National Community Driven Development Project (NCDDP)

TECHNICAL, COST EFFECTIVENESS, ECONOMIC RATES OF RETURN AND SUSTAINABILITY AUDIT

FINDINGS AND RECOMMENDATIONS

DECEMBER 2018

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This study was designed and overseen, and the report was prepared, by independent consultant Neil Neate, certified Professional Engineer (British Columbia). The economic analysis was guided by research tools developed by Eduardo Araral, PhD, who also analyzed and summarized the economic results for the study. The technical team that undertook the fieldwork for the study included two Myanmar consulting civil engineers and twelve civil/mechanical engineers of the Department of Rural Development (but who do not work on the NCDDP). The study was contracted by the World Bank, which also reviewed the terms of reference, sampling strategy, and instrument design to ensure the work met global best practices for technical audits of community-driven development projects. The study was financed by the United Kingdom's Department for International Development (DFID), through a contribution to the Myanmar Partnership Multi-Donor Trust Fund for the NCDDP.

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List of Acronyms

ADB	Asian Development Bank
BOQ	Bill of Quantities
CC	Community Contributions
CDD	Community Driven Development
CFA	Community Force Account
CSP	Comparable Sub-project
DRD	Department of Rural Development
DRM	Disaster Risk Management
ECOP	Environmental Code of Practice
EIRR	Economic Internal Rate of Return
EPC	Electrical Power Contribution
ERR	Economic Rate of Return
ESMF	Environmental and Social Management Framework
FMR	Farm-to-Market Road
GFWS	Gravity-fed Water System
GOM	Government of Myanmar
HH	Household
IRC	International Rescue Committee
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
MDCG	Maggin Development Consultancy Group
MEPE	Myanmar Electric Power Enterprise
MIMU	Myanmar Information Management Unit
MIS	Management Information System
NCDDP	National Community Driven Development Project
NPV	Net Present Value
O&M	Operation and Maintenance
SER	Shadow Foreign Exchange Rate
SMEs	Small and Medium Enterprises
SP	Sub-Project
SWR	Shadow Wage Rate
TOR	Terms of Reference
UA	Universal Accessibility
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
VPSC	Village Project Support Committee

Executive Summary

1. Introduction

The National Community Driven Development Project (NCDDP) was prepared by the Government of Myanmar in 2012, with support from the World Bank, and began implementation in 2013. In 2015, the project was scaled up, with additional financing support and commitments from the Government of Myanmar; the World Bank; and the Governments of Italy and the United Kingdom. The NCDDP is implemented by the Department of Rural Development (DRD) under the Ministry of Agriculture, Livestock, and Irrigation. The project finances technical support and block grants that are managed directly by villagers to identify and construct community-level rural public infrastructure.

Fieldwork for the technical audit and economic analysis was carried out from January to March 2018, and data analysis and report preparation were from April to June 2018. At the time of data collection, the project was active in 47 townships and 8,563 villages and had supported more than 14,700 sub-projects.

This technical and economic assessment was designed to independently assess specifically the technical quality of sub-project design and project facilitation, the cost effectiveness, economic rates of return, compliance with environmental and social safeguards, and the operation and maintenance/sustainability of a random representative sample of infrastructure that had been completed during the last two years of project implementation since the last technical audit in 2016. The study also aimed to identify and compile best practices and lessons learned from the field inspections of infrastructure and interviews with village stakeholders to inform an update of the project's technical designs and community support.

2. Methodology and Sampling

This assessment used similar methodology and survey tools as the 2016 NCDDP technical audit, thereby allowing for useful comparison of results between the two audits.[1] The 2018 assessment was also led by the same international consultant engineer. Unlike the 2016 audit, the 2018 assessment included a specially designed module to collect information on the economic benefits to the communities of the surveyed infrastructure, which allows for the estimate of the net present value (NPV) and economic internal rate of return (EIRR) of the NCDDP-supported infrastructure.

The audit reviewed a stratified random sample of sub-projects drawn from a total of 12,520

1 The 2016 Technical Audit report is available at: http://cdd.drdmyanmar.org/sites/cdd.drdmyanmar.org/files/documents/ncddp_technical_audit_2016-_final_reportneil_neate_p.eng.pdf.

sub-projects constructed in 27 townships during the 2015–16 and 2016–17 community cycles of the NCDDP. In total, 235 sub-projects were analyzed, that is, 1.9 percent of the total number of sub-projects financed and constructed during the 2015–16 and 2016–17 cycles reviewed. As shown in Table E.1, roughly an equal number of sub-projects were selected from each of the two cycles. The selection of the types of sub-projects to be analyzed (that is, roads, bridges, buildings, and so on) was based on the approximate proportion of these sub-project types in the overall NCDDP portfolio, as shown in Chart E.1.

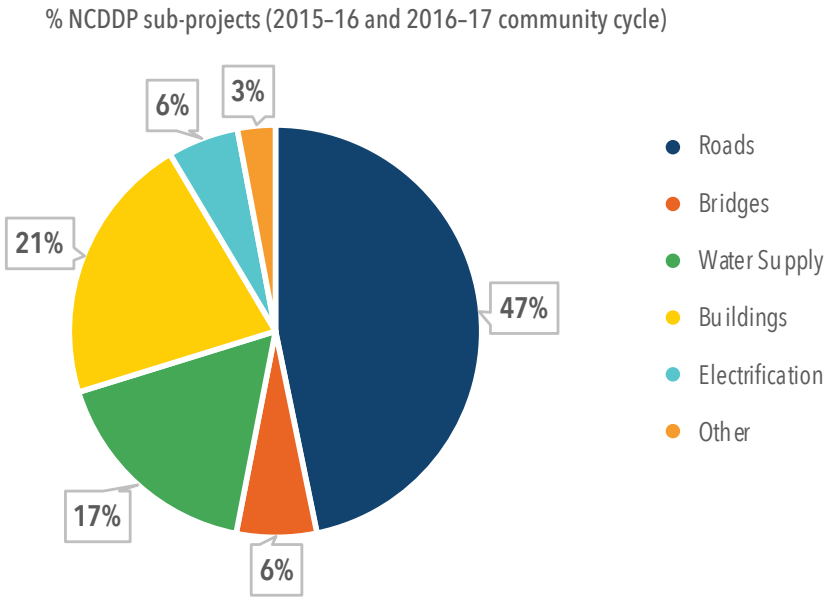
TABLE E.1: Sampling Framework

SP Main Type	Community Cycle Year 3 (2015–16)	Community Cycle Year 4 (2016–17)	Percentage of Sub-project Type
Building	43	25	29
Bridge	22	18	17
Water Supply	7	24	13
Road	40	32	31
Electricity	6	18	10
Total	**118**	**117**	**100**

Note: SP = Sub-project.

In addition, 38 additional sub-projects of comparable size and complexity of the NCDDP, but implemented by other governmental and nongovernmental agencies, were identified and surveyed to determine the relative cost effectiveness of NCDDP investments.

CHART E.1: Universe of Sub-Project Types for Technical Audit Sampling



Source: NCDDP Management Information System (www.ncddmis.com).

The stratification of the sample of sub-projects aimed to reflect the diverse range of operating environments facing the NCDDP, including geographically (both remote and mountainous areas as well as the Ayeyarwaddy river delta) and facing different vulnerabilities (conflict-affected communities, disaster-prone and affected areas), as well as ethnic minorities areas and areas with physical cultural resources. Table E.2 indicates how the survey townships were categorized.

Five types of sub-projects were evaluated: community buildings (that is, schools, village halls, and health centers), bridges, water supply, roads, and electricity. Each sub-project type was evaluated using a set of field tools (see Annex 2 of this report) that were based on the 2016 audit to facilitate comparisons over time, with two additional tools for the economic analysis portion of the current study. The different sets of field tools are adjusted to the specific issues for each type of infrastructure (for example, the community buildings tool considers concrete practices; wall, column, and roof information; and so on, while the water supply field tool examines piping, reservoirs, and public standpipes). Seven field tools were applied to each sub-project type, covering the following issues: technical quality evaluation, cost effectiveness, environmental and social safeguards, operation/maintenance and sustainability, key issues, economic analysis, and brief sub-project description and notes.

TABLE E.2: Township Selection Criteria

Selection Criteria	Conflict Area/ Ethnic Area	Physical Culture Resource Zone	Hilly and Remote	Ayeyarwaddy River Zone	Disaster Affected
Townships	Kyarinnseikkyi	Nyaung U	Moenyo	Sidoktaya	Kawhmu
	Paletwa	Kanpetlet	Myaung	Ann	Lewe
	Loikaw	Banmauk	Kyangin	Tharbaung	Pyawbwe
	Demorso	Kyunsu	Ngazun	Ngaputaw	Mindon
	Tanintharyi		Padaung	Tatkone	Saw
	Belin				Kunchankone

3. Findings of the Technical Audit

Overall

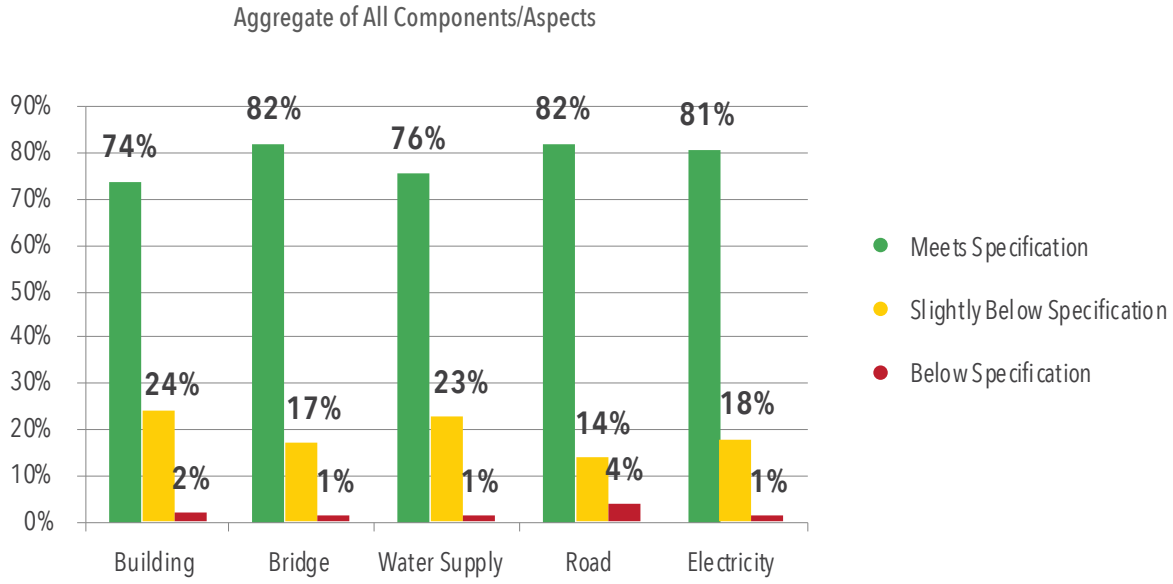
The study found that the overall quality of 92 percent of sub-projects reviewed was considered to be Moderately Satisfactory or higher. The overall quality of sub-projects was determined by examining the four phases of construction: preparation, design, implementation, and follow-up. Each sub-project was rated based on a six-point scale: Highly Satisfactory, Moderately Satisfactory, Satisfactory, Moderately Unsatisfactory, Unsatisfactory, and Highly Unsatisfactory. Of the 92 percent, 7 percent of the sub-projects were Highly Satisfactory, 70 percent Satisfactory, and 15 percent Moderately Satisfactory. **The remaining 8 percent of sub-projects reviewed (19) were considered Unsatisfactory to Highly Unsatisfactory,** which is a notable drop in the results of the 2016 audit when only 1 percent of sub-projects were considered Unsatisfactory. While the overall quality of the NCDDP sub-projects is still considered to be quite high, this increase in the percentage of sub-projects that are not considered Satisfactory warrants further

analysis by the DRD to identify potential causes and corrective actions that should be taken. On the other hand, the percentage of sub-projects rated as Highly Satisfactory in the current study has risen—from 4 percent in 2016 to 7 percent in 2018.

Technical Quality of Infrastructure

The study also found that overall 80 percent of all sub-projects were in accordance with plans and met technical specifications, with an additional 16 percent slightly below specifications. This is an improvement on the results from the 2016 audit where 78 percent of sub-projects met specifications and 19 percent were slightly below. The study also found some differences in technical quality between the types of sub-projects. B**ridge, road, and electricity sub-projects were found to meet plans and specifications 81–82 percent** of the time. The technical quality of electricity sub-projects improved significantly from the 2016 audit, when only 57 percent met specifications; however, the quality of bridge construction fell from a high of 91 percent in 2016. **Water supply and building sub-projects were rated slightly lower, at 76 percent and 74 percent, respectively**. The overall percentage of sub-projects that fell below technical specifications was 4 percent or less, which is comparable to the findings of the 2016 audit.

CHART E.2: Technical Quality Ratings by Sub-project Type



The study also found that the technical quality of sub-projects was fairly consistent between the two years of implementation, as shown in Table E.3. Given the sizeable increase in the number of townships that were covered under the NCDDP from the 2015–16 to 2016–17 implementation cycles (from 27 to 47 townships), this is a tribute to the efforts on the part of DRD and Township Technical Assistance (TTAs) to maintain quality standards.

TABLE E.3: Construction Year, Aggregate of Ratings for All Sub-projects, All Components (%)

Community-cycle Year	Meets Specification	Slightly Below Specification	Below Specification
2015–16 (118 SPs)	80	16	4
2016–17 (117 SPs)	79	17	4

Note: SP = Sub-project.

The technical quality of sub-projects also remained approximately the same among remote and non-remote villages, and indeed remote villages (between 30 minutes and 2 hours drive) were rated higher, as shown in Table E.4. However, quality declined somewhat for those villages classified as very and extremely remote.[2] This difference was not detected in the 2016 audit and warrants further analysis.

Technical Facilitation

The frequency of technical facilitator visits to sub-project sites was noted as part of the evaluation and was found to **average 4.7 visits per month for each sub-project.** The average for sub-project sites in non-remote villages was 5.8 visits per month. The data did show that more remote sites received less technical supervision, which is likely to be linked to the slight fall in the quality of sub-projects in these areas.

TABLE E.4: Remoteness, Aggregate of Ratings for All Sub-projects, All Components (%)

Relative Remoteness	Meets Specification	Slightly Below Specification	Below Specification
Not Remote (62 SPs)	79	19	2
Remote (117 SPs)	82	16	2
Very Remote (43 SPs)	74	24	2
Extremely Remote (13 SPs)	65	35	0

Compliance with Environmental and Social Safeguards

The audit showed that 83 percent of the sub-projects had appropriately addressed all environmental considerations,3 and 98 percent had appropriately applied social safeguard screening tools. Environmental Codes of Practice (ECOPs), the social safeguard screening checklists, and the standards for verification and monitoring of safeguards as outlined in the Project Operations Manual are being applied as intended by communities and project staff for a significant majority of sub-projects. In addition, **proper land transfer documentation was found in village files in all relevant cases.** Voluntary land donations were executed and documented in 20 percent of the sub-projects evaluated; the remaining sub-projects were carried out on existing public lands.

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2 Sub-project villages were categorized by their degree of remoteness from the township center, as follows: 'non-remote', within 30 minutes drive by motorcycle to the township center during the dry season; 'remote', within two hours drive; 'very remote', between 2 and 4 hours drive; and 'extremely remote', greater than 4 hours drive to the township center.

3 The remaining 17 percent had a variety of minor environmental shortcomings that for the most part related to a lack of proper drainage.

Operation and Maintenance; Sub-project Sustainability

The study found that **Operation and Maintenance (O&M) Committees have been formed and are functioning, on average, in 89 percent of the sub-projects.** Water supply projects had the highest level of functioning O&M Committees at 97 percent, while community building sub-projects had the lowest level at 82 percent.

The ability of these O&M Committees to function and to address regular maintenance and routine repairs of infrastructure depends on adequate resources. In that regard, the study found that **75 percent of village committees have established user-fee collection systems, and 76 percent of villages hold O&M funds in a bank account.** When villages implemented their sub-projects using community force account (that is, direct community management and procurement of necessary **sub-project inputs such as labor), these percentages significantly increased to 90 percent of sub-projects instituting user fees and 89 percent of sub-projects using bank accounts to hold O&M funds.** Village committees also report that all ongoing O&M activities are wholly supported by the villagers, with no inputs from line ministries or government agencies.

4. Findings of the Economic Analyses

Cost Effectiveness

The NCDDP's community buildings, bridges, tube-well water supply systems, earth and concrete roads, and electrification sub-projects were found to be cost effective, even with community contributions factored into the total costs. Based on the assessment of 38 other similar types of sub-projects implemented by different government and nongovernmental agencies (see Table E.5), **the unit-cost savings of NCDDP sub-projects range from 4 percent (for earth roads) to 42 percent (for electric grid extension)**, as shown in Table E.6.

TABLE E.5: NCDDP and Comparable Sub-Projects by Type

	Building	Bridge	Water Supply	Road	Electricity	Total
NCDDP SP	68	41	32	72	22	235
Comparable SP	5	7	11	7	5	38

TABLE E.6: Comparison of Unit Costs between NCDDP and Other Agency Sub-projects

	Buildings (kyat/sq. ft.)	Bridge (kyat/sq. ft.)	Earth Road (kyat/sq. ft.)	Concrete Road (kyat/sq. ft.)	Electricity; Grid Extension (kyat/hh)	Water; Borehole (kyat/hh)
NCDDP	10,000	27,250	202	1,597	186,900	20,000
CSP	10,750	32,800	210	1,738	265,500	23,600
% differ.	7.5	20.4	4.0	8.8	42.1	18.0

Note: hh = Household.

The analysis also shows that **implementation using 'community force account' procedures is more cost effective for buildings, bridges, earth and gravel roads, and some water systems.** Where heavy or specialized equipment is required (often for concrete roads and electrical grid extension), however, construction by contractors appears to be more cost effective. This may be because contractors who own their own equipment are charging less for its use when they are implementing NCDDP contracts.

As would be expected, **community contributions** (generally labor and locally sourced materials) **were found to enhance the cost effectiveness of all NCDDP sub-projects**, particularly concrete road schemes. When community contributions are subtracted from sub-project budgets, the NCDDP sub-projects are uniformly and significantly more cost effective than those by other agencies.

Cost-Benefit Analyses

Overall, the economic analyses indicate that **most of the NCDDP's sub-project types (water supply systems, school buildings, roads, and electrification) are economically viable.4 The EIRR for the different types of NCDDP sub-projects range from 12.3 percent for non-remote roads to 132 percent for remote roads.** These positive findings are consistent with those of CDD programs in other countries and are generally robust under sensitivity analyses, which assume (a) a 33 percent reduction in the effective life of the sub-project, (b) a 20 percent cost increase, or (c) a 20 percent reduction in the value of benefits. Table E.7 shows the EIRR and NPV calculations for each of the economic infrastructure sub-projects assessed.

TABLE E.7: Summary of Main Findings of Economic Analyses

Sub-project	BASELINE	SENSITIVITY ANALYSES		
		Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
WATER SUPPLY (n = 30)				
NPV	15,055	8,128	13,308	10,297
EIRR (%)	43	38	35	33
SCHOOL BUILDING (n = 68)				
NPV	30,822	23,080	28,929	22,764
EIRR (%)	56	55	46	45
FARM TO MARKET ROADS (Accessible) (n = 14)				
NPV	1,834	−840	25	−378
EIRR (%)	12	8	10	9
FARM TO MARKET ROADS (Remote) (n = 33)				

4 The one caveat to this observation relates to non-remote roads, where the EIRR falls to or below the official discount rate of 10 percent, suggesting marginal economic returns.

Sub-project	BASELINE	SENSITIVITY ANALYSES		
		Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
NPV	100,701	87,123	108,312	86,157
EIRR (%)	132	132	110	105
ELECTRIFICATION (n = 22)				
NPV	46,932	40,657	50,876	40,121
EIRR (%)	62	61	52	49

Note: NPV in thousand kyat; n = Sample size in the survey; 'accessible' means within 30 minutes by transport to the township center; 'remote' means between 31 and 120 minutes to township center.

5. Operational Recommendations

This report provides a summary of data, analysis, and discussions of the progress and remaining challenges of the NCDDP. On the positive side, the project continues to support the construction of technically sound community-level infrastructure at unit costs below what is normal in rural Myanmar; communities are actively engaged in (and collecting fees for) O&M of this infrastructure; and estimates of the economic internal rate of return (EIRR) for most of these works are substantial.

The report also highlights some continued and new challenges facing the NCDDP and the communities that are responsible for the selection, design, and implementation of the sub-projects. The detailed report contains specific recommendations of corrective measures and improved construction methodologies for individual sub-project types and components. The following are the major recommendations from the study that are aimed at further improving the quality, cost effectiveness, and sustainability of the NCDDP sub-projects. More specific details of these recommendations are contained in the full report.

- The NCDDP Engineering Department should examine the technical resources that the townships have for the infrastructure types where 'Poor' designs have been noted (particularly Road and Electrical). Additional support (drawings, manuals, training, additional personnel, and so on) to some townships is warranted.
- The audit showed that remote communities receive less technical support than those that are less remote. The NCDDP should use the results of this audit to reaffirm its technical support services to villages. Training courses should emphasize the importance of extending design and construction facilitation services to the most remote villages in townships.
- The DRD/NCDDP should undertake a detailed study of village O&M practices (comparing those villages where maintenance activities are deferred versus other communities where maintenance and repair work takes place more regularly) to help improve on this important function and build on the good practices observed during the fieldwork of the audit.
- Refresher O&M and basic repair training sessions should be offered to O&M committees on the 1-year anniversary of the completion of a sub-project. NCDDP engineers should do an inspection of the works beforehand and then offer advice as to how regular periodic maintenance can increase the usefulness and functionality of the infrastructure. Refresher training courses should be specific to each infrastructure type.

- The NCDDP should consider revising O&M committee documentation to stipulate activities that must be undertaken according to a routine schedule, with realistic estimates of costs (including needed labor and materials). User fee calculations should be based on these system-specific costs.
- NCDDP field staff training exercises should include reviews of the village sub-project implementation files during monitoring visits. Community contributions should be checked and signed off on a regular basis.
- Given the high cost-efficiency of implementing sub-projects using community-force account methods, the NCDDP should continue to encourage this approach during the socialization phase in Townships and Village Tracts.
- The NCDDP should develop a list of common building construction problems on which field inspections should concentrate. A similar list should be assembled for all infrastructure types.
- NCDDP engineers should carefully examine the layout of the bridges that received a rating below 'meets specifications'. Additional design sketches and other aids should be developed to guide the design of future bridge sub-projects.
- A section on watershed protection should be added to the NCDDP's technical training manual.
- The existing NCDDP standard drawings should be enhanced to better show important details. Standard drawings of details (for example, reservoir overflow piping, truss-ring beam connections, bridge buttress anchor bolts) should be developed and added to drawing sets.
- Community road construction monitors should be trained in proper construction techniques to produce well-shaped and durable surfaces. Manuals with sketches of good and bad road infrastructure would be useful to help monitors convey this information to village road construction crews. Developing this knowledge in communities will help guide long-term O&M efforts.
- Photographs of acceptable nonstandard, noncommercial (electrical) poles should be included in a field manual for training and illustration purposes, along with suitable examples of concrete pole foundations. Dimensions of the blocks should be included.
- The introduction of disaster-risk management protocols into the sub-project design process should include a specific training course for NCDDP technical staff.

1. Background

The National Community Driven Development Project (NCDDP) was launched in 2013 and has expanded access to basic infrastructure and services in Myanmar's rural areas. Implemented by the Department of Rural Development (DRD), the project provides grants to village tracts to finance community-level infrastructure, coupled with facilitation and capacity building to help communities make choices in an inclusive, informed, and transparent manner. During four community cycles, the program has grown to cover 47 townships across the country, home to an estimated 7 million people. Financing for the NCDDP is provided by the Government of Myanmar, the World Bank, and the Government of Italy, with an estimated US$546 million in financing committed to the program, which is scheduled to run until November 2021.

The NCDDP's objective is to enable poor rural communities to benefit from improved access to and use of basic infrastructure and services through a people-centered approach and to enhance the government's capacity to respond promptly and effectively to an eligible crisis or emergency. The project's objectives are achieved through (a) financing community-identified rural infrastructure investments; (b) strengthening the capacity of communities in partnership with local authorities to effectively identify, plan, and implement their development priorities; and (c) facilitating the participation of the poor and vulnerable, both women and men, throughout the project cycle at the community level.

The project began implementation in three townships in November 2013. Since then, the project has expanded to new townships annually, reaching 47 townships in the 2016–17 community cycle and approximately 8,600 villages in all of Myanmar's 14 states and regions and the Nay Pyi Taw union territory. By March 31, 2017, the project had disbursed a total of 94.39 billion kyats (US$25.9 million) to communities across the country, representing 68 percent of overall project spending. As of the end of FY16/17, the NCDDP had financed more than 6,900 sub-projects.

Note: Concrete jetty/pedestrian access, Panzin village, Taw Pyar VT, Kyunsu township.

2. Scope of the Study

The main scope of the study is described in this section.

2.1 Technical Design Quality of NCDDP Infrastructure Sub-projects

The evaluation undertook an inspection of the infrastructure, examination of sub-project village files, discussions with village implementation committee members, and comparison of the as-built structure with the approved-for-construction drawings.

The scope of questions to be answered is as follows:

- What is the technical quality of the design? Assess the as-built condition insofar as possible as 'good', 'fair', or 'poor' based on the list of key criteria developed for each major type of sub-project.
- What is the quality of materials/inputs and are these consistent with the bill of quantities (BOQ) in the bidding documents?
- Did the sub-projects follow the technical specifications as designed? Were any critical design elements, such as latrines, dropped?
- What documentation exists to show that the sub-project meets the design and specification requirements?
- Have all technical requirements been met and defects addressed before sub-projects are handed over to communities?
- Did the sub-projects take into account disaster risk management (DRM) measures? If so, how?

2.2 Cost Effectiveness

This study of cost effectiveness included the evaluation of similar rural infrastructures funded and constructed by other donors or the Government of Myanmar (GoM). These sub-projects are termed 'comparable'.

The scope of questions to be answered is as follows:

- How do the budget and unit costs compare between the NCDDP sub-projects and comparable infrastructure built by other parties? Break down the NCDDP sub-projects into comparable groups of similar technical quality and utility.
- Are investments implemented through community force account (CFA) more competitive than those implemented by contractors, when the cost of investments, capacity development and supervision, and the cost and quality of O&M are taken into account?

- Are there community contributions, and if yes, how much, how was it calculated, what form did these contributions take, and what percentage of total costs?
- Where community contributions are identified in the sub-project documents,
  - Did the contributions actually occur and were they accounted for properly?
  - Are the costs of the contributions as reported reasonable for the community inputs?
  - Were there additional community contributions that were not reported?
- Assess whether contractors were ever paid for the part of works carried out with community contributions.
- Were community contributions an important factor in determining the cost effectiveness of NCDDP sub-projects relative to similar sub-projects supported by others?
- How reasonable are the costs for materials, transport, labor, and other inputs?
- Were sub-projects designed to maximize community benefits through employment of local labor, procurement of local materials, or other means?
- Were sub-project designs and specifications selected to maximize value for money? Would other designs, technologies, or methods have provided greater value?

2.3 Economic Internal Rate of Return

The objective of the economic analysis part of this consultancy is to estimate the economic internal rate of return (EIRR) of a cross-section of sub-projects, applying a framework for basic public social and economic infrastructure such as small roads, bridges, culverts, jetties, electrification, water supply, and schools. The methodology and framework to be applied will be based on the current portfolio of completed sub-projects under the NCDDP. Specific areas of analysis include, among others,

- Costs of construction;
- Costs of construction management;
- Estimates of the O&M costs of the infrastructure once project construction is completed, for the standard useful lifespan of the investment (considering possible community contribution for parts of such maintenance);
- Estimates of the economic benefits in the short and long term during the sub-projects' estimated life cycle, including wages transferred to local communities during construction phase, and possible multiplier effects of these wage transfers.

A preliminary framework for estimating the economic benefits by type of sub-project was developed as a first step in consultancy. The analysis considered and applied, as appropriate to the NCDDP, the following economic evaluation tools and methodologies:

- Cost effectiveness ratios
- EIRR and the economic net present value (NPV) of the sub-project
- Cost-benefit ratios
- Sensitivity analysis

2.4 Compliance with environmental and social safeguards under the NCDDP investments

The sub-projects visited were also assessed with regard to their compliance with the project's environmental and social safeguard standards and policies.

The scope of this assessment is as follows:

- Proper documentation and recording of Environmental Codes of Practice (ECOP) and the safeguard checklist and the verification and monitoring by the township NCDDP office of contractor/community compliance with the ECOP.
- Loss of land or private assets, the scale of impact, whether or not they are addressed through voluntary donations, and if so, whether all conditions of voluntary donations as provided in the Operations Manual are met.
- Verification of whether any adverse environmental impacts occurred at the sub-project site and how they were mitigated.

