SSIGL 31

NATIONAL GUIDELINES

For Small Scale Irrigation Development in Ethiopia

A Procedural Guideline for Small Scale Irrigation Schemes Revitalization

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:

- Small-scale and Micro Irrigation Support Project (SMIS) and its team for preparation and financing the publication of SSIGL-31, SSIGL-32, SSIGL- 33 and SSIGL- 34. SMIS also made all efforts to have quality GLs developed as envisioned by the Ministry.
- Agriculture Growth Program (AGP) of the MoA for financing the development and publication of all the guidelines.
- 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.

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.

LIST OF GUIDELINES

Part I. SSIGL 1: Project Initiation, Planning and Organization

Part II: SSIGL 2: Site Identification and Prioritization

Part III: Feasibility Study and Detail Design

SSIGL 3: Hydrology and Water Resources Planning

SSIGL 4: Topographic and Irrigation Infrastructures Surveying

SSIGL 5: Soil Survey and Land Suitability Evaluation

SSIGL 6: Geology and Engineering Geology Study

SSIGL 7: Groundwater Study and Design

SSIGL 8: Irrigation Agronomy and Agricultural Development Plan

SSIGL 9: Socio-economy and Community Participation

SSIGL 10: Diversion Weir Study and Design

SSIGL 11: Free River Side Intake Study and Design

SSIGL 12: Small Embankment Dam Study and Design

SSIGL 13: Irrigation Pump Facilities Study and Design

SSIGL 14: Spring Development Study and Design

SSIGL 15: Surface Irrigation System Planning and Design

SSIGL 16: Canals Related Structures Design

SSIGL 17: Sprinkler Irrigation System Study and Design

SSIGL 18: Drip Irrigation System Study and Design

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SSIGL 20: Quantity Surveying

SSIGL 21: Selected Application Software's

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SSIGL 24: Technical Specifications Preparation

SSIGL 25: Environmental & Social Impact Assessment

SSIGL 26: Financial and Economic Analysis

Part IV: Contract Administration & Construction Management

SSIGL 27: Contract Administration

SSIGL 28: Construction Supervision

SSIGL 29: Construction of Irrigation Infrastructures

Part V: SSI Scheme Operation, Maintenance and Management

SSIGL 30: Scheme Operation, Maintenance and Management

SSIGL 31: A Procedural Guideline for Small Scale Irrigation Schemes Revitalization

SSIGL 32: Monitoring and Evaluation

Ancillary Tools for National Guidelines of Small Scale Irrigation Development

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ACRONYMS

ADP	Agricultural Development Plan
AGP – FCU	Agricultural Growth program- Federal Coordination Unit
AGP II	Agriculture Growth Program 2
BOQ	Bill of Quantity
CD	Capacity Development
CWR	Crop Water Requirements
DA	Development Agent
DAI	Diagnostics Assessment of Infrastructure
DAIA	Diagnostics Assessment of Irrigated Agriculture
DASIE	Diagnostic Assessment of Social Institutional and Environment
DASOE	Diagnostics Assessment of Social Organizational and Environment
DFI	Detail Field Investigation
DIIA	Detail investigation of Irrigated Agriculture
DSL	Dead Storage Level
FAO	Food and Agriculture organization (United Nation)
FSL	Full Supply Level
FTC	Farmers Training Center
GIRDC	Generation Integrated Rural Development Consultant
GL	Guideline
GOV	Government
GOV	Government
GPS	Global Positioning System
IMT	Irrigation Management Transfer
IWMI	International Water Management Institutes
IWUA	Irrigation Water User Association
MoALR	Ministry of Agriculture and Livestock Resources
MOWIE	Ministry of Water, Irrigation and Electricity
MXL	Maximum Level
NGO	None Government Organization
O & M	Operation and Maintenance
O&M	Operation and Maintenance
ODA	Overseas Development Administration of the United Kingdom
OFWM	On farm Water Management
PIDM	Participatory Irrigation Development and Management
PISRM	Participatory Irrigation Scheme Revitalization and Management
SSI	Small Scale Irrigation
SSID	Small Scale Irrigation Development
SSIGL	Small Scale Irrigation Guideline
SSIP	Small Scale Irrigation Project
SSIS	Small Scale Irrigation Scheme

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

Strategic direction 1 of the Ethiopia Small Scale Irrigation Capacity Development (Oct, 2011) Strategy deals with improving the existing irrigation schemes and developing new irrigation infrastructures. One of the action steps under this strategic direction is to upgrade and rehabilitate existing small-scale irrigation schemes for their optimum performance. This strategic direction highly realizes the importance of rehabilitating, improving, upgrading and revitalizing of the existing irrigation schemes besides the new SSI development.

In Ethiopia, small-scale irrigation schemes are mainly smallholder projects that are entirely managed by the farmers/IWUAs. It is acknowledged that a considerable number of the SSI schemes are either underperforming or have been inactive for many years. Several causes can be mentioned such as, infrastructure deficiencies emanating from inappropriate planning, design or poor quality construction; poor operational and management structures, both beneficiaries and government assigned extension officers lacking technical know-how and ability leading to inadequate maintenance; lack of ownership and involvement and participation of farmers; poor irrigation water management, inadequate institutional structures to support operation and maintenance (O&M), agronomic technology and/or support services; dependency syndrome, etc.

As a result, despite the considerable investments for development of a large number of SSI Schemes, a considerable number of these schemes are being run far below the planned capacity. This is due to poor management and/or malfunctioning of some of the scheme components, lack of proper maintenance and rehabilitation procedures and practices. Even, some do not live up to the expected economic life. This is the main reason to have a well-structured revitalization guideline.

The Key findings are; lack of standards, design parameters applicable to Ethiopian situation, and guidelines contributing to inadequate study and design of SSI schemes. MoALR – SSID has prepared National SSI guidelines covering various aspects of SSI study and design. It is expected that these guidelines will become acceptable standards for the study and design of all SSI schemes. These National SSI guidelines are expected to provide practical and applicable procedures and parameters not only for new SSI schemes but also for the revitalization of existing SSI schemes.

However, a standard procedural guideline for the revitalization and improvement of existing SSI schemes is lacking. SSID and SMIS have agreed to support the development of a standard procedural guideline for revitalization and improvement of existing SSI schemes.

This revitalization GL address the three mutually interlinked systems: the physical, irrigated agricultural, and Environmental, Organizational and Socio-economic system. The procedural guideline provides a simple and practical roadmap for the revitalization of SSI. The GL outline the procedures for planning, diagnostic assessment, detail investigation and correcting measures. It covers the hardware and software processes in each of the four systems that will lead to a comprehensive revitalization of SSI schemes in an economically viable manner.

In this accord, IWUA led revitalization process of SSI schemes is introduced. Hence, Participatory Irrigation Scheme Revitalization and Management (PISRM) GL, similar to Participatory Irrigation Development Approach (PIDM) is developed.

2 OBJECTIVE

The objective of the procedural guideline is to provide a procedure for revitalization of SSI schemes in order to maximize water use efficiency and in turn productivity of SSI schemes. The secondary aim is to curtail the financial burden of their operation and maintenance costs through proper participations of IWUAs. The guideline is also expected to provide a decision-support system for decision-makers to evaluate the potential for long-term sustainability and economic viability of the proposed revitalization in order to make a decision of a scheme.

3 SCOPE

This guideline is limited to only in addressing major repair, improvement, expansion and rehabilitation of SSI in the context of the revitalization. The GL only discourses critical and common procedures for investigation, diagnostics, and implementation. The details of each activity like study, design, and construction are addressed in the SSI National GLs; where necessary the GLs are quoted to be referred in each activity. Preventive maintenance of SSI is addressed in the SSI NGL 30 – Operation, Maintenance, and Management of SSI.

4 DEFINITIONS

Repair, maintenance, rehabilitation, upgrading, and revitalization are defined differently in different countries. In this document, repair, definitions given by different country and donors are listed below.

- **Repair:** It means major maintenance, fixing damage or deterioration of headwork and irrigation structure that is beyond the beneficiary capacity.
- **Rehabilitation:** It includes engineering- centered re-construction of dilapidated infrastructure and is focused primarily on securing the water supply and the irrigation distribution system. It mainly involves the rebuilding/restoration of non-functional/damaged structures of existing SSI projects to regain the services as per prior design.
- **Expansion/Extension***:* It includes expanding the command area through redesigning for the provision of additional structures such as improvement of heads works, an extension of canal networks, night storage, etc. on existing SSI subprojects.
- **Upgrading /Improvement***:* According to FAO consultation on modernization (Bangkok 1996), Irrigation modernization is a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes combined with institutional reforms, with the objective to improve resource utilization (labour, water, economic, environmental) and water delivery service to farms. Upgrading is something that improves the performance or quality of something else, or something that has better performance or qualities for example replacing surface irrigation with pressurized system.
  - In this guideline, it is tailored that upgrading/Improvement is redesigning or design changes and constructing and/or installing of irrigation facilities. It is to upgrade traditional irrigation schemes with modern technologies like traditional head works with masonry/concrete, earthen canals with lined or pipe, surface irrigation with pressurized system and so on. In general, it improves efficiency, operation, and management of existing SSI project.
- **“Revitalization”:** – According to the Republic of South Africa Agriculture, Forestry and Fishery (2012), it encompasses a broad range of concepts alongside the repair and design of existing infrastructure and includes engagement with the organizational and social dynamics of water apportionment, the agricultural production system, human capital development and empowerment, finances, business strategy development and marketing.

For ease of reference, the term “Revitalization of SSI schemes” in this GL, considered to include all the above definitions.

5 PARTICIPATORY IRRIGATION SCHEME REVITALIZATION AND MANAGEMENT (PISRM) PROCEDURE

The full SSI revitalization development and management should follow the following PISRM procedure, and it explains revitalization procedural from Step1-7, 9, 10 &13. The rest of the steps are addressed in the PIDM guideline.

Table 5-1: PISRM steps

PISRM Steps		Main Planned Activities
Step 1	Initiation, Application and Registration for SSI Scheme Revitalization	• Application submitted for SSI scheme revitalization & registered
Step 2	Planning	• Initial Investigation, prioritization, Diagnostics, Detail Investigation, Implementation, CD
Step 3	Initial Investigation	• Preparation of preliminary IWUA membership list based on prepared landholders' list • Formation of Irrigation Water Users' Association (IWUAs), if do not exist • Focus group meetings with beneficiary/IWUA and/or different interest groups • Problem Analysis tree • walk-through inspection
Step 4	Diagnostics Assessment	• Diagnostic Assessment of infrastructure, • Diagnostic Assessment of agriculture, • Diagnostic Assessment of Social, Institutional & Environment aspects of SSI scheme • Prioritization of the above sub component • Validation by IWUA planning committee

Step 5	Detail Investigation and Corrective Measures	• Detail investigation of SSI Physical Structures
		  ○ hydrology,
		  ○ Geo technics
		  ○ Hydraulics and Structure function
		  ○ Topography survey
		• Detail investigation of Irrigated Agriculture
		• Detail investigation of command area soil (if recommended by step 4)
		• Detail investigation of Social, Institutional and Environment
		• Corrective measures will be done as per SSI NGLs

Step 6	Preparation, submission and Approval of Rectifying Design, ADP, SWCP	• Rectifying design, specification & Drawings • Unit rate, BOQ and Cost estimation • Tender document preparation • ADP (Ref PIDM step 8 and template) • SWCP (Ref PIDM step10 and template) • Participatory validation
Step 7	Preparation and Signing of Scheme revitalization	• Preparation of Scheme Revitalization Agreement modalities based on problems identified and approved study and design • Signing of Scheme revitalization agreement
Step 8	Land Acquisition and Allocation (in case of expansion)	• Raising awareness of land and water rights of scheme affected women (including female headed households and married women) and men farmers • Allocation of irrigable plots of land to male and female farmers in accordance with Proclamation No. 456/2005 – Rural Land Administration and Land Use and legislation enacted by the

PISRM Steps		Main Planned Activities
		regional states, preferably through the issue land use right certificates with the husband and wife names (actual allocation of irrigable plots of land could be carried out once all civil works are completed)
Step 9	Tender and Execution of Construction Works	• Tendering of the execution of civil works • Handover site to the contractor • Participatory construction monitoring/supervision and quality control by Woreda Engineer/IWUA committee • Joint final inspection of completed civil works • A test run of irrigation system during one irrigation season • Final handing over to IWUA
Step 10	Capacity Development	• Capacity development of IWUA, including the preparation of IWUA Bylaws as well as registration of male and female farmers as IWUA members • Execution of Constitutive General Assembly Meeting to adopt IWUA Bylaws and elect of Management Committee members • Tailored training according to the identified problem • ADP and SWCP
Step 11	Preparation and Signing of IMT Agreement	• Inventory of all as-built irrigation, drainage, associated infrastructure and OFWM of the scheme • Preparation, review, approval, and signing of IMT Agreement • Transfer of drawings and technical documents to IWUA
Step 12	Implementation of Agriculture Development Plan	• Capacity development in ADP implementation • Execution of Agriculture Development Plan by all concerned stakeholders, including IWUA
Step 13	Implementation of Soil and Water Conservation Plan	• Capacity development in S&WP implementation • Execution of Soil and Water Conservation Plan by all concerned stakeholders, including IWUA

5.1 INITIATION

The initiation of revitalization can be bottom-up or top to bottom or hybrid approach. Beneficiary communities can request the revitalization of scheme or government/NGO bodies can trigger the revitalization of the scheme. Once it is initiated, it should come to the formal planning process of the implementing body. The initiation should be followed by a formal application of beneficiaries to the nearby irrigation development responsible body. Use Appendix I, application format.

