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:

Annex 2 PDF Forms to be included

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

1. Foundation
2. Ground 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

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
    a. Smell, color
    b. Chemical analysis
    c. Watershed protection
2. Water system design
3. Borehole and pump system
4. Reservoir
    a. Structural integrity
    b. Easy to clean
5. Transmission and distribution pipe - proper installation
6. Public taps
    a. Number and locations
    b. Fixtures
    c. Platform
    d. Drainage
    e. Fencing
7. Water pressure and quantity
8. Other structures
9. Operation and maintenance

Road

1. Road condition
    a. Cross section (crown/camber)
    b. Inadequate roadside ditches
    c. Missing drainage structure
    d. Improper construction materials
    e. Slippery when wet
    f. Very muddy during rainy season
2. Slopes
    a. Unstable slope above (too steep)
    b. Unstable slope below (too steep)
3. Narrow width
4. Surface below standard
5. Pavement below standard
6. Safety concerns

7. Retaining wall
    a. Structural integrity (batter, and so on)
    b. Weep holes
    c. Erosion protection
8. Culvert
    a. Layout
    b. Construction techniques
9. Small bridge
    a. Layout
    b. Construction techniques
10. Operation and maintenance

Electricity

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

ANNEX 4: NCDDP Sub-Projects Evaluated, Technical Audit 2018[1]

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
22	Bilin	Leik Khone	Leik Khone Ywar Lay	School	2
23	Bilin	Ah Naing Pun	Ka Beit Oke Hpo	Bridge	1

[1] 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 Rating[a]
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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
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

No.	Township	Village Tract	Village	Sub-Project Type	Sub-Project Quality Rating[a]
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).[2] 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.[3] 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.[4] 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 construction 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.

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[2] 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

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

[4] 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.

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

	Unit	Without Project	With Project	With-Without Project
Average willingness to pay per gallon of water	Kyat	0	6	6
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
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

Assumptions	Unit	Without Project	With Project	With-Without
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.[5]

- 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 [6] 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 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.

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

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
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

	Unit	Without Project	With Project	With-Without
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
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

	Unit	Without Project	With Project	With-Without
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.[7]

- 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

[7] https://www.mmtimes.com/news/myanmar-fixes-2018-paddy-price-k500000-100-baskets.html.

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).[8]

- 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.

- 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.

[8] https://www.adb.org/sites/default/files/publication/189079/mya-rural-roads.pdf.

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

Sub-project	Baseline	Sensitivity Analyses		
		Reduction in Project Life	20% Cost Escalation	20% Benefits Reduction
FMRs (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: 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.

ATTACHMENT 5.1: 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.