2.5 Operation and Maintenance/Sustainability

The physical examination of the sub-project during the technical evaluation, for Section 2.1, allowed for appraisal of the current state of O&M of the infrastructure. Additional information was gathered during the village implementation committee interviews.

The scope of questions to be answered is as follows:

- Is the current condition of sub-project infrastructure good, fair, or poor?
- Were any major repair or restorative maintenance/rehabilitation works conducted since the completion of civil works or does the current condition require such works? If so, what are the causes of defects? Break down the causes of defects into environmental/natural factors and technical defects in design, implementation, or materials.
- If any O&M works have been done, what were they and who did them?
- Was any routine maintenance (wear and tear and/or replacement of consumables) carried out on the sub-project?
- Is the quality of the O&M plan sufficient? In particular, does it address both normal wear and tear, routine maintenance and replacement of spare parts, and reactive maintenance/capital repair? Do the O&M plans adequately cover the requirements over 3–5 years of operation and clearly spell out specific works to be done and agencies responsible for and expected cost of respective works?
- Is there an O&M committee in place and functioning? What are the O&M arrangements? What are the roles and responsibilities (both financial and technical) of local governments/line agencies and communities? Are roles and responsibilities separated for direct beneficiaries/users and indirect beneficiaries?
- Was any training provided to communities on O&M (including refresher training) and if so, what types of training were provided? Did communities request and/or receive technical support from local governments/line agencies on O&M?
- Is an O&M fund in operation? Who holds the funds? What is the current value of these funds?

How are contributions made? By whom? Are those expected to contribute able and happy to contribute?

- Was the O&M fund developed based on the consideration of technical requirements?
- Assess whether applicable user fees are affordable to users and sustainable to finance longer-term O&M. Did the line ministries contribute to O&M expenses?
- Were necessary government inputs (for example, teachers and learning materials for schools or health workers, drugs, and equipment for dispensaries) provided adequately and in a timely manner?
- Are responsibilities, both financial and technical, clearly spelled out for community members and for the government?
- Did the community or contractor implementation modalities have any impact on O&M? What investment types are more suitable to CFA in terms of long-term cost effectiveness? What conditions have to be met to make the model of CFA cost effective in the long run?
- Does community capacity development carried out by the NCDDP contribute to sub-project sustainability cost-effectively? Compare the total cost including the cost of community engagement and capacity development of investments financed by different sources, taking into account (a) the current conditions of infrastructure, (b) initial condition of infrastructure after completion, and (c) O&M works done. Is there any indication that the NCDDP's investments in the capacity development of communities contribute to long-term sustainability of sub-projects? If such an indication is observed, how cost effective is the NCDDP community capacity development in long-term sustainability of infrastructure?

2.6 Best Practices/Recommendations/Lessons Learned

The technical evaluation team members were encouraged to make note of specific instances where good or bad practices were observed or related during interviews. The field tools provided areas where this commentary could be noted.

The main points to be captured in this section were:

- What examples of good practice can be drawn to enhance technical design quality, O&M, and sustainability for future NCDDP sub-projects?
- What good practices can effectively address threats to sustainability?
- What are the key lessons learned from the sub-projects undertaken? What practices should be replicated and/or avoided in future sub-projects?
- Provide a list of key recommendations based on these good practices and lessons learned for the future design, implementation, and maintenance of future NCDDP subprojects.
- The key recommendations of the technical evaluation are presented in this report by section of review, and consolidated in Annex 1 for convenience.

3. Technical Evaluation Team Members

The technical evaluation and audit was led by Neil Neate, P.Eng., with Eduardo Araral, PhD, performing the economic analysis. The lead consultant was assisted by two Myanmar consulting engineers along with a further 12 DRD engineers recruited from the townships. The DRD engineers were divided into six teams of two engineers and they performed the field audits under the supervision of the independent Myanmar consultants. The selected DRD engineers were not involved with NCDDP activities in their respective townships.

4. Sub-Project Sampling and Selection Process

4.1 Sampling Framework

Sub-projects were selected for the technical audit using a stratified random sampling methodology. The criteria for stratification were (i) types of sub-projects, and (ii) specific physical or geographic attributes that were considered important in terms of implementation. The stratification by sub-project type was based upon the NCDDP management information system (MIS), using the combined totals of the NCDDP's four years of activity. Table 1 provides a summary of this information.

TABLE 1: Summary of NCDDP Sub-projects by Infrastructure Type, Years 1 to 4

	Building	Bridge/Road	Water Supply	Electricity	Subtotal
Year 1	99	146	82	28	355
Year 2	518	687	229	123	1,557
Year 3	1,210	2,307	977	205	4,699
Year 4	1,554	4,265	1,139	485	7,443
TOTAL	**3,381**	**7,405**	**2,427**	**841**	**14,054**
All years (%)	24	53	17	6	–

The selection criteria for physical or geographic attributes were as follows:

Conflict Area/Ethnic Area

A. Physical Culture Resource Area

B. Hilly and Remote Area

C. Flood-affected Area (other than Ayeyarwaddy River Zone)

D. Disaster-affected Area

E. Others

Based on these attributes, 20 townships were selected from the 1st, 2nd, and 3rd cycles (with 10 sub-projects sampled from each) and 7 townships selected from the 4th cycle (with 5 sub-projects selected from each) as shown in table 2 below:

TABLE 2: Distribution of Study Townships by key Physical/Geographic Criteria

Selection Criteria	Conflict Area/ Ethnic Area	Physical Culture Resource Zone	Hilly and Remote	Flood-affected/ River Zone	Disaster Affected
Townships	Kyarinnseikkyi	Nyaung U	Moenyo	Sidoktaya	Kawhmu
	Paletwa	Kanpetlet	Myaung	Ann	Lewe
	Loikaw	Banmauk	Kyangin	Tharbaung	Pyawbwe
	Demorso	Kyunsu	Ngazun	Ngaputaw	Mindon
	Tanintharyi		Padaung	Tatkone	Saw
	Belin				Kunchankone

The sampled distribution of sub-project types was done in general accordance with the total relative percentages accrued during the four cycles of the NCDDP (see Table 1), with slightly higher weightings being given to bridges and electrical sub-projects so that reasonable comparisons of the technical quality evaluations could be made (with the road sampling being accordingly reduced). Table 2 provides a summary of the sub-project sampling by infrastructure type.

TABLE 3: 2018 Technical Audit Sub-project Sampling by Infrastructure Type

	Building	Bridge	Water Supply	Road	Electricity	Total
NCDDP MIS (%)	24	6	17	47	6	–
Evaluated (nos.)	68	41	32	72	22	235
Evaluated (%)	29	17	14	31	9	–

An additional criterion used in the selection process was the degree of remoteness for subject villages. Township personnel provided a table of distances from the township center to each sub-project village, which allowed the evaluation team to select sub-projects based on remoteness. Four degrees of remoteness were used during the preliminary selection of village sub-project sites: Not Remote (within 30 minutes drive from a township center), Remote (within two hours), Very Remote (between 2 and 4 hours), and Extremely Remote (greater than 4 hours from township center). Remoteness of sub-projects is examined in detail in Section 6.7 of this report.

4.2 Final Confirmation of Sub-Project Sampling at the Townships

The study team reviewed the purpose of the study and the preliminary sample of sub-projects to be assessed with township NCDDP teams. The team made adjustments to the initial sampling based on further information from township teams, including time and feasibility of access to certain sub-project sites. A complete list of the NCDDP sub-project sample (and the comparable sub-projects) is provided in Annex 4. Township staff assisted with contacting the subject villages at least one or two days in advance so that Village Project Support Committee (VPSC) and O&M Sub-Committee members could be informed of the proposed audit.

4.3 Site Visit and VPSC Interview

Technical evaluation teams would arrive at a sub-project village, meet the VPSC representatives, and visit the sub-project site immediately. It was helpful to understand the location and state of the infrastructure before embarking on the evaluation questionnaire. Questions could be contextualized with less confusion if the evaluators have seen the infrastructure. Many questions regarding the sub-project can be asked in an informal way during the actual site inspection. Evaluation teams consist of at least two individuals, which allows for a free flow of questions and answers with a variety of people attending the site inspection. Answers to questions can be compared by the inspectors and inconsistencies identified. Further lines of questioning can follow during the more formal, generally sit-down, sessions later.

Note: Attic inspection at community center, Nyaung Aing village, Chit Pyin Kaing VT, Sidoktaya township.

5. Technical Evaluation Methodologies

5.1 Sub-project Types

This technical audit used the same infrastructure typologies as used during the 2016 audit.

TABLE 4: NCDDP 2018 Technical Evaluation Sub-Project Types

Type	Sub-Project Type Descriptor	Sub-Projects Represented
A	Building	School, community halls, health clinic
B	Bridge	Bridge, causeway, jetty
C	Water Supply	Gravity-fed water supply, boreholes, pumped system
D	Road	Road, track improvement
E	Irrigation*	
F	Electricity	Electrical generator, mini-hydro, solar, grid extension

* Irrigation is shown as an eligible sub-project under NCDDP, however, almost no irrigation sub-projects have been financed and none were evaluated during this audit.

Discussion:

The analysis in this report is based upon the sub-project types listed in table 4, and the findings for each specific sub-project type apply across all main types in which such infrastructure is found. For example, the technical evaluation's conclusions regarding reinforced concrete practices will apply equally to buildings, to concrete bridges and road structures, to concrete reservoirs, and so on. Thus, this evaluation's findings for each sub-project type should be viewed and applied with equal interest across the NCDDP categories featuring such infrastructure.

5.2 Technical Evaluation Field Instruments

The technical evaluation teams used unique field instruments for each sub-project type. These field instruments consisted of a set of seven checklists that were completed at villages where the subject sub-projects were located. These instruments were: 1 Technical Evaluation of Infrastructure; 2 Cost Effectiveness; 3 Environmental and Social Safeguards; 4 Operation and Maintenance/Sustainability; 5 Key Issues; 6 Economic Analysis; and 7 Brief SP Description and Best Practices. These field tools are similar to those used in the 2016 audit, with the addition of the economic analysis tool. A sample set of one of the field tools for the technical evaluation of Buildings is provided in Annex 2.

The technical evaluation instruments contain data fields that were completed using a checkmark or notations at the sub-project site itself. Other parts of the instrument would often be completed afterwards, during meetings at a village hall or a VPSC member's home. A summary of the data fields for these field tools is presented below:

- **Field Tool 1 - Technical Evaluation of Infrastructure:** This checklist is unique to each sub-project type. The five sub-project types were divided into a number of components, each to be rated separately (the rating system is defined in Section 5.3). Components for the sub-project type Building, for example, started at the base: Foundation, Ground Beam, Wall, Column, and so on, proceeding up to the Roof Structure. Where a particular component had several distinct aspects that should be evaluated separately, the component was subdivided, for example, Ring Beam - Reinforcement and Ring Beam - Dimension. A complete list of each sub-project type's components and aspects is provided in Annex 3.

  This instrument collected other sub-project quality ratings (Overall Quality, Design Completeness, SP Functionality, and so on) that are more fully discussed in Section 5.4. The second page of Field Tool 1 also provides space for the evaluator to write a brief sub-project description and add comments regarding specific issues that were noted during the evaluation, as well as lessons learned at each site. All of this commentary was digitized and submitted with the field data.

  Some parts of this field instrument were also completed for the comparable sub-projects (CSPs) visited, making possible a comparison of the NCDDP's sub-project technical quality with those of other organizations.

- **Field Tool 2 - Cost Effectiveness:** This checklist contains data fields unique to each sub-project type. Audit team members were instructed to examine construction plans, as-built structures, and specifications to verify and record the dimensions and materials of the sub-project. Information from the first page was used to determine each sub-project's basic unit costs, allowing comparisons to be made between sub-projects. Where possible and when time allowed, teams would check some of the measurements at the sub-project site. This field tool also required that sub-project accounting records be studied to determine if any special costs had been incurred, for specialized inputs or for transport of materials and so on. Community contributions to the sub-projects were also noted. This field instrument was also completed for all CSPs visited, making possible a comparison of the NCDDP sub-project unit costs with those of other organizations.
- **Field Tool 3 - Environmental and Social Safeguards:** This checklist is common to all sub-project types. Audit teams examined the village sub-project implementation files to verify the inclusion of all required policy and code of practice documents, as well as records of monitoring by the NCDDP staff. A physical inspection of the sub-project was also performed to visually confirm the completion of requirements as set out in ECOP.
- **Field Tool 4 - Operation and Maintenance/Sustainability:** This field tool O&M data fields unique to each sub-project type and collect standard information from O&M Committee members and requires the team to examine sub-project documentation and make notes from each O&M plan.
- **Field Tool 5 - Key Issues:** The checklist for this page is unique to each sub-project type. It contains a variety of common problems or issues that are typically found in rural infrastructures. The Building Key Issues list, for example, contains a checklist for the following visible problems: inadequate overlap of roof sheeting; improper connection of roof to truss; un-

reinforced, inadequate, or improperly located splices in truss members; and missing steel strapping in truss. The identification of these issues augments and contributes to the understanding of ratings assigned in Field Tool 1. The number of issues available for each sub-project type are as follows: Building - 37 items, Bridge - 25, Water Supply - 28, Road - 20, and Electricity - 9.

- **Field Tool 6 - Economic Analysis:** This field tool contains questions for each infrastructure type pertaining to the economic uses of the SP, costs for the use or ongoing maintenance of the system, number of users, time saved, and so on.
- **Field Tool 7 - Brief SP Description and Best Practices:** Audit team members are encouraged to write brief notes and comments to provide extra detail for all sections of the audit. This section provides space for this commentary.

5.3 Technical Rating System

Based on Field Tool 1 (Technical Evaluation of Infrastructure), each component or aspect of each sub-project was rated as either: Meets Specifications, Slightly Below Specifications, Below Specifications, Not Inspected, and Not Applicable. The component or aspect was examined in its current condition and reasonable allowances were made for normal wear-and-tear and degradation.

For the purposes of this evaluation, these ratings are defined as follows:

- Meets Specification **(Meets Spec)**. The sub-project component or aspect meets the plans, specifications, or criteria as set out in the sub-project proposal.
- Slightly Below Specification **(Slightly Below Spec)**. The sub-project component or aspect displays certain characteristics that could be improved upon within its design, materials, construction, operation/maintenance, or environmental conditions to meet the plans, specifications, or criteria presented in the sub-project proposal. This rating will normally be accompanied by written commentary describing improvements that can be made to improve technical quality and sustainability.
- Below Specification **(Below Spec)**. The sub-project component or aspect was either (a) not constructed according to the approved plans or specifications in the sub-project proposal or (b) presents a clear and present danger to the life or safety of users. This rating will normally be accompanied by written commentary describing improvements required to ensure technical quality and sustainability.
- **Not Inspected.** It may occasionally be impossible for the auditors to inspect a certain aspect of a sub-project. For example, many completed buildings feature ceilings with limited or no access to the attic. Auditors may not be able to inspect the interior of a building's roof structure in such cases. The team will instead question the village and township personnel to verify sub-project details as much as possible.
- **Not Applicable.** Some components or aspects will not be applicable to certain sub-projects. For example, the Ceiling component is included in the Building Checklist, but many building sub-projects do not include such installations.

Evaluators consider normal deterioration of components over time. The use of this rating system assumes that standard O&M tasks have been carried out. O&M is rated separately for all

sub-project types, and if it has not been carried out properly, the O&M SP component would be rated Slightly Below Spec or Below Spec according to conditions. Extreme deterioration due to poor maintenance practices does not mean that there is a fault with the infrastructure (where the sub-project works were well designed and installed).

5.4 Quality Ratings and Other Criteria

The second page of Field Tool 1 offers the evaluator an opportunity to rate the sub-project's construction quality as well as several more general and less technical areas. These 'Overall Project Assessment' categories are as follows:

- Sub-project construction quality (rated in accordance with a six-point rating system)
- Design completeness (Good, Fair, Poor), with opportunity to write a comment
- Design consultations with users (Yes or No), with opportunity to write a comment
- Sub-project proposal documentation check (rated Yes if documentation found, No if not)

These quality ratings are defined and further discussed separately in Section 6. Analysis of the sub-project quality ratings gathered in this part of Field Tool 1 is presented along with commentary.

The construction quality ratings of all 235 NCDDP sub-projects evaluated are provided in Annex 4.

6. Findings – Technical Design Quality

This section of the report is structured around the key questions from the terms of reference for the study, with discussion and analysis presented for each item, as appropriate.

6.1 Quality of Technical Design

Village sub-project files were studied to verify that the appropriate documentation was present and properly completed. The VPSC was also questioned regarding the support and guidance that the NCDDP provided during the design and construction period.

Proper design drawings created by NCDDP staff, checked by qualified engineers, and provided to the construction site are vital to properly executed sub-projects. The technical quality of the designs was rated by the auditor team using Field Tool 1, under the item Design Completeness, which included a general appraisal of the construction documentation, design drawings and details of construction, and specification requirements. The quality of each sub-project design was rated as "good", "fair", or "poor"[5]. Table 5 shows how an aggregate of each township's sub-project files was rated, along with the total for all sub-projects evaluated.

TABLE 5: Technical Quality of Design (aggregate all sub-projects evaluated) by Township

Township	Good		Fair		Poor	
	Number	%	Number	%	Number	%
Ann	2	20	8	80	–	–
Banmauk	5	50	5	50	–	–
Belin	3	30	7	70	–	–
Chaungzon	5	50	3	30	2	20
Demorso	9	90	1	10	–	–
Kanpetlet	2	22	6	67	1	11
Kawhmu	2	29	5	71	–	–

5 Good, Fair and Poor were defined using examples during the field training of the auditors. Generally, a SP that is functioning and meeting expectations will be rated Good. Fair ratings will be for those SP with some problems for which solutions are available. Poor SPs will be barely functioning and not meeting the needs of the user group.

Township	Good		Fair		Poor	
	Number	%	Number	%	Number	%
Kunchankone	2	40	3	60	–	–
Kyangin	4	40	5	50	1	10
Kyarinnseikkyi	6	60	4	40	–	–
Kyunsu	5	50	5	50	–	–
Loikaw	5	100	–		–	–
Mindon	3	30	7	70	–	–
Moenyo	3	30	7	70	–	–
Myaung	3	30	7	70	–	–
Ngaputaw	2	40	3	60	–	–
Ngazun	4	40	6	60	–	–
Nyaung U	4	40	6	60	–	–
Padaung	–	–	5	100	–	–
Paletwa	3	30	7	70	–	–
Pyawbwe	3	60	2	40	–	–
Pyinmana	1	17	3	50	2	33
Saw	1	20	4	80	–	–
Sidoktaya	4	40	6	60	–	–
Tanintharyi	5	50	5	50	–	–
Tatkone	2	20	4	40	4	40
Tharbaung	6	60	2	20	2	20
Average	**–**	**40%**	**–**	**55%**	**–**	**5%**

Table 6 examines the same data according to sub-project type across all 27 townships.

TABLE 6: Technical Quality of Design by Sub-project Type, 2018 (% of Sub-projects Evaluated)

%	Building (68 SPs evaluated)	Bridge (41)	Water Supply (32)	Road (72)	Electricity (22)
Good	37	37	51	40	48
Fair	61	63	49	53	39
Poor	1	–	–	7	13

These percentages can be compared with the data from the 2016 audit (shown in Table 7).

TABLE 7: Technical Quality of Design by Sub-project Type, 2016 (% of Sub-projects Evaluated)

%	Building (64 SPs evaluated)	Bridge (15)	Water Supply (36)	Road (72)	Electricity (23)
Good	40	20	42	29	27
Fair	58	80	58	68	68
Poor	2	–	–	3	5

Discussion:

Table 5 shows that 12 of the 27 audited townships display less-than-average results for a 'Good' quality of design among the sampled sub-projects (i.e. less than the average of 40%, in column 3). Of these less-than-average townships, 6 were also found to have one or more 'Poor' designs: Chaungzon, Kanpetlet, Kyangin, Pyinmana, Tatkone and Tharbaung .

On a positive note, however, Tables 6 and 7 clearly show that the NCDDP has improved the quality of its designs significantly since the technical audit of 2016. Four of the five infrastructure types have shown an increase in quality, with percentages of 'Good' sub-project files increasing, some markedly so.

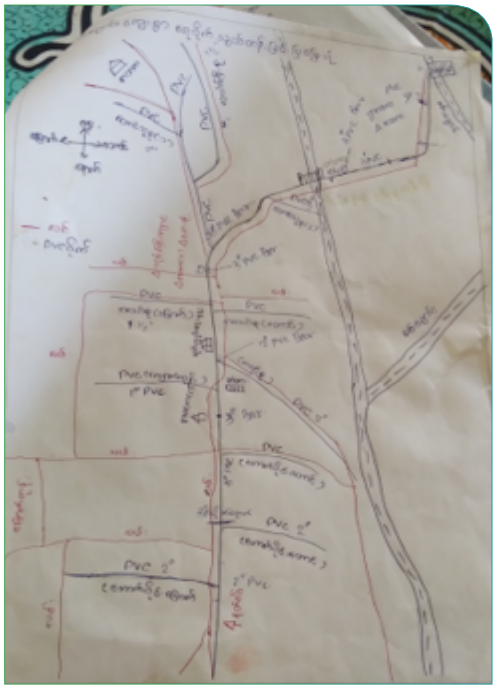
However, the most recent review indicates a worrisome trend with both Road and Electrical sub-project design, where 'Poor' designs have increased (especially for Electrical).

> **Recommendation 1:** The NCDDP Engineering Department should examine the technical resources that the townships have for the infrastructure types where 'Poor' designs have been noted (particularly Road and Electrical). Additional support (drawings, manuals, training, additional personnel and so on) to some townships is warranted.

As-Built Condition Assessment

Field Tool 1 allowed each component or aspect of the five infrastructure types to be rated on five options: Meets Spec (Specification), Slightly Below Spec, Below Spec, Not Inspected, and Not Applicable. The rating is a reflection of how the component/aspect has followed the sub-project specifications, the quality of its material composition/inputs, and its consistency with the BOQ. Dropping critical design elements, such as toilet facilities, from a sub-project would merit a Below Spec rating and, likely, a specific written comment on the field tool. The rating system of Meets Spec/Slightly Below Spec/ Below Spec is analogous to Good/Fair/Poor.

The technical quality for each component of each sub-project was reviewed in detail to understand how well each infrastructure has been constructed. If one



Note: Excellent schematic plan of water system and marked-up in an as-built condition. Kya Khat Chaung village, Kya Khat Chaung VT, Kyarinseikgyi township.

is examining the data collected for a bridge sub-project, for example, the individual technical quality ratings for 14 different components is analyzed, from layout and foundation to connections and apron/ramp. A detailed examination of the data from one bridge might reveal that the concrete foundation and reinforced column works were done poorly, while the upper wood assembly was done properly. This might indicate that local unskilled workers did not receive adequate direction while performing the underside concrete support works but became more confident when they were working with local timber and wood-joinery techniques. Notations on each sub-project's data input sheet might be informative with regard to the circumstances at the respective sub-project.

To form an overall sense of the technical quality of the NCDDP's sub-project work, it is possible to aggregate the component ratings, so that one can identify general trends in the data gathered. Regarding water supply sub-projects, for example, the ratings recorded for each of the 16 components/aspects can be gathered and examined as a representation of the average quality rating of each component/aspect of water supply sub-projects as a whole. An aggregate of the ratings from representative samples will provide insights into the whole group of sub-project types and will point to those parts of the NCDDP's construction methodologies that most require improvements. Table 8 shows the aggregate of ratings from the water supply sub-projects audited in 2018, presenting an abbreviated list of water supply components/aspects. A full list of the components/aspects rated for each sub-project type is provided in Annex 3.

TABLE 8: Aggregated Sub-Project Ratings for Water Supply Components, 2018 (% of Sub-projects Evaluated)

		Meets Spec	Slightly Below Spec	Below Spec
1	Watershed Protection (22 SPs evaluated)	77	18	5
2	Water System Design (30)	70	30	–
3	Transmission/Distribution Pipe (24)	67	33	–
4	Reservoir - Easy to Clean (29)	90	10	–
5	Public Tapstands - Drainage (14)	29	71	–
6	Water Pressure and Quantity (25)	88	12	–

It is useful to compare this table with that presented in the 2016 Final Report (see Table 9).

TABLE 9: Aggregated Sub-Project Ratings for Water Supply Components, 2016 (% of Sub-projects Evaluated)

		Meets Spec	Slightly Below Spec	Below Spec
1	Watershed Protection (29 SPs evaluated)	66	28	7
2	Water System Design (30)	70	27	3
3	Transmission/Distribution Pipe (18)	44	56	–

		Meets Spec	Slightly Below Spec	Below Spec
4	Reservoir - Easy to Clean (28)	89	11	–
5	Public Tapstands - Drainage (11)	45	36	18
6	Water Pressure and Quantity (17)	71	29	–

Discussion:

Table 8 and 9 provide detailed data on specific parts of typical water supply systems. Watershed protection, line 1, refers to the upland area above reservoirs for gravity-fed systems as well as a minimum distance of at least 100 feet of separation for boreholes from a source of contamination. Having some form of protection for these areas is necessary to prevent contamination of the water source. This can take the form of fencing, making the watershed out of bounds, monitoring activities, and ensuring that nothing deleterious is released. Of the 22 sub-projects that were assessed in this regard during the 2018 audit, 77 percent (17 sub-projects) were considered as Meets Spec. A further 18 percent (4 sub-projects) were rated Slightly Below Spec—these may have been gravity systems where it was apparent that some uncontrolled activities might be taking place above a source or a borehole installed without proper fencing or with toilets/pooled stagnant water nearby and so on. One sub-project in the 2018 audit (5 percent of the water supply sub-projects) was considered to be Below Spec. Commentary recorded for this instance indicates that pools of contaminated water were observed near a borehole for the system in Taw Pa Kauk, Chaungzon Township. It can be seen that the results for this component of water supply systems have improved from the 2016 audit to the current one, rising from 66 percent Meets Spec to 77 percent.

Other components of water supply systems can be examined in a similar manner and, for most, some improvement over the last two years is observed. The lone exception, drainage aspects for public tapstands, shows some slippage within the Meets Spec rating, although reduction of the Below Spec instances can be seen as offsetting this.

A thorough analysis of all the components/aspects for each of the sub-project types is offered in Section 10 - Best Practices and Recommendations.

To understand the technical quality of the full breadth of sub-project works, all the ratings assigned to the components/aspects of all the sub-projects can be aggregated, providing a useful overview of the NCDDP's entire construction program.

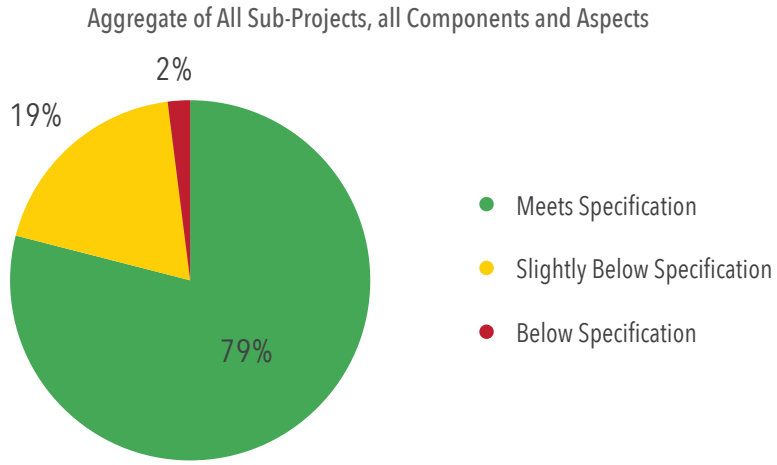
An analysis of these ratings shows that, when considering an aggregate of all sub-project compo-

Note: Good example of proper fencing around water supply well, drainage ditch, shelter. Whay Man Kaw village, Naung Kan VT, Banmauk township.

nents, 79 percent of the sub-projects have been constructed in accordance with the plans and specifications contained in the sub-project proposals and considered to Meet Spec, with a further 21 percent rated Slightly Below Spec in terms of meeting the intent of the sub-project proposal. **Only 2 percent of technical ratings were Below Spec.** (This compares to the 2016 audit where 78 percent of the components were considered to Meet Spec, 22 percent were Slightly Below Spec, and 3 percent Below Spec)

Chart 1 represents this finding, using an aggregate of all the technical components of the sub-projects evaluated.

CHART 1: Technical Quality Rating of Sub-Project Construction



Source: Technical audit study data

Table 10 presents separate totals for each of the sub-project types evaluated.

TABLE 10: Summary of Component Technical Ratings by Sub-project Type, 2018 (% of Sub-projects Evaluated)

	Meets Spec	Slightly Below Spec	Below Spec
Building (68 sub-projects evaluated)	75	23	2
Bridge (41)	82	17	1
Water Supply (32)	76	23	1
Road (72)	82	14	4
Electricity (22)	82	17	1
Average (235 NCDDP sub-projects)	**79**	**19**	**2**

This can be compared to the figures from the 2016 audit (see Table 11).