Box 1: Summary and Deliverables of Initiation

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Agricultural, Water and Other concerned Office
- GOV/NGO

Staff to be involved:

- Region/Zone staff
- Woreda staff
- Irrigation Technicians / DAs
- Any Concerned body, organization, individuals…

Duration: One week

Main Activities:

- Preparation of SSI Revitalization Application
- Submission of SSI Revitalization Application
- Registration of submitted SSI Revitalization Application
- Review of Registered SSI Revitalization Application

Deliverable:

- Application
- Registration

5.2 PRIORITIZATION AND RANKING FOR PLANNING

If there are more than one application of revitalization request, woreda offices can use the following prioritization and ranking indicators (Table 5- 2) with rating listed in the bracket.

Table 5-2: Prioritization and ranking of application for planning

S. No	Prioritization indicators	First priority	Second priority	Third priority	Rate
1	Area reduction (%)	100 %	>60	<60	10 (rate proportionally from 1-10)
2	Irrigation Water supply reduction (%)	>60	40-60	<40	10 rate proportionally from 1-10)
3	Yield reduction of the scheme (%)	>60	40-60	<40	10 (rate proportionally from 1-10)
4	Position of the irrigation scheme in the community livelihood	Significant (40)	Medium(25)	Less(10)	40
5	Recurrence of rainfed production failure	High (10)	Medium (6)	Low (3)	10
6	Main Structure failure/damage	H. work, Main Canal	Main Canal (Branched), secondary, cross drainage	Tertiary, cross drainage on	10

S. No	Prioritization indicators	First priority	Second priority	Third priority	Rate
		(Conveyance part) (10)	(Flume & others) located at critical position , critical farm structures that covers significant command area (6)	territories and less area coverage, other farm structures (3)	
7	Community interest	High (10)	Medium (6)	Low (3)	10

5.3 PLANNING

The planning of the revitalization consists of the application, registration, investigation, diagnostics, and implementation stages. The planning starts once the application by the beneficiaries is submitted. The planning procedure should indicate details of activities, schedule, logistics, finance, and person power (from region, zone and woreda according to the regional context) required for the revitalization study, design and implementation.

Table 5-3: Activity, person power and duration planning

Activities	Professionals required	Minimum recommended (field and Office work) time
Initiation	DA and Others	One Week
Initial Investigation	Engineer, Agronomist, Socio Economist, Environment, Community/ IWUA	One Week
Diagnostics Assessment	AS required based on Initial investigation	Two weeks
Detail Investigation	AS required based on diagnostics assessment	4-6 weeks

5.4 INITIAL INVESTIGATION

At this stage, the initial investigation should be conducted with different techniques involving the beneficiaries. The following techniques can be implied; Public consultation, Group discussion, Problem Tree Analysis and Walk through and Inspection methods. Each of the technique requires knowledge and skill of experts. A multi-disciplinary team should be set up and the experts should make themselves ready for this assignment. Use Appendix II

Box 2: Summary and deliverables of Initial Investigation

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women Sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone staff – Irrigation Engineer, Agronomist, Sociologist/Socio economist, Environmentalist
- DAs

Duration: One weeks

Main Activities:

- Public Consultation
- Focus Group Discussion
- Walkthrough Inspection
- Problem tree analysis
- Initial/Preliminary Assessment of Infrastructure, Agricultural, social and Environmental aspect
- Prioritization of sub components
- Validation the findings by IWUA/ Beneficiaries

Deliverables

- Initial/Preliminary Assessment Report
- IWUA/ Beneficiaries validation minute

The scheme investigation can be started after conducting the following simple clinical checkup.

Main quantitati ve indicators for the "irrigation scheme"

$$\text{Relative irrigation supply: } \frac{\text{Irrigation supply}}{\text{Irrigation demand}}$$

$$\text{Cropping intensity: } \frac{\text{Annual cropped area (ha)}}{\text{Size of command area (ha)}}$$

- If the relative Irrigation Supply is <1, it means there is a shortage of water.
- If the relative Irrigation Supply is >1, it means there is excess/waste of water. it should be investigated what impact will be faced on the scheme.
- If the Cropping intensity is < 1, it should be investigated why the designed area is not covered.

5.4.1 Focus group discussion

This Focus Group discussion should be done with less than 20 persons (preferably 10-12 persons). The objective of this group discussion is to brainstorm on the problem of the SSI scheme. During the focus group discussion;

- Ensure that the beneficiaries from Head, Middle and Tail reaches of the command area are represented
- Make sure Female in the male household and female households are represented
- Make sure elders & youth groups are represented
- If you think women are not free to talk among the male, facilitate independent focus Group for them.
- Make sure participants are free to talk with other group members.
- Select appropriate non-working day and time for farmers

Focus group discussion requires preparation; the preparation should consider proper:

- Discussion point preparation
- participant selection,
- timing,
- venue,
- media of discussion

Hint:

- ✓ The principal objective(s) of the session should focus on the cause of the scheme failure, its consequences and way forward.
- ✓ Carefully develop three to five questions that will lead to the cause, the consequence, and the solution.
- ✓ Exploit information from the group dialogue. Use "What, why, when, who, where & how" questions
- ✓ Make proper notes and write down all salient observations made during the session

5.4.2 Walkthrough and essential structures inspection

The objective of this activity is to verify the focus group and problem tree findings and to identify defined and significant problems of the scheme. This should be done by physical observation of the whole scheme; the abstraction and canal system, field structures and the proximity watershed. Use Appendix-VII.

The walkthrough is a systematic approach to observe the abstraction, the main, secondary, and tertiary canals breach, silt up, and deformation. The direction of the walkthrough should be from head to tail. During this activity, observation can be made on essential structures such as Headwork, Flume, and others physical failure and functionality. Parallel to this, command area coverage, irrigated agronomic practice, social, institutional and environmental aspect can be observed, by asking, listening, and looking.

The walkthrough team member number should be manageable. The walkthrough should be done with key fe/male informants from the head, middle and tail of the scheme, IWUA committee executive representatives, Kebele administration, DAs, irrigation technicians, and important stakeholders. The walkthrough should be done with the help of checklist (Appendix VII). Materials required for this activity:

- Notebook
- Pen
- Measuring tape
- Hand GPS
- Camera
- System layout (if allowable)

Note: During this investigation, appropriate clothing and shoes are important

5.4.3 Problem tree analysis

The problem tree analysis is one participatory tool of mapping out major problems, along with their causes and effects, to revitalize the project. This approach helps:

- To break down the problems into manageable and definable portions.
- It gives a better understanding of the problem and its often interconnected and even contradictory causes.
- It identifies the constituent issues and arguments and can help establish who and what stakeholders and processes are at each stage
- It can help to establish whether further information, evidence or resources are required to make a strong case, or build a convincing solution
- Present issues - rather than apparent, future or past issues - are dealt with and identified
- The process of analysis often helps to build a shared sense of understanding, purpose, and action

There are three stages in this analytic process:

1. The identification of the negative aspects of an existing situation with their “causes and effects” in a problem tree,
2. The inversion of the problems into objectives leading to an objective tree, and
3. The decision of the scope of the project in an analysis of strategies.

The value of this type of assessment is great if it is carried out in a meeting/ workshop with the project beneficiary, giving the opportunity to establish a shared view of the situation.

5.4.4 Deliverable

After the focus group discussion, problem tree analysis and walkthrough, full report that describes the scheme condition, findings and the risk level including schematic map should be prepared. The schematic map should indicate the headwork, the canal system (lined & unlined, rectangular & trapezoidal remarks should be clearly written on the sketch), division and off taking structures, crossings, and other structures in the scheme. In addition, it should indicate the natural boundary and the drainage system. The report should be discussed with beneficiaries and nearby administrative organization. The IWUA should approve the report with a minute of the IWUA main committee.

Once the report is approved, it should be sent to the concerned irrigation development sector for the next level of investigation.

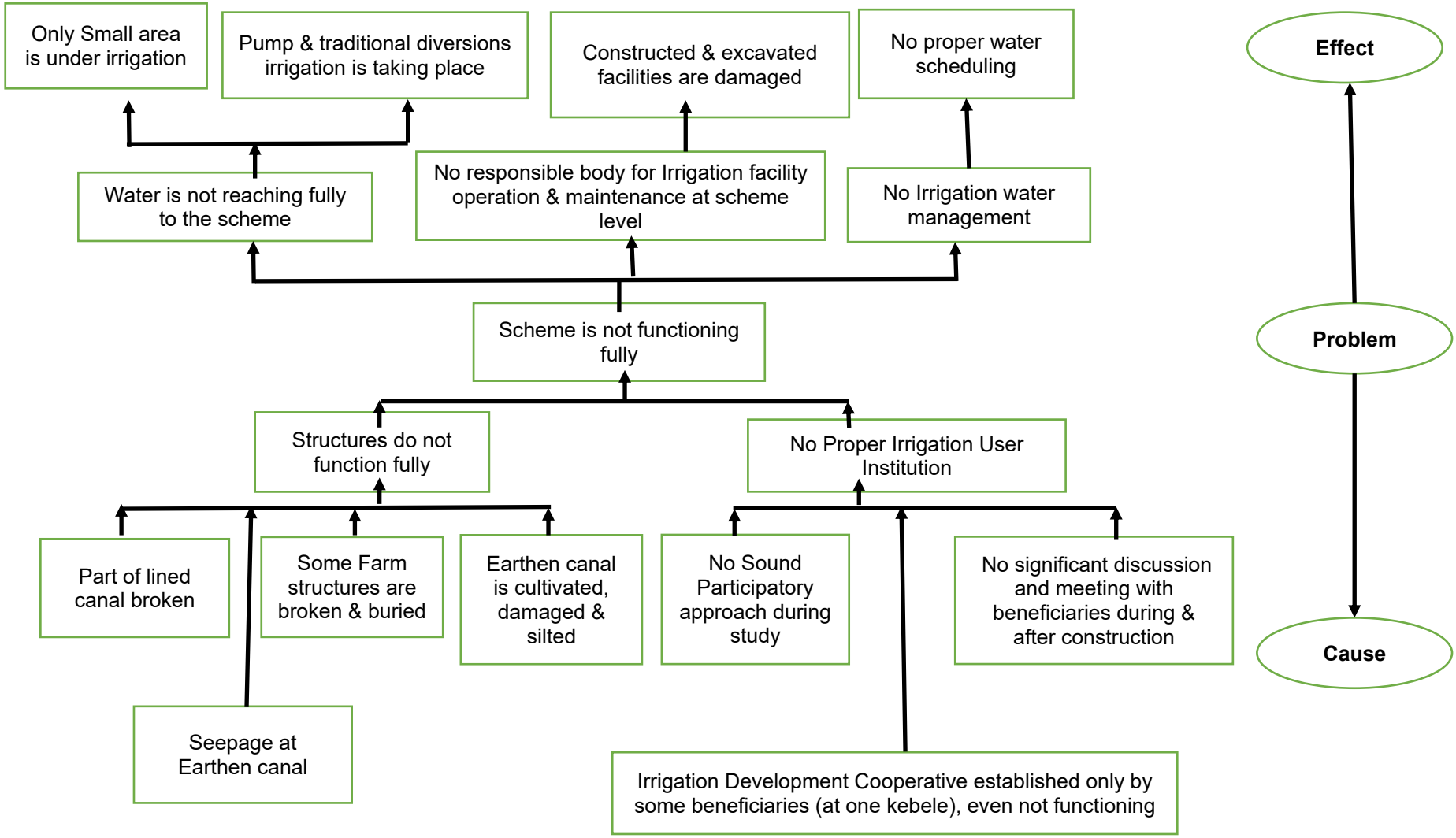

Figure 5-1: Example of Problem Tree – Melkahidda, Oromiya

5.5 DIAGNOSTIC ASSESSMENT

At this stage, scheme that is selected to go through diagnostic assessment will be assessed based on the tools explained under this section. Some of the indicators of underperformance, which may be cited as evidence of a need for revitalization, are termed “perceived defects” as indicated in Figure 5-2. Perceived defects may be due to a number of linked causes, as indicated below. “Primary causes” are set out below the perceived defects in the chart. They have been grouped into the following broad categories: agricultural, economic, design, operation, system deterioration, land degradation and headwork supply. A large number of possible alternative or complementary, underlying causes are also shown in the chart as the primary causes. The chart also depicts the main diagnostic tools which are part of this section. Based on the chart and experience diagnostics tools are customized and prepared for the Ethiopian condition.

