones in larger piece, free of cracks or veins of soft matter. The unit weight of basaltic stone is 2700kg/m^3. It should be as specified in the technical specification that is used for structural analyses during design phase.

6.4 CEMENT

Ordinary Portland Cement (OPC) produced from limestone and clay is the commonly cement type used in Ethiopia for mortar and concrete mixes. It is normally sold in paper bags containing 50 kg each. 50 kg of cement equals 36-liter cement.

It is advisable to store cement in a shed, preferably without windows. A boarded floor or wooden platform raised above the ground is advisable. While storing bags: -

- should not be stocked above person-height,
- should not touch the walls of the shed so that air can freely circulate,
- must be off-loaded by hand in order to keep the paper bags unbroken, and
- should be used up in rotation (first stocked - first used).

Hardened lumps found when opening the bag should be removed by sieving the cement.

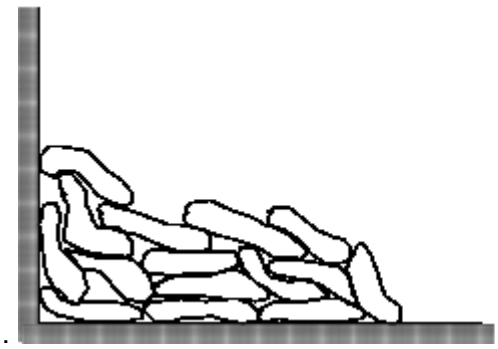


Figure 6-1: Wrong storage of cement

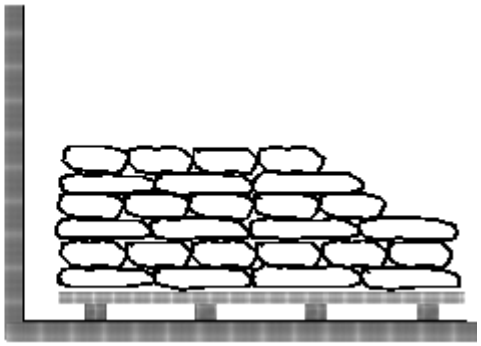


Figure 6-2: Correct storage of cement

6.5 SAND

Sand is referred to as fine aggregates and is used to designate aggregates in which the nominal maximum size as specified in the technical specification forming the contract. The sand particles should be smooth, rounded and hard.

Sand is used as ingredient for mortal and concrete mixes. It is very important to use only clean sand as impurities, like organic material and clay, can cause considerable loss of strength in the finished concrete. If the aggregates need to be washed, attention must be given in order not to wash off the fine particles.

To assess the cleanliness of aggregates a simple **bottle test** can be carried out. Fill a clear bottle half with aggregates, add water to the top and shake well and then allow the aggregates to settle. After about 30 minutes, if the aggregate is clean, there should be no or very little (less than 5%) dirt or silt deposited on top of the aggregates and the water above should also be clear.

On site sand should be deposited on a clean ground (no dirt and no topsoil) on clearly separate heaps to avoid uncontrolled mixing. During the rains it is also advisable to cover sand with a polyethylene sheet in order to avoid the fine particles being washed off.

6.6 GRAVEL

Gravel is referred to as coarse aggregates and has diameters ranging from 2 mm to 50 mm. The stone diameter selected for the preparation of concrete depends on the structure under construction. For example, for 5-cm thick concrete-lined canals the ideal stone size is 19 mm (¾ inch). The gravel should be round or chunky, hard and strong. Poorly-shaped stones, such as those that are flaky and long, should be avoided as this would mean that more of the other materials are needed. The stones should be about the same size. It is used as ingredient in the concrete mixes of different class as specified in the technical specification forming the contract.

On site gravel should be deposited on a clean ground (no dirt and no topsoil) on clearly separate heaps to avoid uncontrolled mixing.

6.7 REINFORCEMENT STEEL BAR

Reinforcement steel bar is a load bearing construction material used for construction of reinforced concrete of different grades as specified in the technical specification forming the contract.

Table 6-1: Useful constants of steel

Parameters	Value	Unit
Modulus of elasticity	$2x10^5$	N/mm^2
Poisson's Ratio	0.25 to 0.30	
Modulus of Rigidity	$7x10^4$ to $8x10^4$	N/mm^2
Coefficient of thermal expansion	$12x10^{-6}$	perc
Specific weight	$7.85x10^4$	N/m^3

Table 6-2: Area, perimeter and weight of different diameter bars

Diameter of bar, mm	Area, mm^2	Perimeter, mm	Weight per meter, N/m	Weight per meter, kg/m
5	20	15.7	1.541	0.154
6	28	18.8	2.22	0.222
8	50	25.1	3.946	0.395
10	79	31.4	6.165	0.617
12	113	37.7	8.878	0.888
14	154	44	12.084	1.208
16	201	50.3	15.783	1.578
18	254	56.5	19.976	1.998
20	314	62.8	24.662	2.466
22	380	69.1	29.84	2.984
25	491	78.5	38.534	3.853
28	616	88	48.337	4.834
32	804	100.5	63.133	6.313

6.8 WATER

Water is used for mixing of mortal and concrete as well as curing of masonry and concrete structures. It is an important ingredient as it actively participates in the chemical reaction with cement. It does have two functions in concrete mix namely chemical reaction with cement, and lubricates all other materials & makes the concrete workable.

Water used in concrete and mortal shall be reasonably clean and free from objectionable quantities of silt, organic matter, alkalis, salts, oils, acid, sugar and other impurities. It can be taken form rivers, lakes (For example Lake Tana and Lake Ziway), wells and from taps. Salt water (sea or lake), surface run-off water and water with other chemical or organic impurities must not be used. Generally, drinking water is suitable for making good concrete and mortal mixes. As guidance, value of different prosperities of drinking water according to Ethiopian Guidelines Specification for Drinking Water Quality March 2002 is as tabulated under.

Property	Acceptable Value according to Ethiopian Guidelines, mg/l
Sodium (Na)	358
Boron (B)	0.3
Iron (Fe)	0.4
Manganese (Mn)	0.5
Sulphate (SO4)	483
Total Hardness (as CaCO3)	392
pH	6.5-8.5
Nitrate (NO3)	50
Fluoride (F)	3

Source: - Ethiopian Guidelines Specification for Drinking Water Quality March 2002.

6.9 FORMWORK

Strong and rigidly braced formworks made of either timber or metal as specified in the technical specification are used for casting of concrete in situ.

6.10 PIPE AND FITTINGS

Currently plasticized polyvinyl chloride (uPVC) is commonly used for construction of canal system. Steel pipes and fittings are used for pressurized irrigation system. The type, diameter and nominal pressure of the pipe should be as specified in the technical specification and drawings forming the contract for each specific project.

6.11 CEMENT MORTAR

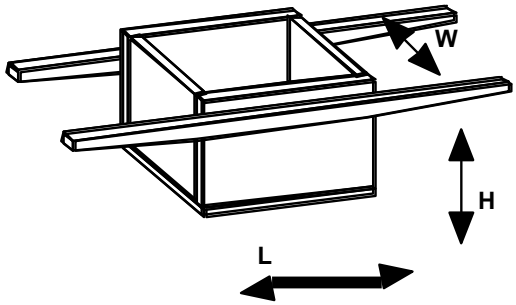
Cement mortar made of cement and sand as specified proportion on the technical specification forming the contract is used for wet masonry, plastering and pointing works. For example, to produce 1 m^3 cement mortal of a 1:2 mixture requires 13 bags of cement and 0.88 m^3 of sand.

Table 6-3: Quantity of cement and sand to produce 1m^3 mortar for different mixes

Mixture (Cement: Sand)	Cement				Sand		
	Kg	m^3	Calculated number of bag*	Recommended number of bag*	Kg	m^3	Number of Box**
1:2	612.5	0.438	12.3	13	1610	0.88	24
1:3	459.4	0.328	9.2	10	1811	0.98	27
1:4	367.5	0.263	7.4	8	1932	1.05	29

*One Bag of cement weighs 50kg.

** **Box** made of Timber having 0.4m*0.30m*0.30m standard dimension and capacity of 0.036m^3.



Inside measurements are: -

- Length = 40 cm
- Width = 30 cm
- Height = 30 cm
- Volume = 0.036 m^3 = 36 liters

6.12 CONCRETE MIX

In irrigation construction C-7, C-10, C-15, C-20, C-25, C-30, and C-35 grades of concrete commonly used. A set of mix for concrete should be well defined either in terms of the proportion of cement, sand and gravel or in terms of the 28days compressive strength requirements. The commonly used concrete mix in terms of proportions of the components are the following but not limited to:

- 1:4:8 used for lean concrete,
- 1:3:6 used for mass concreting and the rear sides of dams,
- 1:2:4 and 1:2:3 used for general reinforced concrete works,
- 1:1.5:3 used for front faces of dam, water tanks columns, etc.

The following are some of grade of concrete based on 28 days' cube strength used in irrigation construction.

Group	Grade designation	Specified characteristic compressive strength of 150mm cube at 28 days (N/mm^2)
Ordinary concrete	M10 (1:3:6) approximate	10
	M15 (1:2:4) approximate	15
	M20 (1:1.5:3) approximate	20
Standard Concrete	M25 (1:1:2) approximate	25
	M30	30
	M35	35

Note that the actual value of *mix proportion* for each grade of concrete for the specific project should be determined by mix design in the laboratory. The material from the query site and type of cement used matters the value.

Cement, sand and gravel quantity to produce 1m^3 of concrete mix for different grade of concrete: -

Mixture (cement: sand: gravel)	Cement				Sand			Gravel		
	Kg	m^3	Calculated number of bag*	Recommended number of bag*	Kg	m^3	Number of Box**	Kg	m^3	Number of Box**
1:1:2	478	0.3	9.6	10	628	0.34	9	1536	0.68	19
1:1.5:3	347	0.2	6.9	7	685	0.37	10	1675	0.74	21
1:2:3	319	0.2	6.4	6.5	837	0.46	13	1536	0.68	19
1:2:4	273	0.2	5.5	6	718	0.39	11	1755	0.78	22
1:3:6	191	0.1	3.8	4	753	0.41	11	1843	0.82	23
1:4:8	147	0.1	2.9	3	773	0.42	12	1890	0.84	23

*One Bag of cement weighs 50kg.

**Box made of Timber having 0.4m*0.30m*0.30m standard dimension and capacity of 0.036m^3.

For example, to produce 1 m^3 concrete mixes of a 1:2:4 proportions require 6 bags of cement, 0.39 m^3 of sand and 0.78 m^3 of gravel.

6.13 GABION

Construction materials for gabion walls and mattresses used in aprons for retaining walls, lining of channels, revetments, and other anti-erosion structures in accordance with the Drawings or as ordered by the Engineer are as discussed here under but not limited to:

Rock: stones or rock for filling gabions shall be clean, hard, sound, durable and un-weathered boulders or rock fragments. It can be obtained from sources located by the Contractor and approved by the Engineer.

No rock particles shall exceed the maximum size given in table below and at least 85% of the rocks shall have a size equal to or above minimum size given in the table.

Table 6-4: Rock size

Depth of cage (mm)	Minimum (mm)	Maximum (mm)
0.2	75* or 95**	125
0.3	100	200
0.5	100	250
1.0	100	300

*Using 60 x 80 mm mesh

**Using 80 x 100 mm mesh

Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013.

Wire: All wire used in the fabrication of the gabions and in the wire operations during construction shall be to ASTM A 910, Grade # 1010 or 1015, having a tensile strength of not less than 350 MPa. Cold drawn steel wire fabric shall meet the requirements of AASHTO M-55.

Galvanizing: All wire used in the fabrication of gabions shall be galvanized in accordance with the provisions of ASTM A 641 with Class 3 coating or aluminized with a coating weight as per ASTM A 809 for Class A heavy galvanized mild steel wire. The minimum mass of the zinc- coating shall be according to the figures shown in Table below.

Table 6-5: Coating of wire

Nominal diameter of coated wire (mm)	Mass of coating (g/m^2 surface area)
3.7-4.0	290
3.0-3.6	275
2.2-2.9	260
below 2.2	245

Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013.

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns round a mandrel of four times the diameter of the wire, it shall not flake or crack to such an extent that any zinc can be removed by rubbing with bare fingers.

Wire mesh and clip fasteners: Wire mesh shall be hexagonal-woven mesh wherein the joints are formed by twisting each pair of wires through three half turns. The tightness of the twisted joints shall be such that a force of not less than 1.7 KN is required when pulling on one wire in order to separate it from the other wire provided each wire is prevented from turning; and the applied forces and the wire are all kept in the same plane. The diameter of the wire and the size of mesh used shall be as shown in Table below.

Table 6-6: Mesh size

Depth of gabion (m)	Mesh size (mm)	Wire diameter (mm)
0.5 and over	80x100	2.5
	100x120	2.7
0.2 -0.3	80x100	2.2
	60x80	2.0

Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013.

The shorter dimensions of the mesh shall be taken from center to center of the twisted joints, and the larger dimensions shall be between the inside ends of twisted joints.

Alternatively; wire used in the body of the mesh shall not be thinner than 11-gauge for galvanized baskets and 12-gauge for PVC coated baskets. Selvage wire shall not be less than 10 gauge, and lacing and tie wire shall not be thinner than 13-gauge. Clip fasteners shall be galvanized and/or PVC coated as required and may be of any type that provides positive lock when installed. They shall be stronger than the mesh to which they are attached.

Galvanizing on the steel clips shall be in accordance with ASTM A 641 with a Class 3 coating, and aluminizing shall be in accordance with ASTM A 809.

Gabions using PVC Coated wire: When gabions using PVC coated wire is specified, the wire used for the gabion mesh, and for wiring the gabions during construction shall be galvanized wire as specified in Clause 9102(b) onto which is extruded a polyvinylchloride (PVC) coating. The average thickness of the PVC coating shall be as specified, either 0.30 mm for use in mildly corrosive conditions or 0.55 mm for use in marine and other severely corrosive or abrasive conditions. The minimum thickness of the coatings shall be 0.25 mm and 0.4 mm respectively, and the coatings shall be capable of resisting the deleterious effects of natural weather and salt-water exposure. The PVC coated gabions shall be of a proven brand and the brand shall be subject to the Engineer's approval.

Geotextile Filter fabric: Where indicated on the Drawings or ordered by the Engineer, one layer of approved geotextile material shall be placed on the prepared surface prior to the placing of gabions. The material shall be placed as directed in vertical strips with a minimum overlap of 300 mm, and shall be properly fastened to prevent any movement or slipping during the placing of gabions.

For detailed information refer *GL 24: Technical Specifications Preparations Guideline for SSID*.

6.14 RIPRAP

Stone for riprap shall be hard field or quarry stone not susceptible to disintegration or excessive Weathering on exposure to the atmosphere or water. It shall be free from soft material such as sand, clay, shale or organic material and shall not contain an excessive amount of elongated or flakey stone.

The required size of stone shall be determined by the "critical mass" specified. At least 50% by mass of the material comprising the riprap shall consist of stones having a mass heavier than the critical mass and not more than 10% by mass of the material shall consist of stone having a mass of less than 10% of the critical mass or more than 5 times the critical mass.

The grading requirements for riprap are shown in Table below.

Table 6-7: Gradation Requirements for Riprap

Class	Mean Diameter (D50)	Critical Mass(Kg)	Rock By Mass (%)	Mass (Kg)	Approximate Cubic Dimension (mm)
1	125	5	20	10– 15	150 – 200
			30	5 – 10	125 – 150
			40	0.5 – 5	50 – 125
			10	0 – 0.5	0 – 50
2	175	10	20	25 – 50	200 – 250
			30	10 – 25	150 – 200
			40	1 – 10	75 – 150
			10	0 – 1	0 – 75
3	300	50	20	100 – 150	350 – 400
			30	50 – 100	250 – 350
			40	5 – 50	125 – 250
			10	0 – 5	0 – 125
4	400	100	20	250 – 350	450 – 500
			30	100 – 250	350 – 450
			40	10 – 100	150 – 350
			10	0 – 10	0 – 150
5	500	350	20	700 – 1000	650 – 700
			30	350 – 700	500 – 650
			40	25 – 350	200 – 500
			10	0 – 25	0 – 200
6	600	500	20	850 – 1600	700 – 850
			30	500 – 850	550 – 700
			40	50 – 500	250 – 550
			10	0 – 50	0 – 250

Source: ERA Standard Technical Specifications and Method of Measurement for Road work, 2013.