TABLE 11: Summary of Component Technical Ratings by Sub-project Type, 2016 (% of Sub-projects Evaluated)

2016	Meets Spec	Slightly Below Spec	Below Spec
Building (64 sub-projects evaluated)	79	19	2
Bridge (15)	91	6	3
Water Supply (36)	79	18	3
Road (72)	75	16	9
Electricity (23)	57	42	2
Average (210 NCDDP sub-projects)	**78**	**19**	**3**

Discussion:

The overall technical quality rating for NCDDP sub-projects has remained remarkably consistent over the past two years (77 percent of all components Meet Spec, slightly down from 78 percent in 2016), which can be considered within the bounds of error and a satisfactory result. These percentages are based on the aggregated quality ratings of an average of 16 components and aspects for each of the five NCDDP infrastructure types.

Note: Diesel generator building with excellent venting, note muffled exhaust discharge to outside; electrical supply to 136 households. Ya Taung (Atwin) village, Maung Hlaw VT, Kyunsu township.

Bridge sub-projects have remained above average in their technical quality and have been joined by electrical and road sub-projects (a promising sign that suggestions for technical improvements in these sectors have been acted upon). All infrastructure types have seen a reduction in the components/aspects considered Below Spec, another indication that technical quality control has been improved.

A detailed examination of the data gathered for each component/aspect of the infrastructures will give an understanding of how each sub-project type can be further improved. Where quality ratings of Slightly Below Spec and Below Spec are selected in the field tools, notations and commentary are often recorded. A full analysis of the data is presented in Section 10 - Findings -- Best Practices and Recommendations. Strategies to improve construction materials or methodologies will be offered.

A similar examination of the data can be done for the sub-projects evaluated in each township, as shown in Table 12.

TABLE 12: Summary of Component Technical Ratings by Township, 2018 (% of Sub-projects Evaluated)

Township	Meets Spec	Slightly Below Spec	Below Spec
Ann	63	37	0
Banmauk	76	23	1
Belin	77	20	3
Chaungzon	90	8	1
Demorso	82	18	0
Kanpetlet	70	26	4
Kawhmu	67	33	0
Kunchankone	68	32	0
Kyangin	95	5	0
Kyarinnseikkyi	85	14	2
Kyunsu	79	21	1
Loikaw	87	10	3
Mindon	81	18	1
Moenyo	86	13	1
Myaung	60	40	0
Ngaputaw	69	28	3
Ngazun	80	20	0
Nyaung U	66	34	0
Padaung	75	21	4
Paletwa	76	23	2

Township	Meets Spec	Slightly Below Spec	Below Spec
Pyawbwe	68	29	3
Pyinmana	85	13	2
Saw	81	17	2
Sidoktaya	82	17	1
Tanintharyi	74	22	5
Tatkone	81	19	0
Tharbaung	80	20	0
Average	**79**	**19**	**2**

Discussion:

Table 12 is useful to identify those townships where the percentage of sub-project components rated Meets Spec falls below the national average. The values for Ann, Kanpetlet, Kawhmu, Kunchankone, Myaung, Ngaputaw, Nyaung U, and Pyawbwe are low enough to warrant some attention in this regard. Further detailed analysis can be done for individual townships to pinpoint problems within specific infrastructure types.

6.2 Quality of Inputs

The quality of the inputs to each sub-project and their consistency with the BOQ and specifications was assessed as part of the technical rating provided in Section 6.1, reported above. Where quality of inputs was perceived to be problematic for a sub-project, the rating assigned would be Slightly Below Spec or Below Spec.

An analysis of these findings, broken down by sub-project type and component is fully presented in Section 10 - Findings -- Best Practices and Recommendations.

6.3 Maintaining Technical Specifications

Similar to 6.2, above, sub-projects were rated based on the technical specifications presented within the sub-project documentation. If a sub-project did not follow the scope as outlined in the village documentation, a rating of Slightly Below Spec or Below Spec would have been assigned as appropriate. The omission of critical design elements would normally spur a rating of Below Spec (and accompanied by a written comment of explanation).

Table 10, Summary of Component Technical Ratings by Sub-project Type, 2018, shows that an average of only 2 percent of the components making up all sub-project types were considered to be Below Spec (with the heaviest weighting of these associated with road sub-projects). Considering that building sub-projects display an average of only 2 percent Below Spec, it is likely that very few (if any) critical design elements have been omitted from site works.

However, the fact that road sub-projects continue to have the highest number of Below Spec ratings (4 percent currently and 9 percent in 2016; see Table 11) does indicate that more attention should be directed to this infrastructure type within the NCDDP's engineering portfolio.

Further detailed analysis of these data and associated findings are provided in Section 10 - Findings -- Best Practices and Recommendations.

6.4 Documentation

6.5 Hand-over

A number of design, file documentation, construction, hand-over, and procedural indicators were verified and checked by the auditor team at each sub-project site visited. The results are shown in Table 13.

TABLE 13: Design Process and Construction Documentation (Aggregate of All Sub-projects Evaluated)

	Design and Documentation Criteria		Yes	No
1	End users consulted during the design process		97%	3%
2	As-built records in possession of VPSC		89%	11%
		Good	Fair	Poor
3	Final inspection form and SP file completeness, 2018 audit	55%	44%	1%
4	Final inspection form and SP file completeness, 2016 audit	23%	69%	7%

Discussion:

NCDDP consultation with the village user groups during the design stage is an important part of the implementation process. As seen in Table 13, line 1, **almost all VPSCs (224 committees (97 percent)) reported that NCDDP staff spent time with them as the sub-project planning and design was under way.** This result confirms that these village interactions follow standard NCDDP practice. This result is slightly less than that found in 2016, when only a single village reported no consultation during that audit.

A large majority of VPSC files (89 percent) contained as-built record drawings, as shown in line 2 of Table 13. This is an improvement from the last audit's outcome where this was the case in only 57 percent of sub-projects audited.

The evaluation of sub-project file completeness also shows improvement between the 2016 and 2018 audits, as seen in Table 13, lines 3 and 4.

> **Recommendation 2:** The NCDDP should investigate the circumstances where it was reported that no user consultations were conducted during the sub-project design period.

6.6 Inclusion of Disaster Risk Mitigation Considerations

To date, DRM has not yet been brought into the NCDDP sub-project planning and implementation process. Forms and training materials are being developed and the NCDDP staff and consultants are awaiting training by DRM experts.

Note: The absence of wingwalls will compromise the performance of this bridge during flood events. High waters will erode and sweep away the road approaches, leaving no access across the water course. Erosion protection measures are needed. U Chun Kone village, Kyar In Shwe Doe VT, Kyarinseikgyi township.

The NCDDP's development of roads, bridges, water supply systems, buildings, and other infrastructure in remote areas will introduce important DRM considerations to villagers. The introduction of DRM manuals and checklists for the sub-project design process will help avoid or mitigate future problems.

Technical evaluators were asked to make note of situations where disaster risks seemed apparent at the sampled sub-project sites, using Field Tool 4 - Operation and Maintenance /Sustainability. Following is a summary of the results of this audit that will help inform the NCDDP's efforts to institutionalize this management procedure.

TABLE 14: Disaster Risk Management, Audit Questions

SP Type	Percent of sub-projects Answering "Yes"			
	Is the SP safe from flooding?	Are erosion protection measures sufficient?	Low landslide risk; no steep slopes	Low forest fire risk; clear area between
Building (68 SPs evaluated)	91	89	96	93
Bridge (41)	97	91	97	97
Water Supply (32)	96	92	96	96
Road (72)	77	88	81	93
Electricity (22)	100	94	82	88

Discussion:

It is evident that the great majority of NCDDP sub-projects audited are at low risk of being damaged during disastrous events. Roads can be singled out as being most susceptible. Proper drainage and slope design/protection will mitigate these threats.

> **Recommendation 3:** The introduction of DRM protocols into the design process should include a training course for NCDDP technical personnel that will emphasize the responsibility of designers to fully consider the forces of nature when planning rural infrastructure and how well-planned, implemented, and maintained structures can withstand damage during disastrous events.

6.7 Overall Quality Ratings

Field Tool 1 has a section where the evaluator, having evaluated the sub-project proposal and each of the components of the infrastructure itself, can review the sub-project as a whole entity, taking into account the severity of imperfections or deficiencies in aspects of the construction. These ratings use the World Bank's standard six-point scale in assessing project performance, as presented in Table 15.

TABLE 15: Overall Quality Rating system

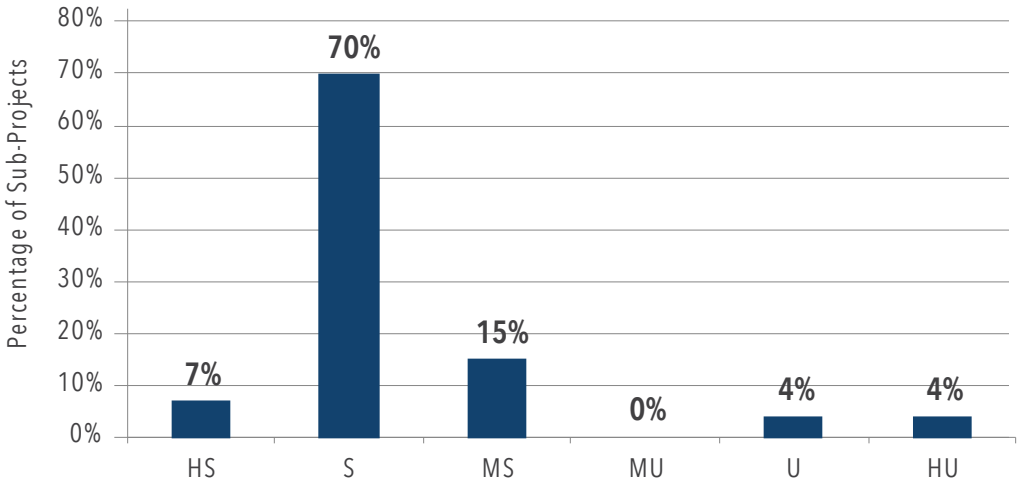
Rating	Description
1. Highly Satisfactory (HS)	Project fully complies with or exceeds policy requirements.
2. Satisfactory (S)	Minor shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
3. Moderately Satisfactory (MS)	Moderate shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
4. Moderately Unsatisfactory (MU)	Moderate shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress but resolution is likely.
5. Unsatisfactory (U)	Significant shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress and resolution is uncertain.
6. Highly Unsatisfactory (HU)	Major shortcomings exist in compliance with policy requirements or achievement of development objectives

Note: A complete listing of the sub-project evaluated and their individual quality ratings is provided in Annex 4.

The overall quality of 16 sub-projects was found to be Highly Satisfactory with another 162 sub-projects rated Satisfactory. A further 33 sub-projects were rated Moderately Satisfactory. About 8 percent of the rural infrastructures were evaluated as Moderately Unsatisfactory or lower.

Most of the infrastructure examined during this evaluation was considered Satisfactory in construction and documentation quality. Seven percent of sub-projects were rated Highly Satisfactory.

CHART 2: Sub-Project Overall Quality Rating



Source: Audit study data

6.8 Impact of Remoteness on Technical Quality

The technical evaluation Field Tool 1 provided data fields where the evaluator recorded the degree of remoteness for a sub-project village. The degrees, their definitions, and number of sub-projects for each are as follows:

TABLE 16: Degree of Remoteness and Sampled Number of Sub-projects

Degree	Definition	No. of SPs
Not Remote	Close to a main road and within 30-minute drive from township center	62
Remote	Off main road; within 2 hours of township center	117
Very Remote	Between 2 and 4 hours from township center	43
Extremely Remote	Greater than 4 hours from township center	13

The data were sorted to determine if remoteness of the village played a significant part in the technical quality rating of a sub-project's components. A hypothesis might be that the technical quality of a sub-project will go down as the degree of remoteness goes up, due to a number of possible factors: increased difficulty for technical facilitators to visit the site, reduced number of skilled laborers being available, increased difficulty in securing proper construction materials, and so on.

Note: Road rated Highly Satisfactory. Note proper camber and drainage. Farmers indicate economic benefits from easier movements of agricultural inputs and crops. Chan Thar Kone village, We Gyi VT, Monyo township.

TABLE 17: Remoteness, Aggregate of Ratings for All Sub-projects, All Components (%)

	Meets Spec	Slightly Below Spec	Below Spec
Not Remote (62 SPs)	79	19	1
Remote (117 SPs)	78	21	2
Very Remote (43 SPs)	74	24	2
Extremely Remote (13 SPs)	65	35	0

Discussion:

The data gathered during this audit indicate that there is a trend toward lower quality of infrastructure as the degree of remoteness rises. It can be seen that the Meets Spec percentage goes from 79 percent (slightly higher than the 2018 national average) on a steadily downward direction to only 65 percent for extremely remote sites. This negative trend was not apparent in the data from the 2016 audit.

To counter this trend, it may be necessary to put additional technical resources into the field to ensure that even the most remote sites receive adequate technical support. Further examination of this issue will be offered later in this report (see 6.9 Technical Facilitation).

6.9 Impact of Age of Sub-project on Technical Quality

Data were also analyzed to determine if there are any apparent trends in technical quality based upon when the sub-project was constructed (see Table 18). The main difference that might influence technical aspects of sub-projects according to cycle is the frequency and quality of technical facilitation and supervision (assuming that quality of material supply and local skilled labor remain the same). The influence of technical facilitation is studied in Section 6.9.

TABLE 18: Construction Year, Aggregate of Ratings for All Sub-projects, All Components, 2018 Technical Audit (%)

	Meets Spec	Slightly Below Spec	Below Spec
2016 (96 SPs)	79	19	2
2017 (139 SPs)	76	23	1

The table shows that there was a small decline in overall technical quality of sub-projects between the 2016 and 2017 implementation period. However, this slight difference may be within the audit's margin of error.

6.10 Technical Facilitation

The audit teams gathered information regarding how often technical facilitators had visited sub-project sites. Auditors consulted the VPSC's construction records book to inspect comments left by technical facilitators during each visit.

Based on records from 219 sub-projects, **technical facilitation visits to sub-project sites averaged 4.7 inspections per month** (a bit more than once per week) during implementation. These data was also sorted by degree of remoteness (Table 19) to see if the number of inspections fluctuated according to this parameter.

TABLE 19: Technical Facilitation Visits/Construction Period, by Sub-project Remoteness

	Not Remote	Remote	Very Remote	Extremely Remote
No. of visits/month - 2018 Audit	5.8	4.7	3.7	3.4
No. of visits/month - 2016 Audit	6.5	5.9	5.3	4.2

Discussion:

Similar to the data from the last technical audit, it is apparent that less remote sites receive more facilitation visits than those that are more remote. The data from this audit indicate that this disparity has grown more acute: Extremely Remote sites in the current audit received only 59 percent of the technical facilitation visits than the Not Remote sites (while in the 2016 audit this was 65 percent).

Referring back to Section 6.7, the technical quality of more remote NCDDP infrastructure has appeared to suffer, perhaps as a result of this lower amount of technical facilitation.

Recommendation 4: The NCDDP should use the results of this audit to reaffirm its technical support services to villages. Training courses should emphasize the importance of extending design and construction facilitation to the most remote villages in townships.

6.11 Universal Accessibility

Universal accessibility (UA) is the concept that public infrastructures and services should be designed and constructed to be inherently accessible to older people, people without disabilities, and people with disabilities. The addition of UA facilities to public buildings can often be done for approximately 1 percent of the infrastructure's total budget, taking the form of wooden or concrete ramps. Ramps steeper than 5 percent should be fitted with a sturdy handrail, and concrete surfaces should be brushed to provide good traction in wet weather.

The NCDDP uses designs from the Ministry of Education for the development of schools. These plans do not feature UA facilities; however, the intention of the NCDDP is to include ramps for disabled persons.

However, the 2018 audit noted that many public buildings have not been equipped with any means for handicapped, elderly, or mobility-challenged people to easily enter and make use of the facilities. In most cases the NCDDP plans and specifications do not show or make reference to the installation or requirement for UA ramps. In these cases, technical auditors were instructed to rate the absence of a sub-project's Ramp and Handrail component as being Slightly Below Spec rather than Below Spec (reasoning that local construction workers would not install a ramp if it was not shown on the drawings but should not be responsible for the oversight on the part of the designers).

TABLE 20: Universal Accessibility (Number of Sub-project Buildings Evaluated)

	Meets Spec	Slightly Below Spec	Below Spec	Not Inspected	Not Applicable
2018 Audit	10	31	4	2	22

Note: Congruent data from 2016 are unavailable.

Recommendation 5: The NCDDP should revise its engineering design guidelines to include explicit provisions for UA in public building infrastructure.

Recommendation 6: Ramps for the disabled are an important feature to guarantee UA to public infrastructure. Ramps should not be constructed steeper than 16 percent and should have a rough/non-slip surface so that the ramps are wheelchair accessible with a helper. Ramps steeper than 5 percent should be equipped with a proper handrail.

7. Findings – Cost Effectiveness

The technical evaluation of the NCDDP sub-projects and CSPs used Field Tool 2 for gathering information that would aid in determining the cost effectiveness of the investments. The instrument collects key infrastructure financial information, dimensions, materials, and construction management costs. Technical evaluators examined sub-project/CSP file resources at the site, village, and township levels to complete these checklists and physically measured the rural infrastructures to confirm their as-built condition. The creation of spreadsheets containing all of this information has allowed comparisons to be made and conclusions drawn regarding the cost effectiveness of investments in the NCDDP sub-projects versus investments in comparable infrastructures by others.

The Cost Effectiveness field tool is unique for each infrastructure type (Building, Bridge, Water Supply, Road, and Electricity) in order to develop relevant unit-cost data. The Building data sheet, for example, required length and width of the building, number of rooms, type of materials used, and so on, while Water Supply required length and size of pipe, size of reservoirs, number of tapstands, and so on. A portion of the field tool, pertaining to standard sub-project management costs, was common to all sub-project types.

BOQs, designs, specifications, and other sub-project documents were examined to record relevant data for these comparisons. Sub-project dimensions were checked at the sites to confirm both as-built drawings and unit area costs of construction.

Table 21 shows the number of NCDDP sub-project types versus the CSPs evaluated. Several CSPs visited could not be used for this analysis as they lacked adequate budget and cost details.

TABLE 21: NCDDP and Comparable Sub-Projects by Type

	Building	Bridge	Water Supply	Road	Electricity	Total
NCDDP SPs	68	41	32	72	22	235
CSPs	6	8	12	7	5	38

Given sample sizes for the CSPs, data gathered for bridge, water supply and electricity sub-project types will be more reliable than that collected for the other sub-projects.

> **Recommendation 7:** More robust methodologies should be developed to increase the number of CSPs evaluated during future technical audits so that analysis can be made with more certainty.

The CSPs evaluated during this study were as follows.

TABLE 22: List of Comparable Sub-projects and Executing Agencies

	CSP Type	Township	Village Tract	Village	Year	Agency
1	Building	Ann	Taik Maw	Taik Maw	2016	MDCG
2	Building	Paletwa	Pyin Wa	Ku Wa	2012	IRC
3	Building	Nyaung U	Kamma	Aing Gyi	2012	Wind of Mingalar Japan
4	Building	Tatkone	Htone Bo	Htone Bo	2016	Ministry of Education
5	Building	Thar Paung	Shan Ma Myaung	Wea Gyi Daung	?	World Vision
6	Bridge	Demoso	Htee Peka Loe	Daw Khu Li	2014	UN Habitat
7	Bridge	Paletwa	Not available	Not available	2016	Municipal
8	Bridge	Myaung	Kin	Kin	2017	Congress Budget
9	Bridge	Kyankhin	Kwa Ma	Chaung Gwa	2018	DRD
10	Bridge	Kunchankone	Su Ka Lat	Su Ka Lat	2017	DRD
11	Bridge	Kunchankone	Let Khoke Kone	Sal Eain Tan	2018	DRD
12	Bridge	Kawhmu	Yar Htut	Pyar Htut	2017	Constituency Fund
13	Water Supply	Loikaw	Daw Phu	Ta Hpo	2016	DRD
14	Water Supply	Kanpetlet	Lun Don	Lun Don	2005	UNDP
15	Water Supply	Ngaputaw	Tha Mar Dae Wa	Ah Le Kone	2017	DRD
16	Water Supply	Pyawbwe	Baw Di Kone	Kyet Hpyu Kone	2017	UNICEF, DRD, community
17	Water Supply	Kyankhin	Sonelae	Thaw Phyu	2017	DRD
18	Water Supply	Myaung	Shwe Pauk Pin	Shwe Pauk Pin	2017	DRD
19	Water Supply	Nyaung U	Da Hat Se	Da Hat Se	2017	DRD
20	Water Supply	Nyaung U	Nyaung Pin Thar	Nyaung Pin Thar	2017	JICA
21	Water Supply	Nyaung U	Su Ti	Taung Taw Pine	2017	UNICEF

	CSP Type	Township	Village Tract	Village	Year	Agency
22	Water Supply	Nyaung U	Tu Yoon Tie	Phoe Ni Khan	2017	JICA
23	Water Supply	Nyaung U	Se	Ta Ma Khar	2018	Congress Budget
24	Road	Kanpetlet	Lun Don	Lun Don	2016	Ministry of Border Affairs
25	Road	Ann	Boke Chaung	Boke Chaung	2017	Constituency Fund
26	Road	Kunchankone	Su Ka Lat	Su Ka Lat	2017	DRD
27	Road	Kunchankone	Hmaw Bi	Ah Dat	2017	Constituency Fund
28	Road	Padaung	Dant Da Lun	Kyar Inn	2017	Constituency Fund
29	Road	Monyo	Ba Yarr Ngu	Moe Thit Sar	217	Constituency Fund
30	Electricity	Loikaw	Daw Paw Kale	Htay Ngha Hlyar	2015	DRD
31	Electricity	Pyawbwe	Kan Gyi	Ma Au Taw	2017	Community
32	Electricity	Kyankhin	Htantapin	Kyauk Mhaw Go	2017	EPC (Tsp Electrical Power Contribution)
33	Electricity	Myaung	Myit Thar	Thu Ka Di Pa	2017	DRD
34	Electricity	Kawhmu	Not available	Tar Lan Thit	2018	MEPE
35	Building	Ann	Taik Maw	Taik Maw	2016	MDCG
36	Water Supply	Kyankhin	Sonelae	Thaw Phyu	2017	DRD
37	Bridge	Myaung	Kin	Kin	2017	Constituency Fund
38	Road	Padaung	Hpa Yon Kar	Myout Phat Kho	2017	Constituency Fund

Note: EPC = Electrical Power Contribution; IRC = International Rescue Committee; JICA = Japan International Cooperation Agency; MDGC = (unknown acronym supplied by auditor), MEPE = Myanmar Electric Power Enterprise; UNDP = United Nations Development Programme; UNICEF = United Nations Children's Fund.

The remainder of this section presents and discusses the findings of the study in terms of the cost-effectiveness of NCDDP sub-projects, organized by the questions posed in the study TORs.

7.1 Unit Cost Comparisons

Buildings

Cost data for building sub-projects were gathered at 68 NCDDP sub-project and 5 CSP sites. However, of these 68 NCDDP sub-projects, only 39 newly constructed building sub-projects were used for cost comparison purposes as the costs for rehabilitation varied considerably. All 5 CSP building sub-projects were new construction.

TABLE 23: NCDDP (new structures) vs Comparable Building Sub-Projects

	Unit Cost (kyat/sq. ft.
NCDDP SPs	10,000
CSPs	10,750

Discussion:

Building square footage costs were calculated based on data drawn from village sub-project files and/or confirmed onsite. Some information was gathered at other sites, mainly NCDDP township offices.

All NCDDP sub-project construction costs cited in this section include all community contributions (whether in cash or in-kind) from villagers. If these community contributions were to be subtracted from the sub-project budgets, **NCDDP infrastructure would be much more cost effective when compared to similar constructions by other agencies.**

Bridges

There is a large variety in the size of and material used for the construction of the bridges that were evaluated in this study. It is necessary to compare bridges that are of generally equal size and constructed of similar materials. Of the seven CSP bridges examined in this study, 5 were concrete (compared to 21 NCDDP concrete bridges) and 1 was wooden (compared with 6 NCDDP).

The average unit costs for NCDDP reinforced concrete bridge construction is 27,250 kyat/sq. ft. (which is consistent with the findings of the 2016 audit of 27,600 kyat/sq. ft.). While the average unit costs for wooden bridges is 17,267 kyat/sq. ft. In comparison, the study found that the average unit costs for comparable concrete bridge construction is approximately 32,800 kyat/sq. ft., and for wooden bridge construction is 16,100 kyat/sq. ft. As such, the unit costs of NCDDP bridge construction are less than those of other implementing agencies and can therefore be considered cost effective.

Note: Bridge - Pan Taw village, Pan Taw VT, Ban Mauk township.

The road between Pan Taw village and its nearest school has always presented a challenge for students: a muddy and sometimes actively running water course to cross. Up to 140 children navigate this route every school day. During rainy periods, longer routes have to be used as the water gets too deep here.

The village decided to build this wooden bridge, 13'3" x 9'. Villagers volunteered labor and supplied local materials worth a total of 90,000 kyat and painted the bridge using 13,300 kyat from the first collection of O&M funds. Villagers intend to support the maintenance of the bridge, collecting 2,400 kyat per household per year, from 150 households. The auditors have recommended and the village O&M Committee supports a plan to replace the wooden wingwalls with mortared stone when sufficient funds have been collected.

Water Supply

Water supply systems are constructed in a variety of ways, with different methodologies being used to collect clean water, pipe it to a village, and deliver it to a user group. Each water system is unique. While some generalizations can be made and conclusions drawn, experienced engineers and technical personnel need to examine each proposed system's plans and specifications together with the budget to determine the true cost effectiveness of sub-project proposals.

The NCDDP primarily uses gravity-fed systems for their water supply sub-projects, where water is gathered at a mountain source and piped to a village. This study examined 14 such NCDDP gravity-fed water systems and two CSPs of this similar type.

The second and third most common water system evaluated in this study are diesel pump equipped boreholes/tube wells (8 sub-projects) or pond/pump systems (7). Six CSP water systems of these types were also evaluated. These various systems were sufficiently unique and different from one another that no comparisons of construction costs are able to be made.

The NCDDP construction costs for gravity-fed water systems (GFWS) vary greatly according to the specific infrastructure required for each scheme. This type of system was therefore analyzed according to the length of pipes for transmission and distribution-- from the source to the village, and within the village.

TABLE 24: NCDDP GFWS Unit Cost/Household by Transmission Pipe Length

Length of pipe	1,000–2,000 ft.	2,000–5,000 ft.	>5,000 ft.
Kyat/household	53,300	144,000	177,000
Number of SPs	3	3	5
Kyat/HH (2016)	15,000	33,000	95,000

Note: Three sub-projects with obvious outlier cost data were not included in determining these averages. Also, the two CSPs evaluated both had transmission pipes <1,000ft, thus not truly comparable to NCDDP's.

Discussion:

The increase in unit costs shown in Table 24 is a logical result of the increase in the length of transmission and distribution pipes. However, the dramatic increase in calculated unit costs between the 2016 and the current audit is less clearly understood, and should be further analyzed. No comparisons with CSPs are able to be done with the data gathered.

The unit cost for NCDDP borehole sub-projects is estimated at approximately 20,000 kyat per household, while CSP borehole construction was evaluated to cost 23,600 kyat per household, suggesting NCDDP borehole sub-projects are also cost-effective.

Roads

There were 72 NCDDP road sub-projects audited, and 7 CSP roads reviewed in comparison. The CSP roads were constructed by the DRD or the Ministry of Border Affairs, many of them using Constituency funds. The type of materials and construction methodologies differed for each sub-project. Table 25 outlines the variety of roads evaluated.

TABLE 25: Road Construction Materials (Number of Sub-projects Evaluated)

	Earth	Gravel/Macadam	Concrete
NCDDP	15	34	23
Comparable	3	–	4

The NCDDP earth road construction costs lie between 29 kyat/sq. ft. and 408 kyat/sq. ft. (excluding a single sub-project that was more than 5,000 kyat/sq. ft.). The average for the NCDDP earth roads, therefore, is 202 kyat/sq. ft.

The NCDDP gravel road construction costs lie between 113 kyat/sq. ft. and 675 kyat/sq. ft. (excluding several outliers above 1,000 kyat/sq. ft.). The average for the NCDDP gravel roads is 485 kyat/sq. ft.

The NCDDP concrete road construction costs lie between 752 kyat/sq. ft. and 3,262 kyat/sq. ft. (excluding some that were above 10,000 kyat/sq. ft.). The average for the NCDDP concrete roads is 1,597 kyat/sq. ft.

In comparing NCDDP road sub-project costs with those of CSPs, the evaluation team needed to add the cost of contributed labor (a condition of support from the executing agency) for the CSP sub-projects. For this purpose, similar unit costs of labor were included for the CSP roads. The comparison of costs between NCDDP road sub-projects and that of CSPs (including added labor costs) is shown in table 26. The labor contributions for roads under NCDDP are presented in Table 32.

TABLE 26: Average Unit Costs for Different Road Building Materials (kyat/sq. ft.)

	Earth	Gravel	Concrete
NCDDP	202	485	1,597
CSP	210	–	1,738

Discussion:

Comparing the NCDDP road sub-projects with CSPs one can see that the **unit-costs of NCDDP road sub-projects are similar to or slightly lower than the comparable CSP roads,** for both earth and concrete construction.