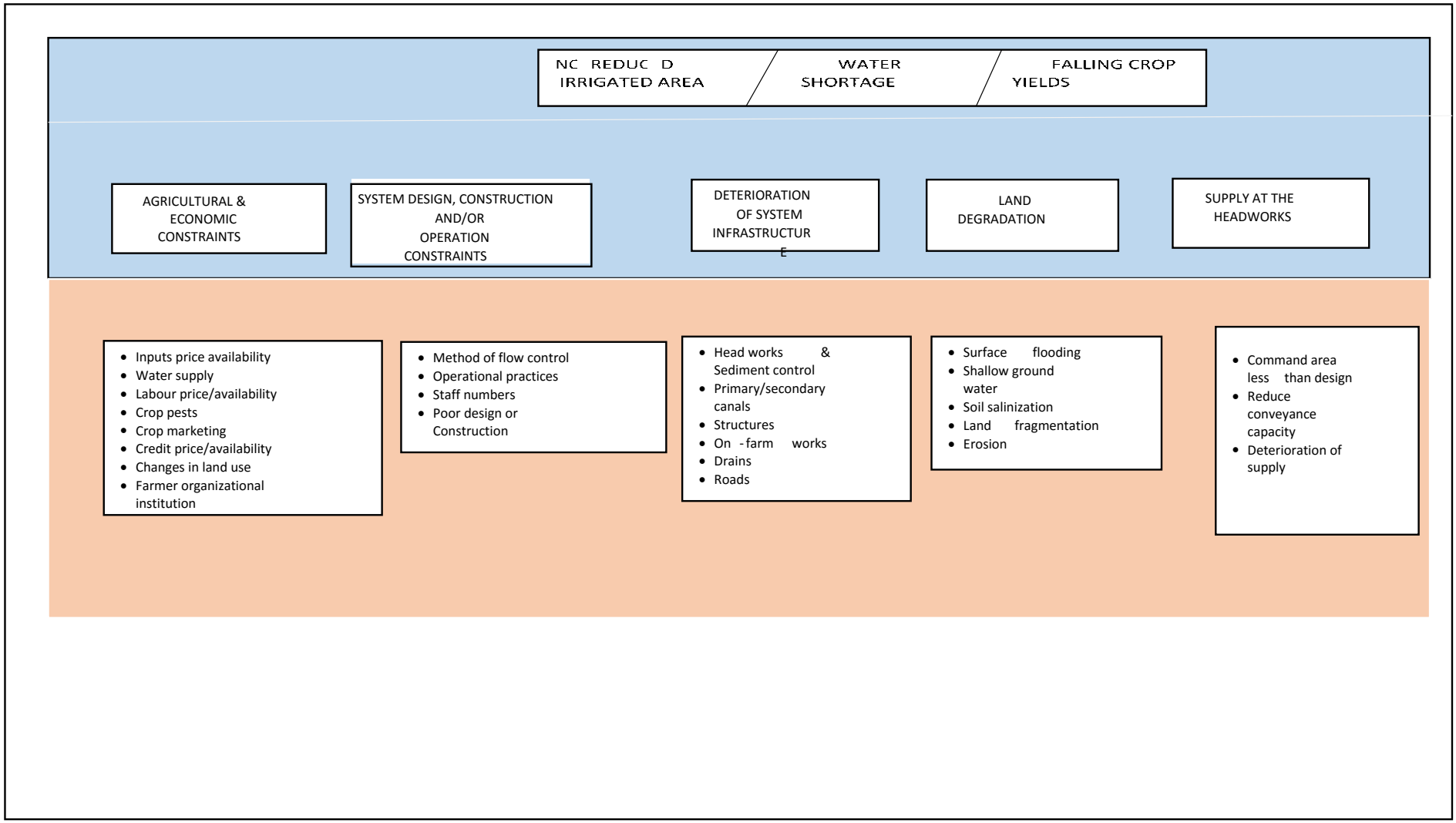

Figure 5-2: Adapted from Performance diagnostics method ODA/HR walling ford, 1997

5.5.1 Diagnostics Assessment of Infrastructure (DAI)

This section describes procedures for determining the condition of irrigation infrastructure, in terms of hydraulic effectiveness and structural soundness. Hydraulic effectiveness is the capacity of the structure to serve the intended purpose as it was designed: discharge, velocity, slope, and other characteristics. Below in Table-4 hydraulics functionality of major structures are displayed. In DAI principal important structures like Dam, Diversion weirs, Barrages and Ponds require formal inspection with senior experts. Use Appendix VIII up to Appendix -XVI

Box 3: Summary Diagnostics Assessment of Infrastructure (DAI)

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Irrigation Engineer, Hydrologist, Surveyor, Geologist,
- DAs

Duration: 4-6 weeks

Main Activities:

- Diagnostics of each structure hydraulically and structurally
- Diagnostics Surveying work

Deliverables

- Diagnostic Report
- IWUA approval minute

Table 5-4: Hydraulic and structural functionality indicators

No	Structure	Hydraulic effectiveness	Structural soundness
1	Dam		
1.1	Reservoir	The capacity of storage decreased/ increased	Stability of the reservoir rim, silt up
1.2	Spillway	Capacity	Physical failure, obstacles,
1.3	Inlet/outlet	Capacity	Movability, silt up, breakage, jamming, bend/bulging, buckling,
1.4	Dam body	Water levels (FSL, MXL, DSL)	Stability, leakage, settlement
2	Diversion weir/ Barrages		
2.1	Intake	Capacity, Intake level	Physical failure, obstacles, movability, silt up, breakage, bend/bulging, buckling, jamming
2.2	Under sluice	Capacity, position, level, leakage	Physical failure, obstacles, movability, silt up, breakage, bend/bulging, buckling, jamming
3	Irrigation & Drainage Canal	Capacity, slope, free board, velocity	Breach, obstacles, shape, silt up, embankment stability, Berm & slope,
4	Division Box/Off take/ turnout	Capacity, flow proportionality, level, free	Physical failure, obstacle, silt up, gate

No	Structure	Hydraulic effectiveness	Structural soundness
		board,	
5	Cross drainage structures/ Flume/siphon	Capacity, slope, level, head	Physical failure, obstacle, silt up, clogging, manhole,
6	Night storage/ Pond		
6.1	Reservoir/Embankment/ cut	Capacity, Level – MXL, FSL, DSL	Stability, leakage, slope, silt up
6.2	In let	Capacity, Level	Gate functionality, obstacles, physical failure, bend/bulging, buckling, jamming
6.3	Out let	Capacity, Level	Gate functionality, obstacles, physical failure, silt up, bend/bulging, buckling, jamming
6.4	Spill way	Capacity, Level	Obstacles, physical failure, silt up
7	Access road	Drainage ditch Capacity, slope, level	Dimensions, martials, settlement, breakage
8	Social Structures like washing basins and cattle trough	Capacity, Level	Physical damage, obstacle, slope
9	Pump	Head, discharge, efficiency, power, capacity…	Leakage, noise, vibration, smoke, others
10	Generator	Power, efficiency	Leakage, noise, vibration, smoke, others

Use Appendix III

During the assessment, the following rating can be used at the initial investigation level.

- **Good** – When the structure is to a minor fault. No significant structural deterioration or loss of hydraulic function.
- **Fair** – when the structure is with partial loss of function and/or some risk to the soundness of the structure. Action not immediately urgent.
- **Poor** - when the structure is with serious loss of function and/or potentially serious threat to structural soundness. Action needs to be taken to prevent progressive failure.
- **Very poor** - Total failure.

Based on the importance of functionality, relative complexity and cost of the structure, for the sake of revitalization this GL classified the structure as listed in Table-5 below: The concept of the classification to guide to identify which structures are more critical in respect to the scheme functionality.

Table 5-5: Degree/level of impact of structures failure in the scheme

Less Critical	Moderate	Critical	Highly critical
Measurement structures	Canal reaches	Cross drainage	Diversion weir
	Drain	Aqueduct	Embankment dam
	Offtakes/ turnouts	Syphon	Barrage
	Cross regulators	Conveyance (including any structures on it)	Intakes
	Drops/chute		
	Farm roads		
	Escapes/ road crossing		

Appendix III can be used during field Diagnostics of the schemes.

Table 5-6: Head Work/ Canal/Structure diagnostics (example - Melka Hidda SSI diagnostics)

S/No	Structure	Location			Assessment Result (Good, Fair, Poor, V. Poor)		Level of Negative impact on the scheme (High, medium, low)	Remark	Advice Measures
		Chainage	Northing	Easting	Hydraulics	Structural			
1	Head Work-Weir	0+00	871497	223632	Poor	Poor	High		Needs boulder at d/s of the weir, gate maintenance.
2	End of the intake pipe canal	0+025	871502	223640	Good	Good	Low		
3	Lined canal beginning & Bend	0+025	871520	223642	Good	Good	Low		
5	Lined canal	0+050	871522	223660	poor	Poor	Medium		Silt removal
6	Lined canal	0+110–0+165	871520	223683	Fair	V. Poor			Reconstruction
8	Lined canal	0+185	871507	223790	Fair	V. Poor			Silt removal & XXXXXx
9	End of the Lined canal	0+200	871507	223830	Fair	Fair			Silt removal
12	Offtake_1		871443	224024	Good	Good			
13	Earthen Canal		871441	224037	poor	Fair	high		Silt removal & shaping
14	Earthen Canal		871445	224075	poor	Fair			Silt removal & shaping
15	Division Box_1		871445	224076	Good	Good	medium		
16	Drop at Mc chute		871431	224125	Good	Good			
18	End of chute		871414	224179	Good	Good			
19	Aqueduct inlet -1		871403	224205	Good	Good			
20	Aqueduct outlet- 1		871388	224220	Good	Good			

Use Appendix IV

Figure 5-3: Examples of non-functional structures

5.5.2 Diagnostics Assessment of Irrigated Agriculture (DAIA)

DAIA is the assessment of the irrigated land and its irrigated agronomy practice. It encompasses the current irrigated coverage compared to the designed, crop diversity, irrigation water management, erosion, salinity, irrigation methods, irrigated agronomy practice, crop health, weed, pest and controlling system. At this level, the following performance indicator can be used:

Table 5-7: Diagnostic assessment indicator for Irrigated agriculture

S. No	Indicator	Description
1	Land Coverage	Actual vs designed
2	Crop Pattern	Type of crops, forage, position, area, crop rotation, crop selection (existing Vs designed)
3	Crop calendar	Planting & harvesting date, length of growing period
4	Water Sufficiency	Water in the stream canal and at field level
5	Irrigation method	Type, quality, layout, furrow stream size, basin or flood volume, emitters discharge
6	Irrigation hour (schedule)	Time, duration, day or night, actual Vs proposed
7	Livestock	Cattle trough, forage, controlled grazing, cut and carry
8	Pest, disease, weed (Crop protection)	Identifying insect pest that occurred at Major crops and control methods (IPM, chemical & biological measures, prevention methods)
9	Soil	Type (texture), erosion, salinity, nutrient, water logging, acidity ,soil depth)
10	Production	Crop per ha for each crop
11	Extension service	Input suppliers, technical advice, Capacity development
12	Irrigation efficiency	Application ,conveyance ,distribution and over all eff

S. No	Indicator	Description
13	Agro ecology	Climatic data (effective rain fall, max and min temperature, wind speed humidity and radiation)
14	Agricultural research center and supporting services	Adoption crop varieties, linage with farmers , demonstration major irrigated crops in FTC and farmers field with d/f aspects agronomic activities (spacing, insect pets control ,fertilizer appellation rate, time, types)
15	Agronomic practices and input utilization	agronomic practices ,agricultural input use (Fertilizers rate ,supply and distribution with on time ,improved seed)

Use Appendix V

Box 4: Summary Diagnostics Assessment of Irrigated Agriculture (DAIA)

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Agronomist, Plant Protection, Pedologist, Gender expert
- DAs

Duration: 2-3 weeks

Main Activities:

- Physical diagnoses of Soil
- Field level diagnostics of Irrigated agronomy practice

Deliverables

- Soil diagnostics report
- Irrigated Agronomy Diagnostics Report

5.5.3 Diagnostics Assessment of social, Organization and Environment (DASOE)

DASOE is an identification of social, organizational and environmental limitation of the scheme within the scope of the scheme non-functionality. The social assessment includes but not limited to extension services & providers, crop market, credit, land use, institutions like IWUA and others, input suppliers, land reallocation and good governance of the scheme. Social service structures in the scheme, crossings, displacement, resettlement, and other related issues should be diagnosed at this stage.

Whereas the environmental assessment deals with water balance along the water source, land degradation, flooding, waterlogging, salinity, eco-system service flow and agro-chemical effects. In the case of dam land submergence, displacement and movement should be diagnosed. The following check list leads the Diagnostic assessment of DASOE:

Table 5-8: Diagnostics assessment check list for DASOE

S. No	Thematic	Indictors	Description
1	Environment	Water use right	U/s- D/ S, head-middle-tail equity, eco system service release
2		Water loss	leakage, overtopping, water logging,
3		Soil	Erosion, salinity, nutrient, silt
4		Chemical/fertilizer	The amount, the application method, the residual effect
5		Social	Crossings, inundation, washing basin, water points, cattle trough, access road, canal cover- slab, compensations
6	Social & Economic	equity	Land redistribution, land holding, water related conflicts, extension services, Water allocation gender – women participation & empowerment,
7		Market	proximity, capacity, labour availability & price, economic, social & financial benefit, accessibility, storage and transport, market linkage, market information
8		Gender	Women (FIMHH, FHH) participation, decision making position, water allocation,
9		Extension & Credit services	input availability and supply, credit facility, technical advice
10		Economic benefits	Productivity, income generation, employment opportunity (women, youth), technology adoption, crop diversity, (description)
11	Organization	GoV/NGO/ public	Irrigation sectors, DAs, input suppliers, the credit facility
		IWUA	Different committee & sub committee, bylaw existence & enforcement, fee collection, operation & maintenance , Banking account, registration, auditing, regular operation & maintenance, capacity building conducted, Meetings held and minutes of meeting recorded accordingly

Use Appendix VI

Box 5: Summary Diagnostics Assessment of social, Organization and Environment (DASOE)

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Socio economist/ Sociologist, Market, Environmentalist, Gender expert
- DAs

Duration: 2 weeks

Main Activities:

- Institutional, scheme, and market assessment
- Environmental observation
- IWUA monitoring
- Gender Analysis

Deliverables

- Diagnostics report
- Environmental observation report
- IWUA M&E report

5.5.4 Prioritization of sub components

After the above mentioned assessments are conducted, prioritizing sub components (infrastructure, agronomy, social, environmental) based on the degree of their influence on the scheme performance should be done. This can lead the revitalization to focus on the sub component with a high degree of impact. The degree of impact can be rated as Very high, High, Medium, and Low in table 10. Table 9 helps in rating the degree of impact.