6.15 GEO-MEMBRANE

Common construction terminology for geo-membranes includes liners, membranes, plastic sheets, and impermeable sheets. Geo-membranes are used almost exclusively as barriers to reduce water or vapor migration through soil. For example, a common usage for geo-membranes is for the lining of Irrigation Canals and Night Storage Reservoirs as shown in Figure.

Figure 6-3: Main Canal Lined by Geo-membrane

Figure 6-4: Night Storage Reservoir Lined by Geo-membrane

6.16 DAM INSTRUMENTATION

Geotechnical instrumentation may be designed and constructed in conjunction with small earth dam to measure performance of structure during construction and long-term monitoring of structure behavior and health so as to save lives, save money and/or reduce risk of failure of the dam. Generally, the reasons to install dam instrumentation are: -

- Indicate impending failures,
- Provide a warning,
- Reveal unknowns,
- Evaluate critical design assumptions,
- Assess contractor's means and methods,
- Minimize damage to the adjacent structures,
- Control construction,
- Control operation,
- Provide data to help select remedial methods to fix problems,
- Documents performance for assessing damages,
- Inform stakeholders,
- Satisfy regulators,
- Reduce litigation, and
- Advanced state of knowledge.

Some of dam instrumentations are as discussed here but not limited to: -

6.16.1 Piezometers

Piezometer is instrument used for measuring pressure head. Periodic piezometer observations furnish data on pore water pressures within the embankment, foundation, and abutments, which indicate the characteristics of seepage conditions, effectiveness of seepage cutoff, and the performance of the drainage system. Generally, piezometers installed at different location of a give earth fill dam used to control placement of fill, monitor pore water pressures to find shear strength and measure uplift pressure, and monitor seepage.

Figure 6-5: Vibrating wire piezometers

6.16.2 Inclinometers

Inclinometer is instrument used to monitor the lateral displacement of earth fill dam. Generally, inclinometers installed in the dam body at different location to monitor lateral earth movements in embankment e.g. detect movement of D/S of earth fill dam, particularly during impounding; determine type of shear and zone in foundation; monitor stability of U/S slope during and after impounding; and determine depth, direction, magnitude and rate of movement.

Figure 6-6: Inclinometer system

6.16.3 Accelerometer

Accelerometer helps to indicate the response of the dam body vibration due to the influence of external loads i.e. seismic. Hence, for important structures in areas of seismic activity, it is desirable to install strong motion, self-triggering recording accelerometers/acelerographs to record the response of the dam to the earthquake motion.

7 SSIP CONSTRUCTION MACHINARY, EQUIPMENTS, PLANTS AND INSTRUMENTS

The efficient and effective implementation of construction projects requires good management of relationships for and among resources, activities and stakeholders as applied to the context where such projects are implemented. Materials, Money, Person power and Machineries are usual resources recognized in most situations. Equipment types used in a construction project is largely dependent on their: -

- Direct input to unit prices or not,
- Type of work or job,
- Scope of work,
- Mobility,
- System of control, and
- Availability.

Small scale irrigation project uses the following construction equipment, though; it is labor intensive construction works or services that largely focusing on tool utilizations. For norm and efficiency of machineries the reader can use the recent research output in the subject matter. Norm and efficiency of machineries used in Ethiopia can be referred from the unit rate analysis presented under *GL 20: Quantity Surveying Guideline for SSID* prepared as part of the main this guideline.

7.1 EARTH WORK EQUIPMENT FOR SSIP CONSTRUCTION

Earth work is a process of moving soil or rock from one location to the other and processing it, so that it meets construction requirements of location, elevation, density, moisture content, etc. Earth work equipment are broadly classified into earth moving and compaction equipment. Some of earth work equipment used in small scale irrigation construction is as tabulated under.

No.	Name of Earth Work Equipment	Purposes
1	Dozer	A dozer is used to moves earth by lowering the blade and cutting until a full blade load of materials is obtained as well as to pushes the material across the ground surface to the required location.
2	Excavator	It is used to excavate and move large quantities of earth or soil or for lifting.
3	Loader	It is used primarily to load excavated materials to a hauling unit, excavate soft to medium materials, loading hoppers, stockpiling materials, backfilling ditches, and moving concrete and other construction materials.
4	Jackhammer	A handheld power tool, usually powered by compressed air and used for splitting or drilling rock, or for breaking up paved areas.
5	Grader	Grader is a machine with a wide blade that levels the ground, used in earth dam or road construction.
6	Compactor	A heavy cylinder, which is moved mechanically or by hand. It is used for compacting soil or shell material for embankment dam or road construction. A compactor is also used for compacting the soil, using a vibrating plate.

7.2 SSIP HAULING EQUIPMENT FOR SSIP CONSTRUCTION

Hauling or the transportation of excavation is a major earthmoving activity. There are many different types of hauling equipment available to the contractor.

No.	Name of Hauling Equipment	Purposes
1	Low/High bed	A truck having a rounded part that projects from its main body and used to transport chain wheel dozer to the project site from somewhere else.
2	Dump Truck	A heavy truck with an open bed that can be tilted up and back to unload cargo such as gravel, sand, selected materials, cart away materials from construction sites. It is also used to transport cement from the factory to the project site.
3	Tractor	A large vehicle, the front section of a truck used to haul heavy loads, with a driving cab, engine, and coupling for trailers. It is sometimes used for inter site transportation of construction material.
4	Vehicle	It is vehicle used on land for carrying people or goods.
5	Wheel barrow	It is a small cart used to transport construction materials, usually in the form of an open container with a single wheel at the front and two handles at the back.

7.3 CONSTRUCTION PLANTS/ EQUIPMENT FOR SSIP CONSTRUCTION

No.	Name of Construction Plants	Purposes
1	Mixer	A machine or device used for mixing concrete. Mixer having the capacity of 1.5 m^3 up to 1.8m^3 is commonly used in SSIP.
2	Vibrator	An electric device used to vibrate concrete during placing so as to strengthening the concrete by reducing water from the mix.
3	Crusher	A plant used to produce crushed gravel from massive stone.

In order to increase job-site productivity, it is beneficial to select equipment with proper characteristics and a size most suitable for the work conditions at a construction site. In excavation for building construction, for examples, factors that could affect the selection of excavators include:

1. **Size of the job: -**Larger volumes of excavation will require larger excavators, or smaller excavators in greater number.
2. **Activity time constraints: -**Shortage of time for excavation may force contractors to increase the size or numbers of equipment for activities related to excavation.
3. **Availability of equipment: -**Productivity of excavation activities will diminish if the equipment used to perform them is available but not the most adequate.
4. **Cost of transportation of equipment: -**This cost depends on the size of the job, the distance of transportation, and the means of transportation.
5. **Type of excavation: -**Principal types of excavation in building projects are cut and/or fill, excavation massive, and excavation for the elements of foundation. The most adequate equipment to perform one of these activities is not the most adequate to perform the others.
6. **Soil characteristics: -**The type and condition of the soil is important when choosing the most adequate equipment since each piece of equipment has different outputs for different soils. Moreover, one excavation pit could have different soils at different stratums.

7. **Geometric characteristics of elements to be excavated: -**Functional characteristics of different types of equipment make such considerations necessary.
8. **Space constraints: -**The performance of equipment is influenced by the spatial limitations for the movement of excavators.
9. **Characteristics of haul units: -**The size of an excavator will depend on the haul units if there is a constraint on the size and/or number of these units.
10. **Location of dumping areas: -**The distance between the construction site and dumping areas determine selection of the type and number of haulers.
11. **Weather and temperature: -**Rain and severe temperature conditions affect the job-site productivity of labor and equipment.

7.4 ELECTRO-MECHANICAL EQUIPMENT FOR SSIP CONSTRUCTION

No.	Name of Electro-Mechanical Equipment	Purposes
1	Pump (Surface pump, Submersible pump)	Pumps are used extensively on construction projects for such operations as: - 1. Removing water from pits, tunnels, and other excavations 2. Dewatering cofferdams 3. Furnishing water for jetting and sluicing 4. Furnishing water for many types of utility services 5. Lowering the water table for excavations
2	Generator	It is a machine or device that is used to convert mechanical energy mainly provided by the combustion of fuel into electricity. It is used as: - ▪ Main source of power for lifting or pressurized irrigation system where there is no national hydropower grid line, ▪ Stand by source of power for lifting or pressurized irrigation system even where there is national hydropower grid line, ▪ Source of electric light for the camp compound.
3	Transformer	A device that transfers electrical energy from one alternating circuit to another with a change in voltage, current, phase, or impedance. It is used as a source of power for lifting or pressurized irrigation system. It is supplied, installed, and repaired by Ethiopian Electric Power Corporation.
4	Solar System	The complete system that drive energy obtained from radiation emitted by the Sun.
5	Control Panel	It is the collection of lights, digital displays, and switches used to monitor and control the operation of machine.
6	Riser Pipe	A long cylindrical tube that water from deep production wells passes through
7	Check valve	A valve designed to allow water to flow in one direction only.
8	Air release valve	It is used to allow air to escape the discharge piping when pumping begins, and to prevent vacuum damage to the discharge piping when pumping stops.
9	Water meter	A device that records the amount of water that passes through a pipe.
10	Elbow	It is a bend in pipe to change the alignment to the standard degree.

7.5 CONSTRUCTION TOOLS AND EQUIPMENT FOR SSIP CONSTRUCTION

No.	Name of Tools and Equipment	Purposes
1	Shovel	Shovel is a hand tool consisting of a broad, usually curved blade attached to a long handle, used for lifting and moving loose material. It is used mainly during the following operations but not limited to: - ▪ Hand mixing of mortal and concrete, and ▪ Excavation and fill works.
2	Spade	Spade is a digging tool with a wide shallow blade flattened where it meets the shaft so it can be pushed into the ground with the foot. It is mainly used during excavation work.
3	Fork	Fork is a tool with a handle and usually three or four prongs, used for digging, lifting, and turning over the soil material. It is mainly used during excavation work.
4	Vessel	Vessel is a hollow receptacle, especially one that is used as a container for liquids. It is used mainly during the following operations but not limited to: - ▪ Water conveyance and application, ▪ Transportation of concrete, and ▪ Transportation of mortal for masonry.
	Hammer	It is a hand tool consisting of a shaft with a metal head at right angles to it, used mainly for driving in nails and beating metal.

7.6 CONSTRUCTION TOOLS AND EQUIPMENT FOR GABION WORKS

No.	Name of Tools and Equipment	Purposes
1	Crow-bar	Used for stretching of lids while closing down and lacing
2	Long nosed pliers	Used for cutting and also lacing of wires.
3	Closing tools	Used for bringing panel selvedge wires of adjacent boxes closer for easy lacing.
4	Formwork	It is made either wooden or steel stakes and used for tensioning the gabion boxes to avoid bulging or sagging before filling with stone.
5	Anchor steel rods	It is special steel rods used to keep gabion structures in a place.
6	Steel wire	It is special wire used to form gabion boxes.
7	Stretcher bar	It is a bar that joins and braces the gabion wire in the operation of gabion erection.
8	Spreader bar	It is a device used to hold gabion wire apart.

7.7 SURVEYING INSTRUMENTS, EQUIPMENT AND TOOLS FOR SSIP CONSTRUCTION

The following are some of common surveying instruments used during construction of irrigation projects.

No.	Name of Surveying Instruments, Tools and Equipment	Purposes
1	Total Station	It is used to set out location of structures on the ground.
2	Theodolite	An optical instrument consisting of a rotating telescopic sight, used by a surveyor to measure horizontal and vertical angles.
3	Automatic Level	An instrument used to measure elevation differences using Vernier readings.
4	Hand GPS	An instrument used to determine positions (3D), time and velocity of an object using three segments: space, operational control and user equipment segments.
5	Walkie-Talkie / Radio	A walkie-talkie is a small portable radio which surveying team members can talk into and hear messages through so that the surveyor can communicate with staff man found far away.
6	Meter Tape	A graduated tool used to measure distance.
7	Compass	An Instrument used to show directions.
8	Staff Gauge	A staff with a standard measurement or scale of measurement used to measure ground elevation using Automatic Level.
9	Computer	It is an electronic device that accepts, processes, stores, and outputs data at high speeds according to programmed instructions. It mainly used for: ▪ Computer aid design, ▪ Drawing preparation and production, and ▪ Topographic survey map preparation and production.
10	Calculator	It is a device used to compute arithmetic operations, especially a small hand-held electronic device. It is mainly used during ground elevation surveying using Automatic Level.
11	Range Pole	It is a pole, usually held vertically and used to mark a specific position when surveying a plot of land.
12	Hammer	Hammer is a hand tool consisting of a shaft with a metal head at right angles to it, used mainly for driving in nails and beating metal.
13	Peg	It is a small piece of wood used to mark the position of the woks. It is mainly used during set out of the works.

8 CONSTRUCTION METHODOLOGY FOR SSIP

In this guideline, construction methodology deals with the techniques used to build small scale irrigation infrastructures of different forms. The construction of every activity shall be executed according to sequence of work specified in the specification forming the contract, the construction crew and necessary equipment for each activity shall be arranged based on the given work schedule, and quality of workmanship and consistency with the specification for each activity shall be to the satisfaction of the engineer,

Construction of irrigation infrastructure may be done in day work, task work and piecework bases as far as task assignment modality for a given work force is concerned.

Day work means simply that a worker is paid a fixed rate for being present on a site for a full working day, which is usually eight hours of work. The amount of work produced depends entirely on the supervisor's ability to encourage the worker, and the worker's own motivation and sense of responsibility. In many circumstances this can lead to very low productivity, especially with permanent staff who have no particular incentive to work hard.

Piecework is a method of setting work, usually preferred by the private sector. The worker is allocated an amount of work for an agreed rate of pay. The work they do is measured and the more they do the more they are paid. This approach can give very high productivities, but it can also result in exploitation, especially when the rate for the work is too low. Casual workers are seldom in a good position to negotiate favorable rates. The most dangerous situation is when workers have to put in very long hours to achieve even a subsistence rate of pay.

Task work evolved on projects where the workers were subject to government regulations, which meant they could not be paid more than the prevailing government wage for a day's work. Some other incentive had to be provided. Setting a realistic task, or amount of work to be completed for the day, meant that workers could work as hard as they wanted and then go home to do other things.

The past experience revealed that, piece work is preferably used for efficient utilization of workforces when there is effective quality control system in place.

8.1 CONSTRUCTION METHODOLOGY FOR EARTH WORK

- Clearing work shall be carried using earth moving machines or person power as required.
- All earth work, stripping top soil, excavation for foundation of major structure and others excavation shall be carried out using earth moving machines or person power as required. For example, headwork foundation excavation mostly by earth moving machines like Dozer or Excavator, whereas, canal and small canal structures foundation excavation mostly by Person Power.
- All excavation works shall be carried out to lines and grades shown in the drawings with care to avoid over excavation under the structure.

8.2 CONSTRUCTION METHODOLOGY FOR FORM WORK

- Steel panel or timber materials would be used for the form work as specified in the technical specification forming the contract.
- Standard type and size of formwork shall be supplied, fixe and dismantle by the skilled carpenter in accordance to the technical specification forming the contract and satisfaction of the engineer.

8.3 CONSTRUCTION METHODOLOGY FOR CONCRETE WORK

- Cement will be supplied in bags and will be stored as per the specification and the supply schedule is stick to the concrete work schedule.
- Crushed aggregates can be produced by crushing plant to be installed at selected quarry site by the project Engineer near by the project.
- Sand shall be supplied from the approved quarry site by the project Engineer.
- Prior to any concrete work, grade of concrete shall be determined by mix design and then get approval by the Engineer.
- Mixing of concrete shall be done by the appropriate mixers.
- Placing of concrete would be done manually with buckets of concrete as well as with concrete pumps as required.
- Compaction of the concrete shall be done by vibrators immediately after placing.
- Curing of casted concrete shall be done by wetting as well as by shading the surface area of the structures.
- To keep the quality of concrete such as batching, mixing, handling, transporting, compacting and curing shall be performing as per the specification and to satisfaction of the engineer.

8.4 CONSTRUCTION METHODOLOGY FOR MASONRY WORK

- The stone for masonry work shall be selected from the nearby quarry site on the approval of the engineer.
- The stone masonry work shall be done according to the specification & also to the satisfaction of the project Engineer by qualified masons.
- Cement Mortar usually mixed by hand commonly used for construction of wetted stone masonry.

8.5 CONSTRUCTION METHODOLOGY FOR CARPENTRY WORK

All carpentry works shall be done by Carpenter as per the given drawing and the specification.