Electricity

The study reviewed 22 NCDDP electricity sub-projects and 5 comparable CSPs. The CSPs were executed by DRD (2), EPC, MEPE, and directly by one community itself. The electrical sub-projects were of different types, as shown in Table 27.

As shown in Table 28, in comparison to comparable sub-projects, **NCDDP's investments to extend access to electricity are between 42 percent (for grid expansion sub-projects) and 220 percent (for mini-/micro grid generators) less expensive per household.**

TABLE 27: Electrical Sub-Project Types (Number of Sub-projects/CSPs)

	Grid Extension	Generator	Solar Panel	Mini-Hydro
NCDDP	9	12	–	1
CSP	4	1	–	–

TABLE 28: Average Unit Costs for Different Electrification Methods - kyat/household (Number of sub-projects/CSPs)

	Grid Extension	Genset	Solar Panel	Mini-Hydro
NCDDP	186,900	24,000	–	Information not available
CSP	265,500	77,000	–	

7.2 Effects of Community Force Account

The majority of sub-projects evaluated were implemented through CFA rather than wholly by contractors, although more than a third of sub-projects did use contractors for some or all elements of the construction. Table 29 provides a breakdown of the sub-project types by implementation modality.

TABLE 29: Evaluated Sub-project Types by Implementation Modality, Number of Sub-projects

Modality	Building	Bridge	Water Supply	Road	Electricity	Total
CFA	41	31	21	63	8	164 (62%)
Contractor	10	3	5	7	9	34 (13%)
Joint	17	7	5	2	6	37 (25%)

To estimate the cost competitiveness of the NCDDP construction methodologies, the unit costs of the different sub-project implementation modalities were analyzed, based on budget information contained in the village sub-project files, which includes the costs for capacity development and supervision. This analysis, shown in Table 30, does not include the estimated O&M costs for the different methods of construction.

TABLE 30: Unit Cost of Sub-project Types by Implementation Modality (Number of Sub-projects)

Modality	Building kyat/sq. ft.	Bridge kyat/sq. ft.	Water Supply (Gravity Fed) kyat/HH	Water Supply (Borehole) kyat/HH
CFA	6,900 (40)	29,800 (31)	28,000 (15)	
Contractor	7,200 (10)	30,800 (3)	–	51,724 (7)
Joint	7,350 (16)	31,000 (7)	29,000 (4)	26,000 (2)

Modality	Road (Earth) kyat/sq. ft.	Road (Gravel) kyat/sq. ft.	Road (Macadam) kyat/sq. ft.	Road (Concrete) kyat/sq. ft.
CFA	77 (4)	410(10)	605 (5)	1,110 (44)
Contractor	56 (4)	325 (2)	–	1,235 (1)
Joint	65 (2)	–	–	–

Modality	Electricity (Grid Extension) kyat/HH	Electricity (Genset) kyat/HH	Electricity (Solar Panel) kyat/HH	Electricity (Mini-Hydro) kyat/HH
CFA	62,000 (4)	85,000 (2)	105,000 (1)	204,000 (1)
Contractor	54,000 (5)	–	205,000 (3)	220,000 (1)
Joint	45,000 (1)	80,500 (2)	158,750 (1)	185,000 (2)

Discussion:

Building

Data collected under the study from a **large sample of building sub-projects showed unit-costs for CFA construction modality to be more cost-effective than when contractors are used.** While the difference in unit costs is less than 5 percent, this is nonetheless an improvement over the findings of the 2016 audit that found CFA costs slightly higher for building sub-projects.

Bridge

A very large sampling of bridge sub-projects indicates a strong preference by communities to construct these structures themselves (CFA: 31 sub-projects; contractor: 3 sub-projects; joint: 7 sub-projects). The **CFA-constructed bridges are also shown as the most cost effective** (CFA 29,400 kyat/sq. ft. versus an average contractor/joint unit cost of 30,900 kyat/sq. ft.). Again, however, the difference in unit costs is minor.

Water Supply

A large number of NCDDP GFWS sub-projects that used CFA and joint construction methods were audited. In this instance, the study found that **CFA modality was slightly more cost effective than the joint implementation for GFWS**. The data for borehole sub-projects (which did not include any fully CFA sub-projects) suggest a significant unit-cost savings between joint community-contractor, versus fully contractor implemented (contractor: 51,700 kyat/household versus joint: 26,000 kyat/household). However, the study team believes that there were substantial cost-saving elements in the joint sub-projects that were not clearly identified sub-project cost documentations.

Road

Most of the study results indicates that contractor implementation (or joint) construction modalities yield lower unit-costs for road sub-projects across all types of roads but particularly earth and gravel (excluding a single outlier concrete road). The study team believes that this is due to the fact that contractors, who often own their own equipment, do not charge full market costs for the use of this equipment for road work they undertake.

Electricity

The unit cost for a grid extension sub-project is about 10 percent lower when using a contractor (compared to 30 percent in the 2016 technical audit). Other modes of electrical generation do not have enough data to arrive at firm conclusions.

In summary, the **CFA implementation modality will be more cost competitive for many NCDDP sub-project types**, including buildings, bridges, some water supply systems, and earth and gravel roads. However, unit-costs are lower for boreholes, concrete roads and grid extension electrical sub-projects where contractors are used.

7.3 Effects of Community Contributions

Local community contributions to NCDDP sub-projects are recorded in the village sub-project implementation files. Local contributions were made through cash contributions and the provision of labor and materials. **The average community contribution to an NCDDP sub-project is 7 percent of the infrastructure's total budget** (identical to the 2016 audit).

The NCDDP collects information on community contributions per guidelines and standard forms provided in the Operations Manual. These forms allow for the detailing of information on labor contributed (by name of laborer), the nature of the work, the type and quantity of materials supplied, and the date of such work. Labor contributions are generally for excavation work; supply of sand, gravel, or stone; general construction activities; and so on. Materials provided generally include those used for construction such as sand, gravel, bamboo, and so on. Form F8 is used to record the person-hours for specific days, along with calculations of estimated daily contributions based on standard hourly wages and typical market price for materials. Audit team members studied the community contribution documentation to see if there was evidence of NCDDP personnel checking and signing off on the information provided.

Table 31 shows the percentage of community contribution by township, along with the percentage of sub-projects where suitable records were found within the village sub-project files to verify the materials and labor that were accounted as contributions to the sub-project.

TABLE 31: Average Community Contribution by Township (% of Sub-project Budget)

Township	Community Contribution	Verification of Accounting
Ann	3%	60% (6 of 10)
Banmauk	8%	90% (9 of 10)
Belin	10%	10% (1 of 10)
Chaungzon	7%	30% (3 of 10)
Demorso	1%	90% (9 of 10)
Kanpetlet	3%	60% (6 of 10)
Kawhmu	8%	100% (10)
Kunchankone	6%	100% (5)
Kyangin	10%	70% (7 of 10)
Kyarinnseikkyi	4%	50% (5 of 10)
Kyunsu	15%	100% (10)
Loikaw	2%	80% (4 of 5)
Mindon	6%	90% (9 of 10)
Moenyo	8%	90% (9 of 10)
Myaung	8%	100% (10)
Ngaputaw	15%	80% (4 of 5)

Township	Community Contribution	Verification of Accounting
Ngazun	11%	100% (5)
Nyaung U	5%	50% (5 of 10)
Padaung	8%	80% (4 of 5)
Paletwa	7%	80% (8 of 10)
Pyawbwe	1%	40% (2 of 5)
Pyinmana	7%	100% (5)
Saw	5%	100% (5)
Sidoktaya	4%	80% (8 of 10)
Tanintharyi	3%	100% (10)
Tatkone	6%	60% (6 of 10)
Tharbaung	7%	80% (8 of 10)
Average (235 NCDDP SPs)	7%	72%

Discussion:

It can be seen that the amounts of voluntary contributions to NCDDP sub-project budgets are highly variable according to township, from a low of 1 percent in Pyawbwe and Demorso to a high of 15 percent in Kyunsu and Ngaputaw. It should be noted that Kyunsu also recorded the highest voluntary contributions in the 2016 audit. No commentary was recorded on the technical inspection forms to suggest why contribution levels differ from township to township.

The filing of proper documentation to record and verify these contributions is, for the most part, adequately performed in townships, with the notable exceptions of Belin, Chaungzon, and Pyawbwe where less than half of the sub-project files were found to contain the proper documents with respect to voluntary contributions. Other townships can also improve their record keeping in this respect to achieve 100 percent compliance with the Operations Manual.

> **Recommendation 8:** The NCDDP field staff training exercises should include field reviews of the village sub-project implementation files during monitoring visits. Community contributions should be checked and signed off on a regular basis.

7.4 Effects of Contributions on Cost-effectiveness

Many recipient communities have voluntarily contributed cash and labor or materials toward the sub-projects being constructed in their villages, contributing an average of 7 percent of the budgets. Table 32 shows the average amounts contributed for each type of the sub-project.

TABLE 32: Average Community Contributions, kyat, Rounded (Number of Sub-projects Sampled)

	Cash Contribution	Labour and Local Materials Supply	Transportation of Materials	Other Contributions	Total
Building (68)	892,000 (6)	476,000 (20)	477,000 (3)	276,000 (18)	2,121,000
Bridge (41)	1,728,000 (4)	856,000 (14)	244,000 (4)	429,000 (14)	3,257,000
Water Supply (32)	187,000 (5)	870,000 (14)	228,000 (5)	67,000 (18)	1,352,000
Road (72)	346,000 (3)	2,855,000 (17)	104,000 (2)	181,000 (24)	3,486,000
Electricity (22)	1,485,000 (7)	1,242,000 (9)	133,000 (4)	64,000 (12)	1,439,000

Discussion:

The number of villages that contribute cash to sub-project construction varies from a low for water supply sub-projects to highs for electricity and bridge sub-projects. While only 4 percent of villages make monetary contributions to road sub-projects, 33 percent contribute cash to an electrification schemes (7 of 22 villages). However, and not surprisingly, a higher percentage of villages contribute labor or local materials, with the lowest being for road sub-projects (24 percent of villages donating labor or materials) and the highest for water supply sub-projects (44 percent).

The total number of villages that were reported as having voluntarily donated cash or contributed labor was 188 sub-projects (80 percent of the sample). Overall, road sub-projects receive the highest level of community contributions, averaging 3.5 million kyat per sub-project, with bridges a close second at 3.3 million kyat per sub-project.

No detailed research was conducted to determine the reasons for the variations in the different types and levels of contributions. Anecdotally, community members mentioned that the timing of the construction sometimes coincided with local agricultural activities, restricting their ability to volunteer labor. Villagers also indicated that cash contributions had been made by village members who are working outside the community.

Based on the evaluation sample's community contribution rate of 7 percent of total sub-project budget and voluntary participation rate of 80 percent, we conclude that the size of the contributions is reasonable for the size of the NCDDP investments.

Were community contributions an important factor in determining the cost effectiveness of NCDDP sub-projects relative to similar sub-projects supported by others?

The value of village voluntary contributions, usually labor or supply of local construction materials, is included as part of the NCDDP sub-project budget. These contributions clearly reduce the cost of NCDDP sub-projects to the overall project (and to Government and the World Bank), but only by approximately 7 percent as outlined above. However, these contributions have been factored into the analysis of cost-effectiveness that is presented in Section 7.1 of this study.

Line 1 in Table 33 provides the NCDDP unit costs as calculated in Section 7.1 for various types of infrastructure. The second line presents the calculation of the actual NCDDP investment by

subtracting the average local contributions (this audit calculated this to be 7 percent) and then calculating a new unit cost per sub-project type. The logical effect of this subtraction is to lower the average unit cost of the NCDDP infrastructure. The table compares the result with the unit costs of other agencies (line 3).

TABLE 33: Community Contributions' (CC) Effect on Cost Effectiveness

	(Number of SPs)	Building kyat/sq. ft.	Bridge (Reinforced Concrete) kyat/sq. ft.	Water Supply (Borehole) kyat/HH
1	NCDDP unit cost	10,000 (66)	27,250 (6)	20,000 (12)
2	NCDDP unit cost less CC	9,300	25,300	18,600
3	Comparable	10,750 (5)	32,800 (0)	23,600 (3)

		Road (Earth) kyat/sq. ft.	Road (Gravel) kyat/sq. ft.	Road (Concrete) kyat/sq. ft.
1	NCDDP unit cost	202 (15)	485 (34)	1,597 (23)
2	NCDDP unit cost less CC	181	436	1,430
3	Comparable	170 (2)		1,242 (4)

		Electricity (Solar Panel) kyat/HH
1	NCDDP unit cost	186,900 (7)
2	NCDDP unit cost less CC	168,000
3	Comparable	265,500 (4)

Discussion:

The cost effectiveness of all NCDDP infrastructure types would be increased by excluding the estimated value of voluntary contributions by communities.

7.5 Reasonableness of Costs

Similar to the findings from the 2016 audit, the costs that have been examined for this study are seen to be very reasonable for the entire sub-projects' works. One can therefore assume that the NCDDP costs for construction materials, transportation, village or contractor labor, and all other inputs are reasonable.

7.6 Considering Local Inputs

The designs for NCDDP sub-projects come from a number of sources, but all are based on local construction practices, which frequently are labor-based methodologies. For example, local laborers perform most excavations manually rather than using machinery. Where concrete is used, it is mixed by hand or using small machines and placed in formwork using buckets. These

techniques enable and promote the use of local unskilled labor. Construction materials are also sourced locally whenever possible, including sand, rock, and wood, allowing the sub-project funds to be used for other benefits to the community. Some of this work by villagers is provided as a community contribution to the sub-project financing, but much of it is paid as skilled or unskilled labor working for a contractor. As of the end of March 2018, there were an estimated 33 billion kyats in wages paid out to local community members for more than 5 million person-days of work carried out on NCDDP sub-projects, equal to approximately 18 percent of sub-project costs.[6]

7.7 Value for Money

The findings of this cost effectiveness study show that the NCDDP model of community sub-project implementation produces rural infrastructure of a generally suitable technical quality with budgets that are quite comparable to those of other agencies. This result is similar to the 2016 technical audit finding.

It continues to be evident from cost comparisons with comparable infrastructure by others that the NCDDP sub-projects have been designed, specified, and constructed to maximize value for money. The majority of the designs, technologies, and construction methods are suitable for the NCDDP communities and beneficiaries.

The social benefits through employment of local labor and procurement of local materials contribute to the economic returns of the sub-projects. This study shows that the CFA construction modality increases the sense of local ownership of the infrastructure which, in turn, benefits the ongoing O&M of the facilities.

6 These figures underestimate the total amount of labor and value of wages paid under NCDDP as these data were not collected for the first two years of project operation.

8. Findings — Compliance with Environmental and Social Safeguards

Following are the questions from the TOR, with discussion and analysis presented for each item as appropriate.

8.1 Safeguard Documentation

Field Tool 3 explores the quality of the infrastructure, the site selection, and the process under which the construction took place was assessed with regard to environmental and social considerations. The auditors referenced the Environmental and Social Management Framework (ESMF) and the Environmental Codes of Practice (ECOP) both presented in the NCDDP Operations Manual.

Project files were examined for proper documentation and evidence of monitoring and verification by Township NCDDP officials of community and contractor compliance with the ECOP. Table 34 presents a summary of these findings for an aggregate of all NCDDP sub-projects evaluated in each township.

TABLE 34: Summary of Environmental and Social Safeguards Findings by Township (% of Sub-Projects)

Township	ECOP Contained in SP File, with Evidence of Monitoring	Safeguard Screening Form PC 13 in Sub-project File	Environmental Management Plan Included in the File (Form PC 15) and Followed (No. of SPs)
Ann	100% (10 of 10)	100% (10 of 10)	2
Banmauk	100% (10 of 10)	100% (10 of 10)	–
Belin	100% (10 of 10)	100% (10 of 10)	–
Chaungzon	100% (10 of 10)	100% (10 of 10)	–
Demorso	100% (10 of 10)	100% (10 of 10)	–
Kanpetlet	100% (10 of 10)	100% (10 of 10)	–
Kawhmu	100% (10 of 10)	100% (10 of 10)	1
Kunchankone	100% (5 of 5)	100% (5 of 5)	–
Kyangin	100% (10 of 10)	100% (10 of 10)	–
Kyarinnseikkyi	100% (10 of 10)	100% (10 of 10)	–

Township	ECOP Contained in SP File, with Evidence of Monitoring	Safeguard Screening Form PC 13 in Sub-project File	Environmental Management Plan Included in the File (Form PC 15) and Followed (No. of SPs)
Kyunsu	100% (10 of 10)	90% (9 of 10)	–
Loikaw	100% (5 of 5)	100% (5 of 5)	–
Mindon	100% (10 of 10)	70% (7 of 10)	1
Moenyo	100% (10 of 10)	100% (10 of 10)	1
Myaung	100% (10 of 10)	100% (10 of 10)	–
Ngaputaw	100% (5 of 5)	100% (5 of 5)	1
Ngazun	100% (10 of 10)	100% (10 of 10)	–
Nyaung U	100% (10 of 10)	100% (10 of 10)	–
Padaung	80% (4 of 5)	100% (5 of 5)	1
Paletwa	100% (10 of 10)	100% (10 of 10)	–
Pyawbwe	100% (5 of 5)	100% (5 of 5)	–
Pyinmana	100% (5 of 5)	100% (5 of 5)	–
Saw	100% (5 of 5)	100% (5 of 5)	–
Sidoktaya	100% (10 of 10)	100% (10 of 10)	–
Tanintharyi	100% (10 of 10)	100% (10 of 10)	–
Tatkone	100% (10 of 10)	100% (10 of 10)	1
Tharbaung	100% (10 of 10)	100% (10 of 10)	1
Total (235)	100% (235 of 235)	98% (231 of 235)	4% (9 of 235)

Discussion:

The assessment of community sub-project files shows that sub-project implementation teams are properly maintaining safeguard documentation. **Documentation and evidence of monitoring of ECOPs existed for all sub-projects reviewed, and safeguard screening forms (PC 13) were present and properly filled in 98 percent of sub-projects reviewed.**

An Environmental Management Plan (EMP) is only required if triggered by the Safeguard Screening Form (PC 13), which asks questions relating to the potential impact a sub-project may have on the natural environment or historical/cultural resources. The audit found that in 4 percent of the sampled sub-projects, an EMP was required and was found in the sub-project files.

Loss of land or private assets, the scale of impact, whether or not they are addressed through voluntary donations, and if so, whether all conditions of voluntary donations as provided in the Operations Manual are met.

Field Tool 3 also asks evaluators to confirm the status of land used for the sub-project and whether or not transfers of land have been carried out in accordance with the NCDDP policy. The

study found that a **majority of sub-projects (80 percent) are constructed on existing public lands requiring no land donations** (see Table 35). The study further found that in 20 percent of cases, land donation was required for sub-project implementation and that NCDDP land policy was followed (with form PC 14 filed in sub-project records). Table 36 provides a breakdown of sub-project types requiring land donations.

TABLE 35: Voluntary Land Donation (Number of Sub-projects)

Township	Voluntary Land Donation Conditions Met (Form PC 14 in file)	No Land Donation Necessary for Sub-project
Ann (10)	3	7
Banmauk (10)	0	10
Belin (10)	0	10
Chaungzon (10)	0	10
Demorso (10)	2	8
Kanpetlet (5)	0	10
Kawhmu (10)	1	9
Kunchankone (5)	0	5
Kyangin (10)	2	8
Kyarinnseikkyi (10)	1	9
Kyunsu (10)	3	7
Loikaw (5)	1	4
Mindon (10)	5	5
Moenyo (10)	2	8
Myaung (10)	4	6
Ngaputaw (5)	1	4
Ngazun (10)	3	7
Nyaung U (10)	1	9
Padaung (5)	1	4
Paletwa (10)	0	10
Pyawbwe (5)	3	2
Pyinmana (5)	0	5
Saw (5)	1	4
Sidoktaya (10)	4	6
Tanintharyi (10)	3	7
Tatkone (10)	5	5

Township	Voluntary Land Donation Conditions Met (Form PC 14 in file)	No Land Donation Necessary for Sub-project
Tharbaung (10)	1	9
Total (235)	47s SP (20%)	188 SPs (80%)

TABLE 36: Land Donated by Sub-project Type

	Building	Bridge	Water Supply	Road	Electricity
Land donation required (number of SPs)	7	3	13	13	11
Total SPs evaluated	68	41	32	72	22

Discussion:

It can be noted from Table 36 that the predominant types of sub-projects requiring land donation are water supply (41 percent) and electrical schemes (50 percent). This reflects the nature and requirements for distributing the benefits of these types of sub-projects, where pipelines or electrical wiring must cross private property to most directly and easily reach all parts of a village. No reports of land disputes were recorded by the evaluation teams.

Verification of whether any adverse environmental impacts occurred at the sub-project site and how they were mitigated.

A thorough examination of the sub-project and surrounding area was performed as part of the Field Tool 1 investigation. Environmental impacts of the sub-project were observed at this time, along with mitigation measures that were part of the construction. Audit team members also reviewed the terms and conditions as set out in the ECOP, where it was available, to verify the sub-project's environmental requirements and mandated mitigation measures.

TABLE 37: ECOP Confirmation

(Number of SPs)	Site Inspection Confirms that ECOP Was Followed during Construction (% of SPs)
Ann (10)	100
Banmauk (10)	100
Belin (10)	100
Chaungzon (10)	100
Demorso (10)	100
Kanpetlet (10)	100
Kawhmu (10)	100
Kunchankone (5)	100
Kyangin (10)	100

(Number of SPs)	Site Inspection Confirms that ECOP Was Followed during Construction (% of SPs)
Kyarinnseikkyi (10)	100
Kyunsu (10)	100
Loikaw (5)	100
Mindon (10)	100
Moenyo (10)	100
Myaung (10)	100
Ngaputaw (5)	100
Ngazun (10)	100
Nyaung U (10)	100
Padaung (5)	80
Paletwa (10)	100
Pyawbwe (5)	100
Pyinmana (5)	100
Saw (5)	100
Sidoktaya (10)	100
Tanintharyi (10)	100
Tatkone (10)	100
Tharbaung (10)	100
Total (235)	100% (235 of 235)

Discussion:

When evaluators noticed specific mitigation measures being taken, they were instructed to make notes on the field instruments and later transcribe these comments to the data input tools. **All sub-projects evaluated were found to have adequately addressed issues that were raised in the ECOP for each site.**

9. Findings — Operation and Maintenance/Sustainability

This section consists of the questions from the TOR, with discussion and analysis presented for each item.

9.1 Current Operational Status of Infrastructure

The current condition of the infrastructure with regard to O&M and sustainability was assessed with Field Tool 1. The quality of the O&M was evaluated against the specifications and documentation contained in the sub-project proposal and files, and rated as: "Meets Spec", "Slightly Below Spec", and "Below Spec" (analogous to "Good", "Fair", and "Poor"). Table 38 presents the aggregated data for all sub-projects in a given township.

TABLE 38: O&M Quality Rating (% of Sub-projects)

	Good	Fair	Poor
Ann (10)	14	86	0
Banmauk (10)	43	43	14
Belin (10)	86	0	14
Chaungzon (10)	86	14	0
Demorso (10)	100	0	0
Kanpetlet	44	44	11
Kawhmu (10)	40	60	0
Kunchankone (5)	67	33	0
Kyangin (10)	100	0	0
Kyarinnseikkyi (10)	71	29	0
Kyunsu (10)	78	11	11
Loikaw (5)	75	0	25
Mindon (10)	44	44	11
Moenyo (10)	56	33	11
Myaung (10)	33	67	0
Ngaputaw (5)	25	75	0

	Good	Fair	Poor
Ngazun (10)	78	22	0
Nyaung U (10)	43	57	0
Padaung (5)	60	40	0
Paletwa (10)	80	20	0
Pyawbwe	0	100	0
Pyinmana (5)	33	33	33
Saw (5)	80	20	0
Sidoktaya (10)	33	50	17
Tanintharyi (10)	56	33	11
Tatkone (10)	63	38	0
Tharbaung (10)	50	50	0
Average (235)	**57%**	**37%**	**6%**

Discussion:

The overall status of sub-projects evaluated, with a large majority (94 percent) in "good" or "fair" operating condition, reflects reasonably well on the NCDDP's O&M arrangements. And even with some sub-projects having been constructed more than two years previously, a very low percentage were considered to be in "poor" condition. The review also found that the ratings of O&M quality in general reflect the age of infrastructure being reviewed. For instance, 65 percent of the sub-projects that were constructed in 2017 were rated as being in "good" operating condition, while only 32 percent were considered "fair".

Note: Proper clearance of vegetation from electrical alignment, Bar Do village, Daw Paw Ka Le VT, Loikaw township.

9.2 Need or Reasons for any major repairs

Village O&M Committee members were questioned by the auditor team about major repair work that had been performed or that was considered necessary (see Table 39). Major repairs are those items requiring attention beyond routine maintenance. Major repairs normally involve expenditures of cash (whereas routine maintenance tasks are usually labor based). Where major repairs were required, the evaluation team identified the main causes, as shown in Table 40.

TABLE 39: Major Repairs, by Sub-project Type - Number of Sub-projects Affected (of Sub-projects Evaluated)

		Building	Bridge	Water Supply	Road	Electricity
1	Major repairs or rehabilitation performed	8 (68)	10 (41)	5 (32)	30 (72)	3 (22)
2	Major repairs or rehabilitation required	18 (68)	14 (41)	9 (32)	29 (72)	6 (22)

TABLE 40: Major Repair Cause

		Environment	Design	Construction	Materials	Poor O&M
1	Building	2	–	4	2	25
2	Bridge	–	–	1	1	19
3	Water Supply	–	–	2	1	13
4	Road	9	6	7	1	39
5	Electricity	–	–	–	2	6

Discussion:

Table provides a clear indication where most of the O&M difficulties in rural communities are seen: with access infrastructure (roads and bridges). Over 80 percent of roads and more than half of the village bridges have required or are in need of major repairs (and this sample consisted only of one- and two-year-old constructions). It is evident from this data that rural villagers are spending time and money to maintain their local infrastructure. It is also apparent from Table 39 that a fairly sizeable portion of communities are deferring repairs on sub-projects (more than 25 percent), which does not contribute to the longevity of the infrastructure nor, often, its ease of use.

It can be noted that the completed versus required repairs for roads and bridges are about equal while the deferred repairs for other village infrastructure are generally twice or more the completed items. This is an indication that villagers recognize the importance of transportation infrastructure and, when time and money allow, tend to spend on this sector at the expense of the other infrastructure types.

Recommendation 9: The NCDDP's understanding of how village committees react to the need for major repairs would benefit from a detailed study of selected villages where these maintenance items are being deferred versus other communities where maintenance and repair work takes place more rapidly. The study could identify the main holdups that cause deferrals and make recommendations for relief or further support for these areas.

9.3 O&M Responsibilities

Community O&M Committees reported that **almost 100 percent of O&M and repair works had used volunteer village labor and that materials had been purchased by the village using locally collected funds.** Contractors had been hired for three building repairs and one electrical repair.

The technical quality of the O&M that had been carried, as rated by the auditors, is shown in Table 41 by type of sub-project.

TABLE 41: O&M Technical Ratings by Sub-project Type (% of Sub-projects and Number)

	Meets Spec	Slightly Below Spec	Below Spec
Building (68 SPs)	60% (32)	32% (17)	8% (4)
Bridge (41)	59% (22)	32% (12)	8% (3)
Water Supply (32)	60% (15)	36% (9)	4% (1)
Road (72)	61% (34)	38% (21)	2% (1)
Electricity (18)	56% (10)	39% (7)	6% (1)
All SP (137)	**58% (80)**	**34% (47)**	**7% (10)**

Discussion:

It can be seen that across all infrastructure types about a third are lacking in proper maintenance techniques or frequency, with some of the more serious instances (of "below spec" or "poor" rating) with building and bridge sub-projects. The reasons for inaction on the part of village O&M Committees is likely different for the various infrastructures.

Recommendation 10: The NCDDP should study those committees that are less active with routine maintenance to understand how best to provide support and advice.

9.4 Routine Maintenance

O&M Committee members were questioned regarding their routine maintenance activities. Table 42 lists individual maintenance tasks for each sub-project infrastructure type, with some notes for each.

TABLE 42: Routine Maintenance Activities - % of Active O&M Committees

Building Routine O&M Activities	Roof Repair	Mechanical	Plumbing	Concrete Repair	Plaster Repair	Washing	Painting	Drainage
% of SPs tasked	13	34	0	1	0	0	43	16
Number of SPs (of 68)	9	23	0	1	0	0	29	11

Building routine maintenance notes:

No O&M Committees report any work on plumbing–systems that malfunction if low-quality materials were purchased. The technical audit reported no problems with these aspects of the buildings audited; confirmation of this finding.

Mechanical repair and painting are high on the maintenance activities to date. Both these tasks indicate civic pride in O&M members–wanting to keep doors and windows in good condition and walls painted.

Seeing that a high number of drainage works have been done also indicates a desire on the part of the committee to keep the general environ of the building well drained and easy to use. The NCDDP's building portfolio includes many schools, some community halls, and a few clinics.