Table 5-9: Sub Component rating Guide

Sub Components	Very high	High	Medium	Low
Infrastructure	If Structures under highly critical are failed	If Structures under critical are failed	If Structures under moderate are failed	If Structures under less critical are failed
Irrigated agriculture	Significant yield /ha reduction (>50%)	Significant yield /ha reduction (>35%)	Significant yield /ha reduction (25%)	Significant yield /ha reduction (>15%)
Social and Economic*	No significant return (IRR & NPV) < B/C ratio < no community interest	No Women participation No land redistribution	No Market service No Credit facility	No technology adoption
Organization & Institutional *	No IWUA	Weak IWUA (absence Fee collection, by law) No credit facility and input suppliers	Weak IWUA (no sub committee, Women participation) No Credit facility	Weak IWUA (NO regular meeting) NO near by market service
Environment*	If no d/s flow released, Salinity & acidity development significant erosion	Some d/s release, if no equitable distribution among head, middle & tail equity Chemical effect	fertilizer effect Significant water loss	Social structures

Table 5-10: Prioritization table

No	Sub components	Degree of Impact
1	Diagnostics of Infrastructure	
2	Diagnostics Assessment of Irrigated Agriculture (DAIA)	
3	Diagnostics Assessment of social, Organization and Environment (DASOE)	
Note: The prioritization should be done as a team composed of all disciplines		

5.5.5 Validation by IWUA planning committee

The initial Assessment findings should be discussed with IWUA and consensus should be reached before passing to the next stage. It should be done in minutes.

5.6 DETAIL INVESTIGATION AND CORRECTIVE MEASURES

5.6.1 Detail investigation and design of physical SSI infrastructure

Based on the Initial Diagnostics Assessment Detail Filed Investigation (DFI) of prioritized sub components should be conducted. When it is about infrastructure component Hydrology, Geology, hydraulics and structure investigations, surveying, rectifying design, BOQ & tendering can take place.

Box 6: Detailed Investigation of infrastructure

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Irrigation Engineer, Hydrologist, Surveyor, Geologist, Environmentalist, Sociologist, Gender expert
- DAs

Duration: 4-6 weeks

Main Activities:

- Detail field investigation of selected thematic (hydrology, geology, hydraulics, structures)
- Surveying work
- Rectifying design
- Rectifying design validation by IWUA

Deliverables

- Rectifying design
- IWUA approval minute for Rectifying design

5.6.1.1 Detail field investigation of hydrology

The hydrological investigation should indicate whether structures are failed/damaged due to flood (if there are failed structures) and/or command area is increased /reduced due to flow change. In addition, if there is any impact on the river morphology and sediment characteristics.

Before further investigation is taking place, the hydrology section of the feasibility study report should be reviewed and compared to the current hydro-meteorological conditions of the stream like flow, rainfall and climate /weather condition and catchment characteristics i.e. changes in land use, land cover, rainfall intensity, abstraction. After this analysis, the linkage between the diagnosed problem and the likely cause of malfunction should be established.

After completing the supplementary hydrological analysis, it should be summarized and presented to the revitalization responsible engineer.

In case of structural failure/damage and surrounding inundation, investigate the following:

- Catchment characteristics – size, stream length, slope, land use/cover, soil type
- Climate data and source (station)
- Flood mark
- The inundated area before and after obstruction in the stream and after
- Climate change
- Reservoirs u/s or d/s condition before and after the construction of the project
- River morphology

In case of dry flow change

- Catchment characteristics – size, stream length, slope, land use/cover, soil type
- Climate data and source (station),
- Climate change
- Reservoirs u/s or d/s condition before and after the project
- Upstream abstraction/ release

In case of the sediment load

- Catchment characteristics – size, stream length, slope, land use/cover, soil type
- Climate data and source (station),
- Flood mark
- The inundated area before and after obstruction in the stream and after
- Climate change
- Reservoirs u/s or d/s condition before and after the project
- River morphology
- Sediment quantification approach

Once it is decided to conduct the detail study and design of the hydrology upon the result of the detail investigation, the hydrology study should focus on problem prone area, as indicated below in table 5-11.

Table 5-11: Hydrology study indicators

No	Investigation Result	Detail study and design to be conducted
1	Diversion headwork failure, over topping,	Re-estimation of the design flood, flood height
2	Dam- reservoir filling	Re-estimation of yield, sedimentation,
3	Dam- Overtopping	Re-estimation of flood, flood routing
4	Cross drainage structures failure,	Flood estimation, flood level, transported material
5	Under/over development, expansion (area)	Dry time (lean, base) flow, evapotranspiration

The detailed analysis of the hydrology study can be done in accordance with the National Guideline, GL3- Hydrology and Water Resource Planning.

5.6.1.2 Detail investigation of geo-technical

This investigation should be conducted based on structural failure that might be caused by the settlement, ground water, scouring, piping, foundation material, river morphology, construction material.

As stated above for others, before further investigation is taking place, the geo-technics section of the feasibility study report should be reviewed and compared to the current geological conditions

of the scheme. After this analysis, the linkage between the diagnosed problem and the likely cause of malfunction should be established. In absence of geotechnical study report full geotechnical study should be conducted"

Geotechnical investigations for the revitalization of existing dams, diversions, and other structures should consider the structural failure and its degree. For major revitalization listed below, the geotechnical evaluations should essentially focus on the root cause of the failure:

- repairing breached irrigation structures,
- increasing the height of a dam,
- permanently raising the normal pool elevation of the reservoir,
- repairing embankment slides,
- modifying excessively steep slopes,
- Constructing control structures for extensive uncontrolled seepage & piping beneath the foundation and inlet outlet conduits.

As described above in the detail investigation of the geo-technical part, the recommendation should focus on the significant existing and potential problem prone areas. At this stage, the geologist should recommend a practical solution for structural failures due to geological reasons.

Table 5-12: Geo-technical study indicators

No	Investigation Result	Detail study and design to be conducted
1	Settlement, piping, structure failure	Re-assessment of the foundation material, recommendation and construction quality
2	Canal Seepage	Geological investigation along the canal and recommendation
3	Back water or free board reduction	Siltation, Rock workability (excavation) to attain the required slope and recommendation
4	Structure crack	Construction material, ground water, foundation material investigation and recommendation

For detail approach of the geo-technic study, refer to the National SSI guideline – Geology and Engineering Geology Study FGL, GL6.

5.6.1.3 Detail investigation of hydraulics and structural functionality

In this guideline, Hydraulics and structural functionality are related to flow and the physical conditions at headwork, canals, and structures. The detail related to each structure is tabulated below in Table 5-13:

The current conditions of the scheme should be reviewed and compared to the hydraulics and a structural section of the feasibility study report before further investigation is taking place.

Table 5-13: Hydraulic and structural investigation indictors

Structure	Hydraulics Characteristics	Structural Characteristics
Dam	• Spill way – Design Flood and Velocity, hydraulic jump length and depth, discharge channel, energy dissipater, approach channel, exist channel, water depth, control structure level & width & capacity, cut-off, scour depth, • Reservoir – Capacity, MXL, FSL, DSL, • Dam Body & foundation – Seepage,	• Spill way – crack, physical failure, blockage, breaching, scouring, • Reservoir – seepage, silt up, • Dam Body- cracking, sliding, piping • Outlet- crack, blockage,

Structure	Hydraulics Characteristics	Structural Characteristics
	• Outlet – level & capacity	breaching
Diversion weir/ Barrage/Intake	Design Flood depth and Velocity, hydraulic jump length and depth, apron length, tail water depth, back water effect, creep length, weir (height, width & length) intake level & capacity, u/s & D/S HFL, wing height, under sluice capacity, cut-off, scour depth, exit gradient,	Physical failure, crack, scouring, blockage, gate malfunctioning,
Canal/ Chute	Capacity, velocity, depth, slope, free board, bed width, berm (width and slope), embankment height- width- slope- seepage, silt	Breaching, silt up, deformation, weed, blockage, crack, burrow
Cross drainage/ Aqueduct/Flume/	Capacity, velocity, depth, slope, free board, bed width, transition, flood level & discharge- water way, scour depth, protection length, working head, pipe diameter,	Breaching, silt up, collapse, weed, blockage, crack, scour, physical failure,
D. Box, Off take, Turn out	Capacity, depth, free board, bed width, transition, gate size, protection (pitching) length, working head, pipe diameter,	Breaching, silt up, weed, blockage, crack, scour, physical failure,
Drop	Capacity, depth, free board, width, transition, (pitching) length, drop and sill height	Breaching, silt up, weed, blockage, crack, scour, physical failure,
Pump irrigation	Water level, Capacity, Cross-section and depth of suction and delivery pool, pressure line size and length, pump seat level, level of approach channel	Breaching, silt up, weed, blockage, crack, scour, physical failure,
Social Structures like washing basins and cattle trough	Capacity, Level	Physical damage, obstacle, slope

For detail approach of Hydraulic and structural investigation, refer to the National SSIGL-6.

5.6.1.4 Topographic survey of the command area and selected priority works

In revitalization, surveying work can be considered for problem investigation occurred due to level and route errors. In addition, it can be used in the rectification process.
The following indicators may lead to identifying the surveying problem:

- If canals are not supplying water to whole or partial part of the command area
- The canal is not conveying water with allowable velocity and back water/ overtopping is appearing
- Structures are buried/elevated
- If sufficient amount of water is not entering to the canal

If the scheme has no topographic map, it should be produced as a part of the revitalization. The revitalization topography should indicate all the structures, water dividing/distributing structures, crossings, and other natural features related to the scheme. Indicating benchmarks with visible nodes is very crucial. The hard and soft copy of the topography map should be availed to woreda office and IWUA.

5.6.1.5 Rectifying design

After going through the above detail investigation and proposed correction measures, rectifying design in accordance with the corresponding National Guideline should be prepared. All the required data for design should be collected in tailored mode. The input data for each specific structure like discharge, elevation, area, and others should stick to the National SSI GL. In addition to the topography survey, the scheme should consist profile of canals, detail drawings and quantities of the structures.

Table 5-14: Drawing indicators

S. No	Drawings	Main items to be indicated on the drawing
1	Topography	Head work, BM, system layout, natural features
2	Head work	Topo, plan, sections, details of the head work components
3	Intake	Levels, height & widths, material specification
4	Canals	Plan, sections, profile, dimensions, discharge, original ground level, water level, free board, full supply level, embankment level, berm height-width-slope, shape, material
5	Drainage and canal related Structures	Plan, sections, levels, dimensions, designed discharge

5.6.1.6 Demolishing study

Demolishing study is about the understanding of the structure to be demolished; the volume of the structure, the construction materials, the construction methods, environmental impact, reuse, and disposal. At this stage, the location of the structures to be demolished, the distances from villages, roads, and significant landmarks should be clearly identified.

Demolishing complex structures sometimes need a plan showing the procedure for the demolition; detailed sequence of demolishing structural members; and the method of demolition to be adopted. This plan should indicate all precautionary measures for the protection of the public and time required for the complete demolition and dumping.

5.6.1.7 Unit Rates, Bill of Quantity, Specification and Cost Estimation of Engineering Components

Once all the rectifying detail study and design of affected structures are completed their specification, drawings, bill of quantities unit rates should be done in detail. In the BOQ, demolishing works and their estimated prices should be discoursed in detail. Demolishing works require their own specialized equipment and safety materials. Sometimes this will make the cost of the revitalization more expensive than new construction. For detail methodology, refer the National Guideline for SSI GL-24.

After the completion of these activities tender should be prepared according to the scope and cost ceiling. Please refer National Guideline SSI GL 23.

5.6.2 Detail Investigation of Irrigated Agriculture (DIIA)

Box 7: detailed Investigation irrigated agriculture

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Irrigation Engineer, Agronomist, Plant Protection, Pedologist Environmentalist, Gender expert
- DAs

Duration: 2-3 weeks

Main Activities:

- Detail field investigation (Soil)
- Study, primary and secondary data collection work
- ADP & Corrective Measure preparation
- ADP validation by IWUA

Deliverables

- ADP & Corrective measures
- IWUA approval minute for ADP

Schemes may face less land coverage, poor quality product, less production, and even may found abandoned. At this stage, the DIIA should identify the root cause of the scheme in terms of Irrigated agronomy to revitalize it. The DIIA of the revitalization should address properly the following investigated results.