8.6 CONSTRUCTION METHODOLOGY FOR STEEL WORKS

All the steel works shall be done by qualified Bar-Bender according to the specification & also to the satisfaction of the Engineer.

8.7 CONSTRUCTION METHODOLOGY FOR REINFORCEMENT BAR WORKS

- Concrete reinforcement bars shall be supplied, cut, bends, and placed in accordance to the specification and drawing for the satisfaction of engineer.
- All the reinforcement bars work shall be done by qualified Bar-Bender according to the specification & also to the satisfaction of the Engineer.
- Referring design drawings, the contractor prepares Shop Drawings for reinforcement bars and submitted to the engineer for approval including the bar schedule.

- Reinforcing steel, before being placed, shall be thoroughly cleaned of coatings that will destroy or reduce bond.
- Place reinforcement to maintain minimum coverage as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

8.8 CONSTRUCTION METHODOLOGY FOR FINISHING WORKS

All finishing works shall be done as per the specification by semi-skilled person power such as Plasterer, Electricians, Plumber, Welder, etc.for the satisfaction of the Engineer.

9 CONSTRUCTION CONTROL FOR SSIP

Quality, time and cost are the three areas of equal importance in a construction project to be controlled progressively. Control of quality, time and cost depend on effective allocation of responsibilities among participants and their performance of their respective duties. So, the contractor is expected to withdraw his/her responsibility laid down in the contract and play his/her role for successful completion practicing construction control monitoring system.

9.1 SSIP CONSTRUCTION QUALITY CONTROL

It is a function of monitoring the quality of construction materials and workmanship referring the technical specifications forming the contract.

The contractor should strictly perform construction after get approval for the followings from the supervisor engineer: -

- Manufactures certificate for those material purchased and supplied from the factories,
- Laboratory test result for those naturally available construction materials of specified quarry site,
- Mortal mix design for the supplied type of cement and already approved sand from specified quarry site,
- Concrete mix for the supplied cement, sand, and gravel,
- Water from approved source.

The contractor should perform tests when the query and type of construction materials get difference from the approved one.

The contractor should control workmanship by continuous monitoring of the following but not limited to: -

- Following and practicing best working methodology,
- Engaging and maintaining qualified construction staffs at the site,
- Mobilizing well performing machineries, equipment, tools and instruments, and
- Performing laboratory test of the work as specified and correcting the defects on time if any.

Construction material control

Quality of construction materials and the construction works shall be kept at good condition so as to get quality work. These can be maintained through recommended quality control mechanisms, which are described as follows.

Production of Quality Concrete

Ingredients used for concrete works should be kept to the required or proposed quality so as to maintain quality of this work. In addition to maintaining good quality of those ingredients, yet concrete work itself shall be taken care of while batching, mixing, transporting, placement, curing, and protection.

Before reinforcement is placed, the reinforcement shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease, or other foreign substances. Reinforcement shall be accurately placed and secured in position so that it will not be displaced during placement of concrete.

Forms shall be used to shape the concrete to the required lines. Exposed unformed surfaces shall be brought to uniform surfaces and given a, reasonably smooth, wood-float or steel-trowel finish as directed. The temperature of the concrete when it is being placed shall be not more than 32^0C and not less than 10^0C. Otherwise it will dry up or frozen before attaining its full strength respectively under these conditions.

The concrete should be cured with dirt-free water, curing compound, or polyethylene sheets. If water cured, the concrete shall be kept continuously moist by sprinkling or spraying for at least 14 days after being placed. Similarly, concrete cured by covering with polyethylene sheeting shall be kept continuously moist for at least 14 days after placement. The implementer shall protect all concrete against injury until final acceptance by the client.

Premeditated nominal maximum size of aggregate and mix proportions should also be maintained as per the design so as to obtain the required quality of concrete works.

Masonry Work

This is also one of the activities required for structural works which need to be kept as per the design especially its mortar ingredients, quality of dressed stone, and placement (keeping centroid of the material vertical). It should be placed on uniformly distributed mass or lean concrete mattress where the soil is of bad in nature.

Some construction joints should be provided to protect the constructed structure from cracking depending on basement conditions.

Earth works

Earth works need to be done by maintaining the required dimensions of excavation and or clearing. Otherwise it incurs additional cost so as to backfill unnecessarily widened section. The excavated material should also be carted away at a distance so that it will not slide back to the working area. Appropriate implements shall also be used so as to be efficient and prevent being fatigued. Use Appendix Part IV/GL 29/H Laboratory Test Format.

9.2 SSIP CONSTRUCTION TIME CONTROL

Time and the work contract are inseparable. Construction time control mainly associated with control of construction schedule. The contractor should play its role in respect to the agreed time frame in the contract. To control the time of construction the contractor should perform the following but not limited to: -

- Extract its responsibilities in the contract and act accordingly,
- Control the inputs of both labour and machineries, and
- Control quality of both construction materials and workmanship and avoid rework.

9.3 SSIP CONSTRUCTION COST CONTROL

The contractor should collect payments equal to the value he adds to the project during a given period. The contractor should control the cost of construction to finalize the project as per agreed time frame and quality with maximum expected profit. In construction cost control the contractor should take care for the following but not limited to: -

- Assign the optimum number of skilled and/or unskilled labourers to accomplish the considered works in a certain predetermined time span,
- Strictly follow up the attendance of the assigned skilled and/or unskilled labourers,
- Record daily output of each staff on daily base, evaluate, and take measures when there is intolerable under performance,
- Improve performance of the construction by increasing productivity of the person power and machinery input,
- Proceed execution of works after getting work instruction from supervisor engineer, and
- Maximize acceptance (minimize rejection) of the executed works by the supervisor engineer controlling the quality of both construction materials and workmanship.

10 CONSTRUCTION SAFETY FOR SSIP

Construction safety should be properly implemented consistently throughout the life of project implementation to maintain conducive working environment.

It is the responsibility of the contractor to prepare and implement safety plan as specified in the technical specification forming the contract. The supervisor should ensure the implementation of the agreed safety plan and even the required safety measures as per site condition and current situation by the contractor.

The following are steps to be followed at site level to ensure safety at construction site: -

i. The contractor should prepare and submit safety plan to the supervisor for approval,
ii. The supervisor should review the contractor safety plan for its conformation with the specification and its implementation on the ground,
iii. All unsafe or unhealthy conditions observed should be reported to the contractor so that immediate corrective actions or measures can be practiced in place,
iv. Construction equipment and hand implements/tools should be inspected regularly and should be properly maintained,

With so many risks on the job, it is no surprise that construction workers are more prone to serious injuries and in some cases, fatalities, than other industries. As a result, employers must continually strive for workplace safety compliance and most importantly, their employees' health and vitality.

Some of very important safety issues and measures are as discussed here under but not limited to: -

a. Workers assigned to scaffolding jobs should be properly trained and continually aware of their environment as falling debris, electrocution from power lines, and falls related to unstable platforms can result in serious injuries. Supported and suspended scaffolds should be properly outfitted with guardrails to prevent workers from falling from an open side, and workers should be secured in appropriate fall protection.
b. All employees whose work conditions include the danger of falling should undergo fall protection training regularly. Company training courses should identify specific hazards and familiarize employees with all fall protection equipment used in the workplace.
c. The misuse of portable ladders can lead to injuries such as sprains and broken bones, but in extreme cases also head and neck trauma or even death. Ladders should be secured and safely positioned at appropriate angles and prior to use be visually inspected for damaged components including hinges, rungs/steps, side rails and feet.
d. At site level workers should use personal protective equipment (PPE). Hard hats, eye, ear and hand protection, earplugs and other protective equipment provide protection from falling objects, head injuries, sparks, dust/fragments and burns.
e. It is common sense that first aid and fire safety are key programs on any given job site.
f. Maintaining up-to-date records of equipment inspections and injury logs is the best way to protect employers from legal ramifications in the event of injury and death.
g. The key to preventing many workplace accidents and injuries is frequent and effective employee training programs.
h. Fence has to be provided around dams, night storage reservoirs, canals, pump stations and any other hazardous areas to protect animals and human from hazards and unnecessary interfere during project/scheme operations. But, where water sources and canals are fenced, drinking access areas should be provided. Similarly, to permit crossing, bridges should be constructed at specified intervals and at regular crossing points.
i. In areas where fencing or covering are impractical, the canal side slopes should be roughened or provided with cleats to allow escape. In addition, turnouts and deflectors can be installed to direct animals into the areas of reduced current where escape ramps are located.

11 CONSTRUCTION PROCEDURE FOR SSIP

11.1 PREPARATORY ACTIVITIES IMPLEMENTATION PROCEDURE

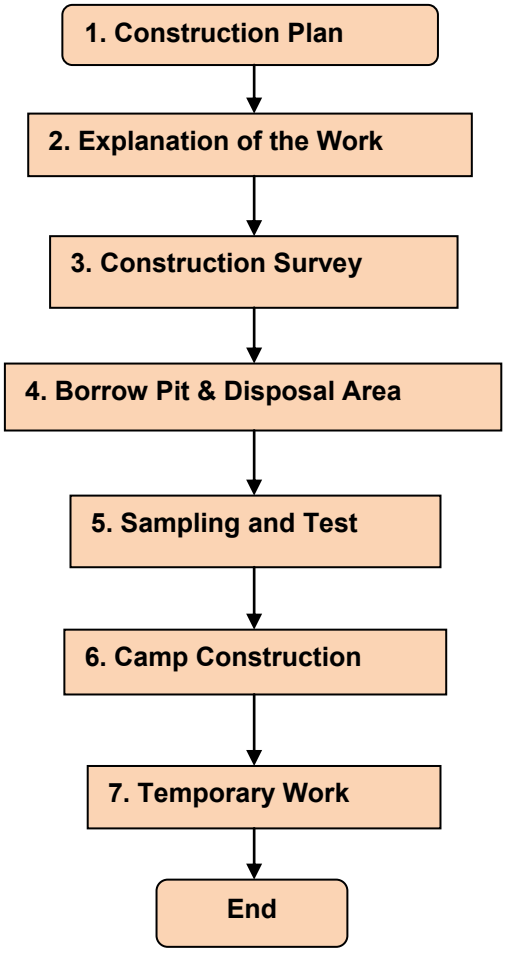


Figure 11-1: Flowchart-showing preparation activities implementation procedure

Description of Preparation Activities Implementation Procedure

1. Construction plan

Before any construction works is being started, shop drawing as per the design, method statement which can indicate how the construction work shall be preceded including list of required resources and schedule shall be prepared for each component of the project and submitted to projects supervisors for approval.

2. Explanation of the work

The details of the work and the area affected during the construction period shall be clearly described. Meeting with beneficiary and local authorities shall be held to explain the work and get consent.

3. Construction survey

Setting out shall be prepared for each component of projects and precise data shall be recorded in order to place framework of structures on proposed ground/site one after another.

4. Borrow pit & disposal area

The contractor should determine with the project supervisor the proposed borrow site (for fill material, masonry stone query site, crushed aggregate query site, natural sand query site) and disposal area during study and design phase. She/he has to discuss with both local authorities and with land owner and/or tenant farmer about the condition of land after construction (such as elevation, landform, and area) until they reached on consensus on the usage of the considered land. Finally, he has to measure the volume of soil material from borrow-pits and disposal area.

5. Sampling and test

A sample from the major activities on the earth, concrete and masonry works have to be taken jointly in the presence of contractor and supervisor/client representatives and tested for its compliance with the specification before the realization of the whole works commencement. Test result should be issued and recorded by both parties.

6. Camp construction

Immediately after required construction materials are secured, camp construction should be executed maintaining the following steps: -

- Clearing and grabbing the camp site,
- Setting out surveying works,
- Foundation excavation,
- Substructure construction,
- Superstructure construction,
- Finishing works, and
- Furnishing the required camp facilities and offices as per agreement.

7. Temporary work

Temporary works need to be executed as preparatory works of small scale irrigation project implementation are the following but not limited to:

- Access
- Water source for construction work
- Dewatering work
- Cofferdam
- Safety facilities
- Power supply
- Concrete plant

11.2 CONSTRUCTION PROCEDURE FOR EARTH WORKS

Earth works can be broadly divided in to two namely excavation, and fill and compaction works. It is discussed in this section separately hereunder.

11.2.1 Construction procedure for excavation works

Excavation works can be also divided in to foundation excavation (for structures like headwork, canal structures), mass excavation (for micro earth dam and night storage reservoir), and trench excavation (for earthen canal system). Furthermore, excavation can be further grouped as normal soil excavation, soft rock excavation, and hard rock excavation.

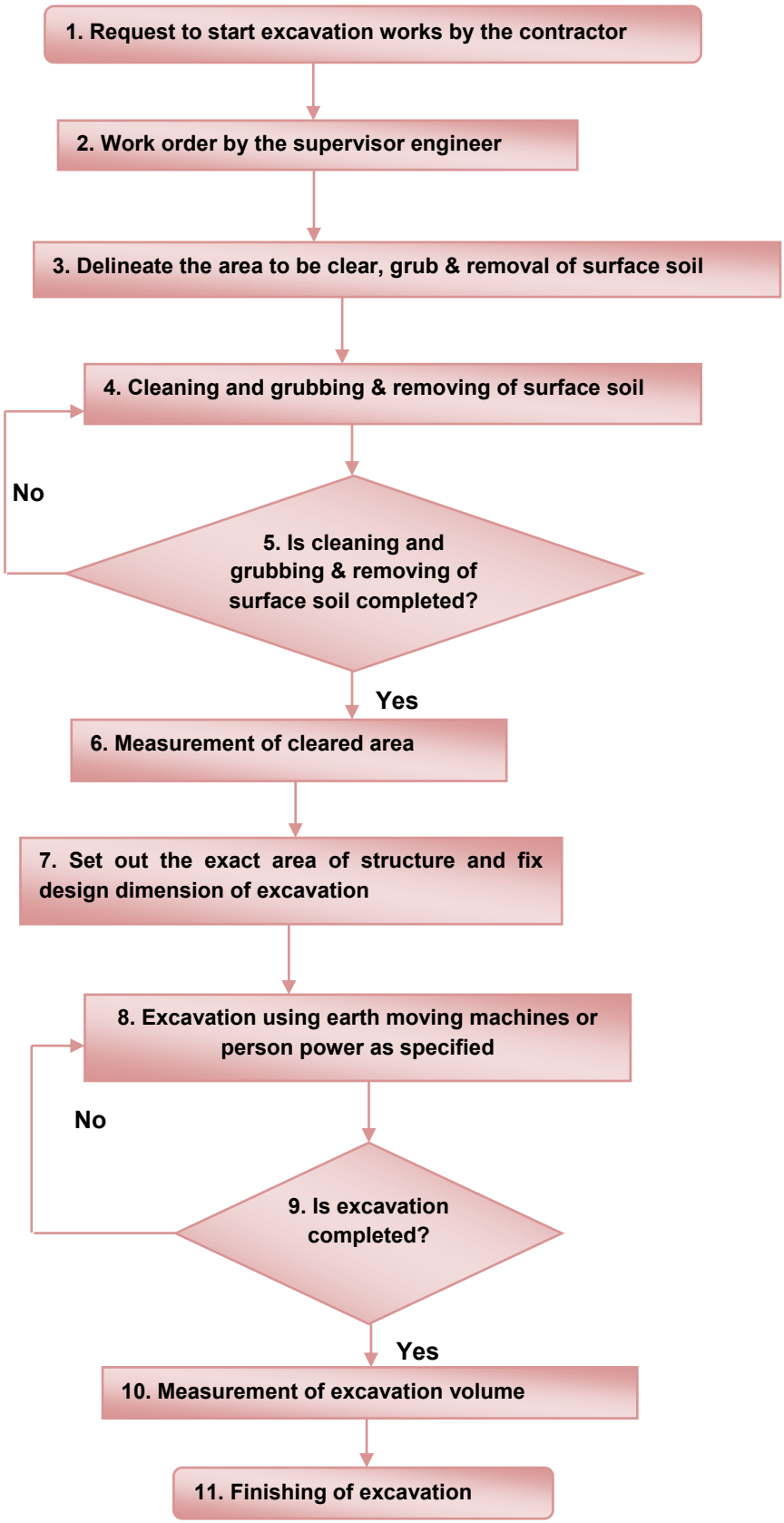


Figure 11-2: Flow chart: excavation works

Description of Excavation works

Step-1: Request to start excavation works by the contractor
The project contractor should submit work requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer
The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side.