Bridge Routine O&M Activities	Deck repair	Concrete repair	Drainage	Apron and Road Repair	Support Structure	Railings	Erosion Protection
% of SPs tasked	7	0	10	20	0	7	29
Number of SPs (of 41)	3	0	4	8	0	3	12

Bridge routine maintenance notes:

The routine maintenance of the erosion protection measures by the O&M Committee members is encouraging, as is the apron and road repair work. Both these items are the most likely to degrade and present problems for the infrastructure's ongoing use and stability.

It is noted that neither the concrete repair item nor the support structure have received any attention from the committee members. This may be because of a lack of capacity. NCDDP engineers should, on occasion, visit concrete structures to inspect and advise the local committee members. If concrete cracking or spalling is starting, rapid repair and rehabilitation will add years of life to structures.

Water Supply Routine O&M Activities	Reservoir Cleaning	Pipe Repair	Pipe Flushing	Valve Exercising	Mechanical Repair	Filter Bed Replacement	Painting	Drainage
% of SPs tasked	50	50	13	25	0	19	3	50
Number of SPs (of 32)	16	16	4	8	0	6	1	16

Water supply routine maintenance notes:

Some of the routine maintenance tasks noted in the field tool do not apply to all water supply systems being evaluated, so that low activity on some items may not be reflective of the needs of each system.

For example, not all water systems feature a filter bed (task 6), so that replacement of 6 of these is quite a high number (and worthy of praise).

The high rates of routine maintenance for reservoir cleaning, pipe repair, valve work, and drainage are all commendable and indicators of successful training.

The fact that no mechanical repair has taken place is discouraging, particularly since many tapstands were noted to be leaking or broken. Additional O&M training sessions should be directed for this part of the water supply infrastructure.

Road Routine O&M Activities	Pot Hole/ Surface Repair	Erosion Control of Shoulders	Erosion Control of Slopes	Drainage	Vegetation Removal	Signs	Minor Repair Culverts/Walls	Regrading and Re-gravelling
% of SPs tasked	39	33	8	42	1	0	4	25
Number of SPs (of 72)	28	24	6	30	1	0	3	18

Road routine maintenance notes:

Fairly good percentages of village maintenance committees are paying attention to surface upkeep; erosion control measures for road shoulders and slopes; and regrading/regravelling the roads. Many NCDDP roads are concrete, so regrading/regravelling is not necessary.

The number of committees indicating that work has been done is the highest for road drainage (30 of 72). While this is good, this number arguably needs to be improved to have all villages keeping drainage infrastructure cleared and open.

Few road beneficiaries are dealing with vegetation growth management and removal. Most roads are constructed within villages on near-level ground, so erosion control on slopes is not necessary.

Electricity Routine O&M Activities	Vegetation Removal	Mechanical Servicing	Washing	Conductor Repair
% of SPs tasked	9	45	9	0
Number of SPs (of 22)	2	10	2	0

Electricity routine maintenance notes:

The activities of the O&M Committees are low, which should serve as a reminder to the NCDDP that further O&M training sessions may be appropriate for this type of infrastructure.

Discussion:

The notes for each infrastructure type describe the predominant activities of the village O&M Committee members. It can be seen that many of these groups are meeting most of the basic maintenance requirements but that further training may be necessary to fully activate all committees. A further study of the data can separate the sub-projects by year of construction, in order to see if there is an increase or decrease in maintenance activities as time goes by. The 2016 audit found that maintenance activities did increase over time (as one would expect, with infrastructure components requiring more attention as they age).

As recommended in the 2016 audit, NCDDP communities and O&M committee members would benefit from additional O&M training, especially for concrete structures, water supply mechanical components, drainage for roads, and vegetation removal for electrical sub-projects.

> **Recommendation 11:** Refresher O&M and basic repair training sessions should be offered to O&M Committees on the 1-year anniversary of the completion of a sub-project. NCDDP engineers should inspect the works beforehand and then offer advice as to how regular periodic maintenance can increase the usefulness and functionality of the infrastructure.

9.5 O&M Plans

The O&M plan for each sub-project was inspected by the auditor team and discussed with the O&M Committee members present. Many of the plans were not completely filled out and were missing or lacking information. Table 43 lists the items verified during this examination. Note lines 1 and 5 where the quality and completeness of the files have fallen from those inspected during the 2016 audit.

TABLE 43: O&M Plan Adequacy (% of 235 Sub-projects Evaluated)

		2018 Audit	2016
1	Routine maintenance tasks and costs	60% of O&M plans contained this	90.0%
2	Major capital repair costs	4% contained this	0.5%
3	Multiyear O&M plan (normally 3–5 years)	97% contained this	99.0%
4	Links to appropriate line ministries	44% contained this	2.0%
5	Clear division of responsibilities and costs	39% contained this	94.0%

Discussion:

The O&M plans audited during this study have not been completed to the high degree seen in the 2016 audit, based on the criteria outlined in Table 43. The one, important, exception is in regards to establishing linkages with appropriate line ministries. The most recent audit find that this is the case in 44 percent of O&M plans, versus only 2 percent in the 2016 audit.

The low percentage of O&M plans that include major capital repair costs (only 9 sub-projects of 235 reviewed) is similar to the findings of the 2016 audit. As pointed out in that report, the responsibility for this element of the plan rests with NCDDP staff, as estimation of major capital repairs is a task best suited to technical personnel who have an understanding of the average life expectancy for the various components of different rural infrastructures. The value of including these costs in community O&M plans, and explaining them as part of O&M training, is so O&M committees will take better care of infrastructure to avoid or delay such expenditures.

Note: Well-maintained road. Note proper cross-section and camber, clear and open ditch, compact and smooth surface. Khaw Khu (Shan) village, Nan Meh Khon VT, Demorso township.

Individual O&M Plans do not address details of routine maintenance for each sub-project type but rather provide general guidelines. Almost all plans contain a three-year schedule but lack specific descriptions of action items and detailed cost estimates. There should be some action from senior levels at the NCDDP to address this issue.

> **Recommendation 12:** O&M plans should contain action items for O&M Committee members to complete on a routine basis. O&M training courses should emphasize these aspects of maintenance duties.

9.6 O&M Committee

TABLE 44: O&M Committees and Implementation Arrangements

	Building	Bridge	Water Supply	Road	Electricity	All SPs
2018						
O&M Committee in place and functioning	82%	85%	97%	93%	95%	89%
	56 of 68	35 of 41	31 of 32	67 of 72	21 of 22	–
Implementation by:						
Villagers	100%	100%	100%	100%	100%	100%
Government forces	0%	0%	0%	0%	0%	0%
2016						

	Building	Bridge	Water Supply	Road	Electricity	All SPs
O&M Committee in place and functioning	96%	100%	97%	97%	95%	96%
	53 of 55	12 SP	31 of 32	59 of 61	18 of 19	–
Implementation by:						
Villagers	100%	100%	100%	100%	100%	100%
Government forces	0%	0%	0%	0%	0%	0%

Discussion:

A majority of sub-projects evaluated (89 percent) reported that an O&M Committee exists and is active. While fairly high, this percentage is lower than from the 2016 audit results, where 96 percent of sub-projects had established and functioning committees. The reduction is most noticeable with building and bridge sub-projects, and to a lesser extent with roads.

All sub-project committees reported that **villagers had provided 100 percent of the labor and materials for all O&M activities to date** (similar to 2016). Very few village committees collect indirect beneficiary fees[7] (only 11 of 235 sub-projects evaluated).

> **Recommendation 13:** The O&M refresher training course should include sessions on financial management, repair/rehabilitation cost estimation, maintenance planning, system trouble shooting, and so on), which can be presented over one day with sessions aimed at specific village committee groups.

9.7 O&M Training

The study team met with O&M Committee members and asked them questions about the O&M training that they had received and whether there was any budget allocated for ongoing training. Villagers reported that the training was generally received shortly after the sub-project construction and that refresher sessions have been offered afterwards. Training consisted of demonstrations of how the infrastructure operates (for water systems, electrical schemes) and routine maintenance activities (cleaning of water reservoirs, solar panel cleaning, clearing of vegetation from water canals, repair of road potholes and shoulders, and so on). Table 45 presents the data gathered using Field Tool 4.

TABLE 45: O&M Training and Support

Township (Number of SPs)	O&M Training Received (% of SP Committees)	Ongoing Capacity Development (% of SP)	Support from Line Ministries/ Government Agencies
Ann	100	90	0%
Banmauk	100	100	0%
Belin	90	90	0%
Chaungzon	100	100	0%

7 Fees collected by communities from users from outside communities.

Township (Number of SPs)	O&M Training Received (% of SP Committees)	Ongoing Capacity Development (% of SP)	Support from Line Ministries/ Government Agencies
Demorso	50	40	0%
Kanpetlet	90	80	0%
Kawhmu	100	100	0%
Kunchankone	100	100	0%
Kyangin	100	60	0%
Kyarinnseikkyi	100	80	0%
Kyunsu	100	60	0%
Loikaw	100	80	0%
Mindon	100	100	0%
Moenyo	100	90	0%
Myaung	90	90	0%
Ngaputaw	100	100	0%
Ngazun	100	100	0%
Nyaung U	90	90	0%
Padaung	100	80	0%
Paletwa	100	100	0%
Pyawbwe	100	100	0%
Pyinmana	100	100	0%
Saw	100	100	0%
Sidoktaya	100	100	0%
Tanintharyi	100	100	0%
Tatkone	100	70	0%
Tharbaung	90	90	0%
Total	95.7% (225 of 235 SPs)	87.7% (206 of 235 SPs)	–

Discussion:

Almost all sub-project committees reported that they had received appropriate training and demonstrations of proper O&M activities. No committees reported any involvement or support from government ministries or sector agencies for this purpose.

9.8 Existence of O&M funds

TABLE 46: O&M Costs and Funds in Account

		Building (68 SP)	Bridge (41)	Water Supply (32)	Road (72)	Electricity (22)	Average
1	O&M user fee in place (Number of SPs and %)	45	30	27	53	22	75% (2016: 18%)
		66%	73%	84%	74%	100%	
2	Current funds in O&M bank account (Average, kyat)	228,000 (52 villages)	141,000 (28 villages)	105,000 (27 villages)	171,000 (53 villages)	265,000 (18 villages)	182,500 (2016: 130,500)
3	Affordability of user fees (% that can afford)	97% (of 46 reporting)	97% (of 27 reporting)	96% (of 27 reporting	93% (of 58 reporting	92% (of 20 reporting	96% (2016: 100%)
4	% of O&M Committees with funds	76%	68%	84%	74%	82%	76% (2016: 23%)

Discussion:

The study found that **O&M user fees are in place in 75 percent of sub-project villages,** which is a significant increase from the 2016 audit findings (where only 18 percent of sub-projects had user-fees). This study also found that **76 percent of O&M Committees now hold funds in reserve** (versus only 23 percent in 2016). It seems apparent that more committees are now collecting user fees for both routine purposes and future use in major repairs or rehabilitations.

Table 46, line 4, shows the percentage of villages that possess O&M funds, by sub-project type. The final column presents an average for all townships. Not surprising, the two 'utility' infrastructure types, water supply and electricity, have the highest percentages for both having a user fee system in place and committees with funds available (84 percent and 82 percent of reviewed water system and electrical sub-projects, respectively, hold funds).

The lower frequency of O&M funds being held for building, bridge, and road sub-projects likely reflects the "common" or public goods nature of these structures where access is much more difficult to restrict and therefore people are less inclined to pay a fee for its use. The review found that villages tend to provide funding for building and road repair works on a more sporadic, as-need, basis.

Almost all O&M Committees (96 percent) report that the majority of village households can afford system user fees without undue hardship.

Note: Potable Water Supply Pond - Ywar Thit Kone village, Man Ka Leik VT, Kunchankone township.

An earthen reservoir has been dug near this village to provide potable water through the dry season. The pond's banks have been built up with a surrounding berm to broaden the catchment area and the bottom dug below the local water table. The outer perimeter measures 80' x 60' and the bottom is about 8' beneath natural grade. The pond supplies potable water to 72 households and 252 people.

Community forces donated the labor to clear the site and supplied the materials and skilled labor to build the bamboo jetty.

The pond has been connected to the village via a new 625' concrete road, built using materials purchased with Parliamentary Funds and donated labor.

O&M funds are collected on the basis of 100 kyat per household per month. Auditors have recommended that fencing be installed around the pond, which has been agreed by the O&M Committee. The village currently has 46,600 kyat in savings to support this work, if necessary.

9.9 Adequacy of O&M funds

The sub-project documentation studied by the auditor teams did not make specific references to O&M funding sources nor provide any formula for the calculation of reasonable fees, such as a percentage of construction costs. Village O&M Committees make their own decisions as to whether or not user fees should be gathered, the amount of fees, schedule of payments, and so on. The NCDDP O&M documentation presents a suggested course of action but does not provide specific guidance.

> **Recommendation 14:** The NCDDP should consider revising O&M Committee documentation to stipulate activities that must be undertaken according to a routine schedule, with realistic funds allocated for labor and materials. User fee calculations should be based on these system-specific costs.

9.10 Affordability of O&M funds

Line 3 in Table 46 provides data regarding the affordability of user fees. **Almost all the O&M Committees report that their village households can afford to pay.**

The amount of funding that O&M Committees are able to save, on average 182,500 kyat per village (see Table 46), is not sufficient to provide adequate financing for longer-term O&M needs that typically will involve major repairs or rehabilitation. Based on the audit sample, the average NCDDP sub-project budget is over 11,000,000 kyat, which makes the average O&M fund about 1.6 percent of the value of infrastructure. This may be sufficient for minor or routine maintenance costs, but it is clearly insufficient to finance longer-term O&M, which depending on the item requiring maintenance or repair, could cost 10–25 percent of the original value. **As such, it does not appear reasonable to expect that most NCDDP sub-project O&M Committees under their current arrangements would be financially able to undertake longer-term O&M and typical capital repair/rehabilitation tasks.**

The review also noted that no line ministries or government agencies are not contributing to O&M expenses of the NCDDP sub-projects.

> **Recommendation 15:** The NCDDP should consider revising O&M Committee documentation to insert specific capital repair estimates. Estimates should be provided appropriate to sub-project type, for example, roof replacement for buildings, with options described to committees for the funding of such major repair capital works.

9.11 Complementary operational inputs

Almost all village sub-project representatives **(97 percent) of building sub-project committees, educators and health workers stated that the government was providing them with inputs in an adequate and timely manner** for schools and health clinics. This is the same percentage as for the 2016 audit.

9.12 Identified operational inputs

Less than half of the O&M plans (44 percent, 103 sub-projects) contained clear statements that linked line ministries to responsibilities for the village infrastructure. This is, however, a large increase from the 2016 audit, when only 4 sub-projects had such linkages.

9.13 Effects of contracting modality on O&M

TABLE 47: CFA/Joint Modality Sub-project with User Fees in Place

		Building (68 SP)	Bridge (41)	Water Supply (32)	Road (72)	Electricity (22)	Average
1	O&M user fee in place (All SPs)	45	30	27	53	22	75%
2	CFA/joint SP with user fee in place	85%	93%	88%	88%	100%	90%
3	Village Committees with bank account	52	28	27	53	18	76%
4	CFA/joint SPs with bank account	85%	96%	85%	87%	100%	89%

Discussion:

The data presented in Table 47 shows a that **O&M financing arrangements (agreed user fees and established bank account) are more common when sub-projects are constructed using CFA or joint construction modalities.** For instance, overall, 90 percent of CFA and joint-constructed sub-projects have user fees, versus 75 percent of all sub-projects. Similarly, 89 percent of CFA and joint-constructed sub-projects have established bank accounts for O&M funds, as compared to 76 percent of all sub-projects.

> **Recommendation 16:** The NCDDP should continue to encourage the use of CFA construction modality during its socialization phase in Townships and Village Tracts.

Does community capacity development carried out by the NCDDP contribute to sub-project sustainability cost-effectively? Compare the total cost including the cost of community engagement and capacity development of investments financed by different sources, taking into account (a) the current conditions of infrastructure, (b) initial condition of infrastructure after completion, and (c) O&M works done. Any indication that the NCDDP's investments in the capacity development of communities contribute to long-term sustainability of sub-projects? If such an indication is observed, how cost effective is the NCDDP community capacity development in long-term sustainability of infrastructure?

Village sub-project committee members were asked about the training and ongoing capacity development that were received as part of the sub-project construction and hand-over process. These interview results are reported above in Table 265. **Almost all sub-project O&M committee members interviewed reported receiving O&M training (225 of 235 sub-projects, 96 percent).** In addition, 206 committees said that they receive ongoing assistance in this regard, which was similar to the results of the 2016 audit.

The evaluation's finding that almost all NCDDP sub-projects receive both O&M training during the sub-project completion process and ongoing capacity development support does not allow any comparisons to be made between *those-that-receive* the training and *those-that-do-not-receive* such training. **It is a logical conclusion, however, that community training and capacity development is an important activity that benefits the long-term sustainability of rural infrastructures** (and therefore increases its cost effectiveness).

10. Findings — Best Practices and Recommendations by Sub-project Type

The technical ratings of sub-project components and aspects have been discussed in Section 6 of this report. The technical ratings data were aggregated, sorted, and studied on a township level, according to sub-project type, by quality of design, remoteness, functionality, construction year, and technical facilitation.

The data can similarly be sorted and studied by sub-project type, components and aspects, which should yield valuable insights to the NCDDP's current construction methodologies and how they might be improved in future cycles.

Additional information regarding design and construction issues was gathered in Field Tool 5 - Key Issues. This checklist allowed the technical evaluators to easily identify the problem areas within each infrastructure type.

10.1 Buildings

Most of the building sub-projects examined during this technical evaluation met technical specifications as designed (74 percent Meet Spec) or were considered Slightly Below Spec (24 percent). Only 2 percent of the building components evaluated were rated Below Spec.

The field team examined buildings by dividing them into 21 components/aspects that were individually assessed and rated. Table 48 below identifies those components or aspects of building sub-projects that were most frequently found to be Slightly Below Spec.

TABLE 48: Building Components/Aspects Considered Slightly Below Spec and Below Spec

Building Component/Aspect (No. of SPs Rated)	Percentage of SPs Rated Slightly Below Spec	Percentage of SPs Rated Below Spec
Ring Beam (52)	13%	-
Truss - Structural (52)	42%	-
Truss - Connection to Ring Beam (53)	47%	-
Roof - Connection to Purlin (55)	38%	-
Floor (59)	15%	-
Plastering (49)	16%	-
Doors and windows (54)	31%	-

Building Component/Aspect (No. of SPs Rated)	Percentage of SPs Rated Slightly Below Spec	Percentage of SPs Rated Below Spec
Septic Tank (3)	67%	-
Ramp for disabled (Note 1) (21)		43% (Note 2)

Note 1: These are buildings where the plans showed a ramp or similar UA feature and it was not constructed.

Note 2: Photographs of the sub-projects reveal that auditors did not use this part of the field tool properly. Rather than 43 percent, it is estimated that 70 to 80 percent of the buildings evaluated are lacking in basic UA features.

Discussion and Recommendation:

Ring beams are those structural members that connect the columns at the top of building walls. The dimensions and connections of these beams (either wood or reinforced concrete depending on the structural design) is an important facet of the building's strength in hurricanes or earthquake events. The percentage of this component found to be lacking was similar to the 2016 audit.

Trusses were evaluated with regard to two aspects: structural standards and conformance with drawings (42 percent Slightly Below Spec) and proper connections to a building's ring beam (47 percent Slightly Below Spec). These figures are high and comparable to the findings of the 2016 audit (which were 28 percent and 67 percent, respectively). Trusses and their connections are often poorly detailed on the design drawings. Auditor's notes about these are found in the Key Issues section of the field tools. Key issues for buildings are poor drawings (22 of 68 subprojects), improper connection of roof to truss (25 of 68), and so on. Commentary and recommendations in the 2016 audit could be repeated here.

The use of proper connections from a building's trusses to the ring beam is very important in a country such as Myanmar that experiences turbulent weather conditions on a regular basis. This detail is often missing on NCDDP design drawings and local people will often disregard vague drawings in favor of using traditional methods of wood joinery. Depending upon the locale, the resulting trusses can often be lacking in sufficient strength to survive hurricane winds. The use of bolts to connect the truss to the ring beam or columns of a building is imperative.

Roofs can start to leak within a few years if the roof sheeting has been improperly installed or if other elements of the roof structure allow vibration during strong winds (roof connection to purlin: 38 percent Slightly Below Spec). Proper fasteners (wind ties, cleats) and attention to correct roof construction methodologies will prolong the life of galvanized sheet steel roofs.

Note: Childcare center, with no trusses, only straps. Very weak and subject to deformation during high winds. Par Kun village, Khant Thar Yon VT, Kanpetlet township.

Doors and windows were again noted as being Slightly Below Spec (31 percent of sub-projects) for many sub-projects (2016 audit: 26 percent). These ratings are directed at sagging and fractured panels that are only a few years old. Properly constructed doors and window panels, using high-grade wood, should last a decade before needing major repair or refurbishment. The use of lower-grade woods, inadequate millwright techniques, and inexpensive hardware serve to devalue a building for its users.

Two of the three **septic tank** facilities inspected had no portal and lid to allow access to the tank for inspection or cleaning.

Ramps and accessibility features for the disabled have been discussed in Section 6.10 – Universal Accessibility. A review of the photographs submitted depicting the sub-project buildings reveals that the majority did not feature adequate UA measures.

> **Recommendation 17:** The NCDDP should develop a list of common building construction problems. Field inspections should concentrate on these items. A similar list should be assembled for all infrastructure types. Recommendations from the 2016 audit can also be used during the development of these tools.

10.2 Bridges

The technical quality ratings for NCDDP bridge sub-projects has stayed quite high (82 percent Meets Spec, 17 percent Slightly Below Spec, 1 percent Below Spec), a comparable result with the 2016 audit (91 percent, 6 percent, 3 percent) but with a much larger sample size (41 sub-projects versus 15 for the 2016 audit). The current results are likely more accurate.

Table 49 provides an abbreviated list of bridge components, showing those that exhibited problems.

TABLE 49: Bridge Components Ratings (% and No. of Sub-projects)

Bridge Component	Percentage of NCDDP SP Rated Slightly Below Spec (No. of SPs)	Percentage of NCDDP SP Rated Below Spec (No. of SPs)
Layout (40 SPs evaluated)	18% (7)	–
Erosion Protection (36)	28% (10)	–
Abutments (32)	22% (7)	–
Wingwalls (29)	21% (6)	–
Connections: Nails, Bolts (13)	23% (3)	8% (1)
Apron/Ramp/Road Access (31)	19% (6)	–
O&M (39)	32% (12)	8% (3)

Discussion and Recommendation:

Forty-one NCDDP bridges were evaluated during the fieldwork, a large increase from the 2016 audit (14 sub-project) and providing much data and valuable insight to NCDDP's bridge program.

The bridge components that most often are rated Slightly Below Spec or Below Spec are discussed in the following paragraphs, along with explanations and suggestions for corrective measures that might be taken by NCDDP or others. Note that all components are not found on all bridges, so that many components are represented on a subset of the bridge sample.

Similar to the 2016 audit, **Layout** was found to be a slight problem on 18 percent (7) of the sub-projects (2016: 14 percent, 2 sub-projects). While the 2016 audit's result might have had some measure of doubt cast with the small sample size, this audit's robust number of bridges has allowed a more accurate assessment of the bridges erected through the NCDDP. The upward trend may be a reflection of underestimation in 2016 caused by a very small sample size. The number of bridge designs that have been cited for improper layout of the structures is of concern, especially with regard to DRM issues. The absence of sub-projects rated Below Spec in this audit (down from 7 percent in 2016), however, is good reason for optimism.

Erosion protection measures were inadequately designed or implemented at 28 percent of the bridges (10 of the 36 sites visited). This is higher than 21 percent in 2016 and based on a sample 2.5 times bigger, so more credence and concern should be paid this component. A cross-reference with the DRM ratings assigned to the bridge sub-projects shows that 91 percent and 97 percent of the sites were respectively considered having adequate erosion protection measures and to be safe from flooding. The auditors were instructed to write detailed explanations for components rated Slightly Below Spec and Below Spec. The NCDDP should consider these descriptions and suggestions for improvement.

The auditors found some Slightly Below Spec faults with the bridge structures, recording this rating for **Abutment** and **Wingwall** components 22 percent (7 of 32 sub-projects) and 21 percent (6 of 29 sub-projects), respectively. No problems were found with these items during the 2016 audit. Again, proper orientation and design/implementation is important for these components of bridges. Abutments and wingwalls are particularly susceptible to damage in flooding disasters. Erosion protection measures should be carefully planned and executed/maintained.

Note: Proper wingwalls. High water flows are controlled and will not erode roadway. Gone Bi village, Nat Ghaung Kannar VT, Kyarinseikgyi township.

Connections were criticized at one sub-project and found slightly deficient at 3 more, resulting in 31 percent of the sampled 13 bridges observed to be lacking in this important aspect of bridges. Photographs, for the most part, indicate that nails rather than bolts have been used. Nails will slowly pull out due to vibration in the bridge deck. Bolts can be tightened periodically, greatly extending the life of bridge deck components and reducing wear throughout the structure.

> **Recommendation 18:** NCDDP engineers should carefully examine the layout of the bridges that were rated less than Meets Spec. Design sketches and design aids should be developed, providing guidance to designers of future bridge sub-projects.

10.3 Water Supply Systems

The water system design and implementation program of the NCDDP continues to develop its capabilities. The technical quality of the water systems audited in 2018 is slightly below average (Table , 76 percent Meets Spec versus 79 percent sample average). The 2016 audit produced very similar results (79 percent Meets Spec vs. 78 percent average). The audit ratings do not show that the water system design/implementation program has improved since the last audit.

Table 50 presents a sample of the noteworthy items for the following discussion and analysis.

TABLE 50: Water Supply Component/Aspect Ratings (% and No. of Sub-projects)

Water Supply Component/Aspect	Percentage of NCDDP SPs Rated Slightly Below Spec	Percentage of NCDDP SPs Rated Below Spec
Chemical analysis (7 SPs evaluated)	14% (1)	–
Watershed protection (22)	18% (4)	5% (1)
Water system design (30)	30% (9)	–
Reservoir - Structural integrity (29)	24% (7)	–
Reservoir - Easy to clean (29)	10% (3)	–
Transmission pipe (24)	33% (8)	–
Public tap - fixture/platform (15)	47% (7)	–
Public tap - drainage (11)	36% (4)	–
Water pressure/quantity (25)	12% (3)	–

Discussion:

Chemical analysis documentation was found in village files only 6 times for 32 sub-projects. The NCDDP needs to consider making this item mandatory for all village water supply systems. The auditors did not rate the systems where this was lacking as Below Spec, as the NCDDP Operations Manual does not mention the testing of water sources.

Watershed protection has improved since the last audit, now 23 percent Slightly Below Spec/Below Spec (from 35 percent in 2016). More needs to be done to emphasize this important feature for community watershed areas.

Water supply system design continues to present problems for the NCDDP, with this year's 9 sub-projects rated Slightly Below Spec (30 percent of 30 sub-projects rated) matching that of the last audit (also 9 but with one Below Spec included). Suggestions for improvements can be found in the notes and comments provided by the auditors.

Note: Water system designers did not contain this shut-off valve in an underground box; it is easily broken. Thu Htay-East village, Thein Daw VT, Tanintharyi township.

Structural integrity was rated as Slightly Below Spec for 24 percent of sub-projects featuring reservoirs or other concrete infrastructure (7 of 29 sub-projects rated). This specific issue of concern was not found in the 2016 audit.

Plumbing provisions for reservoir cleaning and overflow continue to be included in most NCDDP water supply sub-projects (90 percent included these items, similar to 89 percent, 2016 audit). NCDDP engineers should continue to ensure that these important plumbing connections are fitted to all village water storage infrastructures. Many drawings do not show these features clearly (or at all).

The **water transmission pipes** (transporting water from the catchment reservoir or tank to the village) have improved since the last audit. Now the rating is 33 percent Slightly Below Spec (8 of 24 sub-projects). The 2016 audit showed that 56 percent of the sub-projects evaluated had deficient pipes or installation practices, so design and implementation practices have demonstrably improved.

Public tapstand platforms and drainage have higher percentages of Slightly Below Spec ratings (47 percent and 71 percent, respectively) than the last audit (33 percent and 36 percent, respectively), a circumstance that deserves attention by senior levels at the NCDDP engineering department. Convenient, well-designed, and implemented tapstands provide great benefits to village life in terms of user satisfaction and ease of cleaning and maintenance. Standard drawing details that enable the creation of attractive and easy-to-use tapstands will encourage volunteers to step forward for voluntary O&M activities.

Note: The lack of an overflow pipe has resulted in this reservoir spilling excess flows along its upper wall, creating ugly and messy conditions around its perimeter. Min Goat village, Min Goat VT, Kyunsu township.

Note: Well-planned and convenient tapstand for villagers. Note that platform is well drained to rear outlet. Hpa Yar Ngu village, Hpa Yar Ngu VT, Monyo township.