Table 5-15: Irrigated Agriculture investigation Main indicators

No	Investigation Result	Detail study and design to be conducted
1	Less land coverage compared to the design	Water availability & reliability, Soil, OFWM, salinity, water logging, CWR, agronomy practice, cropping pattern, crop election, crop rotation, Crop pest-diseases- weeds, irrigation methods, inputs availability
2	Less Quality and Productivity	Crop pattern, Crop selection, seedling, Crop pest-diseases- weeds control measures, irrigation method(s), Soil, fertilization, crop/plant population-density, CWR- OFWM, agronomy practice, input, postharvest
3	Illegal expansion	Water availability & reliability, Soil, Slope, land use, OFWM, CWR, agronomy practice, cropping calendar, irrigation methods, deficit irrigation, drainage

The following indicators should be used where data are available or estimated.

Output per Irrigated cropped area for each crop (qu/ha)	$= Production / Actual\ Irrigated\ Crop\ area$
Output per Designed command area for each crop (qu/ha)	$= Production / Designed\ Command\ area$
Output per unit irrigation supply (qu/m3)	$= Production / Diverted\ water\ at\ headwork$
Output per unit water consumed (qu/m3)	$= Production / availed\ water\ at\ field\ level$

Table 5-16: Description of Irrigated Agriculture main indicators

S. No	General indicators	Description
1	Soil (physical and Chemical properties)	Field capacity, Wilting point, Bulk density, texture, Erosion
		Salinity/ Acidity
		Fertility
		Nutrient
2	Cropping Pattern	Place/ position/ location
		Area/size
		Soil
		Water availability
		The market for Harvesting time
		Crop rotation
		Planting date
		Length of growing period
		Harvesting time
		Critical/ sensitive CW demand/ period
3	CWR-OFWM	Availability of Volume of Gross water required
		Availability of Volume of Gross water required at each growing stage
		Flow management – stream size, timing
		Irrigation method (furrow, basin, border, sprinkler, drip)
		Irrigation frequency
		Irrigation depth (amount)
4	Seedling	Seed (type, application rate/amount, timing) bed type
		Density, spacing
		Treatment
		Soil treatment
		Transplanting techniques
		Watering/irrigation
5	Input	Type
		Seed
		availability
		Fertilizer (Type, application rate/amount, timing)
		Chemicals (type, application rate/amount, timing)
		Application
6	Crop population	Amount/ha
		Spacing b/n crops
		Space b/n rows
7	Crop pest-diseases-weeds control measures	Prevention
		Chemical
		Biological
		Hand & mechanical weeding
8	Harvest/Post harvest	Sign/symptoms
		Timing
		Methods
		Transporting
		Storage
		Storage treatment
		Market

The DIIA report should be comprehensive; it should encompass the detail indicators listed above in table 5-15 & 5-16.

5.6.2.1 ADP and corrective measure preparation

After detail investigations, primary and secondary data collection proper corrective measure should be proposed based on the study. The corrective measures should indicate the root cause of each identified problem and the way forward. New or revised general indicative ADP should be prepared. The ADP should indicate specific corrective measures, recommended crops and management, recommended water management, tailored soil management, and related activities. All the corrective measures and the new or modified ADP should follow the National Guideline procedures and elements.

The ADP should have cost estimation, schedules, evaluation & monitoring indicators, and seasonal ADP template.

5.6.3 Detail Diagnostics Assessment of Social, Institutional, and Environment (DASIE)

Environmental, institutional, social and economic constraints play a greater role in reducing scheme output, even some time leading schemes to abandon. At this level, the DASIE should critically identify the root cause of the scheme for proper revitalization plan. The scheme may abandon or reduce their output due to social conflict, institutional and market problem, IWUA weakness, gender inequality, land redistribution and allocation challenges and environment related problems.

Box 8: detailed investigation social, organization & environment

Target Group:

- Existing and/or potential Fe/Male Beneficiaries
- Existing IWUA – Irrigation Women sub Committee
- Kebele Administration
- Woreda Office

Staff to be involved:

- Woreda/ Zone/Region staff – Irrigation Engineer, Socio economist/ Sociologist, Market, Environmentalist, Gender expert
- DAs

Duration: 2-3 weeks

Main Activities:

- Institutional, scheme, and market assessment
- Study, primary and secondary data collection work including exact beneficiary identification
- Environmental Audit
- Existing IWUA monitoring & evaluation
- Establishing/ strengthening IWUA in case of upgrading and expansion
- Gender Analysis
- Financial and Economic Analysis
- Comparison before and after revitalization (Cost vs benefit)
- Impacts:- Affected land, crops, households, settlement and other properties, displacement, compensation issues, water use conflict

Deliverables

- Assessment report & Corrective measures
- Environmental Audit report
- IWUA strengthen and CD plan

Table 5-17: Main Indicators for DASIE

No	Investigation Result	Detail study and design to be conducted
1	Less land coverage compared to the design	Land redistribution, water allocation problem, land holding size, water right of way (canal conveyance), market, health, input, IWUA, gender, conflict, watershed
2	Less Quality and Productivity	Input, capacity, water allocation, market
3	Illegal expansion	Water right, market, landholding & redistribution

The following indicators assist the DASE investigation;

Table 5-18: Detailed description for main indicators of DASIE

S.No	Main Indicator	Description
1	Scheme Assessment	Functionality
		Land redistribution
		Landholding size
		Water- right of way
2	Market	Labour availability
		Labour Price
		Infrastructure (storage and transport)
		Proximity
		Accessibility,
		Capacity
		Market linkage,
		Market information,
		Economic, social & financial benefit
3	Institution	Social Service
		Public infrastructure (like health, water supply, schools…..)
		Input suppliers, credit institutions, Extension services, DAs
4	IWUA	Number of project beneficiaries (Male, Female)
		Main Management Committee, Other Committee
		Sub-Committee
		By law – (existence & Enforcement)
		Fee Collection & Management
		Water Allocation
		Operation & Maintenance
		banking system,
		registration, auditing, regular operation & maintenance,
		capacity building conducted,
		Meetings held and minutes of meeting taken accordingly
5	Gender	Women participation and empowerment
		Women in IWUA decision Committee
		Women subcommittee in IWUA
		Extension service
		Water allocation & timing
6	Economic Benefits	Productivity,
		Income generation,
		Employment opportunity (women, youth),
		Technology adoption,
		Crop diversity,
		Cropping intensity
7	Negative impacts	Affected land, crops, households, settlement, other properties,

S.No	Main Indicator	Description
		displacement, compensation issues
8	Safe Guard & Environment	U/S- D/S water allocation including ecosystem service
		Culture/heritage impact
		Health
		Environmental Audit
		New Environmental Impact
		Displacement/ resettlement
		Climate change
9	Watershed	Degradation
		Base flow due to degradation
		flood
		Silt

5.7 SUMMARY

After all, the detailed investigations are done and designs are completed, the following indicators may help for decision making. The result indicated under value column leads to decision for revitalization.

Table 5-19: Decision support tool

Aspect	Unit	Value
Agricultural		
Areal coverage	Actual command Vs Design	< 50%
Cropping Intensity (consider only irrigation including supplementary)	Annual total cropped area Vs design	Low land - < 150%
		Middle land < 100%
Yield (crop type)	Crop(s)output per ha	< 25% decrease from norm
Hydraulic		
Conveyance and distribution efficiency	Canal and structures efficiency	< 50 %
System level release	Area irrigated per unit of water	(>11000m3/ha for head cabbage, tomato > 14000m3/ha, Onion > 12000m3/ha, potato 16000m3/ha, pepper 14000m3/ha) or an average – 13000m3/ha for furrow)
Economic and Financial		
Development	Invested Cost to develop the scheme per hectare Vs currently under Irrigation area	>50%
Economic & Financial	Financial and economic cost benefit analysis result (NPV, IRR, B/C ratio)	Ethiopian NPV & IRR indicator, B/C to ration >1

5.8 IMPLEMENTATION

5.8.1 Construction

The construction part of revitalization can be done either by hiring or by own force account, depending on the significance, complexity, and size of the work. The scale of the work in terms of value, time and volume determine the construction modality. The following points may give hint:

1. By Contractors; if the damage is a significant and substantial expansion is to be addressed with new structures
2. Own Force account; GoV or NGOs can handle if revitalization construction is not complicated and can be handle with the requirement of Forman, mason and other locally available semi-skilled labour. By providing construction materials
3. IWUA; if the damage is very small and can be handled by local labour, material or small investment.

The construction of any revitalization project has two main steps

1. Demolishing of the existing and
2. Reconstruction or new construction

By its nature, revitalization construction demands considerable caution. The construction period is advised to be during idle time as much as possible unless the scheme is at zero functioning level. This will help to mobilize and demobilize construction equipment, material, and labour easily. If it is done during irrigation season alternative method of irrigation water supply should be designed for existing irrigation.

5.8.1.1 Demolishing of existing structures and reconstruction

Demolition is the destruction, breaking down or removal of existing structures. Demolition of irrigation structures is the process of dismantling or destroying of a structure due to malfunctioning, partial functioning or after its life of serviceability by pre-planned and controlled methods. Some times, demolishing may use implosion. The demolishing procedures for existing structures differ based on the size, complexity, and type of construction material used. Some structures may need construction machinery for demolishing like Bull Dozers or excavators. For construction outsourcing refers GL-27 and GL-28 and for detail construction works refer GL-29.

Different steps are involved in the process of demolition of irrigation structures, which are:

I. Study
II. Removal of demolished Materials
III. Safety measures

5.8.1.2 Demolishing study

This study is discussed under 5.6.1.6.

5.8.1.3 Removal of demolished Materials

The demolished materials may vary in volume and type. Some of the demolished materials can be re-used or can be sold with salvage value. During removal, the materials should be kept or disposed of based on the material type. Sometimes, specialized personals are called for the removal of some of the material that may need dis-assembling like a gate, iron bars, sheet metals, pipes and others.

5.8.2 Repair procedure for concrete, masonry, and plastering

5.8.2.1 Reinforced concrete/ mass concrete

As a first step to increase the likelihood of a successful concrete repair, it is paramount to use a consistent, systematic approach to concrete repair. Concrete repair and maintenance system consists of seven basic steps:

1. Determine the cause(s) of damage
2. Evaluate the extent of the damage
3. Evaluate the need to repair
4. Select the repair method and material
5. Prepare the existing concrete for repair
6. Apply the repair method
7. Cure the repair properly

The need for repairs can vary from minor imperfections, such as she bolt holes, snap tie holes, or normal weathering, to major damage resulting from chemical or physical deterioration, water energy, or structural failure. Although the procedures described for repairs may initially appear to be unnecessarily detailed, experience has shown that no step in a repair operation can be omitted or carelessly performed without detriment to the serviceability of the entire repair.

I. Workmanship

Inadequate workmanship, procedures, or materials will result in inferior repairs, which will likely fail prematurely. Workmanship and skill of the craftsperson are of paramount importance for a successful concrete repair, especially because most repair procedures involve predominantly manual operations.

Repair personnel is responsible for making repairs that are durable, ideally crack-free, and, when appropriate, well bonded to existing surfaces. It is particularly important that key personnel be fully instructed concerning procedural details of repairing concrete and the reasons for the procedures. Masons should also be informed of the more critical aspects of repairing concrete. The proper inspection must be performed to ensure compliance with required quality of workmanship.

II. Procedure

Good concrete repairs result only if proper methods are chosen and techniques are carefully performed. Wrong or ineffective repair or construction procedures, coupled with poor workmanship, lead to poor quality repairs. The following procedure helps for good concrete repairs:

1. Usually, the first step in preparing the old concrete for repair is to saw cut the perimeter of the repair area to a minimum depth of 3-5 cm or more if possible below the damaged depth, and 15-20cm diameter outskirt.
2. All deteriorated or damaged concrete must be removed from the repair area to provide sound concrete for bonding of the repair material. No repair material will be an effective long term when placed on damaged or deteriorated concrete.

Reinforcing steel exposed during concrete removal requires special treatment. In general, if more than one-third of the circumference of the steel is exposed, the concrete should be completely excavated from around the steel. In other cases, it is best to completely expose the reinforcing

steel if any of it is exposed during concrete removal. For concrete repairs that may be subjected to unusual loads, it may be appropriate to excavate around reinforcing steel, even if the damage is shallow. The depth of excavation under reinforcing steel should be at least equal to the nominal maximum size aggregate of the repair material plus 1cm deep, whichever is greater.

- If the steel is corroded, it should be completely exposed, and all the surrounding concrete should be removed. The bars should be exposed to the point where the concrete is well bonded to the steel, and the steel is not affected by corrosion.
- The cause of the corrosion should be determined. If the corrosion is a result of chloride contamination, all concrete with water soluble chloride content higher than about 0.15 percent to 1.00 percent, by mass, of cementitious materials should be removed, depending on service conditions.
- If contaminated concrete is not removed, there is a good chance that corrosion of the steel near the intersection of the new and old concrete will accelerate, which is commonly called the “halo” or “ring” effect.