Step-3: Delineate the area to be clear, and grub& removal of surface soil
The contractor together with supervisor/client should delineate the area to be clear, and grub & removal of surface soil as specified.

Step-4: Cleaning, grubbing and removing of surface soil
Clearing, grubbing and removing of surface soil works should be performed by the contractor either by machine or person power as specified based on scope of the works.

Step-5: Step-5: Is cleaning, grubbing and removing of surface soil completed?
The contractor together with supervisor/client checking the compliance of clearing, and grubbing & removing of surface soil works with the specification. If it is compliant go to Step-6. If not continue clearing, and grubbing & removing of surface soil operation until it becomes compliant to specification (Step-4).

Step-6: Measurement of cleared area
Measure the surface area where cleaning, grubbing & removal of surface soil performed prior to excavation.

Step-7: Set out the exact area of structure and fix design dimensions of excavation
The contractor surveyor should perform set out of the exact area of structure and fix design dimensions of excavation. The final set out should be confirmed by supervisor/client. For headwork and canal structures foundation excavation working space should be considered in addition to the exact design dimensions of structures, whereas, for earthen canal and small canal structures suited on shallow cut depth the exact design dimensions may be dimensions excavation dimensions.

Design dimensions to be considered for structures foundation excavation are width, length and depth; whereas, design dimensions to be considered for canal excavation are width, length, depth and longitudinal.

Step-8: Excavation using earth moving machines or person power as specified
The contractor perform excavation works either by earth moving machines or person power as specified on the technical specification document forming contract documents. For headwork foundation excavation the contractor may use dozer or excavator. In the case of canal and small canal structures suited on shallow cut depth the contractor may use person power for ordinary soil Blasting or Jack Hammer may be used when the cut is hard rock depending on the volume of works. Besides, local techniques can also be used to deal with rock outcrops, like heating and fast cooling to weaken the rocks and then hitting them with a hammer.

Step-9: Is excavation completed?

The contractor together with supervisor engineer checking the compliance of excavation works with the specification. If it is compliant go to Step-10. If not, continue excavation operation until it becomes compliant to specification (Step-8).

Step-10: Measurement of excavation volume

Excavation for canals drains and open cuts will be measured at the volume in place of excavation actually carried out within the lines of the typical cross-section and below the ground surface before construction starts, but after clearing and grubbing, if any. Structural excavation will be measured as the volume in place actually excavated below the ground level within the vertical plains coincident with the outer sides of the culverts, floors or structure and above the elevation of the foundation as indicated in the drawing or as directed, i.e. the volume will be calculated as a products of the exact length and width of the lowest strip of the foundation according to the drawings and the depth measured vertically; where ground is not level, average depth shall be taken. Measurement should be done jointly with the supervisor engineer.

Step-11: Finishing of excavation works

The entire excavated canal sections and structures foundation area shall be left in neat and presentable conditions.

11.2.2 Construction flow for fill and compaction works

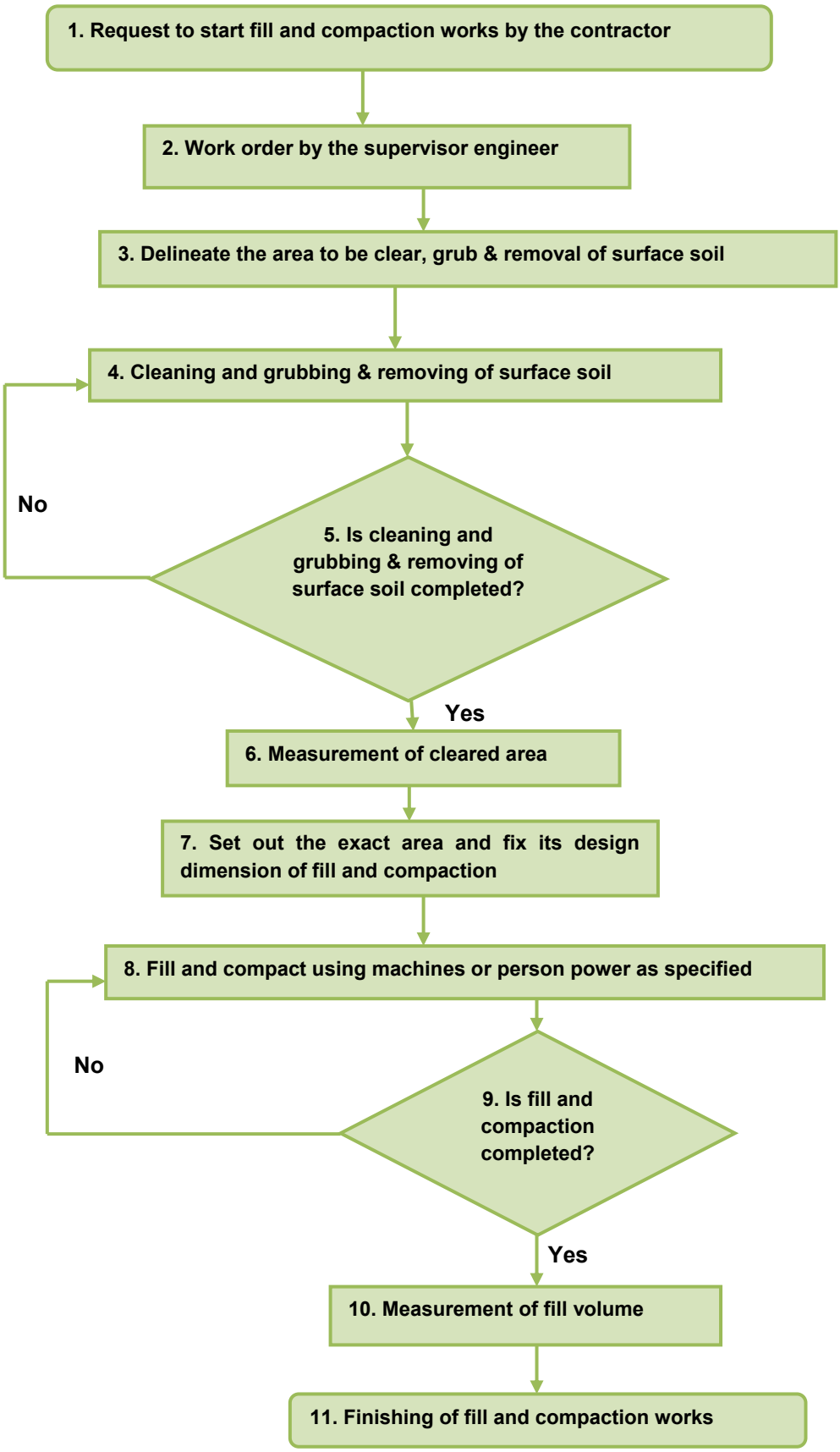


Figure 11-3: Flow chart: fill and compaction works

Description of Fill and Compaction Works

Step-1: Request to start fill and compaction works by the contractor
The project contractor should submit fill and compaction works requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer
The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side. Certificate of fill material test result compliant to the technical specification and works methodology should be submitted and approved by supervisor engineer. Carry suitable soil from the borrow pit to the site.

Step-3: Delineate the area to be clear, and grub& removal of surface soil
The contractor together with supervisor/client should delineate the area to be clear, and grub & removal of surface soil as specified.

Step-4: Cleaning, grubbing and removing of surface soil
Clearing and grubbing works should be performed by the contractor either by machine or person power as specified based on scope of the works.

Step-5: Is cleaning, grubbing and removing of surface soil completed?
The contractor together with supervisor/client checking the compliance of clearing, and grubbing & removing of surface soil works with the specification. If it is compliant go to Step-6. If not continue clearing, and grubbing & removing of surface soil operation until it becomes compliant to specification (Step-4).

Step-6: Measurement of cleared area
Measure the surface area where cleaning, grubbing & removal of surface soil performed prior to fill and compaction.

Step-7: Set out the exact area and fix design dimension of fill and compaction
The contractor surveyor should perform set out of fill and compaction area and fix its design dimensions. The final set out should be confirmed by supervisor engineer.

Step-8: Fill and compact using machines or person power as specified
The contractor perform fill and compaction works either by machines or person power as specified on the technical specification document forming contract documents. For micro earthen dam the contractor may use heavy duty compactor. In the case of canal and small canal structures the contractor may use person power and or manual compactor depending on the volume of works.

Spread soil by layer keeping the recommended layer thickness in the specification. Usually the layer thickness ranges 20cm to 30cm. Compact spread soil layer by layer at decided the number of Compaction. Compaction speed shall be optimum (less than walking speed of person). For high grade compaction do the following control.

- Check the number of compaction and compaction speed
- Measure the density of soil by field density test on each layer at the interval on the construction plan and the criteria of construction
- If the test result is out of the criteria, examine the followings check the water content of soil and,

a. If water content is over allowable range, remove the soil and bank with allowable soil again and adjust water at stock yard for the next work place
b. If water content is lower than allowable range, spread water and compact at the place again and adjust water at stock yard for the next work place.
c. If water content is in allowable range, cut the top soil (thin thickness) and compact again and change the thickness of soil spreading to thin from next place.

Step-9: Is fill and compaction completed?

The contractor together with supervisor engineer checking the compliance of fill and compaction works with the specification. If it is compliant go to Step-10. If not continue fill and compaction operation until it becomes compliant to specification (Step-8).

Step-10: Measurement of fill volume

Fill for embankment construction will be measured as volume of embankment within the lines of the typical cross-section or as directed by the Engineer, in its final compacted position after finishing and trimming, and above the ground-surface before embankment construction starts but after clearing and grubbing, if any.

Compacted backfill measurement will be made of the actual number of cubic meter of material placed in the earth fill and approved by the Engineer. Calculation of volume will be made after compaction operation have been completed and within dimensions and elevations shown on the drawing or modified by the resident Engineer so that they represent the existing field condition accepted by the Engineer.

Overhaul for excavated material used in embankment construction disposed of with a transportation of more than 1000m, unless otherwise specified in the drawings and the bill of quantities in a straight line between the center of mass of excavation to the Centre of mass of embankment construction, will be measured as the volume in place in the embankment within the limitation as specified. Measurement should be done jointly with the supervisor engineer.

Step-11: Finishing of fill and compaction works

The entire fill and compaction shall be left in neat and presentable conditions.

11.3 CONSTRUCTION PROCEDURE FOR MASONRY WORKS

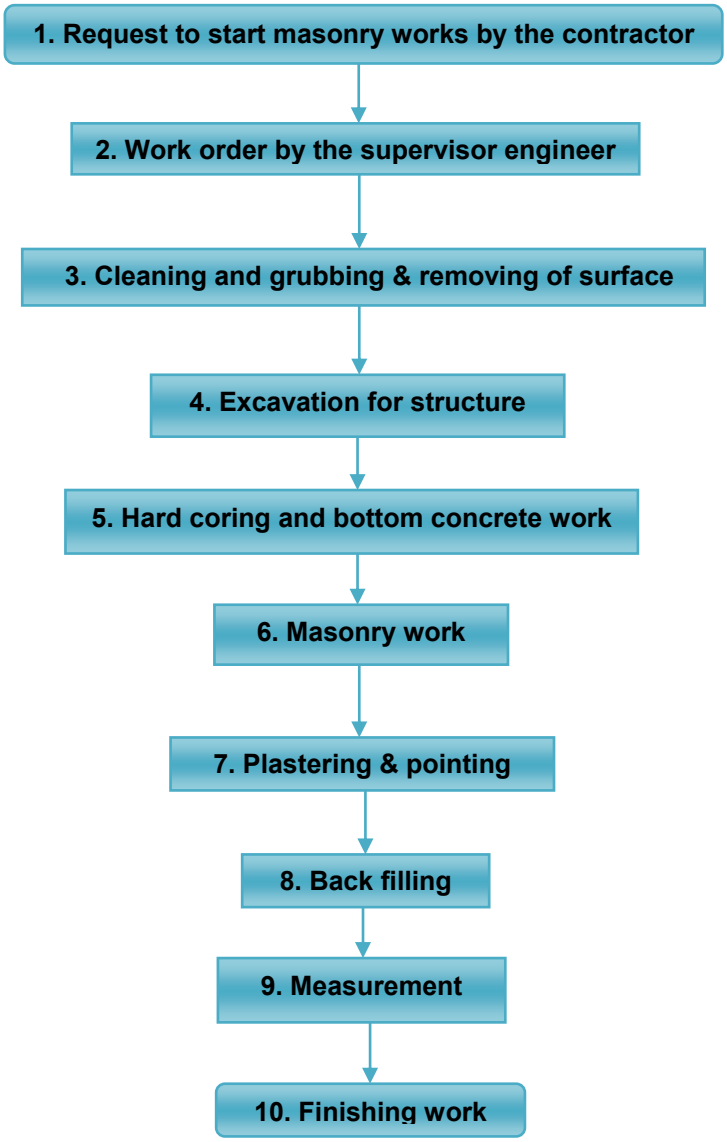


Figure 11-4: Flow chart: masonry works

Description of masonry works

Step-1: Request to start masonry works by the contractor
The project contractor should submit work requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer
The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side.

Step-3: Cleaning, grubbing and removing of surface soil
The contractor together with supervisor engineer should delineate the area to be clear, and grub & removal of surface soil as specified if any. Clearing, grubbing and removing of surface soil works should be performed by the contractor either by machine or person power as specified based on

scope of the works. Measure the surface area where cleaning, grubbing & removal of surface soil performed prior to excavation.

Step-4: Excavation for structure

The Contractor shall set out the working corners and alignment using the data shown on the Drawings or as instructed by the Engineer. The Engineer shall certify his acceptance of the setting out of corners and alignment to the Contractor in writing before commencing masonry works foundation excavation.

Excavation for stone and/or gravel lining shall be accurately trimmed to the specified dimensions. Where over excavation occurs it shall be back filled with gravel as specified below, or such other fill material as the Engineer may order, entirely at the Contractor's expense. Excavation for structures shall be done according to the drawing and specification. Elevation shall be checked using Leveling by contractor and supervisor jointly for its conformity with the drawing and specification. Measurement should be done jointly with the supervisor engineer.

Step-5: Hard coring and bottom concrete work

Stone for hard coring shall be obtained from an approved source. It shall be clean, hard, durable, sound and free from impurities or decomposed rock. Stones shall be set in position with their natural beds as near as possible to the horizontal. The commonly depth of hard coring is 20cm. Measurement of hard core is in m^2.

Bottom concrete work (if any) can be executed mix proportion for plain concrete of material as recommended and stated in the specification. The commonly depth of bottom concrete work is 10cm. Measurement of bottom concrete work is in m^3.

Step-6: Masonry work

Stone for masonry shall be obtained from an approved source. It shall be clean, hard, durable, sound and free from impurities or decomposed rock.

Because the masonry walls of headwork retaining walls and canal are required to be as water proof as possible against the hydrostatic pressure of the water inside, particular attention must be paid to the workmanship of the masons. The stones should be lightly taped down into the mortar, and then securely fixed using mortar. Do not leave air voids between stones.

Stone for various masonry works shall be selected and shaped as follows: -

- Stone for facing work shall generally be selected for consistency in grain, colour, and texture throughout the work.
- Stone for below grade work concealed from view shall be chiselled natural stone average size 450mm.
- Stone for rough dressed exposed faces shall be fair chiselled and in average 450mm and individual not less than 380mm length.
- Stone to receive other finish shall be chiselled natural stone in average 450mm and individual not less than 380mm.

Cement mortar is used for stone masonry considering 1:3 Cement to Sand mix ratio. The mortal that results of mixing sand cement and water fill the spaces between the stones and coats them thickly to keep them apart.

Step-7: Plastering & pointing

Provide cement, aggregate, labour, equipment and tools for plaster and pointing as required for the satisfactory installation of the works. Aggregate for plaster and pointing shall be naturally occurring sand or crushed aggregate. The aggregate shall be hard, clean, and free from adhered coatings with no clay content. Or the clay and fine silt content of aggregate shall not exceed 5% by weight. Aggregate shall be free of harmful organic and inorganic material that may affect the setting, strength, durability and appearance of render or undercoat and material in contract with it.

In instances where hand mixing is unavoidable, the cement content shall be increased by 10%. The dry and wet mixes shall be turned over sufficient number of times to produce the respective consistencies as required by batch mixers. Cement mortar shall be used within half hour of adding cement to the mix.

Plaster shall be applied in two coats with the following mix proportion for mortar. The aggregate for mortar to be used shall comply with table 1 of BS (British standard) 1199.