The 2016 audit identified **water pressure and quantity** as problematic at roughly a third of the sub-projects evaluated. The current audit shows this has reduced to only 12 percent of 25 sub-projects rated for this aspect.

> **Recommendation 19:** A short feature on watershed protection should be added to the NCDDP's technical training manual.
>
> **Recommendation 20:** Standard drawings of details (for example, reservoir overflow piping) should be developed for all infrastructure types.

10.4 Road, Drainage, and Retaining Wall

The NCDDP roads are constructed using several construction materials and methodologies. These are as follows, with the percentage of each road type as evaluated by this study (per Table 9, Road Construction Materials):

1) Earth road (20 percent)
2) Gravel/macadam road (49 percent)
3) Concrete road or concrete wheel paths (31 percent)

Most of the NCDDP's road building works, based on the evaluation sample, has taken place on flat terrain, mostly within villages, with few major drainage courses crossing the road alignments. The construction program has produced some durable and well-constructed village roads.

The road components that received ratings of Slightly Below Spec and Below Spec are as follows:

TABLE 51: Road Component/Aspect Ratings (% and No. of Sub-projects)

Road Component/Aspect (No. of SPs Evaluated)	Percentage of SPs Rated Slightly Below Spec	Percentage of SPs Rated Below Spec
Retaining Wall (4)	50% (2)	25% (1)
Culvert - Layout and Construction Technique (20)	45% (9)	5% (1)

Discussion:

Very few roads have required **retaining walls** (reflecting the flat terrain that is typical within villages). Four walls were inspected, and three presented problems with respect to the installation of proper weep holes. Two sub-project walls did not feature these groundwater-relief drains but did not show weep holes on their drawings (so how would villagers know to install them?); these were rated Slightly Below Spec. The fourth wall's drawing showed weep holes but they had not been installed, thus a Below Spec rating for this sub-project.

Weep holes are short lengths of pipe inserted through the walls during construction. It is very difficult to retrofit an existing wall with proper rear drainage. The weep hole pipes provide relief for rising groundwater levels behind these walls. Walls that have not been equipped with this drainage will experience heightened water levels behind the wall, destabilizing the retained slope. The weight of the water within the soil will cause bank collapse and wall instability.

Drawings must show the installation and orientation of weep holes, along with a sketch and specification for a filter cloth and gravel enclosure of the buried end of the weeping pipe.

Half of the **culverts** evaluated could be improved in one way or another. Culverts were frequently found with an inadequate or no headwall. Headwalls are important parts of culverts: they are prominent (and can be attractive) drainage features that indicate a village's economic progress while also protecting the fragile pipe ends from breakage. Well-designed and constructed retaining walls will prevent road gravels migrating into the drainage channel. Excess amounts of road gravel in a roadside ditch or culvert will impede large flows, causing erosional damage to banks and drainage facilities during large storms.

Note: Headwalls should be constructed of mortared stone or concrete. This culvert will be very difficult to clean. Lel Kyin village, Pin Sin Te VT, Ban Mauk township.

Roads were also rated using a field tool that identified 12 aspects that are typical road problems or common issues. These are outlined in Table 322. Each road evaluation aspect is noted as being most closely associated with functional cause (or two in some cases); these are Poor Design, Improper

Construction Techniques, and Faulty Materials. For an example, a road that has been constructed too narrow for its proper and safe use might have as a cause either Poor Design or Improper Construction Techniques.

The roads were walked during the audit and each 100 foot section was inspected under the criteria for 12 aspects and given a rating for '% Affected by Problem'. Two of these aspects, #3 and #12, were also noted with an indication of how many missing drainage structures or safety concerns were apparent.

TABLE 52: Typical Road Problems - Classification of Cause

Problem	Poor Design	Improper Construction Techniques	Faulty Materials
1 Poor cross-section (crown/camber)		✓	
2 Inadequate roadside ditches		✓	
3 Missing drainage structure	✓		
4 Improper construction materials			✓
5 Slippery when wet			✓
6 Very muddy during rainy season	✓	✓	
7 Unstable slope above (too steep)	✓		
8 Unstable slope below (too steep)	✓	✓	
9 Narrow width	✓	✓	
10 Surface below standard		✓	✓
11 Pavement below standard		✓	✓
12 Safety concerns	✓		

The road ratings for each 100 foot length can be averaged for each road sub-project to determine where the majority of NCDDP road design or implementation problems lie.

Table 333 shows the relative percentages for the causal factors: design, construction techniques, or materials (some problems commonly stem from two causes).

TABLE 53: Typical Road Problems - Aggregated % Affected by Causal Factor

	Poor Design	Improper Construction Techniques	Faulty Materials
% of Road Lengths Affected by Causal Factors	6	19	1

Discussion:

This table clarifies that the majority of problems arising within the road sector are caused by poor and improper construction techniques. Approximately 20 percent of road sections are affected by one or more problems stemming from poor construction. Following is the analysis and suggestions regarding the main causal factors.

Note: Good road cross-section serving 335 villagers, raised high above adjacent lands that regularly flood, proper crown, well drained. Tha Bawt Chaung village, Si Son VT, Thar Paung township.

Road surface issues, crown, and surface standards. The audit found many sections of road that were poorly shaped, allowing storm water runoff to collect, pool, and run along road centerlines or wheel tracks. Road surface quality is rapidly degraded when rainfall is not drained away—the road surface softens and traffic loads soon create gullies and the situation gets worse over time. Constructing and maintaining a proper cross-section is important, with gradients suitable to the materials used.

Ditches. Approximately 10 percent of the roads examined by the auditors did not feature appropriate ditching (usually an error of omission). Properly shaped and situated ditches are an important feature of roads, particularly within villages where muddy, unsightly, or inconvenient conditions can arise in areas when the storm water drainage facilities are inadequate.

> **Recommendation 21:** The NCDDP road construction monitors need to be trained in proper construction techniques to produce well-shaped and durable surfaces. Manuals with sketches of good and bad road infrastructure would be useful to help monitors convey this information to village road construction crews.

10.5 Electricity

Twenty-three NCDDP electrical sub-projects were evaluated during this assignment. Thirteen of the schemes featured diesel generators and distribution networks, nine were national grid extension schemes, and one was a mini-hydro installation plus distribution.

TABLE 54: Electricity Components/Aspects Ratings (% and No. of Sub-projects)

Electricity Component/Aspect (No. of SPs reporting)	Percentage of SPs Rated Slightly Below Spec	Percentage of SPs Rated Below Spec
Equipment Installation/Venting (13)	38% (5)	–
Poles - Quality (20)	35% (7)	–
Poles - Installation (24)	27% (6)	–

Discussion:

Faulty **engine exhaust venting** was a problem in more than a third (38 percent) of the electrical sub-projects evaluated (an improvement from 2016 audit: 57 percent). Diesel engine fumes in small, enclosed places can be debilitating to the operator. These exhausts must be connected to a pipe venting outside the generator building.

Note: Acceptable locally sourced, peeled electrical conductor support, Bin Ban village, Pi Ti VT, Bilin township

Two aspects of electrical poles were considered: **quality of the pole and installation practices**. These were found to be 35 percent and 27 percent Slightly Below Spec, respectively, in this audit, a mixed change from the 2016 audit (24 percent and 44 percent, respectively). Photographs of the poles that were cited in this audit show that villagers have frequently used freshly harvested trees for electrical conductor support systems throughout villages. Plans normally show straight unblemished poles, so that auditors sometimes found these 'rustic' poles to be less than specification. In most cases these locally sourced poles suffice. However, some sub-projects included misaligned or damaged tree-poles for electricity distribution; these poor installations should be actively discouraged.

> **Recommendation 22:** Photographs of acceptable nonstandard, noncommercial poles should be included in a field manual for training and illustration purposes, along with suitable examples of concrete pole foundations. Dimensions of the blocks should be included.

The **horizontal separation positioning of the electrical conductors on the pole alignments** saw an improvement in this audit compared to the 2016 result: now only 10 percent are considered to be Slightly Below Spec, where 18 percent were considered so in 2016. The minimum separation distances for electrical transmission wires depend upon the voltage being transmitted and ensure that short circuits are avoided as wires sway in high winds. The vertical clearance minimum distances were considered Slightly Below Spec in 10 percent of the samples (2 sub-projects), which is similar to the 2016 results (11 percent).

10.6 Design Drawings and Construction Detailing

Field Tool 5 - Key Issues - contained a section on Design that was similar between all sub-project types. The list of potential key issues that could be selected as problematic at sub-project sites are listed in Table 355, along with the data reported from the NCDDP sub-projects evaluated.

TABLE 55: Key Issues with Design - % of Sub-projects Evaluated

2018	Building	Bridge	Water Supply	Road	Electrical
Lack of construction details/ elevations on drawing	32	27	31	26	36
Inaccurate drawings of connection details	26	22	19	17	18
2016	**Building**	**Bridge**	**Water Supply**	**Road**	**Electrical**
Lack of construction details/ elevations on drawing	31	60	28	36	38
Inaccurate drawings of connection details	17	33	31	14	48

Discussion:

Many of the Key Issue percentages have stayed approximately the same or decreased from the 2016 audit. Only a single category, Building, Inaccurate drawings of connection details, saw a large increase (17 percent in 2016 versus 26 percent in this audit).

11. Findings — Economic Analysis

As part of this study, economic analyses were undertaken for the four most common types of NCDDP infrastructure sub-projects (farm-to-market roads, rural water supply, rural electrification, and school buildings) using standard methodology for community driven development projects. The costs and benefits for each of these sub-projects were identified and valued based on a survey of a representative sample of sub-projects and information from other sources.

Table 56 provides a summary of the types and number of sub-projects sampled. The stratified sample for the analyses was based on sub-projects from implementation years 3 and 4 (2016 and 2017) of the project from 27 townships that covered a range of different implementation contexts under the NCDDP.[8] A total of 235 sub-projects or roughly 1.6 percent of NCDDP sub-projects were evaluated during this audit.

TABLE 56: Sampling of sub-projects Covered in the Field Survey

SP Main Type	Year of Construction 2016	Year of Construction 2017	Total Number of SPs Evaluated
School building	43	25	68
Bridge	22	19	41
Water supply	7	24	31
Road	40	32	72
Electricity	5	18	23
Total	117	118	235

11.1 Costs and Benefits

The costs of sub-projects are of two types: financial and economic. Financial costs are costs directly paid for by the project and households such as direct costs of construction (labor, materials, and equipment) and O&M costs. Economic costs are costs borne by society as a whole, which include both financial costs as well as indirect costs such as environmental and social costs, foreign exchange costs, and shadow wage cost or the value of unskilled labor.

8 This included townships in ethnic minority dominated areas, the Ayeyarwaddy river delta, hill or remote zones, areas where physical cultural heritage is found, and areas that experience conflict or are prone to natural disasters.

The benefits from farm-to-market roads and bridges generally include savings in transporting agricultural inputs (seeds, fertilizers, and so on) from markets to farms, and agricultural production to markets, lower travel costs for households for other activities, and reduction in post-harvest losses. Other possible benefits of farm-to-market roads include higher cropping intensity (for example farmers planting two crops a year instead of one), increased property values, increased area of land cultivated or increase in number of farmers engaging in agricultural production, changes in the product mix toward higher-value crops, reduction in maintenance cost, time savings of other users, better access to health stations, lower number of accidents, increase in number of children attending school, and increased traffic volume.

Benefits from water supply projects generally include additional water consumption, time saved from fetching water and reduction in waterborne diseases due to clean water. Benefits from electrification include additional electricity for lighting, charging of appliances and cellphones, time saved from fetching firewood, additional time to study at night for school children, and productivity gains for rural enterprises that use electricity, for example, rice mills, wood craft, and garments. Benefits from a new school building include additional years of schooling (and hence higher wages in the labor market) and more students going to school.

The benefits described above are what would be valued in an ideal situation. The actual estimation of benefits for this current study was limited to those that could be quantified based on the available field survey data. As such, benefits of farm-to-market roads did not include estimates related to intra-village transport. Therefore, the estimates presented in this analysis are considered conservative. These data gaps are described in greater detail in the discussion for the individual sub-project types in Annex 5.

11.2 Net Present Value and Internal Rate of Return

The economic costs and benefits were compared over the lifespan of the given sub-project type (which ranged from to 10 to 15 years depending on the type of sub-project) and their NPV and EIRR were calculated based on the official discount rate of 10 percent. The NPV of a sub-project compares the present value of the sub-project costs, including the initial capital cost and annual O&M costs, to the present value of future expected benefits. The EIRR is the rate of discount at which the present value of the cost stream is equal to the present value of the benefit stream.

11.3 Decision Rule and Sensitivity Analyses

The decision rule is that a project is economically viable and hence should be supported if the NPV is equal to or greater than 0, and the EIRR is greater than the official discount rate of 10 percent. In addition, a sensitivity analysis was performed under three scenarios: (a) reduction in project life due to poor infrastructure maintenance, (b) a 20 percent increase in costs due to unforeseen factors, and (c) a 20 percent decrease in benefits due to over estimation or if benefits do not materialize as expected for various reasons.

11.4 Summary Results

The overall results of the financial and economic analyses are summarized in Table 37. Overall, the findings suggest that most of the NCDDP sub-projects (water supply, school building, electrification, and farm-to-market roads) are economically viable. In other words, the benefits of

these sub-projects to society exceed their costs. This is consistent with results from similar CDD projects around the world. The one caveat to this observation relates to farm-to-market roads in accessible villages, where the economic viability of the sub-project is sensitive to a reduction in the estimated life of the sub-project, a reduction to estimated benefits, or an increase in costs, which would put the EIRR at or below the official discount rate. On the other hand, farm-to-market roads in remote villages registered the highest EIRR (of 131 percent) mainly due to savings in transport of produce and farm inputs. The details of the results for each sub-project are found in Annex 5 of the report.

TABLE 57: Summary of Main Findings of Economic Analyses

Sub-project Typea	Baseline Results	Sensitivity Analysis		
		Reduction in project life	20% cost escalation	20% benefits reduction
WATER SUPPLY (n = 30)				
NPV	15,055	8,128	13,308	10,297
EIRR (%)	43	38	35	33
SCHOOL BUILDING (n = 68)				
NPV	30,822	23,080	28,929	22,764
EIRR (%)	56	55	46	45
FARM-TO-MARKET ROADS (Accessible) (n = 14)				
NPV	1,833	−840	25	−378
EIRR (%)	12	8	10	9
FARM-TO-MARKET ROADS (Remote) (n = 33)				
NPV	100,701	87,123	108,312	86,157
EIRR (%)	132	132	110	105
ELECTRIFICATION (n = 22)				
NPV	46,932	40,657	50,876	40,121
EIRR (%)	62	61	52	49

Note: a. NPV in thousand kyat; EIRR in percentage; n = Sample size in the survey; 'accessible' means within 30 minutes motorcycle transport to township center; 'remote' means more than 30 minutes transport to township center.

Annexes

ANNEX 1: Recommendations of the 2018 Technical Audit

- Recommendation 1: The NCDDP Engineering Department should examine the technical resources that the townships have for the infrastructure types where 'Poor' designs have been noted (particularly Road and Electrical). Additional support (drawings, manuals, training, additional personnel, and so on) to some townships is warranted.
- Recommendation 2: The NCDDP should investigate the circumstances where it was reported that no user consultations were conducted during the design period. This practice will produce less-sustainable products and the reasons for these instances should be understood so that they can be avoided in the future.
- Recommendation 3: The introduction of DRM protocols into the design process should include a training course for NCDDP technical personnel that will emphasize the responsibility of designers to fully consider the forces of nature when planning rural infrastructures, and how well-planned, implemented, and maintained structures can withstand damage during disastrous events.
- Recommendation 4: The NCDDP should use the results of this audit to reaffirm its technical support services to villages. Training courses should emphasize the importance of extending design and construction facilitation to the most remote villages in townships.
- Recommendation 5: The NCDDP should revise its engineering design guidelines to include explicit provisions for UA to public building infrastructure.
- Recommendation 6: Ramps for the disabled are an important feature to guarantee UA to public infrastructure. Ramps should not be constructed steeper than 16 percent (1V: 6.25H) and should have a rough/non-slip surface so that the ramps are wheelchair accessible with helper. Ramps steeper than 5 percent should be equipped with a proper handrail.
- Recommendation 7: More robust methodologies should be developed to increase the number of CSPs evaluated during technical audits so that analysis can be made with more certainty.
- Recommendation 8: The NCDDP field staff training exercises should include reviews of the village sub-project implementation files during monitoring visits. Community contributions should be checked and signed off on a regular basis.
- Recommendation 9: The NCDDP's understanding of how village committees react to the need for major repairs would benefit from a detailed study of selected villages where these maintenance items are being deferred versus other communities where maintenance and repair work takes place more rapidly. The study could identify the main holdups that cause deferrals and make recommendations for relief or further support for these areas.
- Recommendation 10: The NCDDP should study those committees that are less active with routine maintenance to understand how best to provide support and advice.

- Recommendation 11: Refresher O&M and basic repair training sessions should be offered to O&M committees on the 1-year anniversary of the completion of a sub-project. NCDDP engineers should inspect the works beforehand and then offer advice as to how regular periodic maintenance can increase the usefulness and functionality of the infrastructure.
- Recommendation 12: O&M plans should contain action items for O&M Committee members to complete on a routine basis. O&M training courses should emphasize these aspects of maintenance duties.
- Recommendation 13: The NCDDP should combat the downward trend in functionality of community O&M Committees by creating a useful refresher training session for each infrastructure type, to be offered on the 1-year anniversary of the sub-project completion. This course should consist of a number of sessions (financial management, repair/rehabilitation cost estimation, maintenance planning, system trouble shooting, and so on), which can be presented over one day with sessions aimed at specific village committee groups.
- Recommendation 14: The NCDDP should consider revising O&M Committee documentation to stipulate activities that must be undertaken according to a routine schedule, with realistic funds allocated for labor and materials. User fee calculations should be based on these system-specific costs.
- Recommendation 15: The NCDDP should consider revising O&M Committee documentation to insert specific capital repair estimates. Estimates should be provided appropriate to sub-project type, for example, roof replacement for buildings, with options described to committees for the funding of such major repair capital works.
- Recommendation 16: The NCDDP should continue to encourage the use of CFA construction modality during its socialization phase in Townships and Village Tracts.
- Recommendation 17: The NCDDP should develop a list of common building construction problems. Field inspections should concentrate on these items. A similar list should be assembled for all infrastructure types. Recommendations from the 2016 audit can also be used during the development of these tools.
- Recommendation 18: NCDDP engineers should carefully examine the layout of the bridges that were rated less than Meets Spec. Design sketches and design aids should be developed, providing guidance to designers of future bridge sub-projects.
- Recommendation 19: A short feature on watershed protection should be added to the NCDDP's technical training manual.
- Recommendation 20: Standard drawings of details (for example, reservoir overflow piping) should be developed for all infrastructure types.
- Recommendation 21: The NCDDP road construction monitors need to be trained in proper construction techniques to produce well-shaped and durable surfaces. Manuals with sketches of good and bad road infrastructure would be useful to help monitors convey this information to village road construction crews.
- Recommendation 22: Photographs of acceptable nonstandard, noncommercial poles should be included in a field manual for training and illustration purposes, along with suitable examples of concrete pole foundations. Dimensions of the blocks should be included.

ANNEX 2: Sample Technical Evaluation Field Instrument

These Field Tools are for the sub-project type Building. Similar instruments were used for sub-project types Bridge, Water Supply, Road and Irrigation

2018 TECHNICAL EVALUATION CHECKLIST 1A
BUILDING

State/Division		Construction Year			
Township		Remoteness	NR	R VR	ER
Village Tract		GPS Coordinates	N	E	
Village		Com. Force Acc't ☐	Contractor ☐	Joint ☐	
Village ID	MMR	New construction ☐	Rehabilitation ☐		
Comparable ☐	Agency:	Inspection date:	Inspection by:		

Buildings, e.g. School, Community Centre, Toilet block (detached from the building) etc.	Inspection Details: Inspection Result				
	Meets Spec.	Slightly Below Spec	Below Spec.	Not inspected	Not applicable
1 Foundation					
2 Ground beam/plinth beam					
3 Wall					
4 Column					
5 Ring beam					
6 Truss					
a. Structural assembly and components					
b. Connection to ring beam					
7 Roof structure					
a. Roof sheeting/tiles/fasteners					
b. Connections to purlin					
8 Floor					
9 Plastering					
10 Ceiling					
11 Painting					
12 Doors and windows					
13 Toilet					
14 Septic tank					
15 Ramp and handrail					

16 Service utilities					
a. Water					
b. Electrical installation					
c. Drainage					
17 Other structures					
18 Operation and Maintenance					

Beneficiaries: Men Women Children Total

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2A Cost Effectiveness
Key Infrastructure Information and Dimensions for Unit Cost Calculations

State/Division	
Township	
Village Tract	
Village	
Project ID	MMR

Building

	Width (ft)	Length (ft)	= Area	No. of Rooms
1 Building			0	
2 Building			0	
3 Building			0	
4 Building			0	
		Total	0	0

Materials	Reinf. Conc	Wood	Masonry/Tile	Steel	
5 Structural					✓
6 Non-structural					✓
7 Trusswork					✓
8 Roof					✓

Watsan	Public syste	Borehole	Gravity	Other	
9 Water supply					✓

10 Watsan subtotal budget [ ] Kyat

11 Electricity subtotal [ ] Kyat

Furniture and Siteworks - subtotal budgets				
12 Furniture				Kyat
13 Fencing		ft		Kyat
14 Road access lane		ft		Kyat
15 Drainage		ft		Kyat
16/17 No entry				
18 Total Sub-Project Budget		Kyat		

1

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2A Cost Effectiveness

Breakout Costs (as part of total Building Budget)			
19 Specialized trades		Kyat	Make note
20 Transport cost		Kyat	
Community contribution for NCDDP Sub-Projects - Form F8			
21 Cash contribution		Kyat	
22 Labour and local materials supply		Kyat	
23 Transportation of materials		Kyat	
24 Other contributions not reported		Kyat	Make note of what it is.
25 Verification of accounting for community contribution			✓or ✗

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3 Environmental and Social Safeguards
Verification of Completion of NCDDP Standard Forms and Adherence to Guidelines

State/Division	
Township	
Village Tract	
Village	
Project ID	MMR

Environmental Practices

1 Site inspection confirms that the Environmental Codes of Practice (ECoP) were followed during construction ☐ ✓or ✗ or n/a

2 Environmental Management Plan included in the file (Form PC 15) and site inspection confirms it was followed during construction ☐ ✓or ✗ or n/a

Land Acquisition

3 Voluntary land donation conditions met. Form PC 14 on file ☐ ✓or ✗ or n/a

Safeguards

4 Safeguard Screening Form PC 13 in sub-project file ☐ ✓or ✗

Notes and commentary:

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4A Operations and Maintenance/Sustainability

State/Division	
Township	
Village Tract	
Village	
Project ID	MMR

Building

1 Major repairs or rehabilitation performed		Yes/No
2 Major repairs or rehabilitation required		Yes/No
3 Environmental		✓nature of defect
4 Design		
5 Construction		
6 Materials		
7 O&M		

Other - Make notes next page

8.1 Repair costs		Kyat
8.2 Estimate costs		Kyat

	Village labour	Contractor	Gov't	
9 Repair by whom				✓

10 Repair date		MM/YYYY

Routine maintenance (make notes next page)

11 Roof repair		✓active areas
12 Mechanical (hinges, locks, etc.)		
13 Plumbing		
14 Concrete repair		
15 Plaster repair		
16 Washing		
17 Painting		
18 Drainage		

19 No entry

1

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4A Operations and Maintenance/Sustainability

How good is the O&M Plan? (make notes below)

20	Contains three-year maintenance plan?		Yes/No
21	Linkages to line Ministries?		Yes/No
22	Clear division of responsibilities and costs		Yes/No
23	Contains estimated costs: Routine		Yes/No
	Capital repair		Yes/No

O&M Committee (make notes below)

24	In place and functioning		Yes/No
25	O&M user fee in place		Yes/No
26	Indirect beneficiary fees		Yes/No
27	Contributions from other sources		Yes/No
28	Current funds within O&M account		Kyat
29	Affordibility of user fees		% of users who are able to easily pay
30	Government inputs adequate/timely		Yes/No use two boxes!
31	Labour/material input Community		% annually Notes below
	Government		% annually

O&M Training

32	O&M training received		Yes/No
33	Ongoing capacity development		Yes/No
34	Annual training budget		Kyat

Climate Resiliency - DRM

35	Is the SP safe from flooding?		Yes/No
36	Erosion protection measures sufficient?		Yes/No
37	Low landslide risk; no steep slopes		Yes/No
38	Low forest fire risk; clear area between building and forest		Yes/No

2

2018 NCDDP Technical Evaluation

5A Key Issues
Key Infrastructure Issues Noted During Technical Evaluation

State/Division	
Township	
Village Tract	
Village	
Project ID	

KEY ISSUES - BUILDING

Design

- 1 ☐ Lack of construction details on drawings
- 2 ☐ Inaccurate drawings of connection details
- 3 ☐ Improper steel reinforcement design
- 4 ☐ Constructed dimensions differ from plan

Roof/Truss

- 5 ☐ Inadequate overlap of roof sheeting
- 6 ☐ Improper connection of roof to truss (no cleat, etc.)
- 7 ☐ Unreinforced splices in truss members
- 8 ☐ Missing steel strapping
- 9 ☐ Use of nails rather than bolts
- 10 ☐ Undersized/missing truss members
- 11 ☐ Improper connection of truss to ring beam

Steel Reinforcement

- 12 ☐ Short development length in steel reinforcing
- 13 ☐ Improperly bent reinforcing cage stirrups
- 14 ☐ Lack of tie bar wiring
- 15 ☐ Missing anchors, foundation to ground beam
- 16 ☐ Missing anchors, column to wall

Concrete/plaster

- 17 ☐ Absence of concrete mix design
- 18 ☐ Honeycombing in concrete
- 19 ☐ Exposed/shallow reinforcing steel
- 20 ☐ Improper materials or poorly mixed concrete
- 21 ☐ Undersized concrete column/beam
- 22 ☐ Improper plastering technique
- 23 ☐ Poor plastering and finishing

Sanitary Facilities

- 24 ☐ Toilet building not provided
- 25 ☐ No water connection to public system
- 26 ☐ Poor drainage/ponding on floor
- 27 ☐ Exposed PVC pipe
- 28 ☐ No access lid to septic tank
- 29 ☐ High watertable in septic tank

Electrical

- 30 ☐ No junction box at wiring connections
- 31 ☐ Low/unattached wiring in public area
- 32 ☐ Broken switch
- 33 ☐ Wiring installed but not energized

Miscellaneous

- 34 ☐ Broken mechanical fixtures
- 35 ☐ No handicap ramp/too steep
- 36 ☐ Ponding on the floor
- 37 ☐ Poor drainage around building

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6 Economic Analysis

Building

School

1 School enrolment number before construction/renovation		students
2 School enrolment number after construction/renovation		students
3 School drop-out number before construction/renovation		students
4 School drop-out number after construction/renovation		students

Health Center

5 Willingness/ability to pay per visit for health care services		%
6 Cost of health care professional at the facility / year		Kyat/year
7 Average number of patients per day		Patients/day
8 Number of days facility is operating in a month		Days/mth
9 Average annual O&M cost of facility (drugs, utilities, building repair / maintenance)		Kyat/year

Bridge

10 Cost of post harvest losses before construction/renovation		Kyat
11 Cost of post harvest losses after construction/renovation		Kyat
12 Cost to transport farm produce to market before bridge project		Kyat
13 Cost to transport farm produce to market after bridge project		Kyat

1

2018 NCDDP Technical Evaluation

Brief Sub-project Description, Notes and Commentary, Best Practices

Brief Sub-Project Description: brief description of the SP will provide a few sentences that include type of infra, size (or length, width, etc.) of infra, materials used to build infra, approximate number of users, special characteristics of infra, etc.
Notes and Comments from Audit:
Best Practices: * What examples of good practice can be drawn to enhance technical quality, operation and maintenance and sustainability for future NCDDP sub-projects? * What are the key lessons learned from the sub-projects undertaken? What practices should be replicated and/or avoided in future sub-projects? Provide a list of key recommendations.

ANNEX 3: Sub-Project Components/Aspects

The following list indicates the components (and sub-components/aspects) for each type of sub-project analyzed under this review. References in the report offer aggregated totals for all components/aspects of a sub-project type. In these cases, tabular percentages represent aggregate total of the ratings for 25 components/aspects for Building, 15 for Bridge, 19 for Water Supply, 25 for Road, and 15 for Electricity.