3. When the reinforcing steel is exposed, all loose scale, rust, and concrete must be removed by wire brushing or high-pressure water or sand blasting. It is not necessary to clean the steel to white metal condition; just remove all the loose or poorly bonded debris that would affect the bond between the repair material and the reinforcing steel.
4. After concrete removal and preparation of the reinforcing steel are completed, primary cleaning must be performed. Remove any other materials that will weaken the bond between the remaining concrete and the repair material. Include saw cut or ground faces in this step.
5. Prepare and place concrete batch according to the recommendation. The concrete contains cement, water, aggregate, and sand. As much as possible, the concrete cement should be of the same type used in the concrete being repaired. The water and sand should be suitable for use in concrete, and the sand should pass the require sieve no. The cement to sand ratio should be between 1:2:3 by volume, depending on the application technique. Only enough water should be added to the cement-sand-aggregate mixture to permit placing, which is usually a thick, creamy consistency if it is placed by hand.
6. Sometimes the cracks over mass concrete and/or masonry structures will come from due to the exertion of tensile forces by different factors which are applied on the structure. In this case, you should not forget to substitute the old mass concrete and/or masonry structures by re-in forced concrete.
7. Before placing the concrete batch on the surface, it needs to moisten the cleaned surface of remaining concrete by water and thin mix of cement with water which is sometimes known as “Behaka”. This mix should simply flow over the surface of the remaining concrete for repair by its own flowing velocity. This should be done immediately after the concrete batch is prepared and before is placed over the remaining old concrete. No need of allowing the “Behaka” to set/cure on the old concrete surface before the concrete batch is placed. Immediately after the “Behaka” is placed put the concrete batch according to the recommendation.
8. All of the standard repair materials require proper curing procedures. Some systems require extensive water curing, others require water curing followed by drying, and some systems require protection with no water exposure until they are hardened. Curing is usually the final step of the repair process, followed only by cleanup and demobilization. Curing is the process of removing the air in the micro pockets/pore spaces in the surface of structures. This curing is very critical part of any new/repair constructions in which every technical professionals even should not give sufficient attention. The failure of original structure that needs our repair work now may be most likely because of this proper curing problem. More likely, inadequate or improper curing will result in the need to remove and replace the repairs. The costs of the original repair are completely lost, and

the costs of the replacement repair will be greater because the replacement repairs will be larger and must include the cost of removing the failed repair material.

9. Sometimes in small scale irrigation/hydraulic structures construction or repair, we should not forget to apply dry mix of concrete in places where continuous flow/seepage which is difficult to make dry the surface exists.

5.8.2.2 Masonry

The cracking and failure of masonry walls result when quality standards, serviceability requirements unsatisfactorily comply or due to emergency or intentional accidents occurred. The selection of repair strategies is conditioned by the type of defect, its causes and the features that are intended to be improved (stability, structural, and water-tightness, or others). There are two main strategies to reconstruct masonry walls; they can be used alternatively or combined:

1. The single defect with a specific technique (example - local crack sealing or tying, controlled demolition and reconstruction, reinforcement of corner angles, one or limited stone course failure-high stress areas, etc.); −
2. An extended and multi-purpose repairing technique (example - global tying and bed joint reinforcement, full or partial failure, etc.).

Choosing one or both of these strategies depends on several factors:

- The number and spatial distribution of the defects in the wall;
- The diversity of defects observed; − the existence of a multi-purpose repairing technique, for the multiplicity of defects, compatible with the construction of the masonry, its coating, and finishing solution.

The most frequent groups of defects are cracking, water penetration, ageing, local degradation and partial failure. The structural stability is only affected in a few cases of cracking but, when it happens, it is the most important factor concerning the repairing strategy and the repairing techniques. For all the defects not having structural consequences, there are several approaches that can be taken together to obtain a more durable versus economic solution:

- suppression of the defect,
- replacement of the affected materials,
- concealing or hiding of the defects,
- protection against aggressive agents,
- elimination of causes and
- Upgrading of specific features.

Soft techniques, such as repairing coatings and finishing - like thin reinforced mortar layers, elastic and water-tight paints coats – are used when the main defects affect all of the walls but only its external surface (cracking, humidity, ageing, etc.). They are often used as a supplementary corrective action after the local repairing of cracks using wall ties, embedded steel bars, anchors, etc. Considering structural walls, the selected repairing techniques must re-establish the continuity that allows the correct (and, if possible, the original) transmission of compressive, tensile, shear and flexural forces, without exceeding masonry strength and avoiding local stress concentration under the expected loads and imposed deformation, although an upgrading of strength cannot be neglected if the actions responsible for the previous failure are not reduced and will remain effective. In these situations, the repairing strategy should involve other construction components related to the masonry walls, such as slabs, beams, and columns.

Reconstruction/repair method

Deciding how the reconstruction or repair should be done depends on the cause of the problem and its implications. A well monitored inspection is required to stabilize the problem. Having confirmed the stabilization, three repair methods can be chosen, as summarized below. In addition to these, any reconstruction or repair works one should think always that the skill and workmanship of mason who build the masonry structures should be given attention.

Table 5-20: Repair methods of masonry

Method	Applicability	Observations
Raking and Re-pointing	Usually applied to cracks localized in the mortar joints. Effective for small leakage and cosmetic reasons only. Requires a skilled mason and correct specification of a compatible mortar.	Difficulty to completely fill the joint. Long term shrinkage of fresh mortar can cause cracking to re-appear at the same interface. The use of a polymer modified cement mortar can allow better penetration and bonding characteristics. Special care should be taken with facing stone masonry, in order to preserve aesthetics.
Re-construction of Selected Areas.	Usually applied to restore structural integrity, including demolition and re-building of the damaged area. Also requires skilled mason and the correct specification of materials.	Difficult to guarantee a bond between new and old masonry unless a control joint is provided. The use of a new reinforced coating, when possible, is recommendable
Resin injection	Usually applied to cracks in masonry units and to mortar joints. Requires specialized equipment and personnel.	Epoxy infection, despite the extra cost compared with conventional methods, provides mostly full penetration and effective bond. The resin must have the compatible stiffness to the repaired material, to avoid local stress concentrations under future movements. The exposed resin must be resilient.

5.8.3 Cement mortar plaster repair

Cement plaster is a building facing material consisting of cement and sand, mixed with water to form a workable mixture. Plaster is applied either by hand or machine to the exterior and interior wall surfaces in two or three coats. It may be applied directly to a solid base, such as masonry or concrete walls, or it can be applied to metal lath attached to frame construction, masonry, or concrete construction. Applied directly to concrete or masonry, plaster provides a tough, 13-mm thick facing that is integrally bonded to the substrate. The first coat is often referred to as the scratch coat, the second is the brown coat, and the third is the finish coat. cement plaster has many qualities that make it a desirable facing material, including hardness, fire resistance, and attractive appearance. Plaster has proved to be a durable wall covering in all climates and has great appeal as a surface finish because of its utility, low first cost, and need for minimal maintenance. But like all building materials, plaster deteriorates with age and exposure to the elements. Although cement plaster provides a hard, durable cladding, it is not intended to resist building movements, such as those from settlement or the expansion of frame members as a result of moisture intrusion.

Causes of Plaster Damage Cement Mortar plaster can deteriorate for a variety of reasons, including inadequate design details, poor installation, or the use of improper materials. In many cases, damage results from water infiltration into the structure either through cracks, through the overtopping, and inundation. Water that gets behind the plaster can cause wood lath to rot and metal lath and nails to rust, and can cause plaster to delaminate from the substrate. Cracking in plaster is usually shrinkage-related or the result of external loads, such as ground settlement or inadequate stiffness of the backing. Common causes of cracking are improperly placed control joints, improper lath installation, and inadequate curing. Control joints are provided in plaster to

relieve drying shrinkage stresses and to provide stress relief in areas subjected to movement, such as gates.

Identifying damaged plaster

Before beginning any repair, the plaster should be evaluated to determine the extent of damage and how much must be repaired or replaced. Water-damaged plaster and plastering of structurally cracked surface often bulges or falls away from the structures and cracked surface because excessive moisture causes the coats of plaster to delaminate and the metal lath and nails to rust. Unsound or soft areas that have delaminated will make a hollow sound when tapped with a hammer. This information can offer clues as to the expected useful life of the plaster that remains and aid in determining the appropriate scope of the repair project

I. Plaster removal

Plaster that has delaminated from the base, but is otherwise sound, may require a saw or diamond grinder to be removed. Soft or crumbled plaster can usually be removed with a chisel or other hand tool. If the plaster is properly keyed into the lath, the lath may have to be cut as well. In these cases, sound plaster at the patch perimeter will have to be removed to make room for lapping the new and existing lath.

II. Surface preparation

Masonry or concrete substrates usually require preparation to ensure that the plaster establishes a strong bond. These surfaces should be sandblasted or mechanically abraded to remove contaminants and roughen the surface to maximize the bonding area of the new plaster. However, don't rake out masonry mortar joints to provide a "key." Doing so will create plaster of varying thickness, which can cause cracking. If the masonry or concrete is dry, dampen the surface to prevent it from absorbing an excessive amount of water from the plaster. The prepared substrate should be at, or slightly drier than, a saturated surface dry condition.

III. Patch application

The same techniques used to apply plaster in new construction are used in repair and are outlined in National SSID GL. Apply the scratch coat at the same thickness as the surrounding scratch coat and with enough pressure to completely embed the metal lath (when present). As soon as the scratch coat becomes firm, score the surface in one direction only. Vertical wall surfaces should be scored horizontally. After allowing the scratch coat (first coat) to cure for at least 24 hours, apply the brown (second) coat at the same thickness as the existing brown (third) coat. Follow the same rules for applying the finish coat.

IV. Curing patches

Proper curing of patches is essential to avoid rapid water loss from the plaster, which can lead to cracking and de-bonding of the patch material from the surrounding plaster. Wind, high temperatures, and exposure to direct sunlight will accelerate water loss from the plaster. Curing procedures should maintain a relative humidity of 80% for at least 24 hours, and up to 7 days in some cases.

5.8.4 Safety measures

Demolishing demands strict safety measures. The demolishing process sometime faces uncontrollable events like downstream flooding, stone-sprint, dust, covered nails and others. Due to this all the workers, site supervisors, and engineers including plant and equipment operators should be briefed on the potential hazards and process of demolitions. They should be provided with safety materials like shoes, clothes, gloves, helmets and so on. First aid kits and the emergency transporting facility should be arranged.

Once the demolition is done successfully, the reconstruction can begin. Please follow the steps explained on the SSI National Guideline Construction operation for reconstruction/new construction.

5.9 CAPACITY DEVELOPMENT

Before revitalization activities are undergoing, capacity development should be done at all level-Regional, zone, Woreda, DA, and IWUA. The CD should focus on the root cause of scheme failure, revitalization activities, operation and management of the scheme and prevention measures.

Each sub component should identify and design tailored CD based on the diagnostics findings and recommended measures.

5.10 COMMISSIONING AND IMT

Once the construction is completed, before it is transferred to the beneficiaries testing and commissioning should be conducted. The testing can be done partially while some part of the revitalization is completed or can be done after the completion of the construction.

The commissioning is very crucial. It gives confidence to the beneficiaries to takeover and also can serve as capacity building. The commissioning may take from one week up to limited months based on the agreement entered into between parties. During the commissioning, the beneficiaries should involve and their comments should be heard and rectifying measures should be taken.

The Irrigation Management Transfer should take place after all the above steps are performed and the consensus is reached. The procedure for the IMT is explained in the PIDM GL.

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1. CIB (2014), Defects in Masonry walls Guidance on Cracking: Identification, Prevention, and Repair, Pub. No. 13
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3. IWMI (2004), Improving small-scale irrigation performance in Ethiopia through on the job training of extension officers: Experience of the APPIA project, Philippe Lempérière, Martin Van der Schans, Addis Ababa
4. MoALR (2018), Small Scale National Guide line, Addis Ababa
5. ODA. (1997), Procedure for planning Irrigation Scheme Rehabilitation, G. Cornish - J. Skutsch, TDR Project R5832, Report OD/TN 84, HR Wallingford
6. PCA, Portland Cement Association (2001), Masonry information, Publication No. IS 526
7. USBR (2015), Guide to concrete repair, 2nd edition, USA

APPENDICES

APPENDIX I: Revitalization Application Format

Date: _____

To: _____
(Address)

1. Subject: Request for Revitalization of XXXXX SSI Scheme
2. Applicant Name (s) (IWUA/WUG): _____
3. Name of the Scheme : _____
4. River Name : _____
5. Beneficiary: _____ (Total HH), _____(FHH), _____(MHH)
6. Type of the scheme : (select one)
   i. D. Weir
   ii. Intake
   iii. Barrage
   iv. Dam
   v. Pump
   vi. Others (specify)_____
7. Area (ha) : T. designed command area ; _____, currently under irrigation _____
8. Constructed year (if Known) _____, Constructed by :_____
9. If there is any document (Please list and attach the copy) :
   i. _____
   ii. _____
10. Main Problem of the scheme (write briefly):
    _____
    _____
    _____
11. Main cause for the dis-functionality of the scheme (in your opinion)
    _____
    _____
12. Explain Reason for application or your request (technical/ finical/ both/ other)
    _____
    _____
13. Submitted by :

	Full Name,	Position	Signature
i.	Mr/s. _____	_____	_____
ii.	Mr/s. _____	_____	_____
iii.	Mr/s. _____	_____	_____