- First coat: 1 Part cement to 2.5 parts aggregate (fine) by volume.
- Second coat: 1 Part of cement to 4 parts of aggregate (fine) by volume.

The first coat shall be wetted and the plumb line for the second coat established after 24 hours. The second coat of plaster shall be applied within 4 hours of the establishment of plumb line on the surfaces.

The second coat shall be applied by trowel to a maximum thickness of 12mm. This coat shall be allowed to cure for days before further finish is applied as per specification.

Measurement will be made for the plain area m^2 of plastering or pointing work acceptable to the level and quality of finishing shown on the drawing or to the satisfaction of the Engineer.

Payment shall be made for the number of m^2 of measured area as provided above at the contract unit price for each plastering and pointing works that shall constitute full compensation of material transportation and mixing mortar together with its cost of application to the required work quality of finishing.

Step-8: Back filling of structures

Back filling around structures shall be executed spreading and compacting the recommended fill material layer by layer as per the specifications.

Step-9: Measurement of masonry works

Measurement will be made for the number of m^3 of masonry work acceptable placed to the line, Level, grades and cross-section shown on the drawing or established by the engineer.

Payment shall be made for the number of m^3 measured as provided above at the contract unit price for the masonry work shall constitute full compensation for quarrying transporting material to the site, mixing mortar and all other work related to item.

Step-10: Finishing of masonry works

Masonry works shall be well finished and left in neat and presentable conditions for the satisfaction of the Engineer.

11.4 CONSTRUCTION PROCEDURE FOR CONCRETE WORK

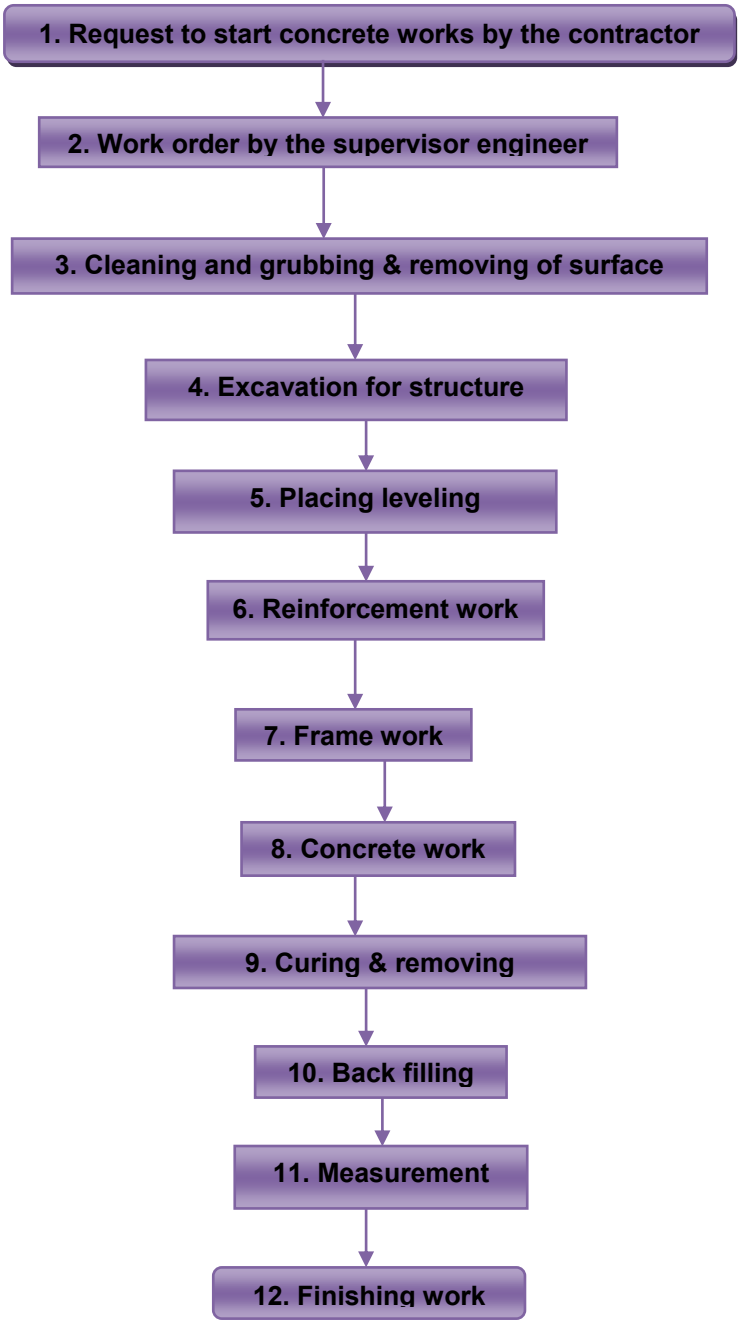


Figure 11-5: Flow chart-concrete works

Description of concrete works

Step-1: Request to start concrete works by the contractor

The project contractor should submit work requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer

The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side.

Step-3: Cleaning, grubbing and removing of surface soil

The contractor together with supervisor engineer should delineate the area to be clear, and grub & removal of surface soil as specified if any. Clearing, grubbing and removing of surface soil works should be performed by the contractor either by machine or person power as specified based on scope of the works. Measure the surface area where cleaning, grubbing & removal of surface soil performed prior to excavation.

Step-4: Excavation for structure

The Contractor shall set out the working corners and alignment using the data shown on the Drawings or as instructed by the Engineer. The Engineer shall certify his acceptance of the setting out of corners and alignment to the Contractor in writing before commencing concrete works foundation excavation.

Excavation for stone and/or gravel lining shall be accurately trimmed to the specified dimensions. Where over excavation occurs it shall be back filled with gravel as specified below, or such other fill material as the Engineer may order, entirely at the Contractor's expense. Excavation for structures shall be done according to the drawing and specification. Elevation shall be checked using Leveling by contractor and supervisor jointly for its conformity with the drawing and specification. Measurement should be done jointly with the supervisor engineer.

Step-5: Placing leveling concrete

Mass/plain concrete can be casted to make the weight of structure spread evenly to the ground, and to make reinforcing bars assembled so that reinforcing bars can be placed properly (level or vertically, etc. as indicated in drawings. The commonly depth of level concrete work is 10cm. Measurement of level concrete work is in m^3.

Step-6: Reinforcement work

Steel reinforcement for concrete shall consist of steel bars or welded deformed steel wire fabric except where otherwise shown. Steel bars shall consist of deformed and plain billet-steel bars as specified in ASTM A.615. Steel wire fabric for concrete reinforcement shall be in accordance with the requirements of ASTM A.497.

All deformed and plain steel bars to be used as reinforcement in concrete constructions shall be of Grade 60 and Grade 40 respectively in accordance with the requirements as described in ASTM A.615.

All steel wire fabric shall be delivered in flat sheets.
The Contractor shall prepare test specimens of steel reinforcement to be used in the Works.

Test specimens shall be taken in the presence of the Engineer and shall be of a size sufficient to carry out the tests as described below.

They shall be tested in a nominated laboratory and the certified copies of the results of the tests shall be submitted to the Engineer.

The specimens shall be tested on bending and tensile properties and the steel wire fabric also on weld shear strength. The methods and requirements for testing shall be carried out in accordance with the applicable specifications of A.S.T.M. A.497 and ASTM A.615.

No steel reinforcement shall be used in the Works until the testing results have been approved by the Engineer. If ordered by the Engineer, test procedures shall be repeated at the Contractor's expense for any new supply of reinforcement during the course of the Works.

Storage of reinforcement shall be on racks or supports clear of the ground. Different types and dimensions of the reinforcement shall be kept separate.

Reinforcement processing consisting clean reinforcing bar, cut reinforcing bar by the total length of each bar, and bend reinforcing bar by following processing plan. Please note that *reinforcing bar shall be bent without heating*.

Assembling of the reinforcing bar consisting placing spacer blocks on the leveling concrete to secure the designated clearance between the structure bottom and reinforcement bars, placing the reinforcing bar on the position of structure, binding the reinforcing bars each other by binding wire tightly not to move them by concrete placing, and putting the spacer for keeping space between the reinforcing bars and forms assembly at right position. Payment for reinforcing steel will be made at the price tendered per kilogram or tone for "*reinforcing in place*".

Example-1
What is the unit weight of 10mm diameter bar?

Given
Diameter, d = 10mm

Required
Unit Weight = Weight per unit length of 10mm diameter bar, kg/m

Solution
Unit Weight = Specific Weight of bar * Cross sectional Area of bar
Where,

Specific Weight of bar = $7.85x10^4$ N/m^3
Cross sectional Area of bar = $\pi d^2/4$
D = bar diameter = 10mm
π = 3.14
g = specific gravity = $10m/s^2$

Unit Weight = $7.85x10^4$ N/m^3 * 3.14 * $(0.01m)^2/4$ = 6.165 N/m = 6. $165kg.m/s^2/m/10m/s^2$ = 0.617kg/m. Therefore, Unit Weight of 10mm diameter bar = **0.617kg/m**.

Example-2
The length of steel, with a diameter of 8mm, required for **X** irrigation scheme is 4,000 meters. How many tons of steel should be ordered for the project?

Given
Diameter, d = 8mm
Length, l = 4000m

Required
Weight of 8mm diameter bar, tons

Solution

Weight of 8mm diameter bar = Unit Weight * length = 0.395kg/m * 4000m = 1580kg = 1.58tons
Therefore, the quantity of 8mm diameter bar to be ordered for project X is **1.58tons**.

Example-3

What is the payment if the 1510m of 12mm diameter bars supplied, cut, bent, and fixed in place as per technical specification and for the satisfaction of supervisor engineer? Consider the tendered price for bar is 45 birr per kilogram.

Given

Diameter, d = 12mm
Executed quantity of bar = 1510m
Tendered price = 45 birr/kg

Required

Payment, birr

Solution

Amount executed, Birr = Executed quantity, kg * tendered price, birr
Executed quantity of bar in terms of bill tendered = 1510m * 0.888kg/m = 1340.88kg
Amount executed = 1340.88kg * 45 birr/kg = 60,339.60 birr
Therefore, payment request for the executed 1510m of 12mm diameter bars tendered price for bar is 45 birr per kilogram worth **60,339.60 birr** only excluding VAT.

Step-7: Frame work

Forms shall be true to line and grade with in allowable tolerances for concrete surface, mortar tight and sufficiently rigid or prevent objectionable deformation under load. Care shall be taken to fit the forms over the completed surface so as to obtain accurate alignments of the surface and to prevent leakage of mortar.

Forms for exposed surfaces shall be coated with approved non-straining from oil, which shall be applied shortly before the concrete is placed. All forms shall be so constructed that they can be removed without damaging the concrete.

Form shall be sufficient and properly braced. The maximum tolerance is 1cm in width and elevation, and 5cm in length.

Step-8: Concrete work

Cast in place concrete is concrete premixed at a batching plant and transported to the work site or concrete whose ingredients are transported to the site and mixed just before casting in place. Provide cement, aggregate, water admixture, labour equipment and tools for cast in place concrete as required for the satisfactory installation of the works.

Mix Proportion

The proportion of concrete ingredients given in the "Standard mixes for ordinary Structural Concrete" of this Specification shown below or proportions obtained by tests shall be used for concrete mixing.

The proportion of ingredients shall be such as to produce a mixture, which will work readily into the corners and angles of the forms and around reinforcement without segregation of the material

components. Where the proportion of ingredients given in the Concrete Class Section of the Specification is not applicable, trial batches shall be made and the mix from which the desired strength is established by testing shall be used for the works.

General Formula used to determine the required material in concrete mix design is:
Concrete Mix ratio = 1:2:4

Let Volume of concrete = Z m^3
Then a) Cement = 1/7 x Zm^3 x 1400 kg/m^3 x 1.30
Shrinkage x 1.05 wastage
= 273 kg Z
= 0.19 m^3 Z
b) Sand =2/7 x Zm^3 x 1840kg/m^3 x 1.30
Shrinkage x 1.05 wastage
= 718 kg Z
= 0.39m^3 Z
c) Gravel = 4/7x Zm^3 x 2250 kg/m^3 x 1.30
Shrinkage x 1.05 wastage
= 1755 kg Z
= 0.95 m^3 Z

General assumption while calculating materials in Concrete Mix

- Shrinkage = 30%
- Wastage = 5%
- Water-cement ratio
    - For Machine mix = 0.4 – 0.5
    - For Hand mix = 0.4 – 0.65

Note: Hand mix shall only be allowed for class II concrete, and shall not be allowed for concrete of class C-20 and above.

Step-9: Curing & removing form
Curing is the process of supplying water to the concrete after casting. It should be done for at least 7 days in foundation concrete and 28 days in surface concrete by sprinkling water, at least two times in a day by the Construction Engineer. The main functions of curing are (1) to maintain the required chemical action of cement in setting so as to attain the maximum strength of concrete, and (2) to prevent formation of surface cracks, due to quick loss of water while the concrete is fresh & wet.

Form shall not remove before the expiration of the minimum time indicated below, except as otherwise directed.

Slab = 7 days
Wall = 2 days

Step-10: Back filling
Back filling around structures shall be executed spreading and compacting the recommended fill material layer by layer as per the specifications.

Step-11: Measurement

Measurement will be made of the number of cubic meters of concrete acceptably placed as directed by the engineer.

Payment will be made of the number of cubic meters measured by provided above at the contract unit price per cubic meters.

Step-12: Finishing work

Immediately after removal of forms, all unsightly or lips shall be removed and undesirable local building on the surface to be permanently exposed shall be remedied. All finishing shall be performed immediately after the forms are removed. Care shall be taken to see that all free water which has accumulated at the surface, is removed before making any finish.

11.5 CONSTRUCTION PROCEDURE FOR GABION WORKS

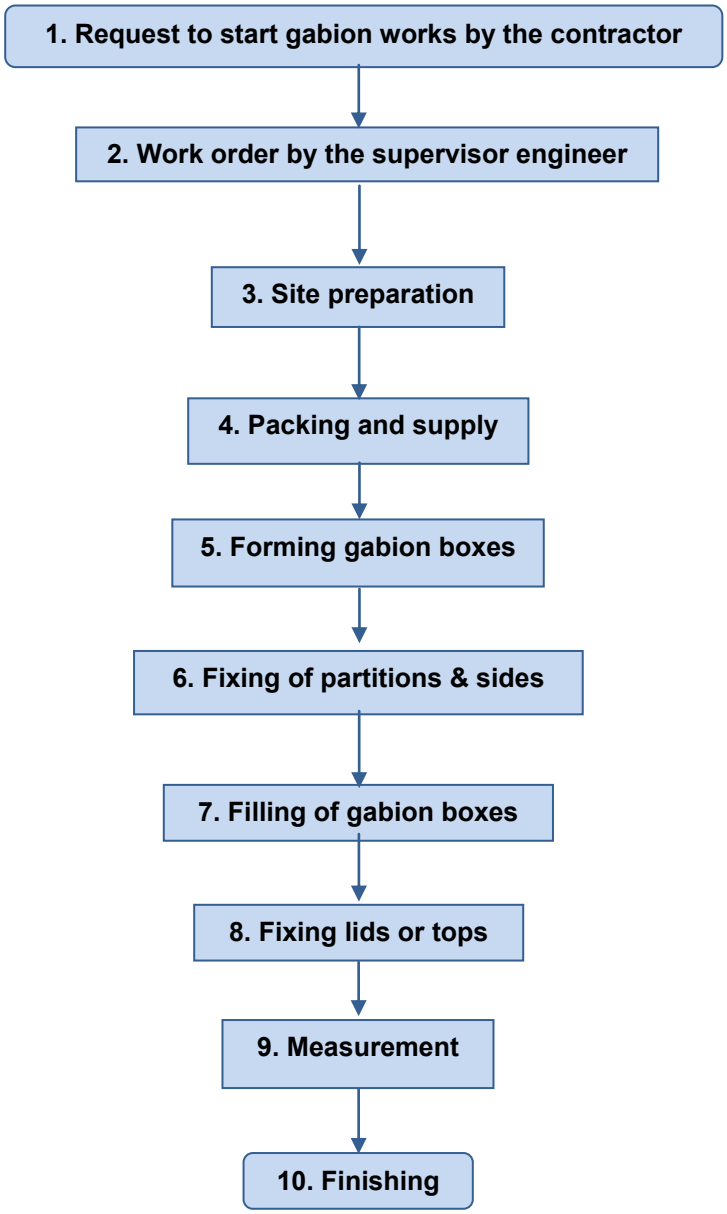


Figure 11-6: Flow chart-gabion works

Description of gabion works

Step-1: Request to start gabion works by the contractor
The project contractor should submit work requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer
The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side.