Building

4. Foundation
5. Ground beam
6. Wall
7. Column
8. Ring beam
9. Truss
    a. Structural assembly and components
    b. Connection to ring beam
10. Roof structure
    a. Roof sheeting/tiles/fasteners
    b. Connections to purlin
11. Floor
12. Plastering
13. Ceiling
14. Painting
15. Doors and windows
16. Toilet
17. Septic tank
18. Ramp and handrail
19. Service utilities
    a. Water
    b. Electrical installation
    c. Drainage
20. Other structures
21. Operation and maintenance

Bridge

1. Layout
2. Foundation
3. Erosion protection
4. Abutments
5. Pier/supports
6. Wingwalls
7. Concrete
8. Deck beams
9. Deck
10. Submerged concrete laneway
11. Handrail
12. Connections (nails, bolts)
13. Apron/ramp
14. Other structure
15. Operation and maintenance

Water Supply

1. Water source
2. Smell, color
3. Chemical analysis
4. Watershed protection
5. Water system design
6. Borehole and pump system
7. Reservoir
8. Structural integrity
9. Easy to clean
10. Transmission and distribution pipe - proper installation
11. Public taps
12. Number and locations
13. Fixtures
14. Platform
15. Drainage
16. Fencing
17. Water pressure and quantity
18. Other structures
19. Operation and maintenance

Road

1. Road condition
2. Cross section (crown/ camber)
3. Inadequate roadside ditches
4. Missing drainage structure
5. Improper construction materials
6. Slippery when wet
7. Very muddy during rainy season
8. Slopes
9. Unstable slope above (too steep)
10. Unstable slope below (too steep)
11. Narrow width
12. Surface below standard
13. Pavement below standard
14. Safety concerns
15. Retaining wall
16. Structural integrity (batter, and so on)
17. Weep holes
18. Erosion protection
19. Culvert
20. Layout
21. Construction techniques
22. Small bridge
23. Layout
24. Construction techniques
25. Operation and maintenance

Electricity

1. Genset/Solar Voltaic/Mini-Hydro
2. Manufacturer, model
3. Installation of equipment and venting
4. Wiring connections within structures
5. Electrical utility poles
6. Pole quality
7. Installation practices
8. Pole stay
9. Conductor installation practices on poles
10. Horizontal separation
11. Vertical distance to ground
12. Conductor burial
13. Grounding
14. Street lights
15. Operation and maintenance

ANNEX 4: NCDDP Sub-Projects Evaluated, Technical Audit 2018[9]

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
1	Ann	Ann (North)	Kywe Ta Lin	Water supply	2
2	Ann	Ann (South)	Kyet Yae San	Electricity	2
3	Ann	Myannar Boke Chaung	Boke Chaung	Road	2
4	Ann	Lon Kauk	Pyaung The	Hall	2
5	Ann	Taik Maw	Taik Maw	Road	2
6	Ann	Laung Don Kwin	Maw Gyi	Hall	2
7	Ann	Ga Nan Pyin	Kan Bwe	Road	3
8	Ann	Taung phe Lar	Laung Sa Ya Pin	Bridge	2
9	Ann	Taung phe Lar	Laung Sa Ya Pin	Bridge	2
10	Ann	Sa Khan Maw	Auk Zin Gaung	School	2
11	Ban Mauk	Pin Hin Khar	Shwe Kyaung	Bridge	2
12	Ban Mauk	Pan Taw	Pan Taw	Bridge	3
13	Ban mauk	Kho Nan	Pa Mon	Library	2
14	Ban Mauk	Lay thi	Lay Thi	Hall	2
15	Ban Mauk	Man Laung Pay Pin	Whay Thauk Chi	School	2
16	Ban Mauk	Ga Nan Mu Thar	Pin Laing	Electricity	2
17	Ban Mauk	Aung Thar Kone	Kywe Kaw Kone	Road	2
18	Ban mauk	Pin Sin Te	Lel kyin	Road	2
19	Ban mauk	Kan Taw	Taung Hlwe	Road	2
20	Ban mauk	Naung Kan	Whay man kaw	Water supply	2
21	Bilin	Hnin Pale	Yae Phyu Kan	Road	1

9 Quality rating based on a six-point scale as follows: 1–highly satisfactory; 2–satisfactory; 3–moderately satisfactory; 4–moderately unsatisfactory; 5–unsatisfactory; and 6–highly unsatisfactory. More specific details of these ratings are found on the final page of this annex.

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
22	Bilin	Leik Khone	Leik Khone Ywar Lay	School	2
23	Bilin	Ah Naing Pun	Ka Beit Oke Hpo	Bridge	1
24	Bilin	Muu Thin	Waing Patt	Road	1
25	Bilin	Kadipu	Thitchataung	Hall	2
26	Bilin	Ah Hone Wa	Pho Gyi Seik	Hall	2
27	Bilin	Pi Ti	Pho Kalalt Htaw	Water supply	2
28	Bilin	Pi Ti	Bin Ban	Electricity	3
29	Bilin	Kyar Kwin	Ah Hone Wa Ah Nauk	Bridge	2
30	Billin	Gone Hnyin New	Gone Hnyin New	Road	2
31	Chaung Zone	Kamarmo	Kamarmo	School	1
32	Chaung Zone	Ka Lawt	Ah Pyaing	Bridge	2
33	Chaung Zone	Saw Kae	Saw Kae	Hall	2
34	Chaung Zone	Ka Yaik Du	Yae Twin Kone	School	2
35	Chaung Zone	Mu Yit Ka Lay	Ta Ku Ha Awee	Bridge	1
36	Chaung Zone	Phan Pha	Phan Pha	Electricity	2
37	Chaung Zone	Kha Yaik Hnee Hu	Taw Pa Kauk	Water supply	2
38	Chaung Zone	Boe Net	Boe Net	Road	1
39	Chaungzone	Dayal	Dayal	Road	1
40	Chaungzone	Hintharkyun	Hintharkyun	Road	3
41	Demoso	Hpa Yar Hpyu	Hpa Yar Hpyr	Road	2
42	Demoso	Nan Meh Khon	Khaw Khu (Shan)	Road	2
43	Demoso	Daw Bu Ku	Daw Bu Ku	Building	2
44	Demoso	Saung Du Ywar Thit	Done Ka Mee	Road	2
45	Demoso	Naung Pele	Law Si	Hall	2
46	Demoso	Daw Yauk Khu	Le Ma An Khu	School	2
47	Demoso	Lo Pu	Cherry Gone	Water supply	2
48	Demoso	Pan Pet	Pan Pet Ka Tel Ku	Bridge	2
49	Demoso	Htee Poe Ka Loe	Daw Khu Li	Bridge	2
50	Kanpetlet	Khant Thar Yon	Par Kun	Child Care Center	3
51	Kanpetlet	Kyet Chan	Nhga Do	Road	2
52	Kanpetlet	Ngon Laung	Ngon Laung	School	3
53	Kanpetlet	Ngon Laung	Chin Let Mon	Water supply	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
54	Kanpetlet	Khi Taw	Ma Swi Twi	Health Center	2
55	Kanpetlet	Le Pon	Le Pon	Bridge	2
56	Kanpetlet	Lun Don	Lun Don	Road	2
57	Kanpetlet	Lun Don	Ma Swi Twi	Road	2
58	Kanpetlet	Hman Taung	Hlaing Doke	Water supply	2
59	Kawhmu	Tha Meit	Tha Meit(upper)	Bridge	2
60	Kawhmu	Hmaw Taw	Hmaw Taw	Bridge	2
61	Kawhmu	Shar Bwar	Hpa Yar Ni	School	2
62	Kawhmu	Ywar Tan Shey	Done Nyo	Road	3
63	Kawhmu	Ah Hpyauk	Ah Hpyauk	Hall	2
64	Kawhmu	Kyar Kan	Kyar Kan	Water supply	3
65	Kawhmu	Pyar Hmut	Pyar Hmut	Road	2
66	Kawhmu	Ka Mar Ka Nee	Ka Mar Ka Nee	Health	2
67	Kawhmu	Sar Taing Hmut	Sar Taing Hmut	Road	2
68	Kawhmu	Tha Yet Taw	Tha Yet Taw	Electricity	1
69	Kun Chan Kone	Kan Hylar Shay	Ka Nyin Pin	Road	3
70	Kun Chan Kone	Kayin Chaung	Thar Yar Aye	Road	3
71	Kun Chan Kone	Su Ka Lat	Su Ka Lat	School	2
72	Kun Chan Kone	Hmaw Bi	Ah Dat	Bridge	2
73	Kun Chan Kone	Man Ka Leik	Ywar Thit Kone	Water supply	2
74	Kyan Kin	Ta Lime Kwin	Kyun Su	Road	2
75	Kyan Kin	Kwayt Ma	Nga Pi Su	Water supply	2
76	Kyan Kin	Thae Phyu	Min Te Lay	Hall	2
77	Kyan Kin	Chin Myaung	Gyoe Gyar Tan	Road	2
78	Kyan Kin	Ahlon	Thar Yar Kone	Water supply	2
79	Kyan Kin	Kone Gyi	San Ton	Bridge	1
80	Kyan Kin	Pauk New San	Me Za Li	Library	2
81	Kyan Kin	Thit Seint Kaing	Oke Shit Kone	Electricity	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
82	Kyan Kin	Thit Seint Kaing	Oke Shit Kone	Electricity	2
83	Kyan Kin	Pauk New San	Tha Yet Taw	Hall	2
84	Kyar In Seik Gyi	Kyar In Shwe Doe	Shwe Doe	Road	2
85	Kyar In Seik Gyi	Kyar In Shwe Doe	U Chun Kone	Bridge	2
86	Kyar In Seik Gyi	Nat Ghaung Kannar	Gone Bi	Bridge	1
87	Kyar In Seik Gyi	Da None	Si Sone	Road	2
88	Kyar In Seik Gyi	Mi Tan	Yay Pu/Pu Yay	School	3
89	Kyar In Seik Gyi	Khwi Ka Lone	Mae Naw Dar Khee	Electricity	2
90	kyarinseikgyi	kyarinshwedoe	mingalarkone	School	2
91	Kyarinseikgyi	Kya Khat Chaung	Kya Khat Chaung	Water supply	2
92	Kyarinseikgyi	Ta Khun Taing	Ta Khun Taing	Hall	1
93	Kyarinseikgyi	Kha Lel	Kha Lel Ywar Lay	Road	2
94	Kyunsu	Kywe Kha Yan	Thazin	Road	2
95	Kyunsu	Taw Pyar	Panzin	Bridge	2
96	Kyunsu	S Khan Thit	S Khan Thit	Bridge	3
97	Kyunsu	Min Goat	Min Goat	Water supply	2
98	Kyunsu	Min Goat	Pyin Wun	School	2
99	Kyunsu	Kata Lu	Htein Chaung	Water supply	2
100	Kyunsu	Maung Hlaw	Ya Taung(Atwin)	Electricity	2
101	Kyunsu	Zay Ka Mi	Zay Ka Mi	Road	2
102	Kyunsu	Kan Gyi	Maw Tone Gyi	Health Center	2
103	Kyunsu	Ka Pa	Ka Tan	Hall	2
104	Loikaw	Htee See Khar	Daw Ta Hay	Bridge	2
105	Loikaw	Loilen Lay	Loilen Lay	School	2
106	Loikaw	Daw Paw Ka Le	Bar Do	Electricity	2
107	Loikaw	Nwar La Woe	Thone Maing Pa Kye Sanpya	Road	2
108	Loikaw	Law Pi Ta	So Sa Lel	Water supply	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
109	Loikaw	Daw Phu	Ta Hpo	Water supply	2
110	Mindon	Ta Dar	Nyaung Pin Thar	Bridge	3
111	Mindon	Htein Kaing	Pauk Kaing(Middle)	Road	2
112	Mindon	Htein Kaing	Kywe Bay(Upper)	Road	2
113	Mindon	Kyoet Wa	Kyoet Wa	Road	2
114	Mindon	Hlwar	Hmaik	Water supply	2
115	Mindon	Chin Hnit	Chin Hnit	Electricity	2
116	Mindon	Taung Pat	Taung Pat	School	3
117	Mindon	Ah Lel Chaung	Ah Lel Chaung	Hall	1
118	Mindon	Inn Pyet	Kyauk Pyoke	Road	2
119	Mindone	Kyauk gyi	Kyauk Gyi(kyin)	Building	3
120	Missing	Missing	Missing	Missing	Missing
121	Monyo	We Gyi	Chan Thar Kone	Road	2
122	Monyo	Htein Taw	Parami	School	2
123	Monyo	Pauk Kone	Baw Di Kone	School	2
124	Monyo	Hpa Yar Ngu	Hpa Yar Ngu	Water supply	2
125	Monyo	Yae Kin	Yae Kin	Road	2
126	Monyo	Yae Kin	Min Gyi	Hall	2
127	Monyo	Lat Pan Kon	Lat Pan Kon	Road	2
128	Monyo	Sin Gaung	Yae Oe Sin Kone	Road	2
129	Monyo	Min Du	Gon Hnyin Tan	Bridge	2
130	Monyo	Oe Bo Kyun	Shit Kwet	Electricity	2
131	Myaung	2	Aung chan tar	School	2
132	Myaung	Kyaut tan	Chan thar	Electricity	2
133	Myaung	Let Yet Ma	Thi Ri Zay Ra	WS	2
134	Myaung	Oke Hne Boke	Mya San	Bridge	2
135	Myaung	Shwe Pauk Pin	Shwe Pauk Pin	Bridge	2
136	Myaung	Pauk Taw	Pauk Taw (east)	Road	2
137	Myaung	Shwe bon thar	Sin Min(Zee kone)	Road	2
138	Myaung	Kyaung Hpyu	Kyaung Hpyu	School	2
139	Myaung	Kyaung Hpyu	Hne Hmoke	School	2
140	Myaung	Myit son	Myit son	Road	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
141	Nga Pu Taw	Ohn Pin Su	Kyaung Su	Water supply	3
142	Nga Pu Taw	Gone Nyin Tan	Tha Yet Taw	School	3
143	Nga Pu Taw	Ah Yoe Dar	Ka Mar Lu	Electricity	1
144	Nga Pu Taw	Tha Mar Dae Wa	Al Le Kone	Bridge	3
145	Nga Pu Taw	Ka Nyin Chaung	Kone Tan	Road	1
146	Ngazun	Gyo	Gyo	Road	2
147	Ngazun	Kyauk Ta Lone	Thar Si	Health Center	2
148	Ngazun	Chin Thayt Let	Shwe Twin Kone	Building	2
149	Ngazun	Thu Nat sit	Thar Paung	Building	2
150	Ngazun	Pyin Hla Taw	Pyin Hla Taw	Road	3
151	Ngazun	Kaung Zin	Kaung Zin	Road	3
152	Ngazun	Yae Lel Thaung	Bay Thaung	Bridge	2
153	Ngazun	Moe Taung	Lel Chin U	Water supply	2
154	Ngazun	Kone Lel	Myay Ni	Electricity	1
155	Ngazun	Tha Yet Cho Pin	Don Din	Road	1
156	Nyaung U	Thaung Zin	Ka Kye	Bridge	2
157	Nyaung U	Let Htoke	Let Htoke	Road	2
158	Nyaung U	Pyawt Kan	Pyawt Kan	Road	2
159	Nyaung U	Ah Htet Nyint	Ah Htet Nyint	Electricity	2
160	Nyaung U	Ku Taw	Kyo Pyin Thar	Road	2
161	Nyaung U	Kyun Khin Gyi	Kyun Khin Gyi	Bridge	2
162	Nyaung U	Nyaung Pin	Oke Hlay Kar	School	2
163	Nyaung U	Pyun	Pyun	Hall	3
164	Nyaung U	Myay Ni	Bo Kone	Water supply	2
165	Nyaung U	Kamma	Aing Gyi	School	2
166	Padaung	Ma Gyi Htone	Kyoet Kone	Road	2
167	Padaung	Daung Ma Nar	Ywar Thit	Bridge	2
168	Padaung	Kaing Gyi	Kaing Gyi	Electricity	2
169	Padaung	Nyaung Pin	Nyaung Pin	Building	3
170	Padaung	Hpa Yon Kar	Kyar Chay Yar	Water supply	2
171	Pawbye	Htan Taw Gyi	Warsukyi	Water supply	2
172	Pletwa	Kin Wa	Kin Wa	Road	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
173	Pletwa	Lel Hla	Lel Hla	Bridge	2
174	Pletwa	Hna Ma Dar	Hnan Chaung	Water supply	3
175	Pletwa	Yoke Wa	Yoke Wa	Water supply	3
176	Pletwa	Pein Hne Ta Pin	Kun Boke	School	2
177	Pletwa	Nga Shar	Hnone Bu Nge	School	2
178	Pletwa	Kyee Lay	Kyee Lay (Upper)	Bridge	1
179	Pletwa	Laung Tin	Kyway Thaung	Hall	2
180	Pletwa	Auk Ba Lai	Auk Ba Lai	Road	2
181	Pletwa	Pyin Wa	Ku Wa	Road	2
182	Pyawbye	Chaung Ma Gyi	Kone Thar	Road	2
183	Pyawbye	Ge Gyi	Ge Gyi	Road	2
184	Pyawbye	Bat Ta	Kan Kaung	Library	2
185	Pyawbye	Ayekarit Kone	Ywar Thit	Bridge	2
186	Pyinmana	Kyee Inn	Kyee Inn	Road	2
187	Pyinmana	Nhantaw	Nhantaw	School	2
188	Pyinmana	Bantbar	Thanmaye	Bridge	2
189	Pyinmana	Thiton	Mayantaung(upper)	School	2
190	Pyinmana	Boet Ma	Boet Ma Kant Hpa Lar	Water supply	2
191	Saw	Kyein Gyi	Per Chaung	Water supply	2
192	Saw	Kyein Gyi	Lal U	Electricity	2
193	Saw	Kyun Taw	Kyun Taw	School	2
194	Saw	Kyauk Laik	Hnget Gyi U	Road	3
195	Saw	Yint Ye	Yint Ye	Bridge	2
196	Sidoktaya	Chit Pyin Kaing	Nyaung Aing	Hall	2
197	Sidoktaya	Nan Kyu	Nan Kyu	Road	2
198	Sidoktaya	Nan Kyu	Paung Chaung	School	3
199	Sidoktaya	Ah Le Pon	Auk Pon	Electricity	2
200	Sidoktaya	Yae Taung	Yae Taung	Road	3
201	Sidoktaya	Mye Ni	Mye Ni	Road	3
202	Sidoktaya	Thet Le	Kyauk Phu	Road	2
203	Sidoktaya	Kyee Wa	Kyee Wa	Bridge	2
204	Sidoktaya	Tezar	Te Zar	Water supply	2

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Ratinga
205	Sidoktaya	Man Tut Kaing	Ku Taw	Hall	2
206	Tanintharyi	Sin Chay Hpone	Baw Di Kan	Electricity	2
207	Tanintharyi	Sin Chay Hpone	Auk Kin (West)	Road	2
208	Tanintharyi	Pa Wa	Kyun Shay	Bridge	2
209	Tanintharyi	Maw Tone (East)	Maw Tone (East)	School	2
210	Tanintharyi	Lel Thit	Lel Thit (East)	Bridge	2
211	Tanintharyi	Ban La Mut	Yan Hpo	School	2
212	Tanintharyi	Thein Daw	Thu Htay-East	Water supply	2
213	Tanintharyi	Ban Law	Ban Law (East)	Road	2
214	Tanintharyi	Ta Ku	Inn Shay Gone	Road	2
215	Tanintharyi	Nyaung Bin Kwin	Nyaung Bin Kwin (West)	School	2
216	Tatkone	Kha Yan Sut Kone	In Phet Kone	Water supply	2
217	Tatkone	Htone Bo	Htone Bo	School	2
218	Tatkone	Kan Gyi	Latt Pan Pu	Bridge	2
219	Tatkone	Thit Saint Pin	Chin Su	Hall	2
220	Tatkone	Kan Hla	Gut Kone	Road	2
221	Tatkone	Naung Tone Aine	Naung Kone	Road	2
222	Tatkone	Htan Taw Gyi	Kone Ywar	Electricity	2
223	Tatkone	Latt Pan	Inn Khone	Road	3
224	Tatkone	Shwe Maung Good	Yadanar Myay	Health Center	3
225	Tatkone	Shwe Maung Good	Shwe Inn Thar	School	3
226	Thar Paung	Nga Wun Daunt Gyi	Nga Wun Daunt Gyi	Bridge	3
227	Thar Paung	Kyar Ye	Nyaung Kone	Hall	3
228	Thar Paung	Zee Hpyu Kwin	Kan Kone	Road	2
229	Thar Paung	Khway Koke	Ga Mone Kyaw	Electricity	2
230	Thar Paung	Hpa Yar Kone	Hpa Yar Kone	Bridge	2
231	Thar Paung	Gon Hnyin Tan	Gon Hnyin Tan	Hall	2
232	Thar Paung	Si Son	Tha Bawt Chaung	Road	2
233	Thar Paung	Hlay Gyi Pyet	Nan Pin Kone	Road	2
234	Thar Paung	Shan Ma Myaung	Wea Gyi Daunt	School	3
235	Thar Paung	Thit Phyu	Thit Wan Pu	Water supply	3

Note: a. World Bank Six-Level Rating System.

1. Highly Satisfactory (HS)	Project fully complies with or exceeds policy requirements.
2. Satisfactory (S)	Minor shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
3. Moderately Satisfactory (MS)	Moderate shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
4. Moderately Unsatisfactory (MU)	Moderate shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress but resolution is likely.
5. Unsatisfactory (U)	Significant shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress and resolution is uncertain.
6. Highly Unsatisfactory (HU)	Major shortcomings exist in compliance with policy requirements or achievement of development objectives

ANNEX 5: Economic Analyses of Infrastructure Sub-Projects of the NCDDP

I. INTRODUCTION

Economic analyses were undertaken for four types of NCDDP infrastructure sub-projects (farm-to-market roads [FMRs], rural water supply, rural electrification, and school building) using a standard methodology for CDD projects (see Araral and Holmemo 2007).[10] The costs and benefits for each of these sub-projects were identified and valued based on a survey of a representative sample of sub-projects and information from other sources. The survey was undertaken from January to April 2018 by trained field staff who were supervised by a consultant engineer using a pre-tested survey questionnaire.[11] Attachment 1 of this annex describes the general methodology and assumptions used for this analysis. Attachment 2 provides details of the parameters of the economic analyses as well as the worksheets. Attachment 3 presents the survey data used for the calculations.

The technical and economic analysis was based on a stratified random sample of 235 sub-projects selected from 27 NCDDP townships from project implementation years 2016 and 2017.[12] Townships were selected based on the range of implementation contexts under which the NCDDP operates, specifically conflict-affected areas, disaster-affected areas, areas dominated by ethnic minorities, areas with physical culture resources, hilly and remote areas, and the Ayeyarwaddy river zone. Based on these stratification criteria, the following townships were selected: Kyarinnseikkyi, Paletwa, Loikaw, Demorso, Tanintharyi, Belin, Nyaung U, Kanpetlet, Banmauk, Kyunsu, Moenyo, Myaung, Kyangin, Ngazun, Padaung, Sidoktaya, Ann, Tharbaung, Ngaputaw, Tatkone, Kawhmu, Lewe, Pyawbwe, Mindon, Saw, Kunchankone, and Chaungzon. Within these townships, sub-projects were purposefully selected to approximately reflect the mix of the different types of sub-projects under the NCDDP and to include a mix of remote and accessible villages.

II. ECONOMIC ANALYSES OF INDIVIDUAL SUB-PROJECTS

A. Village Water Supply

Table A5-1 summarizes the parameters for the economic analyses for water supply sub-projects. A total of 31 water supply sub-projects were audited in the field survey. The financial cost of con-

10 See Araral and Holmemo (2007). "Measuring the Costs and Benefits of Community Driven Development." World Bank. http://documents.worldbank.org/curated/en/918181468294317356/pdf/393860Eco0Analysis0KALAHI01PUBLIC1.pdf

11 Neate, N. 2018. Technical, Cost Effectiveness, Economic Rates of Return and Sustainability Audit, National Community Driven Development Project (NCDDP). Final Report.

12 Implementation years 2016 and 2017 were chosen for the study as a previous technical audit had already looked at sub-projects from 2014 and 2015.

struction on average was estimated at kyat 8.73 million. Adjusted for the labor cost component and shadow wage rate (SWR), the economic cost is kyat 7.86 million.

Assumptions for valuing water supply benefits

- Based on survey records, the average number of beneficiaries of the water supply sub-project is 476 individuals.
- The potable water supplied by the project will fully replace the old sources of water (non-incremental demand).
- The gross benefits of the water supply sub-project are estimated to come from three sources: (a) the total value of incremental (or new) water consumed by the beneficiaries as a result of the project; (b) the total (conservative) value of time saved from fetching water; and (c) the health benefits from clean water supply. Of these three benefits, the first two were quantifiable in the current analysis. Health benefits, which were not quantified, are substantial such as reduction in water-borne diseases and reduction in infant mortality, among others.
- In the 'with' project situation, water demand (incremental water) is about 17 liters per person per day. This incremental amount is consistent with other studies (see Araral and Holmemo 2007).
- With the project, each household saves 1.22 hours per day from fetching water. There are 103 beneficiary households on average, and adults (mainly women) are assumed to be responsible for fetching half of the water on a daily basis (the other half by school-age children). The time spent by adults was valued as follows:
  - On an annual basis, 30 percent of their time are spent on farming-related tasks (planting, weeding, and harvesting) for which they are compensated. The average willingness to pay for a gallon of water per household is kyat 6 per gallon based on the field survey. The official minimum wage in Myanmar is kyat 4,800 per day but in the rural areas unskilled farm workers are compensated only about a third of this amount or about kyat 1,584 per day.
  - Furthermore, the value of time spent by children fetching water was not imputed into the analysis thus making it a conservative estimate.

TABLE A5-1: Parameters for Economic Analyses of Rural Water Supply

	Unit	Without Project	With Project	With-Without Project
Average financial cost of construction	Kyat	0	8,734,644	8,734,644
Proportion of labor cost	%		25	
Adjustment for unskilled labor	% of official rate		60	
Economic cost of construction	Kyat	0	7,861,180	7,861,180
Number of household beneficiaries	Household	0	103	103
Average members of a household	Number	5	5	
Total number of beneficiaries	Number	0	515	515
Average willingness to pay per gallon of water	Kyat	0	6	6

	Unit	Without Project	With Project	With-Without Project
Benefit 1: Value of incremental water supply	Kyat per year	0	3,024,078	3,024,078
Benefit 2: Value of time saved fetching water	Kyat per year	0	1,240,780	1,240,780
Gross annual benefit	Kyat per year	0	4,264,858	4,264,858
Annual O&M cost	Kyat per year	0	393,059	393,059
Annual net benefits	Kyat per year	0	3,871,799	3,871,799
Project life	Years	0	10	10
Discount rate				10%

- The gross benefit of the water system is calculated as cost savings on non-incremental water and the value of incremental water consumption. The cost savings on non-incremental water are calculated as the opportunity cost of fetching non-incremental water in the without-project situation plus the cost of water in the without-project situation. The value of incremental water is approximated by the average of the current and future costs of water in financial prices. The financial cost of incremental water consists of two elements: amount spent on O&M in the with-project situation, and time
- The official discount rate is set at 10 percent. The project life is assumed to be 10 years and O&M was found to be satisfactory.

Results

Based on these assumptions, **overall, rural water supply sub-projects are economically viable** (see Table A5-2). The NPV of the project is high at kyat 15 million reflecting the value of time saved by economically active adults throughout the life span of the project. Adults were assumed to be primarily responsible for fetching water for the households. Children are also responsible but the economic value of their time was not imputed in the model. The EIRR is also high at 43 percent. The estimate is conservative because other benefits such as reduction in morbidity was not estimated for lack of data. The result is not sensitive to reduction in project life, escalation in project cost, and reduction in project benefits.

TABLE A5-2: Summary of Economic Analyses for Rural Water Supply Sub-projects

Sub-project	Baseline	Sensitivity Analyses		
		Reduction in Project Life (10 to 5 years)	20% Cost Escalation	20% Benefits Reduction
Water Supply (n = 31)				
NPV (Kyat, thousands)	15,055	8,128	13,308	10,297
EIRR (%)	43	38	35	33

B. School Buildings

Table A5-3 summarizes the parameters for the economic analyses for school buildings. The financial cost of construction for a two-classroom unit was estimated at kyat 9.4 million based on the field survey and NCDDP records. Adjusting for the value of unskilled labor, the economic cost is kyat 8.51 million.

Assumptions for valuing benefits

- It is assumed that the school buildings are used mainly for primary education. It is also assumed that increasing availability of classrooms will increase the completion rates of primary and secondary education thereby increasing years of schooling and thus increasing the likelihood of a student obtaining gainful employment. This assumption is supported by official statistics. The Myanmar Information Management Unit (MIMU) database on education reports that the primary school completion rate is around 54 percent while the proportion of the national population with access to secondary school is only 24 percent. The school buildings constructed by the NCDDP therefore help alleviate these infrastructure constraints.