APPENDIX II: Questionnaire for farmer/s

1. **Date: _____**
2. **Scheme Name and Type: _____**
3. **Type of interview:**
   1. Single farmer □ Name: _____
   2. Group of farmers □
4. **Water use : Most irrigation water is taken from:**
   i. Authorized off-take □
   ii. Unauthorized off-take □
   iii. Re-use from drains □
   iv. Wells □

   Notes: _____

5. **Cropping intensity**
   a. Do you regularly leave land un-planted in one season or more per year?
      Yes □ No □

   b. If "Yes", why do you not plant in those seasons?
      i. Lack of water □
      ii. Land is flooded □
      iii. Poor supply of other inputs -labour, seed, fertilizer, pesticides □
      iv. Prefer to spend time in other activities □
      v. High risk of pest attack □
      vi. Other _____
6. **Have you been able to irrigate more land or plant more crops per year in the past?**
   Yes □ No □

   a. If "Yes", what has caused the change:
      i. Lack of water □
      ii. Land is flooded □
      iii. Less land available (land use changed) □
      iv. Poor supply of other inputs - labour, seed, fertilizer, pesticides □
      v. No need/desire to work for another crop □
      vi. Prefer to spend time in other activities □
      vii. Other _____
      viii. Notes: _____
7. **CROPPING - YIELDS**
   a. Do farmers think their yields are normally:

	Good	Average	Poor
i. First Season (month of harvest_____)	□	□	□
ii. Second Season (month of harvest_____)	□	□	□

   iii. If yields are poor then what, in the farmers' opinion, is the cause?
      a. Water supply □
      b. Seed type □
      c. Time of planting □
      d. Soil fertility □
      e. Weeds □
      f. Crop pests □
      g. Drainage □
      h. Other _____

   Notes: _____

8. **Water supply**
   a. Was the rainfall higher in the past? Yes □ No □
   b. Is the irrigation supply normally good, i.e. enough water and a regular supply?

      i. in First Season Yes □ No □

ii. in Second Season Yes □ No □

c. If the supply is not good, do farmers describe the supply as:

	1st season	2nd Season
i. Insufficient all through the season	□	□
ii. Insufficient at times of peak demand (land prep).	□	□
iii. Erratic and unpredictable (unreliable)	□	□

d. If the supply is not good then what, in the farmers' opinion, is the cause?

	1st season	2nd Season
i. Not enough water in the river or reservoir	□	□
ii. Bad control/operation of the main canal system	□	□
iii. Other farmers take too much water	□	□
iv. The condition of the main canal system	□	□
v. Distribution/control of water below the tertiary off-take	□	□

vi. Other _____

Notes: _____

9. Flooding

10. Does flooding around this area ever prevent planting or cause damage to crops? Yes □ No □

a. If "Yes", then:

In which month or months is flooding a problem?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
□	□	□	□	□	□	□	□	□	□	□	□

b. For how long is the land flooded? _____

c. Does flooding prevent cropping or reduce yield:

Every year □ Most years□ Occasionally □

d. Farmers think the cause is: Blocked drains □ No drains □ Other _____ Notes: _____

11. On-farm structures and water distribution

a. Does the off-take from the main system, or the canal and structures below it, cause problems of water supply for any farmers in the block?

Yes □ No□

b. If yes, describe the problem _____

_____

_____

_____

12. Priorities for change

a. What is the most serious problem that limits crop production in:

First Season? _____

_____

_____

Second Season? _____

_____

_____

Notes

Note any unusual and short term constraints influencing production or farmer perceptions at the time of carrying out the interview of farmers

_____

_____

_____

APPENDIX III: Hydraulic and structural functionality indicators Diagnostic Assessment Checklist

No	Structure	Hydraulic effectiveness	Structural soundness
1	Dam		
1.1	Reservoir		
1.2	Spillway		
1.3	Inlet/outlet		
1.4	Dam body		
1.5	Berm		
2	Diversion weir/ Barrages		
2.1	Intake		
2.2	Under sluice		
2.3	Flood height		
2.4	Weir length		
2.5	Jump height		
2.6	Jump length		
2.7	Protection structures		
2.8	Retaining wall		
3	Canal		
3.1	Capacity		
3.2	Water depth		
3.3	Free board		
3.4	Longitudinal slope		
3.5	Side slope(z, s)		
3.6	Embankment		
3.7	Canal bed level		
3.8	Silt *		
3.9	Berm		
4	Division Box/Off take/ turnout		
4.1	Capacity		
4.2	Depth		
4.3	Width		
4.4	length		
4.5	Inlet dimension		
4.6	Outlet dimension		
4.7	Shape		
5	Cross drainage structures/ Flume/siphon		
5.1	Capacity		
5.2	Flood level		
5.3	Width		
5.4	Length		
5.5	Depth		
5.6	Height		
5.7	Slope		
5.8	Diameter		
5.9	Stream /river bed level		
6	Night storage/ Pond		
6.1	Reservoir/Embankment/ cut		
6.2	In let		
6.3	Out let		
6.4	Spill way		
6.5	Capacity		
6.6	Embankment height		
6.7	Free board		
7	Drop		
7.1	Fall height		
7.2	The capacity of the drop inlet		

No	Structure	Hydraulic effectiveness	Structural soundness
7.3	The capacity of the drop outlet		
7.4	Basin length		
7.5	Basin width		
7.6	Basin depth		
8	Pump and Generator (Electro mechanical Parts		
8.1	Pump and its parts		
8.2	Generator and its parts		
8.3	Approach canal		
8.4	Anchorages		
8.5	Valves and fittings		
8.6	Suction and delivery pipe conditions		
8.7	Suction and delivery pool conditions		

*depth increment if more than 30% & capacity decreased by 35%, if manning increment is observed

APPENDIX IV: Diagnostics Template

No	Headwork/ Canal/ Structure	Location (Coordinate/Chainage)			Assessment Result (Good, Fair, Poor, V. Poor)		Level of Negative impact on the scheme (High, medium, low)	Remark	Advice/ Measure
		Chainage	X	Y	Hydraulics	Structure			

APPENDIX V: Diagnostic assessment indicator check list for Irrigated agriculture

S. No	Indicator	Description	Findings
1	Land Coverage	Actual vs designed	
2	Crop Pattern	Type of crops, position, area, crop rotation, crop selection	
3	Crop calendar	Planting & harvesting date, length of growing period	
4	Water Sufficiency	Water in the stream canal and at field level	
5	Irrigation method	Type, quality, layout, furrow stream size, basin or flood volume, emitters discharge	
6	Irrigation hour	Time, duration, day or night	
7	Livestock	Cattle trough, forage, controlled grazing, cut and carry	
8	Pest, disease, weed	IPM, chemical & biological measures, prevention methods	
9	Soil	Type, erosion, salinity, nutrient, water logging	
10	Production	Crop per ha for each crop	
11	Extension service	Input suppliers, technical advice, CD	
	Other		

APPENDIX VI: Diagnostics assessment check list for DASOE

S. No	Thematic	Indictors	Description	Findings
1	Environment	Water right	U/s- D/ S, head-middle-tail equity, eco system service release	
2		Water use	Loss, leakage, overtopping, water logging,	
3		Soil	Erosion, salinity, nutrient, silt	
4		Social	Crossings, inundation, washing basin, water points, cattle trough, access road, canal cover- slab,	
5		Chemical/fertilizer	The amount, the application method, the residual effect	
6	Social & Economic	equity	Land redistribution, irrigated land holding, conflicts, extension services, gender – women participation & empowerment, , Water allocation	
7		Market	proximity, capacity, labour availability & price, accessibility, storage and transport, market linkage, market information	
8		Extension and credit Services	Extension services, input availability, credit facility	
9		Economic benefits	Productivity, income generation, employment opportunity (women, youth), technology adoption, crop diversity	
10		Gender	Women (FIMHH, FHH) participation, decision making position, water allocation,	
11	Organization	GoV/NGO/ public	Irrigation sectors, DAs, input suppliers, the credit facility	
12		IWUA	Different committee & subcommittee, bylaw existence & enforcement, fee collection, regular operation & maintenance, banking system, registration, auditing, , capacity building conducted, Meetings held and minutes of meeting recorded accordingly	
13	Others			

APPENDIX VII: Walkthrough Check list

Date……

I. Scheme Name……..
II. Scheme type……
III. Zone……
IV. Woreda……
V. Kebele……

1. Head Work
   - Water Availability: Available ☐ Not available ☐
     - If available sufficient ☐ Insufficient ☐
   - Intake gate functionality: Functional ☐ Not functional ☐
     - If Functional Fully func. ☐ Semi Func. ☐
   - Silt gate functionality: Functional ☐ Not functional ☐
     - If Functional Fully func. ☐ Semi Func. ☐
   - Is water entering canal: yes ☐ No ☐
     - If entering Fully func. ☐ Semi Func. ☐
   - Downstream release: yes ☐ No ☐
   - List broken/ damaged components

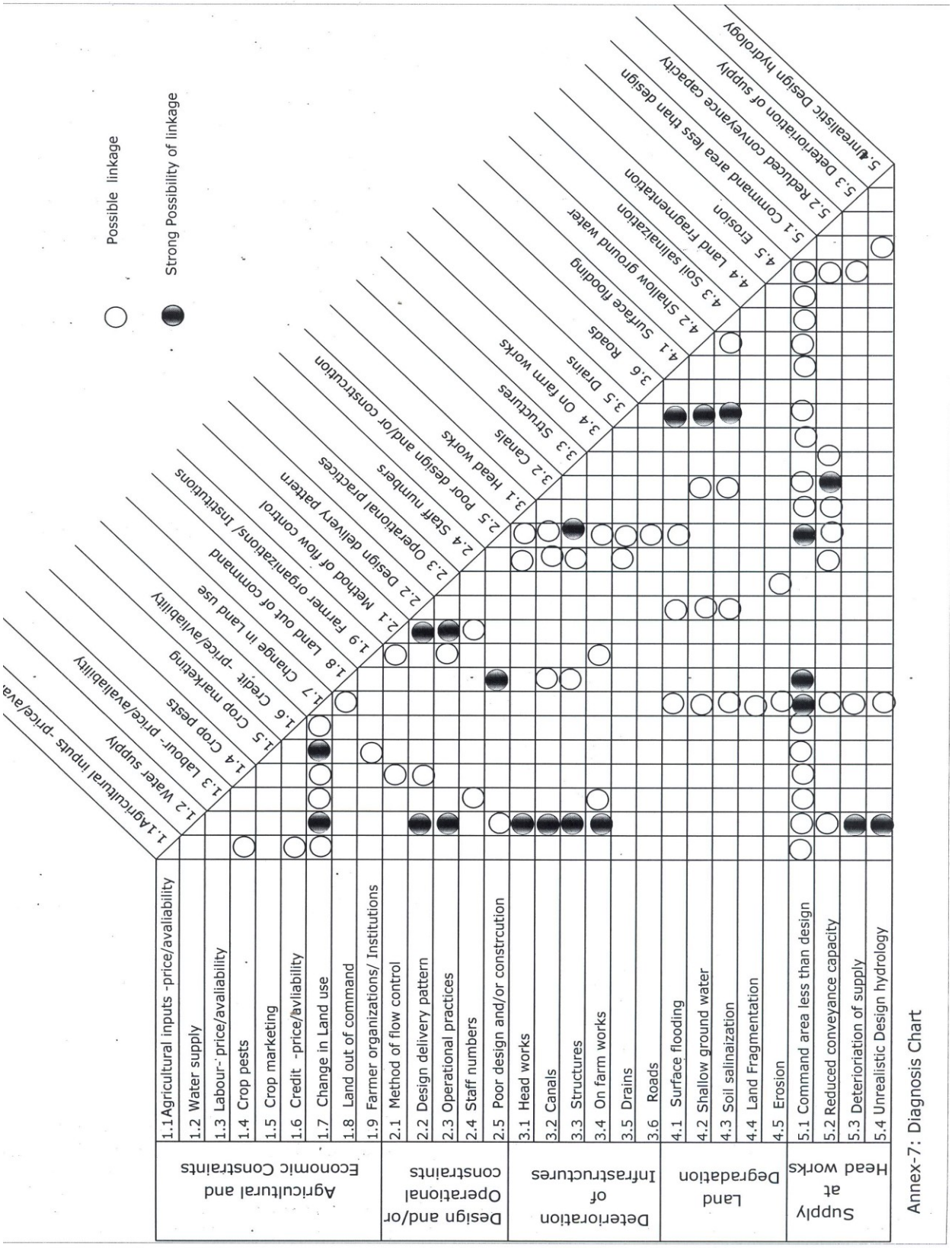
   1……2……
   3……4……

2. Irrigation and Drainage Canal system
   - Breach: yes ☐ No ☐
   - Silt up: yes ☐ No ☐
   - Seepage: Yes ☐ No ☐
   - overtopping yes ☐ No ☐
3. Irrigation field structure
   - List broken / Damaged structure (Name and Quantity)

     1……2……
     3……4……

   - Availability of cropped area: yes ☐ No ☐
   - Field coverage by crop: Full ☐ Partial ☐, estimate in %.....
   - Irrigation method: Gravity ☐ pressurized ☐
   - Soil erosion: yes ☐ No ☐
   - Salinity: Available ☐ Not available ☐
   - Extension service: Available ☐ Not available ☐
4. Socio Economy/Gender/Environment (Check and tick on the availability)
   - The settlement with in irrigated area: Yes No
   - Water taping point: Yes ☐ No ☐ , if the multi-purpose use case
   - Cloth washing and bathing: yes ☐ No ☐
   - Canal crossing structure: Yes ☐ No ☐
   - Cattle trough: Yes ☐ No ☐
   - Water logging: Yes ☐ No ☐
   - Footpath Yes ☐ No ☐
   - Nearby market Yes ☐ No ☐
   - camping Yes ☐ No ☐
   - Access road Yes ☐ No ☐
   - Credit institution Yes ☐ No ☐

APPENDIX VIII: Diagnosis Chart



Annex-7: Diagnosis Chart

APPENDIX IX: Condition assessment of structure type: intake (or head regulator)

YES/ NO assessment

a. Are any of the gates missing?
b. Is it difficult to fully open or close any of the gates?
c. Is any gate seriously corroded or rotting?
d. Are there serious cracks or movement in any part of the structure?
e. Is any part of the structure blocked by sediment?
f. Is seepage occurring around the structure?
g. Is the d/s apron seriously damaged or undercut?
h. Is it difficult to read the u/s or d/s gauge boards?
i. Does the overall condition concern you?