Step-3: Site preparation
Preparation of the site is of utmost importance in erection of gabions. Site preparation may include clearing, excavation, and back fill works. The contractor together with supervisor engineer should delineate the area where a gabion structures is to be erected. The ground on which a gabion structures is to be erected must be firm and even. The contractor should excavate any loose and soft or unsuitable material and back fill with sound material. Besides, any uneven surfaces, ruts and holes should be filled by the contractor. A granular fill of about 200mm with material such as sand or gravel graded and compacted to the correct line and level as specified is recommended.

Where geotextile fabric is used as lining under the gabion structure, care should be taken so that any sharp material fill does not puncture and damage the fabric. Care should also be taken before gabion boxes are laid, that they do not have sharp loose wire ends that may damage the fabric. All loose ends are to be tucked inside the gabion boxes.

Finally, elevation shall be checked using Leveling by contractor and supervisor jointly for its conformity with the drawing and specification. Measurement should be done jointly with the supervisor engineer.

The unit of measurement shall be the cubic meter of each class of excavation and for backfilling made in accordance with the authorized dimensions. The tendered rate shall include excavating in each class of material; over break; trimming trenches, compacting and consolidating backfill; and disposal of surplus material.

Step-4: Packing and supply
Gabion boxes are supplied in bales which normally contain six bundles. Each bundle contains usually twenty individual boxes. In the case of gabion boxes larger than two meters in length, the lids or tops are supplied separately.

Step-5: Forming gabion boxes
The contractor shall form the gabion boxes with a great care so that all four corners match and form an exact rectangular shape and size as designed. The boxes or group of boxes are positioned at the required location to match the structure design accurately.

Individual boxes are to be tensioned by using steel or wooden stakes to avoid bulging or sagging before filling with stone. The stakes can be easily removed after stone filling, or left in place where recommended. Proper formwork for tensioning the gabion boxes is used as an economy measure for large repetitive jobs.

Step-6: Fixing of partitions & sides
All the partition or diaphragms come readily laced from the factory. The contractor should fix partitions so that it laced to the bottom of the gabion boxes, providing adequate allowance, so that adjacent can be made of the required height.

Each partition is made to stand vertically on its base; the height is adjusted to the required level. The sides of the boxes are then unfolded and also made to stand vertically, taking measurement of the height. All corners of gabion boxes should match exactly as designed. The sides and partitions are then fully laced as per “lacing procedure” provided by the manufacturer or the recommendation given by supervisor engineer.

Step-7: Filling of gabion boxes
Once all the sides of partitions are fully laced and the gabion box is formed, filling can commence with the consent and prior approval of the supervisor engineer. Filling is to be done either manually or mechanically using specified stone. Filling is to be started at the bottom of gabions first and then gradually filled up to the top. The stones are to be packed tightly with minimum possible voids as specified on the specification forming a contract. Overfill the gabions marginally giving allowance for settlement.

Note that when gabions are one third full, the first pair of bracings shall be made tie using lacing wire in single or double strands to avoid bulging and deformation of basic shape gabion structure.

Step-8: Fixing lids or tops
The lids or tops of gabion boxes shall be fixed after the boxes are overfilled for the satisfaction of the supervisor engineer. As the result of overfilling, the lids are stretched over the stone fill, hence, laced down first and securing the corners in the corrected positions prior to fixing lids. While fixing lids, avoid overstretching and damage to the mesh fabric by removing or redistribution of the fill.

Step-9: Measurement of gabion works
The unit of measurement shall be the cubic meter of the rock-filled boxes and the quantity shall be calculated from the dimensions of the gabions and mattresses indicated on the drawings or prescribed by the Engineer, irrespective of any deformation or bulging of the completed units.

The tendered rate shall include procurement of materials; tying and connecting wires; loading, transporting and off-loading; and assembling and filling of the cages.

Step-10: Finishing of gabion works
Gabion works shall be well finished and left in neat and presentable conditions for the satisfaction of the Engineer.

11.6 PIPE SUPPLY, INSTALLATION, TESTING, AND COMMISSIONING PROCEDURE

Pipe works may happen in irrigation infrastructure for conveying irrigation water as main canal, secondary canal, and tertiary canal; pressure line in irrigation pump system; and irrigation or drainage culverts.

The common nominal pressure (PN) pipe used for irrigation is 4bar, 6bar, 10bar. The outer diameter of uPVC Pipe currently used are 600mm, 500mm, 450mm, 400mm, 350mm, 300mm, 250mm, 200mm, 150mm, 100mm, 75mm.

Construction of underground pipelines involves the initial setting out of the trench, the actual trenching, preparation of the trench bottom, bedding, pipe laying, pipe jointing, back-filling, placing thrust blocks and pressure testing.

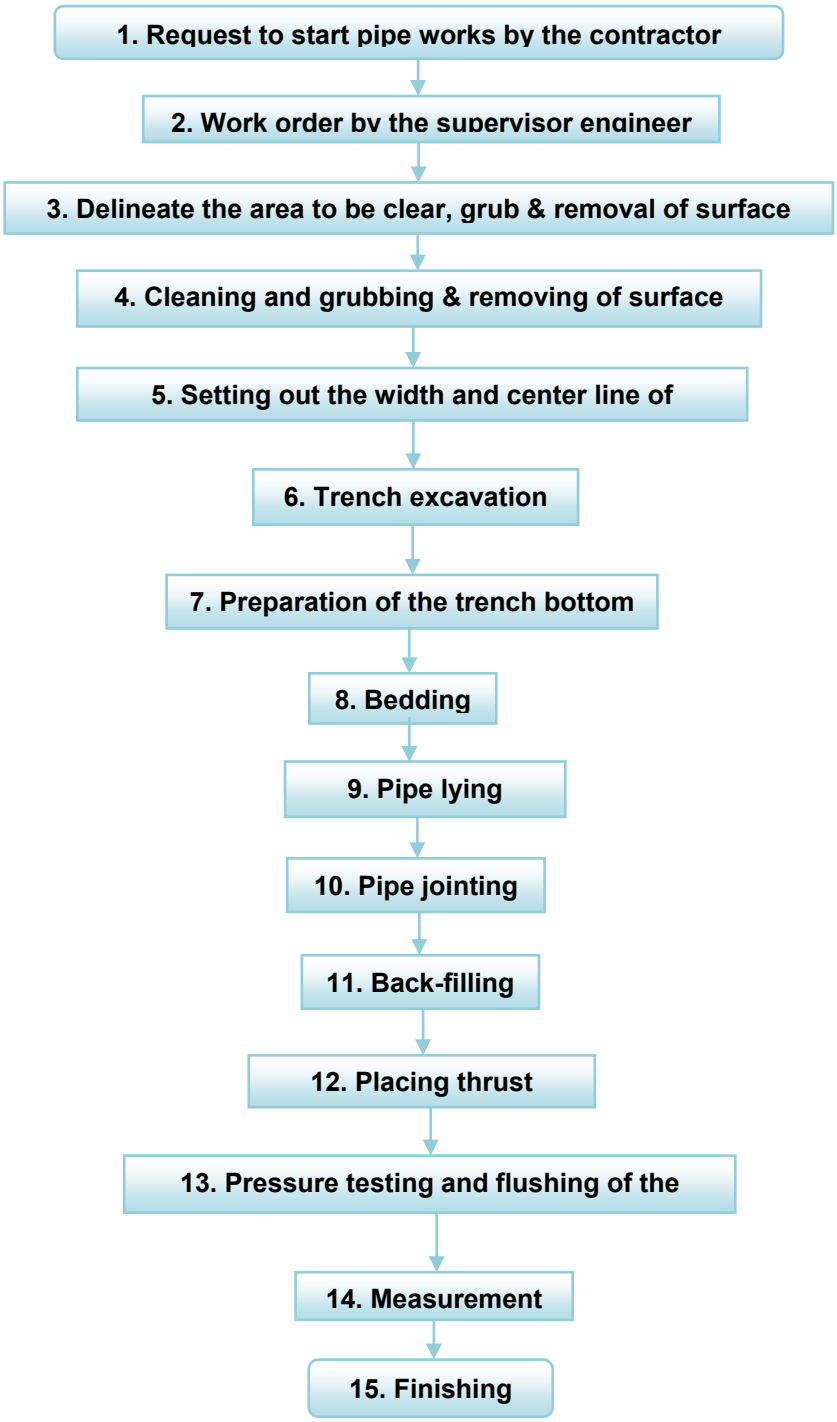


Figure 11-7: Flow Chart-Pipe Works

Description of pipe works

Step-1: Request to start pipe works by the contractor

The project contractor should submit pipe works requesting letter mentioning his readiness to perform the task.

Step-2: Work order by the supervisor engineer

The supervisor engineer should give job order to the contractor within the specified period checking the fulfillment of logistics to start the task from the contractor side. Manufacturers Certificate of pipe that compliant to the technical specification and works methodology should be submitted and approved by supervisor engineer.

Step-3: Delineate the area to be clear, and grub& removal of surface soil

The contractor together with supervisor/client should delineate the area to be clear, and grub & removal of surface soil as specified.

Step-4: Cleaning, grubbing and removing of surface soil

Clearing and grubbing works should be performed by the contractor either by machine or person power as specified based on scope of the works and concluded by taking measurement.

Step-5: Setting out the width and center line of trenches

Setting out the width and Center line of trenches should be precisely done using benchmarks fixed during study and design phase. The width of the trench at the depth equivalent to the uppermost part of the pipe should be at least 30cm greater than the nominal diameter of the pipe.

Step-6: Trench excavation

Trenching can be quite tedious if the ground is hard and larger diameter pipes are to be used. Trenches are dug using picks, mattocks and shovels, but if rock outcrops are encountered in the process, blasting may be used depending on the severity of the situation. Local techniques can also be used to deal with rock outcrops, like heating and fast cooling to weaken the rocks and then hitting them with a hammer.

To avoid the anticipated load damaging the pipe, it should be covered as specified in the technical specification made for the same. For example, ASAE EP340.2 standards recommend a minimum cover of 75 cm and a maximum of 120 cm when traffic will be passing above the uPVC pipes, whereas, at least 45 cm cover for 63 mm uPVC pipes, and at least 60 cm for larger uPVC pipes.

Measure the excavated volume based on cross-sections and formation levels taken at intervals of specified length and located at the specified Chainage points on the trench center line. Measurement should be done jointly with the supervisor engineer.

Step-7: Preparation of the trench bottom

The bottom of the trench should be level or of a uniform slope, to accommodate the full length of the pipe.

Step-8: Bedding

Where an uneven trench bottom is encountered, especially in rocky or hard ground, a 10 cm (or at least one third of nominal diameter) fine back-fill or bedding should be provided for during setting out. This layer has to be back-filled, using suitable bedding material such as free-draining coarse sand, gravel, loam or a soil of friable nature, and be leveled.

Step-9: Pipe lying

A pipeline and appurtenances installed to convey water for storage or application, as part of an irrigation water system. Pipes should be laid in accordance to the technical specification forming the contract document. The following points should be considered while installing pipes but not limited to: -

- Completeness of the preceding activities,
- Availability of sufficient quantity in stock for the intended work,
- Capability of plumber,
- Availability of clear method statement,
- Pipe type,
- Nominal diameter of the supplied with respect to the designed pipe diameter,
- Nominal pressure of the supplied with respect to the designed pipe diameter,
- Physical condition of the supplied pipe,
- Rubber seal compatibility, etc.

Step-10: Pipe jointing

When pipes have to be joined, they have to be clean of dirt. All the solvent cleaners, adhesives and lubricants used in joining pipes should be those recommended by the manufacturer of the pipe or fitting. It has to be remembered that solvent cleaners and adhesives are highly volatile. For example, in the case of uPVC piping less than 200 mm in diameter, an injection-mould adhesive type of fitting or an integral rubber ring should be used, whereas, for sizes larger than 250 mm diameter, a rubber ring end socket should be used.

Pipes can be cut if shorter pipes are needed, but, if jointing is not done immediately, the pipes have to be temporarily closed in order to avoid the entrance of animals or dirt. It also, is important to ensure that the temporary closures are opened on re-commencement of pipe laying works. Valves and outlets should be closed every day.

Step-11: Back-filling

After checking that the levels of all joints are correctly set out, side filling can then be done in layers that are 75 mm thick, using fine material for the fill. The layers have to be tamped by hand, ensuring that the joints are left exposed. Tamping should be done simultaneously on both sides of the pipe, in order to avoid misalignment. This should continue up to a height of two thirds of the pipe diameter, or up to 10 cm above the crown when the material is spread over the whole length of the pipeline except the joints. Beyond that, the rest of the back-filling can be done in layers of 15-30 cm. The trenches should be over-filled to allow for settlement.

Note that the space between the joints is backfilled after the pipeline has been pressurized and the joints inspected to ensure that there are no leaks. It is necessary to ensure that all pipes are back-filled once they are installed, in order to prevent them from floating due to rainwater or groundwater.

Step-12: Placing thrust blocks

Thrust blocks that helps to transfer the load from a fitting or branch to a wide load-bearing area minimizing the chances of the fitting moving should be placed in a position when the pipeline changes direction, at the end of a pipeline, and when there is a branch such as a tee.

Step-13: Pressure testing and flushing of the system

The purpose of testing pipelines is to ensure that the pipe joints are water-tight and that the permanent concrete thrust blocks are capable of resisting the load.

Normally, at least 7 days should be allowed after constructing the last thrust block before the system is tested. By this time, the last thrust block should be able to withstand the load.

When pressure testing, the pressure should not exceed one and half times the maximum working pressure. It is also important that the valves and all other outlets be opened and closed slowly.

The flushing is intended to remove all the dirt that inevitably gets into the system during pipe laying and it should be done for a couple of hours with the flush valves at the end of the lateral lines open (in the case of pressurized irrigation system). The flushing process should be stopped once clean water starts coming out of the valves.

Step-14: Measurement

Measurements of pipe works will be taken jointly in the presence of contractor and supervisor engineers as in the drawing and itemized in the billed quantity.

Step-15: Finishing of fill and compaction works

The entire pipe works shall be left in neat and presentable conditions.

11.7 ELECTRO-MECHANICAL EQUIPMENT SUPPLY, INSTALLATION, TESTING, AND COMMISSIONING PROCEDURE

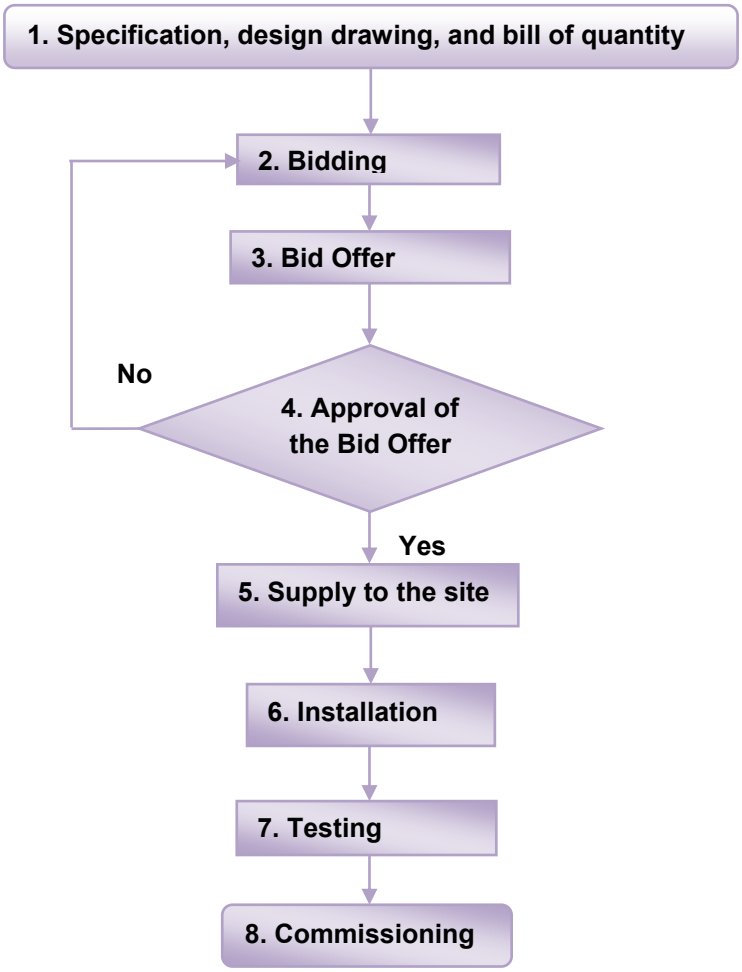


Figure 11-8: Flowchart-procedure for electro-mechanical equipment supply, installation, testing, and commissioning works

The construction engineer should control the procedure of electro-mechanical equipment supply, installation testing and commissioning.