TABLE A5-3: Parameters for Economic Analyses of School Buildings

Assumptions	Unit	Without Project	With Project	With-Without
Financial cost of construction	Kyat	0	9,464,941	9,464,941
Proportion of labor cost	%		25	
SWR unskilled labor	%		60	
Economic cost of construction	Kyat		8,518,447	8,518,447
Additional school children enrolled due to sub-project	Number	0	25	25
Growth rate of primary school enrolment	%	0	10	10
Average number of additional school children enrolled over 15-year lifetime of sub-project	Number children	0	47	47
Primary school completion rate (national average)	%	54	54	
Benefit: Average additional years of schooling given number of new enrollees and primary school completion rates	Years	0	94	94
Proportion of population with access to secondary school (national baseline)	%	24	24	0
Primary education completion rate (national average	%	54	54	0

Assumptions	Unit	Without Project	With Project	With-Without
Wage rate for semi-skilled workers, with high school education	Kyat per year per worker	0	193,248	193,248
Gross annual benefit for additional year of schooling	Kyat per SP per year		9,082,656	9,082,656
O&M cost - general	Kyat per year		2,839,482	2,839,482
O&M cost - repairs	Kyat per year		946,494	946,494
Annual net benefits	Kyat per year		5,296,680	5,296,680
Project life	Years		15	15
Discount rate				10%

- No assumptions were made of students continuing on to university education. Instead, it is assumed that they will start to work after completion of secondary education. It is assumed that they will perform general, semi-skilled labor (farm/off-farm) for which a high school degree is sufficient. There are many other benefits of completing a high school diploma such as civic education, vocational training but these were not included in the analysis due to lack of data. Thus, the results should be considered conservative.[13]
- Based on the school audit, there are on average 25 additional children who went to school as a result of the additional school buildings. Based on the MIMU[14] education database of Myanmar, the number of primary school children grew annually (national average) by 10 percent since 2012. Over the 15-year life span of the school building, there will be on average 47 school children a year who will be able to go to school. Given the 54 percent national average completion rate for primary school, this translates to about an average of 94 years of additional schooling a year by sub-project.
- The national minimum daily wage is kyat 4,800 for companies that employ more than 10 people. It is assumed that high school educated, semi-skilled workers would get the equivalent of 33 percent of official wage rate or kyat 1,584 per day. It is further assumed that these workers would find gainful employment for 120 days a year for seasonal, semi-skilled employment requiring some primary and high school education.
- The O&M cost for school buildings is estimated as follows: General O&M cost (teachers, utilities, and so on) is around 30 percent of capital cost while minor annual repairs are pegged at 1 percent of capital cost.

Results

Table A5-4 summarizes the results of the analyses. **Overall, the school building sub-project is economically viable.** The NPV is kyat 30.82 million and the EIRR is 56 percent. These estimates are conservative as explained earlier. This result for school building sub-projects is not sensitive

13 See the World Bank's estimates of schooling: http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079967208/547671-1120139762595/chapter2.pdf).
14 MIMU, Education Data. Produced by the UN Statistics Office (2017).

to reduction in life span of the building (from 15 to 10 years), a 20 percent increase in cost (due to inflation, increase in O&M costs, and so on), and a 20 percent reduction in estimated benefits.

TABLE A5-4: Summary of Economic Analyses for School Building Sub-projects

	Baseline	Reduction in Project Life (15 to 10 years)	20% Cost Escalation	20% Benefits Reduction
School buildings (n = 68)				
NPV (Kyat, thousands)	30,822	23,080	28,929	22,764
EIRR (%)	56	55	46	45

C. Farm-to-Market Roads

The field survey included a total of 72 road sub-projects, of which 65 percent (47) were FMRs, while the 35 percent were intra-village roads. The economic analysis focused on the FMRs as insufficient data were collected to assess the intra-village roads. Assessing the benefits of the intra-village roads would require contingent valuation of villagers' willingness to pay to travel from one village to another, the frequency of that travel, opportunity cost of time for those who travel (farmers, women, school children), and so on, which was beyond the scope of the field survey. As two-thirds of the surveyed roads were FMRs, the approach used is considered adequate. Of the 47 FMRs, 66 percent (31) benefit farming areas which focus primarily on rice production. The economic analyses therefore focused mainly on these villages and this crop. Other crops found in the project areas such as vegetables, wao, rubber, beans, and flowers are negligible, and little information on local prices is available—unlike for paddy rice.

The FMR sub-projects were divided into two categories: (a) 'accessible' roads, which are defined as being within 30 minutes motorcycle transport from the township center (this consisted of 14 out of 72 roads); and (b) 'remote' roads, which are defined as being greater than 30 minutes motorcycle drive from the township center (33 out of 72 roads). This distinction was made due to the significant differences in both costs and benefits.

Tables A5-5 and A5-6 summarize the parameters used in the economic analyses of FMRs for accessible and remote villages, respectively. The parameters vary in terms of cost of construction, O&M, and labor; number of beneficiaries; transport cost of produce and inputs; and distance to market centers. These differences have significant implications for the economic analyses.

TABLE A5-5: Parameters for Economic Analyses of 'Accessible' FMRs

	Unit	Without Project	With Project	With-Without
Financial cost of construction	Kyat	0	11,000,000	11,000,000
Labor component	%	0	25	25
Adjustment factor for unskilled labor	%	0	60	60

	Unit	Without Project	With Project	With-Without
Economic cost of construction	Kyat	0	9,960,530	9,960,530
Number of beneficiary farmers	Farmers	0	82	82
Average paddy yield per farmer per year	Kg per year	0	427	427
Official farmgate price of paddy (2017)	Kyat per kg	0	238	238
Transport cost of farm produce inputs	Kyat per ton-km	2,750	1,375	−1,375
Average distance of farm-to-regional market	Km	30	30	0
Average savings from transport of produce	Kyat per farmer per year	0	17,614	17,614
Benefit 1: Total savings transport of produce	Kyat per year per SP	0	1,444,328	1,444,328
Farm inputs/year (fertilizer/seeds/pesticides)	Tons per year	0.10	0.10	0
Average savings from transport of farm inputs	Kyat per farmer per year	275	137.5	−138
Benefit 2: Total savings transport of inputs	Kyat per year per SP	676,500	338,250	338,250
Benefit 3: Productivity improvements			1,666,666	1,666,666
Total benefits	Kyat per year per SP			3,449,244
Average annual O&M cost	Kyat per year	0	1,494,080	1,494,080
Net annual benefits	Kyat per year	0		1,955,164
Project life	Years			15
Official discount rate				10%

TABLE A5-6: Parameters for Economic Analysis of 'Remote' FMRs

	Unit	Without Project	With Project	With-Without
Financial cost of construction	Kyat	0	14,300,000	14,300,000
Labor component	%	0	35	3
Adjustment factor for unskilled labor	%	0	60	60%
Economic cost of construction	Kyat	0	12,298,000	12,298,000
Number of beneficiary farmers	Farmers	0	91	91

	Unit	Without Project	With Project	With-Without
Average paddy yield per farmer per year	Kg per year	0	1538	1,538
Official price of paddy (2017)	Kyat per kg	0	238	238
Transport cost of farm produce/inputs	Kyat per ton-km	4,125	2,750	−1,375
Average distance of farms to market	Km	50	50	0
Average savings from transport of produce	kyat per farmer per year	0	211,475	211,475
Total savings from transport of produce	Kyat per year per SP	0	19,244,225	19,244,225
Farm inputs/year (fertilizer, seeds, pesticides, tools)	Tons per year	0.10	0.10	0
Average savings from transport of farm inputs	Kyat per farmer per year	413	275	−138
Total savings from transport of farm inputs	Kyat per year per SP	1,876,875	1,251,250	625,625
Total savings (cost of transporting farm produce and inputs)	Kyat per year per SP			19,869,850
Average annual O&M cost	Kyat per year	0	3,689,400	3,689,400
Net annual benefits	Kyat per year	0	3,689,400	16,180,450
Project life	Years			15
Official discount rate				10%

Assumptions for valuing benefits

- The average financial cost of a road project in accessible villages is about kyat 11 million, while it is kyat 14.3 million for remote villages. Adjusted for economic value of unskilled labor and labor cost component of the project (25 percent for accessible villages and 35 percent for remote ones, as reported in the survey), the economic cost of a road project is estimated at kyat 9.96 million for accessible villages and kyat 12.3 million for remote ones. The average annual O&M cost for roads is about 15 percent of its economic cost for accessible villages and 30 percent for remote ones.
- Based on the field surveys, there are on average 82 farmer beneficiaries per road sub-project in accessible villages and 91 for remote villages. The average paddy yield per farmer per year for typical rice varieties was reported at 427 kg per farmer in accessible villages and 1,538 kg per farmer for remote ones, assumed to be due to larger farms. The official 2017 farm gate price for paddy (unhusked) is kyat 238 per kg. This was derived from the official paddy price

of kyat 500,000 per 100 baskets with each basket equivalent to about 21 kg.[15]

- The quantifiable benefits from the project comes from savings from transporting produce from farms to markets and farm inputs such as fertilizers, seeds, chemicals, and farm tools. Benefits coming from new sources of farm incomes (newly opened farm lands due to new road project), savings from post-harvest losses, and diversification of produce due to new roads were not calculated due to insufficient data. Also, the reduction in the cost of travel to town centers for leisure, education, health care, and so on, was not calculated. As such, the resulting analyses should be considered conservative.
- Savings from transporting farm produce and inputs depend on a variety of factors such as (a) quality of the roads (all weather or not), (b) distance from market centers, (c) economies of scale, (d) weight of cargo, and (e) modalities of transport in rural areas in Myanmar (oxcart, motor bike, tractor trailer, mid-sized truck, and heavy-duty cargo trucks). Given the variety of factors and the large variations among villages and states, there is a need to normalize the unit cost of transport savings, that is, to use fixed ton-km as a unit. Data on unit costs can be derived from the field survey or from other authoritative studies. This analysis proposes to draw from a study by the Asian Development Bank (ADB) on rural transport in Myanmar (2014).[16]
- The ADB report notes that in rural areas in Myanmar with all-weather roads, the cost of freight transport would vary, but US$1 (kyat 1,370) per ton-km using midsize to cargo trucks (similar to Toyota Hylux or dyna) as modes of transport would be reasonable. The ADB estimates are not significantly different from the results of the field survey by the NCDDP project engineers in which farmers reported a savings of kyat 718 to transport an average of 0.423 tons of farm produce (or about kyat 1,436 per ton) in relatively accessible villages/farms. In farms where there are no all-weather roads, transport cost would be at least twice. In remote villages, transport costs can go up considerably, not only due to distance of transport but also due to limited freight transport options (that is, limited to tractors and motor bikes).
- The road project is assumed to improve farmers' access to knowledge and technology through more accessible extension services and demonstration effects. Productivity gains are assumed to conservatively increase on average by 20 percent for the 15 years life span of the road project starting in year 3 of the project. This makes the assumptions conservative. Productivity gains result from farmers using higher yielding and premium rice variety seed; better pest, soil and water management; higher cropping intensity; and higher value added of produce. These new roads are also assumed to reduce post-harvest losses through better access to storing, drying, and milling facilities, and thereby fetching better market prices. The average number of farmers per sub-project in accessible villages (of 82) is also small, so the demonstration effect of productivity improvements can spread much faster in the three-year adoption period. Given the current average paddy yield per farmer per year of 427 kg per farmer, a 20 percent increase in production translates to 85.4 kg per farmer additional harvest over the 15-year project life span. Using the paddy farm gate price of 238 kyat per kg, a conservatively estimated productivity gain would be kyat 20,325 per farmer per year (85.4 per kg per farmer per year × kyat 238 per kg) over the 15-year life span of the road project. With an average of 82 farmers per sub-project, this translates to productivity gains of kyat 1,666,666 per sub-project per year.

15 https://www.mmtimes.com/news/myanmar-fixes-2018-paddy-price-k500000-100-baskets.html.
16 https://www.adb.org/sites/default/files/publication/189079/mya-rural-roads.pdf.

- It is assumed that the road project would have a 15-year life span. This is considered conservative given the high sense of community ownership on road projects and that the survey also found O&M to be performed satisfactorily in 9 out of 12 regions.

Results

The results of the economic analyses for road sub-projects are summarized in Tables A5-7 and A5-8 for accessible and remote villages, respectively. Table A5-7 shows that accessible FMRs are economically viable with an NPV of kyat 1.8 million and an EIRR of 12.29 percent. Productivity gains come from use of higher yielding and premium rice varieties due to accessibility to markets, better pest, soil and water management due to demonstration effects from other farms, higher cropping intensity, higher value added of produce due to proximity to market centers, and increased use of fertilizers and pest control due to access to markets, and so on. These new roads are also assumed to reduce post-harvest losses through better access to storing, drying, and milling facilities and thereby fetch better market prices. The results are conservative as other important benefits such as reduction in travel time for health care, education, and leisure were not included. Accessible FMRs, however, are sensitive to an increase in costs, reduction in life span, and reduction in benefits, underscoring the need for adequate and regular maintenance. Higher annual estimated O&M costs (at 15 percent of total sub-project cost) were included to make the economic analyses robust.

Remote FMRs are economically viable and, in fact, registered the highest economic rates of return at 131 percent in the baseline scenario (Table A5-8). They are also not sensitive to reduction in project life, cost escalation, and benefits reduction. The main benefits come from savings in cost of transporting produce from farms to markets and farm inputs from markets to farms, which are otherwise significantly higher given the remoteness of the villages. These results are also conservative because other benefits were not included in the model.

TABLE A5-7: Summary of Economic Analyses for Accessible FMRs

	Baseline	Reduction in Project Life (15 to 10 years)	20% Cost Escalation	20% Benefits Reduction
NPV (Kyat, thousands)	1,833,797	−840,319	25,071	−378,365
EIRR (%)	12.29	8	10	9

TABLE A5-8: Summary of Economic Analyses for Remote FMRs

	Baseline	Reduction in Project Life (15 to 10 years)	20% Cost Escalation	20% Benefits Reduction
NPV (Kyat, thousands)	100,701	87,123	108,312	86,157
EIRR (%)	132	132	110	105

D. Electrification

Table A5-9 summarizes the parameters used to model the economic analyses for the rural electrification sub-projects. A total of 23 electrification sub-projects were covered by the technical survey. The financial cost of construction, on average, is kyat 14.49 million per sub-project. Adjusted for the labor component (25 percent of total cost), and value of unskilled labor (60 percent), the economic cost is on average kyat 13.04 million.

TABLE A5-9: Parameters for Economic Analyses of Rural Electrification

	Unit	Without Project	With Project	With-Without
Average economic cost of construction	Kyat	0	14,490,000	14,490,000
Average number of household beneficiaries (from survey)	Households	0	120	120
Percentage of household benefiting from electrification	%	0	50	–
Number of beneficiaries	individuals	0	600	600
New electricity produced/village	kWh per village per day	0	848	848
Willingness to pay for electrification (appliances)	Kyat per year per household	0	108,000	108,000
Benefit 1: Willingness to pay for appliances	Kyat per year per SP	0	6,480,000	6,480,000
Benefit 2: Productivity gains from rice mills	Kyat per year per SP	0	1,622,000	1,622,000
Benefit 3: Productivity gains from other rural enterprise (wood working, garments)	Kyat per year per SP	0	873,000	873,000
Total Benefits (Kyats)			8,975,000	8,975,000
Discount rate				10%
Project life span				15 years

Assumptions for valuing benefits

- The audit covered 23 electrification sub-projects. The financial cost of construction is on average estimated at kyat 14.49 million. The economic cost of construction, adjusted for the economic value of unskilled labor is kyat 13,041. The sub project produces, on average, 848 kWh per day per village. There are no major social and environmental costs associated with the electrification sub-project.
- The average willingness to pay for electricity (for appliances) is conservatively estimated at the lower end of kyat 300 per household per day based on data from the Bank's National Electrification Project in Myanmar (See Appraisal document, p. 83, para. 7) http://documents.worldbank.org/curated/en/149061468191334165/pdf/PAD1410-CORRIGENDUM-IDA-R2015-0237-2-Box393200B-OUO-9.pdf.

- Before the village electrification, households used a variety of energy sources such as wood, candle, genset, battery, petrol, among others. It is assumed that households will shift to grid electricity once it is available.
- There are on average 120 households per village based on the field surveys of representative villages and sub-projects. It is conservatively assumed that only 50 percent of village households would have access to the grid electricity.
- The benefits of electrification includes (a) lower energy costs for households; (b) benefits of having access to television sets, computers, and cellular phones as measured by willingness to pay; (c) productivity benefits to rural small and medium enterprises (SMEs) in terms of use of small electricity-powered machineries; in this study we estimate productivity for rural village rice mills and other village enterprises; (d) longer study periods (for students); (d) time saved from fetching firewood and fuel for generators.
- The village electrification sub-project provides last mile connectivity, that is, from the regional grid/off-grid to village consumers. The O&M cost therefore is shared throughout the network rather than internalized exclusively in the village.
- The average revenue per hour worked for rice mills in rural villages is kyat 13,600 per mill based on a UN WIDER study on SMEs in Myanmar (2017) (see Table 5.2, row LP3 rice mill of the UN WIDER Report). https://www.wider.unu.edu/sites/default/files/Publications/Report/PDF/Myanmar-MSME-survey-2017.pdf.
- It is assumed that every village would have a small electricity-powered rice mill that works 5 hours a day in a week or 5 hours per day × 30 days per month = 150 hours per month. It is assumed that milling season runs for 4 months a year or 150 hours per month × 4 months = 600 hours per year per mill. The average revenue per mill per year therefore is 600 hours per year × kyat 13,600 per hour = kyat 8,160,000 per mill. The same study also showed that on average, nationally electricity is not available for at least 20 percent of the time due to lack of connectivity to the grid (see Table 3.3, column 5 of the UN WIDER Report). This means that productivity per rice mill will increase by 20 percent as a result of the electrification project or an additional benefit of kyat 8,220,000 × 20% = kyat 1,644,000 per mill per year per village. It is assumed that with the electrification project, electricity would be available on a 24/7 basis.
- In addition to rice mills, electrification will also increase productivity of other small rural village enterprises (garments, wood working, and so on). Based on the UN WIDER study, the average revenue per hour worked is kyat 4,200 (Table 5.2). It is conservatively assumed that the enterprise works 5 hours a day, 4 days a week or 20 hours a week or 52 weeks per year = 1,040 hours per year or kyat 4,368,000 per village enterprise. This means that productivity per village enterprise will increase by 20 percent as a result of the electrification sub- project or an additional benefit of kyat 4,368,000 × 20% = kyat 873,600 per enterprise per village per year. It is assumed that each village has one small enterprise. It is also assumed that with the electrification project, electricity would be available on a 24/7 basis.

Results

Table A5-10 summarizes the results of the analyses for electrification sub-projects. Most studies of CDD village electrification sub-projects find them to be economically viable. The benefits of village electrification include (a) lower energy costs for households and SMEs; (b) increased access to and benefits from various electrical appliances such as refrigerators, computers, and cellular phones; and (c) benefits from higher productivity by SMEs and agro-businesses with access to electricity. In this report, the analyses were limited to the benefits from access to electricity powered appliances (based on willingness to pay of beneficiaries) as well as benefits from higher

productivity by rural village enterprises such as rice mills, wood working and garments, which are the most common rural village enterprises. The resulting economic analyses are therefore considered highly conservative.

Table A5-10 shows that the electrification sub-project is economically feasible with internal rate of return (IRR) of 62 percent and NPV of kyat 46,657,000. The results are also robust to reduction in project life, cost escalation, and benefit reduction.

TABLE A5-10: Summary of Economic Analyses for Electrification Sub-projects

	Baseline	Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
NPV (Kyat, thousands)	46,932	40,657	50,876	40,121
IRR (%)	62	61	52	49

III. CONCLUSION

Table A5-11 summarizes the main results of the analyses. Overall, the findings suggest that all sub-projects (water supply, school building, electrification and FMRs (especially for remote villages) were economically viable. The results suggest that the overall benefits of these sub-projects to society exceed their costs. The results are robust to various scenarios in the sensitivity analyses (except in the case of non-remote roads) and are generally conservative. This is consistent with analyses of CDD from other countries.

TABLE A5-11: Summary of Main Findings of Economic Analyses

Sub-project	Baseline	Sensitivity Analyses		
		Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
Water supply (n = 30)				
NPV	15,055	8,128	13,308	10,297
EIRR (%)	43	38	35	33
School building (n = 68)				
NPV	30,822	23,080	28,929	22,764
EIRR (%)	56	55	46	45
FMRs (Accessible) (n = 14)				
NPV	1,834	−840	25	−378
EIRR (%)	12	8	10	9
FMRs (Remote) (n = 33)				
NPV	100,701	87,123	108,312	86,157

Sub-project	Baseline	Sensitivity Analyses		
		Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
EIRR (%)	132	132	110	105
Electrification (n = 22)				
NPV	46,932	40,657	50,876	40,121
EIRR (%)	62	61	52	49

Note: NPV in thousand kyat; n = sample size in the survey; 'accessible' means within 30 minutes by transport to the market center; 'remote' means between 31 and 120 minutes to the regional state market center.

ANNEX 6: Economic Analysis General Methodology

The overall methodology follows the World Bank's guidelines for economic analyses (Guidance Note 2013). Details of calculations for each sub-projects are provided in Annex 2 Excel File).

1. **Identification of economic costs and benefits.** Project costs and benefits were evaluated in terms of their addition to or reduction of the national income. Economic costs are those costs that involve the use of real resources while economic benefits constitute an increase in output or savings in real resource use. In addition to direct project benefits, project externalities involving a significant economic cost (that is, environmental or social cost) or that confer a significant economic benefit (that is, additional years of education, additional water or electricity consumption; savings in transport costs) were also considered in estimating the overall economic impact of the project.
2. **Valuation of economic costs.** The relevant costs include direct costs such as labor costs (skilled and non-skilled), construction materials, and equipment and indirect costs such as environmental and social costs from road construction. For some inputs that are imported, or are substitutes for exports, the foreign exchange cost involved, corrected by the shadow price of foreign exchange, was estimated and transport costs and trade service margins added, for example, construction materials. However, all inputs are assumed to be produced domestically. If ever there are foreign components, these are of small quantities that will not have significant effects on the economy as a whole.
3. **Valuation of economic benefits.** Estimation of direct benefits involved the following steps: For outputs leading to additional supply, the shadow price (or willingness to pay) is the market price. Examples include additional consumption of water or electricity, savings in the cost of transporting produce and farm inputs, reduction in post-harvest losses, higher cropping intensity, crop diversification, lower transport costs for residents, higher traffic volume, improved access to school, and health centers, among others.
4. **Price adjustments.** Financial prices were adjusted accordingly to reflect their economic values and account for distortions. The following parameters were used for price adjustments.
    - **Shadow foreign exchange rate (SER).** The SER will be applied to all direct and indirect foreign exchange costs of a project. It was also used for those benefits which may be expressed in foreign exchange. There is no significant foreign exchange cost component in the project as most inputs are sourced domestically.
    - **SWR.** The SWR will be used to reflect the true economic value of unskilled labor employed in the project. Labor cost component is 35 percent of total cost of the sub-project in remote villages and 25 percent in accessible one as reported by the field engineers. The value of unskilled labor is 60 percent of skilled labor. This is the only cost component that was adjusted in the computation.
    - **Discount rate.** The social discount rate (SDR), currently pegged at 10 percent will be

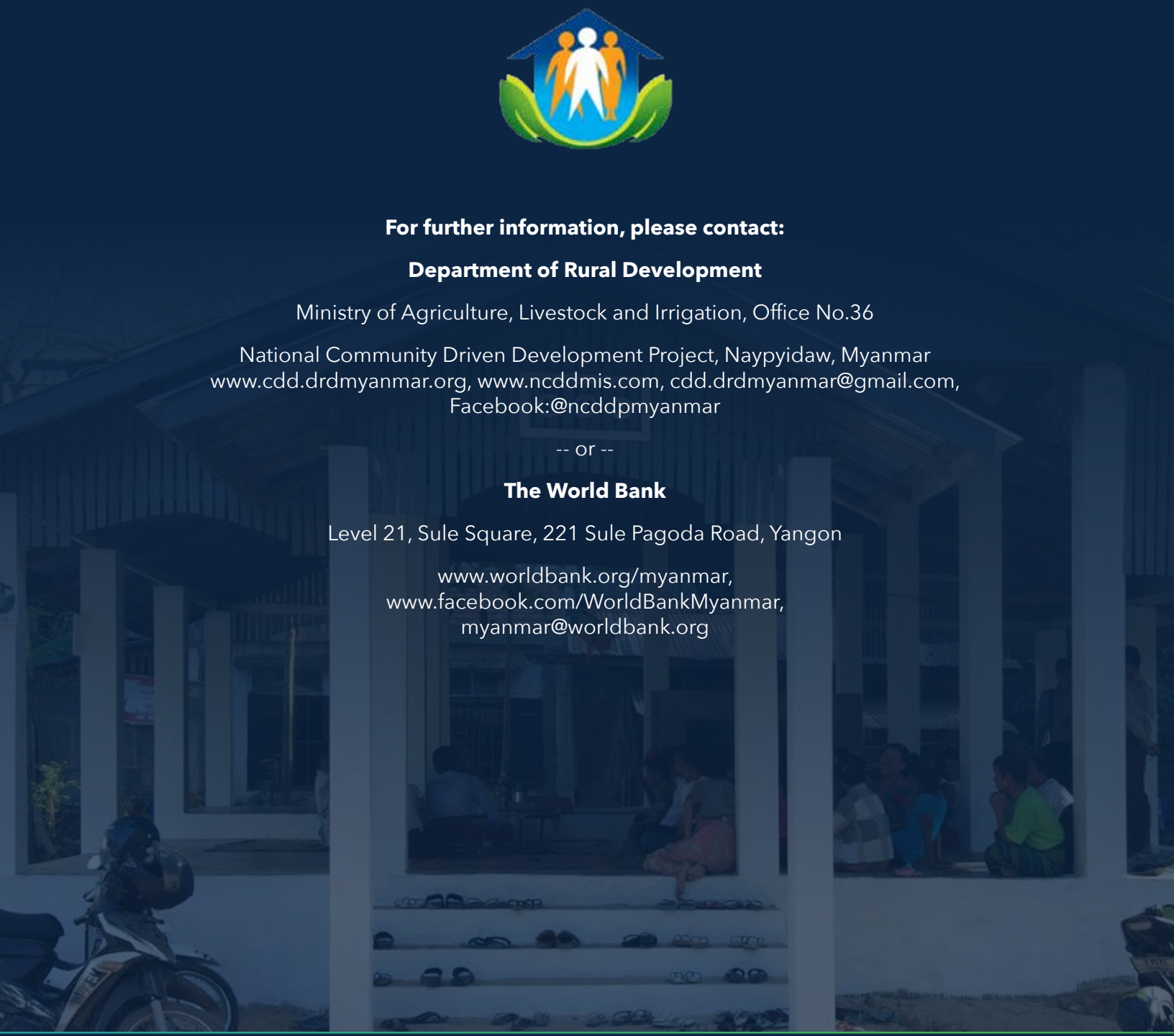
used to discount the stream of economic costs and benefits to their NPVs.

- **Project costs.** Project costs will be distinguished in terms of foreign costs, local costs, and taxes. Foreign cost components were valued in constant prices. Other costs will include environmental, social, and O&M costs. It is assumed that there are no significant foreign cost components. It is also assumed that there are no significant social and environmental costs with the sub-projects. Some minor soil erosion is expected from the FMR sub-project but this is not significant to affect the total economic costs.
- **Economic desirability.** The economic desirability of the project was determined by two parameters: the EIRR and the NPV of the project. The decision rule is to accept a project where the EIRR is greater than the hurdle rate of 10 percent and the NPV is greater than zero.
- **Sensitivity analyses.** Sensitivity analyses was performed under three scenarios: (a) reduction in project lifetime, (b) 20 percent increase in project cost, and (c) 20 percent reduction in project benefits (due to poor maintenance).
- **Fiscal sustainability.** There are no fiscal sustainability issues because the infrastructure sub-projects are small, community owned, and operated. Village associations are expected to be responsible for their O&M.

General Assumptions

The base scenario of the economic analysis makes the following general assumptions:

1. The full benefit is realized in each year and over the full lifetime of the project. Because sub-projects are 'demand driven', with active community participation and willingness to contribute to construction and O&M, it can be assumed that the projects will be operated and maintained satisfactorily so that full benefits can be realized over the entire lifetime of each sub-project. This assumption is supported by the results of initial analyses, which show that in 9 out of 12 regions, O&M was rated fair to very satisfactory and that there is a high and positive correlation between O&M and stronger community participation and local governance.
2. The full expected benefits of the sub-project will be realized in year 1. When analyzing large-scale projects, it is commonly assumed that full benefits will not be realized until a few years after the start of project operations. The simplifying assumption for sub-projects is reasonable, considering that they are small scale and planned to be implemented within 6 months.
3. O&M costs are constant over time and spent annually. The rationale is that for full expected benefit realization throughout the life of the project, the physical infrastructure must be repaired and maintained on a regularly scheduled basis. While O&M costs actually vary by project by year, with more costs toward the latter part of the investment life, a constant amount can be assumed as the average annual cost over the life of the subproject.
4. Expected benefit realization immediately ceases after the subproject lifetime is complete. For example, in the case of a school building with a project life of 15 years, no benefits from that subproject are realized in year 16 onward. While this is likely not the case for subprojects that have been operated and maintained properly throughout their project life, the analysis nonetheless makes this simplifying and conservative assumption.
5. A discount rate of 10 percent is used in computing the NPV and evaluating the EIRR. This is the official discount rate applied by the GOM.



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