Missing Gate
Only answer YES if a gate has been removed from the structure. Where a gate is broken but still present, answer NO to this question and YES to question 2.

Gate operation
Answer YES when the condition of the lift mechanism, missing components or other factors make it impossible to effectively operate a gate. If a gate is missing, answer YES to question 1 and NO to this question.

Gate Condition
Answer YES where corrosion or rotting has reduced the strength or water tightness of any gate. Disregard minor patches of surface corrosion or minor deterioration of any gate.

Cracks/damage and movement
Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure. The vertical, horizontal or rotational movement may be visible. Disregard shallow, surface cracks or minor damage that does not affect function.

Blockage
Answer YES where sediment accumulation is seriously reducing the open area for water to pass through. Disregard blockage by floating vegetation or other debris that could be quickly pulled away.

Seepage
Answer YES if there is a washout of fine soil particles, very wet areas of fill or other evidence of water flowing around the structure.

D/s Apron
Answer YES where the apron, or other bed protection, is breaking up or unstable because of serious undercutting and piping effect. Disregard minor surface abrasion or bed/bank scour if this appears stable and does not threaten the stability of the structure. Answer NOT KNOWN, if you cannot see the apron or gain reliable information from the operator.

Gauge Boards (if applicable)
Answer NO when gauge boards have not been installed.

Overall Condition
Answer YES, if:
• There is a serious fault or deterioration or failure to a function that is not covered by any other question. OR Deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX X: Condition Assessment structure type: Canals reach

YES/ NO assessment

1. Is the canal partially blocked at any location by illegal weirs or debris?
2. Is there serious siltation at any location?
3. Is there serious weed growth at any location?
4. Do farmers and/or staff report the canal capacity restricts water supply?
5. Where the reach is in fill, has the water level been dangerously near the canal top at any point?
6. Are there problems of serious bank slippage or erosion?
7. If lined - Is there important damage to lining?
8. Are there any unauthorized off-takes?
9. Does water pondage observed at any location of the canal reach?
10. Is seepage a problem in the reach?
11. Does the overall condition concern you?

Notes

1. Illegal weirs or debris

Answer YES where farmers have placed material in the reach to raise the water level or where a land slip or accumulation of rubbish appears to reduce the conveyance capacity of the reach.

2. Sediment

Disregard minor and localized accumulation of sediment which does not reduce the conveyance capacity of the canal or cause a reduction in the freeboard. If you are uncertain, answer YES.

3. Weed

Disregard small areas of weed which do not appear to restrict the conveyance capacity of the canal or cause a reduction in the freeboard. If you are uncertain, answer YES.

4. Conveyance capacity

Ask farmers or staff if they believe that water supply is limited because of a problem in THIS reach. If so, answer YES.

5. Freeboard

Answer YES where: There is sometimes a risk of overtopping that might result in washout of an embankment and serious structural damage. Disregard minor low points where the canal is in the cut.

OR, the condition is not yet dangerous but the deterioration of the canal freeboard is continuing and may become dangerous before the next inspection.

6. Bank slippage or erosion

Answer YES if slippage or erosion threatens to block the canal or, where the canal is in fill, weaken the embankment. Disregard minor erosion of the channel section unless it threatens the integrity of the reach.

7. Lining damage

Disregard isolated damaged panels or masonry. Answer YES where more than 1 in 10 of the lining panels or 10% of the surface within the reach is seriously damaged.

8. Unauthorized off-takes

Look for deliberate cuts or submerged pipes etc. in the canal bank.

9. Answer yes, if there is significant poundage along the canal or very low flow velocity

10. Seepage

Look for standing water, washout of fine particles from the embankment, flowing water emerging from the toe of the embankment, reeds or salt deposits on the ground lying close to the canal embankment. If any of these is widespread answer YES.

11. Overall condition

Answer YES, if:

• There is a serious fault or deterioration or failure to a function that is not covered by any other question.

OR

• Deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XI: Condition Assessment structure type: gated offtake

YES NO UNASSESSED

1. Are any of the gates missing?
2. Is it difficult to fully open or close any of the gates?
3. Is any gate seriously corroded or rotting?
4. Are there serious cracks or movement in any part of the structure?
5. Is any part of the structure blocked by sediment?
6. Is seepage occurring around the structure?
7. Is the d/s apron seriously damaged or undercut?
8. Is it difficult to read the u/s or d/s gauge board?
9. Does the overall condition concern you?

Notes

Missing Gate

Only answer YES if a gate has been removed from the structure. Where a gate is broken but still present, answer NO to this question and YES to question 2.

Gate operation

Answer YES when the condition of the lift mechanism, missing components or other factors make it impossible to effectively operate a gate. If a gate is missing, answer YES to question 1 and NO to this question.

Gate Condition

Answer YES where corrosion or rotting has reduced the strength or water tightness of any gate. Disregard minor patches of surface corrosion or minor deterioration of any gate.

Cracks/damage and movement

Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure. The vertical, horizontal or rotational movement may be visible. Disregard shallow, surface cracks or minor damage that does not affect function.

Blockage

Answer YES where sediment accumulation is seriously reducing the open area for water to pass through. Disregard blockage by floating vegetation or other debris that could be quickly pulled away.

Seepage

Answer YES if there is/are a washout of fine soil particles, very wet areas of fill or other evidence of water flowing around the structure.

D/s Apron

Answer YES where the apron, or other bed protection, is breaking up or unstable because of serious undercutting and piping. Disregard minor surface abrasion or bed/bank scour if this is now stable and does not threaten the stability of the structure. Answer UNASSESSED, if you cannot see the apron or gain reliable information from the operator.

Gauge Boards

Answer NO when gauge boards have not been installed.

Overall condition

Answer YES, if there is a serious fault or deterioration or failure to a function that is
not covered by any other question, OR deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XII: Condition of Assessments Structure Type: Drain

YES/ NO Assessment

1. Is the flow seriously limited at any location by silt, weeds or debris?
2. Are there any signs that water has overtopped the drain?
3. Is there evidence of waterlogging (salts, mud, reeds) in this area?
4. Is there serious bank slippage at any location?
5. Are any structures in this reach seriously deteriorated?
6. Does the overall condition concern you?

Notes

Channel obstruction

Answer YES if silt, weed or debris limits flow in the drain so that localized flooding or waterlogging of land occur frequently.

Overtopping

Look for the high water mark in the drain or for debris caught on the banks or in adjacent vegetation.

Waterlogging

If necessary, ask farmers if problems of waterlogging, due to inadequate drainage, are common.

Bank slippage

Answer YES where slippage threatens to restrict flow capacity of the drain. Disregard minor slides if they are now stable.

Drainage structures

Answer YES only where damage to a structure threatens the correct functioning of the drain.

Overall condition

Answer YES, if there is a serious fault or deterioration or failure to function that is not covered by any other question, OR deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XIII: Condition Assessment Structure Type: Drop/Chute

YES/ NO assessment

1. Are there serious cracks or movement in any part of the structure?
2. Is leakage occurring around the structure?
3. Is the d/s structure - stilling basin/apron - seriously damaged or undercut?
4. Is the d/s bed or channel section seriously eroded?
5. Does the Capacity of stilling basin is sufficient to accommodate the flow?
6. Does the overall condition concern you?

Notes

1. Cracks/damage and movement

Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure. The vertical, horizontal or rotational movement may be visible. Disregard shallow, surface cracks or minor damage that does not affect function.

2. Leakage

Answer YES if there is/are a washout of fine soil particles, very wet areas of fill or other evidence of water flowing around the structure.

3. D/s protection

Answer YES where the apron, or other bed protection, is breaking up or unstable because of serious undercutting. Disregard minor surface abrasion or bed/bank scour if this is now stable and does not threaten the stability of the structure. Answer NOT KNOWN, if you cannot see the apron or
gain reliable information from the operator.

4. D/s bed & channel

Answer YES if erosion of the bed or banks threatens the stability of the drop structure or the canal reach. Disregard minor scours or bank erosion if this appears to be stable. Answer UNASSESSED if you cannot see the bed or channel section or gain reliable information from the operator.

5. Stilling basin capacity

Answer No if the flow velocity in the D/S of the structure is very high (the capacity of stilling is not sufficient to accommodate the flow)

6. Overall condition

Answer YES, if there is a serious fault or deterioration or failure to a function that is not covered by any other question, deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XIV: Condition Assessment Structure Type: Cross Drainage Culvert

YES/ NO Assessment

1. Are there serious cracks or movement in any part of the structure?
2. Is the canal visibly leaking into the culvert?
3. Do farmers or staff say the culvert fails to effectively carry peak flow?
4. Does the culvert appear blocked?
5. Is there serious erosion around the entry or exit of the culvert?
6. Does the overall condition concern you?

Notes

1. Cracks/damage and movement

Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure. The vertical, horizontal or rotational movement may be visible. Disregard shallow, surface cracks or minor damage that does not affect function.

2. Leakage into culvert

Answer YES if there is an obvious and important loss of water from the canal into the culvert. Disregard minor seepage.

3. Culvert capacity

Answer YES If farmers report that the drain frequently floods on the u/s side of the culvert.

4. Blockage

Answer YES, where more than one quarter of the open area appears blocked. Disregard small quantities of sediment or weed in the bottom of the culvert.

5. Erosion

Answer YES if erosion is occurring that could lead to undercutting of the structure.

6. Overall condition

Answer YES, if there is a serious fault or deterioration or failure to a function that is
not covered by any other question, or deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XV: Condition Assessments Structure Type: Aqueduct / Flume

YES/ NO Assessment

1. Are there serious cracks or movement in any part of the structure?
2. Is there any serious separation of the backfill & structure?
3. Does the aqueduct leak at the union with u/s or d/s reach?
4. Are there important leaks from the aqueduct itself?
5. Is there evidence of overtopping in the aqueduct or immediately u/s?
6. Is there evidence of serious damage, to supporting piers and/or superstructure?
7. Does the overall condition concern you?

Notes

1. Cracks

Disregard shallow, surface cracks. Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure.

2. Separation from Backfill

Report YES where gaps can allow seepage.

3. Aqueduct/canal

Answer YES if there is any leakage, resulting in a serious loss of water or erosion of the foundation slab.

4. Leakage

Disregard minor leakage from construction joints, but answer YES where there are important leaks from expansion/contraction joint fillers.

5. Overtopping

Check the high water line or consult local farmers.

6. Damage to piers/Superstructure

Look for exposure/corrosion of reinforcing bars, split masonry or settlement of any pier which can crack the aqueduct.

7. Overall condition

Answer YES, if there is a serious fault or deterioration or failure to function that is not covered by any other question, or deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

APPENDIX XVI: Condition Assessments Structure Type: Syphon

YES/NO Assessment

1. Are there serious cracks or movement in any part of the structure?
2. Is there any serious separation of the backfill & structure?
3. Are there signs of leakage from the syphon?
4. Is there, or has there been overtopping immediately u/s of the syphon?
5. Is the syphon blocked or partially blocked?
6. Is there serious erosion in the d/s transition section?
7. Is there serious erosion or settlement in the section which the syphon crosses?
8. Does the overall condition concern you?

Notes

1. Cracks

Disregard shallow, surface cracks. Answer YES where cracks appear to be caused by differential movement of the structure or overloading of the structure.

2. Separation from Backfill

Report YES where gaps can allow seepage.

3. Leakage from syphon

Look for damp patches in soil or seepage from soil surface at low points

4. Overtopping u/s of the syphon

Look at the level of the high water line.

5. Blockage

It is not possible to inspect the syphon itself. The blockage will be indicated by high u/s water levels.

6. Erosion in d/s transition

Answer YES if erosion of the bed or banks threatens the stability of the structure or the canal reach. Disregard minor scours or bank erosion if this appears to be stable.

7. Erosion of channel/drain

Answer YES if the barrel of the syphon is exposed where the channel or roadway crosses. Where the syphon crosses a drainage line answer YES if erosion of the drain bed threatens the stability of any part of the syphon.

8. Overall condition

Answer YES, if there is a serious fault or deterioration or failure to a function that is
not covered by any other question, or deterioration has begun and may progress rapidly causing important loss of function or risk of structural failure before next inspection.

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