Step-1: Specification, design drawing, and bill of quantity
The construction engineer should review the specification, design drawing and bill of quantity with respect to the design calculation and update it if required.

Step-2: Bidding
The contractor should enter in to bid process on time following the directives.

Step-3: Bid Offer
The contractor/client should evaluate the technical and financial bid offer with respect to specification, design drawing, and bill of quantity forming the contract. Then, he/she has to submit the technical offer to the supervisor for approval before award.

Step-4: Approval of the bid offer
Up on submission of the contractor for approval, the supervisor engineer should evaluate the technical bid offer with respect to specification, design drawing, and bill of quantity forming the contract. Then, he/she has to give written confirmation whether it is conformance or no-conformance.

Step-5: Supply to the site

Once the contractor gate approval from the supervisor, he/she has to give award for the selected bidder and supply the equipment at site level.

Step-6: Installation

Installation of electro-mechanical equipment shall begin after fulfillments of the following but not limited to: -

- Arrival of the whole electro-mechanical equipment and their accessories. For example,
  - Pumps and accessories
    - Surface pump
    - Submersible pump
    - Riser Pipe
  - Head work fittings
    - Check valve
    - Air release valve
    - Water meter
    - Elbow
  - Equipment for Power sources
    - Generator
    - Transformer
  - Solar System
  - Control Panel
- Pre requisite activities completed and get consent by the supervisor,
- Capability of Contractor's and consultant person power available at site, and
- Fulfillment of installation equipment and tools arrived at site.

The following activities should be done prior to submersible pumps installation:

- *Checking of water level using deep meter through preservation pipe by hydrogeologist;*
- *The hydrogeologist should analysis and draw sound recommendation for the current measured water level with respect to the design input and well completion report made for the same;*
- *If it is recommended by the assigned hydrogeologist, flush the well with the recommended compressor for the recommended time;*
- *If the ground water disagrees with the design parameter in any case of the following cases, please discuss with the CST to bring solution and proceed or stop the installation activity*
  - *The water level in the production well deeper than the recommended and considered pump position,*
  - *The water level in the production well higher than the recommended and considered pump position but less than the assumed water column above the pump,*

Step-7: Testing: - Testing should be done jointly in the presence of qualified contractor and consultant personnel's as per the specified methods and duration set in the specification forming the contract.

Step-8: Commissioning

Commissioning should be done after fulfillment of conditions specified in the contract document.

11.8 HYDRO-MECHANICAL EQUIPMENT SUPPLY, INSTALLATION, TESTING, AND COMMISSIONING PROCEDURE

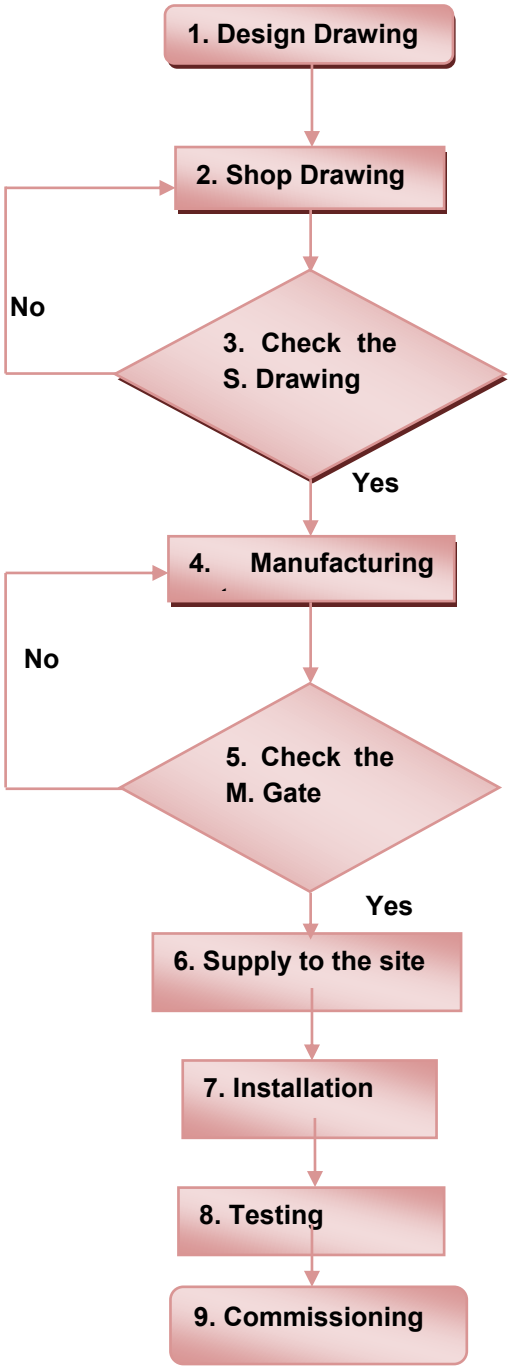


Figure 11-9: Flowchart-Procedure for Hydro-Mechanical Equipment Supply, Installation, Testing and Commissioning

The construction engineer should control the quality of Hydro-Mechanical Equipment such as gates works at each steps of gate manufacturing, supply, installation, testing and commissioning.

Step-1: Design Drawing

The construction engineer should review the design drawing with respect to the design calculation and specification made for the same and update it if required.

Step-2: Shop Drawing
Construction engineer should prepare shop drawing (working drawing) based on the specification and design drawing forming the bid and submit to supervisor engineer for approval.

Step-3: Checking the Shop Drawing
Construction engineer should confirm the approval of his shop drawing (working drawing) by the supervisor engineer prior to manufacturing.

Step-4: Manufacturing
Once the construction engineer gets an approval by the supervisor engineer for his shopping drawing (working drawing), he has to proceed the manufacturing of the gate.

Step-5: Check the manufactured gate
During this period of manufacturing, the supervisor engineer should inspect the workshop to inspect the process and the final gate manufactured in accordance with the specification, shop drawing and method statement forming the bid. If it is acceptable he can instruct the construction engineer to proceed supply at site, if not, give instruction to correct the defect. Here, the supervisor engineer should check the type of material, design dimensions (height, width, length, thickness) with respect to specification and drawing forming the bid.

Step-6: Supply to the site
Immediately after the construction engineer get an approval by the supervisor engineer for the manufactured gate, he has to transport and supply the gate to the site. Supervisor engineer should check and ensure the proper handling during transportation and supply of full set at site level without major damage that may require rectification at workshop level.

Step-7: Installation
The supervisor engineer can instruct the construction engineer if and only if the following activities are per performed but not limited to:

- Civil structures are completed or ready to be completed,
- Materials required during installation are full filled,
- The required Construction staff for installation and related works are ready and well organized,
- Installation plan and method statement are submitted by construction engineer and approved by supervisor engineer.

Step-8: Testing
After completion of installation operation for the satisfaction of the supervisor engineer, dry and wet test should be taken jointly in the presences of supervisory and contractor civil and electro-mechanical engineers.

Step-9: Commissioning
Finally, the work should be finished as recommended by the supervisor engineer. The finishing works may be cleaning, repainting, hammering to rectify minor error, and the like. Commissioning should be done after fulfillment of conditions specified in the contract document.

12 CONSTRUCTION MANAGEMENT SOFTWARE'S

AutoCAD, MS-Project, Primavera Project Planner, and ConMIS Software are construction management software's that currently applied by the engineers assigned in construction industry. The reader should refer *GL 21: Major Application Software's Guideline for SSID* for its detailed presentation and application guidance.

12.1 AUTOCAD

AutoCAD is software program used to made computer-aided design.

12.2 MS-PROJECT

Microsoft Project, the project management software program by Microsoft, is a very handy tool for project managers that help them develop a schedule, assign resources to tasks, track the progress, manage the budget, and analyze workloads for an ongoing project.

12.3 PRIMAVERA PROJECT PLANNER

Primavera Project Planner is used for construction planning & scheduling.

12.4 CONMIS SOFTWARE

ConMIS Software used for bill of quantity calculation, take-off sheet analysis, payment certification and report preparation.

REFERENCE MATERIALS

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APPENDICES

APPENDIX I: PART IV/GL 29/A CONTRACT MANAGEMENT FORMAT

Appendix Part IV/GL 29/A-1: Procurement Outcome Review Format

Name of the Project: _____

No	Reviewed items	Yes/ No	Remark
1	If missed items exist		
2	Unsound unit cost/rate		
3	Undermined or exaggerated quantity		
4	Undefined specifications		
5			
6			
7			
8			
9			
10			

(Use this place to summarize the findings and discuss with the responsible persons on the review result)

_____

_____

_____

Appendix Part IV/GL 29/A-2: Contract Mobilization Checking Format

Mobilisation	Action	When done make a mark (X)	Remark
Document	Distribute contract documents to Consultant/Client (Region. Zone, District - Legal section, Relevant departments)		
	Establish Contract file in the name of the project		
Site Handover	Site handover format preparation		
	• Beneficiary and locally area administrative & line office courtesy call		
	• Camp site handover		
	• Headwork and Main structure		
	• Bench Marks		
	• Access road if applicable		
Communication &Relationship	• Establish reporting structure and formats		
	• Contractor contract management personnel acceptance		
	• Establish meeting schedules		
	• Establish communication protocols (diary, memos, letters, email. FAX, telephone calls etc.)		

Appendix Part IV/GL 29/A-3: Risk Analysis Format

No	Risk	Category (technical/cost/ managerial)	Degree (High/Medium /Low)	Mitigation Measures
1	Right off way issue			
2	Design modification			
3	Change in client interest			
4	Price escalation			
5	Labour availability			
6	Limitation in construction material			
7				
8				
9				
10				

(Use this place to summarize the risk analysis and mitigation measures after discussing with the responsible persons)

_____

_____

_____

Appendix Part IV/GL 29/A-4: Communication Ledger & Follow-Up Format

Date	Ref Number of Letter	Letter issued by	Main Message/Subject	Response from Client/ Contractor/Consultant/Contract Manager

Appendix Part IV/GL 29/A-5: Documentation and Record Summary Keeping Format

Name of the Project _____

I. **Cost**

Initial Contract Price _____ Advance Paid _____

First Amended Contract Price _____ Second Amended Contract Price _____

Interim	Payments (ETB)	Variations On Each payment		Retention (__ %)	Liquidated damages	Compensation effect
		Amount (ETB)	%			
1						
2						
3						
Final						

Dispute	(Please write a narrative in the following space when a dispute occurs and how it is resolved – dispute dates / resolved dates and specific issues are important)

Time

Contract Completion time _____ First Extended Completion Time _____

Second extended Completion time _____

Third extended Completion time _____

Actual Completion time _____

Warnings letter Ref		
Letter RF	date	Subject

Conducted meetings with Contractor		
Venue	date	Subject & minutes

Quality
Use this space if there is quality complain at each interim payment level & where necessary

Appendix Part IV/GL 29/A-6: Minutes of Meeting Format

Venue: _____
Date: _____
Time: _____

No	Participants Full Name	Organization	Position
1			
2			
3			
4			
5			
6			

Meeting Agenda:

1. _____
2. _____
3. _____
4. _____

Result of discussion:

1. _____
2. _____
3. _____
4. _____

Signature of participants at the end of the meeting:

Appendix Part IV/GL 29/A-7: Contract Monitoring Format

Please use this form for Contract monitoring; *(items can be increased or decreased based on the specific project. Monitoring indicator also can be modified)*

No	Item to be Monitored	Compliance to (Yes/No)							Remark
		Size/Dimension	Specification	Time	Cost	Quality	Shape	Type	
1	Head Work								
1.1	Weir body								
1.2	U/S apron								
1.3	D/S apron								
1.4	Wing walls								
1.5	Gates								
2	Conveyance canal								
3	Main Canal								
4	Secondary Canal								
5	Tertiary Canal								
6	Other canals								
7	Structures								
7.1	Drops								
7.2	Division boxes								
7.3	Turnouts/ Off takes								
7.4	Bed bars								
7.5	Aqueducts								
7.6	Cross drainages								
7.7	Culverts								
7.8	Level crossing								
7.9	Others								

General Comment: (use this space for detail comments of the monitoring result)

Signature of the monitoring team members / individual:

_____

APPENDIX II: Part IV/GL 29/B Planning and Scheduling Format

Appendix Part IV/GL 29/B-1: Physical Work Schedule Format

Project Name_____

Client:_____

Consultant_____

Contractor: _____

Physical Work Schedule in Quantity for the year _____ EFY

Item No.	Description	Unit	Contract quantity	Physical Work Plan in Quantity for the year____ EFY	Physical Work Schedule for the year _____ EFY Monthly Distribution																							
					July		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		June	
					Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%	Qt.	%

Appendix Part IV/GL 29/B-2: Financial Schedule Format

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____
Financial Schedule in ETB for the year _____ EFY

Item No.	Description	Unit	Contract Amount, Birr	Financial Plan in Birr for the year _____ EFY	Financial Schedule for the year _____ EFY Monthly Distribution																							
					July		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		June	
					Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%	Amt, Birr	%

Appendix Part IV/GL 29/B-3: Person power Schedule Format

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____
Person power Schedule in number for the year _____ EFY

Item No.	Description	Unit	Agreed Person power	Person power Plan for the year _____ EFY	Person power Schedule for the year _____ EFY Monthly Distribution											
					July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June

Appendix Part IV/GL 29/B-4: Machinery Schedule Format

Project Name:_____

Client:_____

Consultant:_____

Contractor:_____

Machinery Schedule in hours for the year _____ EFY

Item No.	Description	Unit	Agreed Machinery	Machinery Plan for the year _____ EFY	Machinery Schedule in hours for the year _____ EFY Monthly Distribution											
					July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June

Appendix Part IV/GL 29/B-5: Construction Material Schedule Format

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____
Construction Material Schedule in Quantity for the year _____ EFY

Item No.	Description	Unit	Agreed Material	Material Plan for the year _____ EFY	Construction Material Schedule in Quantity for the year _____ EFY Monthly Distribution											
					July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June

Appendix Part IV/GL 29/B-6: Financial Flow Schedule Format

Project Name:_____

Client:_____

Consultant:_____

Contractor:_____

Financial Flow Schedule in ETB for the year _____ EFY

Item No.	Description	Total Financial Flow Plan (ETB) for the year _____ EFY	Financial Flow Schedule (ETB) Month Distribution											
			July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1	Material cost													
2	Machinery cost													
3	Person power Cost													
4	Overhead cost													
5	Others													
	Total cost													

APPENDIX III: Part IV/GL 29/C Payment Format

Appendix Part IV/GL 29/C-1 Sample Advance Payment Requesting Letter

Contractor Letter Head

Ref. No: _____
Date: _____

To / Name of the organization/
Subject: -**Request for Advance Payment**
Please allow this letter to serve as our request to receive an advance payment from your organization, / Organization Name/ for a contract our company entered into /Insert contract # ------/ for the Construction/ Consultancy/ supply/. The contract amount including VAT is ETB _____ / number & figure/. Hereby we request a /--% / advance payment, in the amount of Birr_____ /number & figure/.
We understand that costs paid for the advance will be dedicated proportionally from the subsequent payment request. Furthermore, the advance will be deducted from the total amount of reimbursement requested.
Here with, we attached the required amount of Advance Security Ref. No _____ dated _____ for the amount of _____ ETB from _____ Bank.
The Company commits itself for full return of the advance payment, in case of any failure to do so and expiration of the security the company will renew the security or will pay back the remaining advance payment in Cash.
If you have any questions or need additional information to process this request, please contact _____ at (_____) _____.

Sincerely, Designated Authorized Representative

(THIS LETTER MUST BE SIGNED BY THE DESIGNATED AUTHORIZED REPRESENTATIVE).

Appendix Part IV/GL 29/C-2 Sample Interim Payment Requesting Letter

Contractor Letter Head

Ref. No._____
Date_____

(Insert the Client/Consultant Name)
(Insert the Client Address)

Ref: - Construction of ***(Insert the Project Name)***

Subject: **Request for Approval of Interim Payment No.------**
It is to be recalled that the contract agreement has been signed between your honored office, ***(Insert Client Name)***, and our firm, ***(Insert Contractors Name)*** for the construction of ***(Insert project Name)*** located in ***(Insert Region Name)***, ***(Insert Zone Name)***, ***(Insert District Name),*** and ***(Insert Kebele Name)*** with contract amount ETB ***(Insert Amount in figure) (Insert Amount in Words)*** only including15% VAT.
Accordingly, we have accomplished ***(Put items of works executed)*** that worth ETB ***(Insert Amount in figure) (Insert Amount in Words)*** only including15% VAT.
Hence, according to GCC/SCC ____ we here by request your good office approval and effect Interim Payment No.__ for the work executed this month that worth ***(Insert Amount in figure) (Insert Amount in Words)*** only including15% VAT.
Please find attached herewith _____ pages of summary of work executed for IPC _____ and other supporting documents.

With regards,
Person in Charge
Position

C.C

- ***(Insert Client Name)***
  (Insert the Client Address)
- ***(Insert Name of different internal stockholders)***
-
-

  (Insert the Contractor Name)
  (Insert the Contractor Address)

(THIS LETTER MUST BE SIGNED BY THE DESIGNATED AUTHORIZED REPRESENTATIVE).

Appendix Part IV/GL 29/C-3 Take off sheet Format

Project Name:_____

Type of Structure:_____

Payment No.:_____ Page No.:_____

Item No.	Description	Unit	Dimension					
			No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)/Area (m^2)	Remark

Contractor Representative

Name

Sign

Date

Consultant Representative

Name

Sign

Date

Appendix Part IV/GL 29/C-4 Summary of Executed Amount Format

SUMMARY OF EXCUTED AMOUNT

Project				Location		
Client						
Consultant						
Contractor						

CERTIFICATE OF PAYMENT No.__

Summary of Executed B.O.Q Amount (Birr)

Item No	Type of Work	Contract Amount	Previous Amount	current Amount	Total executed Amount
	Total				

Consultant's Representative
Name _____
Signature _____
Date _____

Client's Representative
Name _____
Signature _____
Date _____

APPENDIX IV: Part IV/GL 29/D Reporting Format

Appendix Part IV/GL 29/D-1 Monthly Project Information Format

Project Name: _____
Client: _____
Consultant: _____
Contractor: _____

1. General Information
    1.1 Location: _____
    1.2Altitude: _____
    1.3 Weather Condition: _____
    1.4 Working Hours: _____

2. Short and descriptive comparison of work progress against schedule:
_____
_____.

3. Current project status:
_____
_____.

4. Problem encountered:
_____
_____.

5. Measures taken:
_____
_____.

6. Pending issues that needs attention:
_____
_____.

7. Net amount of payment certified during previous time:
_____
_____.

8. Estimated amount of work accomplished during this month:
_____
_____.

9. Others:
_____
_____.

Appendix Part IV/GL 29/D-2 Monthly Work Progress Format (Quantity)

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Plan Period : _____ Contract Time: _____

Fiscal Year: _____ Utilized time: _____

Commencement date : _____ Remaining contract time: _____

Completion Date: _____ Percentage completion to date: _____

Bill Item No	Activity	Unit	Unit Price' Birr	Tender Quantity	Previously completed quantity	Accomplished Quantity				To - Date Certified Quantity	Difference Accomp-Certified Quantity	Remark
						This month		To - Date				
						Planned	Executed	Planned	Executed			

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/D-3 Monthly Work Progress Format (Amount)

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Plan Period : _____ Contract Time: _____

Fiscal Year: _____ Utilized time: _____

Commencement date : _____ Remaining contract time: _____

Completion Date: _____ Percentage completion to date: _____

Bill Item No	Activity	Unit	Unit Price' Birr	Tender Amount, Birr	Previously Amount, Birr	Accomplished Amount, Birr				To - Date Certified Amount, Birr	Difference (Accomp-Certified) Amount, Birr	Remark
						This month		To - Date Amount, Birr				
						Planned	Executed	Planned	Executed			
1												
2												
Etc.												

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/D-4 Person power Mobilized to the Site during the Month

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Plan Period : _____ Contract Time: _____

Fiscal Year: _____ Utilized time: _____

Commencement date : _____ Remaining contract time: _____

Completion Date: _____ Percentage completion to date: _____

S/No	Description	Unit	Month, Year		
			Plan	Mobilized	%

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/D-5 Machinery/Equipment Utilization during the Month

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Item No.	Type of Machinery/Equipment	Plate No.	Capacity	Name of Operator	Total			Operation Hours		Remark
					Available Hrs	Idle Time	Down Time	Bill Item No.	Total	

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/D-6 Construction Materials Used during the Month

Project Name:_____

Client:_____

Consultant:_____

Contractor:_____

Item No.	Description	Unit	Total Quantity	Total Cost		Bill Item Number			Remark
							Cost		
				Birr	Cents	Qty.	Birr	Cents	

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

APPENDIX V: Part IV/GL 29/E Resource Allocation Format

Appendix Part IV/GL 29/E-1 Machinery/Equipment Allocation Format

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Description of works	Unit	Quantity	Machinery/Equipment Allocation								
			Dozer	Excavator	Scraper	Grader	Loader	Compactor	Transit mixer	Dump truck	Water truck

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/E-2 Labour Allocation Format

Project Name:_____

Client:_____

Consultant:_____

Contractor:_____

Description of works	Unit	Quantity	Labour Allocation				
			Forman	Mason	Carpenter	Bar bender	Daily Labours

Remarks: _____.

Prepared by

Name: _____
Signature _____
Date _____

Approved by

Name: _____
Signature _____
Date _____

Appendix Part IV/GL 29/E-3 Construction Materials Allocation Format

Project Name:_____
Client:_____
Consultant:_____
Contractor:_____

Description of works	Unit	Quantity	Construction Materials Allocation					
			Sand	Aggregate	Cement	Re-Bar	Form Work	Stone

Remarks: _____.

Prepared by
Name: _____
Signature _____
Date _____

Approved by
Name: _____
Signature _____
Date _____

APPENDIX VI: Part IV/GL 29/F Work Request Format

Request for permission to proceed_____

Employer _____ Approval No. _____
Consultant _____ Request No. _____
Contractor_____

APPROVAL REQUEST

Date _____ Date _____
Time _____ Time _____
Requested by _____ Received by _____
Please you are requested to check the following works for approval
Item of Work : _____
_____
Location of Work : _____
Time of checking : _____
Next stage of work : _____

For Engineer's use only

Surveying executed by :_____
For the contractor _____Date_____hour_____
For the consultant_____ Date_____hour_____

REMARK

Approved ☐ Not approved ☐

Supervising Engineer _____ Construction Engineer
Time _____ Time _____
Date _____ Date _____

Note:
The contents of approve does not relieve the contractor from any of his obligation toward the work as per the drawing and specification of the contract and as per clause --------- of the general condition of contract

N.B.:-Next stage of work shall be commenced after getting approval from the consultant.

Contractor Resident Engineer

APPENDIX VII: Part IV/GL 29/G Surveying Data Collection Format

Appendix Part IV/GL 29/G-1 Leveling Data Sheet

Project Name_____

Type of work_____ Date_____

Chainage from_____to _____ Page_____

Location

PT	Chainage	BS	HI	IS	FS	OGL EL	Bed Level	Remark

Contractor

Name_____

Sign_____

Date_____

Consultant

Name_____

Sign_____

Date_____

APPENDIX VIII: Part IV/GL 29/H Laboratory Test Format

Appendix Part IV/GL 29/H-1Laboratory Test Format for Fine Aggregate

Project :- Pro.No:-

Client :- Date:-

Location :-

Object :- Clay content and gradation of sand

1. Clay content of sand

No	Material Type	Location	Silt content %
1	sand		

2 Gradation test for Sand

No	Sieve Size (mm)	% Pass				
			Soil			
1	75					
2	63					
3	50					
4	37.5					
5	25					
6	19					
7	12.5					
8	9.5					
9	4.75					
10	2.36					
11	1.18					
12	0.6					
13	0.3					
14	0.15					
15	0.075					

Tested by: ……

Date : ……..

Checked by ……..

Date : ……..

Approved By ……

Date ……

Appendix Part IV/GL 29/H-2 Laboratory Test Format for Reinforcement Bar

Project:- **W.O.No:-**
Client :- **Date:-**
Location :-

Sample No.	Diameter (mm)	Cross section area ($mm^{2)}$	Yield Stress (Mpa)	Ultimate Tensile Stress (Mpa)	Elongation (%)	Mass/meter (kg/m)

Tested by: …… **Approved By ……**
Date : …….. **Date ……**

Checked by ……..
Date : ……..

Appendix Part IV/GL 29/H-3 Laboratory Test Format for Compressive Strength

Project:- _____ Pro.No :-_____
Client:- _____ Date : _____
Location :- _____
Object:- _____

Ingredient Information		
	Type	
Cement	Volume	
	Weight	
	Type	
Sand	Volume	
	Weight	
	Type	
Aggregate	Volume	
	Weight	
Water/Cement ratio		

Consistency	
Box size ($cm^{3)}$	

Material type	Unit weight kg/m^3
Agg.	
Sand	

Marking	Date		Age in Days	Dimension (m)	Unit Weight Kg/m^3	Compressive Strength (Mpa)
	Poured	Tested		LXWXH		

Tested by _____ Approved by _____
Date- _____ Date _____

Checked by _____
Date- _____

APPENDIX IX: PART IV/GL 29/I PROJECT HANDING OVER FORMAT

Appendix Part IV/GL 29/I-1 SSI Project Site Handover to Commence Construction Format

1. General Aspect of the Project
   - Project Name:
   - Administrative Location:
     - Region:
     - Zone:
     - District:
     - PA:
     - Specific Site:
   - Distance from Towns:
     - District Capital (---) = -------km
     - Zone Capital () = -----------km
     - Country Capital (Addis Ababa) = ------km
   - Geographic Coordinate of
     - Headwork Site
       - Longitude/East (UTM): ----------
       - Latitude/North (UTM): ----------
       - Altitude (masl): ----------
     - Command Area
       - Longitude/East (UTM): From ---------- to ----------
       - Latitude/North (UTM): From ---------- to ----------
       - Altitude (masl): From ---------- to ----------
   - Client: ----------
   - Contractor: ----------
   - Consultant: ----------
   - Month and year of project startup: ----------
   - Command Area: ----------hectare
   - Total Number of Beneficiaries: ----------HH

2. Checking and handing over of detail design drawings at site level
   a) Checking and handing over of Bench Marks at Headwork and Command area ----------.
   b) Checking and handing over of headwork site topographic map and water abstraction system ----------.
   c) Checking and handing over of command area system layout ----------.
   d) Checking and handing over of location orientation and dimension of canal system ----------.
   e) Checking and handing over of location and dimension canal and social structures ----------.

3. Checking and Handing Over of Major Components of the Project at Site Level

Item No.	Description of project major components	Detail of the Structures							Remark
		Shape	Type	Specification	Length (m)	Width (m)	Depth (m)	Elevation (masl)	
1	Head Work								
1.1	Weir body								
1.2	U/S apron								
1.3	D/S apron								
1.4	Wing walls								
1.5	Gates								
2	Conveyance canal								
3	Main Canal								
4	Secondary Canal								
5	Tertiary Canal								
6	Other canals								
7	Structures								
7.1	Drops								
7.2	Division boxes								
7.3	Turnouts								
7.4	Off takes								
7.5	Bed bars								
7.6	Aqueducts								
7.7	Measuring structures								
7.8	Cross drainages								
7.9	Culverts								
7.10	Bridges								
7.11	Level crossing								
7.12	Others								

Narrative Remarks: ----------

---.

4. Conclusion

   ---.

This SSI Project Site Handover to Commence Construction effected on: _____.

In the presence of:

On behave of Project Client

Name_____ Signature_____ Date_____

On behave of Project Consultant/Contractor

Name_____ Signature_____ Date_____

Witness and Signature

1.
2.
3.
4.
5.
6.

Appendix Part IV/GL 29/I-2 Constructed Project Handover Format

1. General Aspect of the Project
   - Project Name:
   - Administrative Location:
     - Region:
     - Zone:
     - District:
     - PA:
     - Specific Site:
   - Distance from Towns:
     - District Capital (---) = -------km
     - Zone Capital () = ----------km
     - Country Capital (Addis Ababa) = ------km
   - Geographic Coordinate of
     - Headwork Site
       - Longitude/East (UTM): ----------
       - Latitude/North (UTM): ----------
       - Altitude (masl): ----------
     - Command Area
       - Longitude/East (UTM): From ---------- to ----------
       - Latitude/North (UTM): From ---------- to ----------
       - Altitude (masl): From ---------- to ----------
   - Client: ----------
   - Contractor: ----------
   - Consultant: ----------
   - Month and year of project startup: ----------
   - Command Area: ----------hectare
   - Total Number of Beneficiaries: ----------HH
   - Total Investment cost: ETB ----------

2. Project handover status
   ----------.
3. Current status of the project
   ----------.

4. Inspection and testing during project handover process

Item No.	Project major components Description	Unit	Contract Quantity	Result of inspection and testing				Remarks
				Length (m)	Width (m)	Depth (m)	Elevation (masl)	
I	**Civil Structures**							
1	Headwork							
2	Canal							
3	Canal Structures							
4	Others							
II	**Electro-Mechanical Equipment's**			**Inspected Quantity**	**Supplied**	**Installed**	**Test**	
1	Pump							
2	Generator							
3	Pipe							
4	Others							

Narrative Remarks: ----------

---.

5. Conclusion

   ---.

This project ---------- hand over effected on: _____

In the presence of:

On behave of Project Client

Name_____ Signature_____ Date_____

On behave of Project Contractor

Name_____ Signature_____ Date_____

On behave of Project Consultant

Name_____ Signature_____ Date_____

Witness and Signature

1.
2.
3.
4.
5.

Appendix Part IV/GL 29/I-3 Format for Irrigation Project/Scheme Transferring to the Beneficiary

1. General Aspect of the Project
   - Project Name:
   - Administrative Location:
     - Region:
     - Zone:
     - District:
     - PA:
     - Specific Site:
   - Distance from Towns:
     - District Capital (---) = -------km
     - Zone Capital () = ----------km
     - Country Capital (Addis Ababa) = ------km
   - Geographic Coordinate of
     - Headwork Site
       - Longitude/East (UTM): ----------
       - Latitude/North (UTM): ----------
       - Altitude (masl): ----------
     - Command Area
       - Longitude/East (UTM): From ---------- to ----------
       - Latitude/North (UTM): From ---------- to ----------
       - Altitude (masl): From ---------- to ----------
   - Client: ----------
   - Contractor: ----------
   - Consultant: ----------
   - Project commencement date: ----------
   - Project completion date: ----------
   - Command Area: ----------hectare
   - Total Number of Beneficiaries: ----------HH
     - Male Headed----------
     - Female Headed.....
   - Source of Fund
   - Total Investment cost: ETB ----------
     - Share of Funding Agent: ETB ----------
     - Share of Beneficiary: ETB ----------

2. Statement of consensus about the project with the beneficiaries
   - Land use (present land occupation) ----------.
   - Existing Water Users Association ----------.
   - Existing cooperative organization ----------.
   - Works well be improved and scale up in the future ----------.

3. Substantially or totally completed components of the project

Item No.	Project major components Description	Unit	Quantity	Result of inspection and testing				Remarks
				Length (m)	Width (m)	Depth (m)	Elevation (masl)	
I	**Civil Structures**							
1	Headwork							
2	Canal							
3	Canal Structures							
4	Others							
II	**Electro-Mechanical Equipment**			**Inspected Quantity**	**Supplied**	**Installed**	**Test**	
1	Pump							
2	Generator							
3	Pipe							
4	Others							

Narrative Remarks: ----------

---.

4. As built documents transferred to the beneficiary
   - Design document

   - As built drawings

   - Operation and maintenance manual (s)

     ---
5. Execution of training for operators

   ---.
6. Conclusion

   ---.

This scheme is transferred to the beneficiary effected on: _____

In the presence of:

<u>On behave of Project Client</u>

Name_____ Signature_____ Date_____

<u>On behave of Project Beneficiary</u>

Name_____ Signature_____ Date_____

<u>On behave of Project Contractor</u>

Name_____ Signature_____ Date_____

<u>On behave of Project Consultant</u>

Name_____ Signature_____ Date_____

<u>Witness and Signature</u>

1.
2.
3.
4.

SSIGL 29

Prepared by

GIRDC