

**Ministry of Works, Transport and Communications  
Reli Assets Holding Company  
United Republic of Tanzania**

**Preparatory Survey on  
Flood Protection Measures for  
Central Railway Line  
in the United Republic of Tanzania**

**Final Report  
Volume 2: Appendices**

**July 2016**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**PADECO Co., Ltd.  
Nippon Koei Co., Ltd.  
Japan International Consultants for  
Transportation Co., Ltd.  
Fukken Engineering Co., Ltd.**

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## **APPENDIX A**

### **RECORDS OF FLOODS IN KILOSA–DODOMA SECTION 2011–2014**

### Records of Floods in Kilosa–Dodoma Section 2011–2014

Date and Time of Floods	Location	Damage	Impact	Duration of closing the line (Hour: Min.)	Measures
KLO/ACC/6/2014 29/03/2014 17.30 Hrs	312/7–312/8 MGA/MZZ	Wash-away 312/7–312/8 at 100 m length × 2 m depth. Track structure hanging unsupported.	Section was closed to traffic.	3:20	Boulders and sand bags were placed for the repair.
GLW/ACC/16/2014 28/03/2014 02.10 Hrs	365/5.5 KID/GLW	Water passed over the bridge. Loco. 8906 and some wagons dropped into the river.	Section was closed to traffic.	NA	NA
GLW/ACC/15/2014 26/03/2014 07.15 Hrs	365/5–365/6 GLW STN YARD	The formation and sub-ballast washed away, 5 m length × 5 m width × 1 m depth. 6 sleepers hanging unsupported.	Section was closed to traffic.	3:00	Quarry dust was applied to repair formation.
KID/ACC/09/2014 15/03/2014 06.15 Hrs	349/6B –349/7B GLW/KID	Water passing over the track. Ballast and boulders on the formation washed away, 100 m length × 3 m width × 0.5 m depth. 349/4.5–349/5.5 2B boulders washed away 120 m length × 3 m width. 28 sleepers are hanging.	Section was closed to traffic.	14:50	Boulders and quarry dust used to repair the damaged formation
GLW/ACC/14/2014 13/03/2014 18.30 Hrs	360/1–360/3 GLW/GGD	Washed away 150 m length × 1 m width × 0.25 m depth.	Section was closed to traffic.	4:55	Quarry dust applied.
KID/ACC/08/2014 08/03/2014	338/8 KID/GGD	Water passing over the track. Track buried by sand for 100 m length. Formation, boulders and ballast washed away, 48 m length × 4 m width × 0.5 m depth. 50 sleepers hanging.	Section was closed to traffic.	5:15	Removal of sand from the track.
GLW/ACC/10/2014 20/02/2014 06.00 Hrs	349/3B–349/4B KID/GGD	Ballast boulders washed away and rail hanging unsupported about 60 m length.	Section was closed to traffic.	17:25	Quarry dust was placed on the damaged portion.
GLW/ACC/09/2014 15/02/2014 23.30 Hrs	365/5–365/6 GLW/GGD	Ballast and formation washed away on bridge. 52 m of track shifted. At km 365/5–365/6.5 a cave of 5 m length × 5 m width × 2 m depth.	NA	NA	NA
GLW/ACC/09/2014 15/02/2014 23.30 Hrs	365/5–365/6	365/5 a hole formed at the centre of the track 4 m length × 4 m width × 1 m depth.	Section was closed to traffic.	21:00	Quarry dust and packing on track.
GLW/ACC/06/2014 26/01/2014 09.00 Hrs	363/0–363/9 GGD/GLW	Water passing over the track 60 cm above.	Section was closed to traffic.	NA	NA
KID/ACC/05/2014 22/01/2014 12.10 Hrs	341/2–341/9 KID/GGD	Water passed over the track.	Section was closed to traffic.	9:20	NA
KID/ACC/03/2014 20/01/2014 03.57 Hrs	363/2–363/8 349/1 GGD/GLW 349/88B 349/98B 349/7B 349/7.5 349/6B–349/6.25	Water passing over the track. Track buried by sand 100 m length. Formation and boulders/ballast washed away 48 m length × 4 m × 0.5 m. 50 sleepers hanging. Formation ballast boulders washed away 72 m × 4 m × 0.5 m. 91 sleepers hanging.	Section was closed to traffic.	NA	Boulders and quarry dust were used to repair damaged formation

<b>Date and Time of Floods</b>	<b>Location</b>	<b>Damage</b>	<b>Impact</b>	<b>Duration of closing the line (Hour: Min.)</b>	<b>Measures</b>
KID/ACC/03/2014 20/01/2014 03.57 Hrs	349/4.5–349/5.5 GGD/GLW 349/4R–349/4.5 349/3.5–349/4	Formation washed away 48 m long × 4 m × 1.25 m. 58 sleepers hanging. Track buried by sand 50 m long. Formation bouders ballast washed away 72 m × 2 m × 1 m. 65 sleepers hanging.	Section was closed to traffic.	34:03	Boulders and ballast were used to repair formation.
KID/ACC/01/2014 19/01/2014 16.10 Hrs	349/3 1/3 and 359/9–360/5GGD	Ballast washed away.		28:10	Ballast was replaced.
GLW/ACC/04/2014 18/01/2014 18.30 hrs	378/4 GLW/MSG	Ballast and formation washed away. Culvert at 388/6 collapsed. Sand bags moved and track is hanging by 12 m length × 30 cm.	Section was closed to traffic.	2:25	Boulders and quarry dust were used to repair damaged formation.
GLW/ACC/03/2014 13/01/2014 17.30 Hrs	388/6 MSG/IGD	Water flowing over the track. Track formation washed away. Culverts at 288/6 completely collapsed. 8 steel sleepers hanging.	Section was closed to traffic.	20:30	Boulders and quarry dust was used to repair damaged formation.
GLW/ACC/07/2014 09/01/2014 05.30 Hrs	349/5B GGD/GLW	Ballast washed away 40 m × 2 m × 1 m. 349/2B–349/9B water passing over the track.	Section was closed to traffic.	NA	Boulders and quarry dust were used to repair damaged formation.
2/1/2014 09.00 Hrs	360/3–372/1-2 GGD/GLW	360/3 partial 80 m length: 378/4–5 hole of 12 feet deep, 8 sleepers hanging. 388/6 culvert collapsed and track hanging. 349 water flowing over track. 349/5-B sleepers hanging. 349/5-B. Track pushed away 20 m downstream. 349/6–B 7.5 formation washed away. 372/1–7 sleepers hanging.	Section was closed to traffic.	81:15	Mobilized boulders to site Ex DSM–MOR and quarry dust from DOM. Temporary timber cub to support the collapsed abutment on the Igandu end. Packing of sand bags.
1/2/2014	GLW/MSG	378/4–5 weak formation.	NA	NA	NA
1/2/2014	MSG/IGD	388/6 Bridge abutment collapsed. Km 388/0–389/0 culvert collapsed.	NA	NA	NA
GLW/ACC/21/2013 30/12/2013 02.30 Hrs	349/4b–349/6b GGD/GLW	Ballast formation and boulders washed away.	Section was closed to traffic.	NA	Ballast and boulders were applied.
GLW/ACC/20/2013 19/12/2013 10.30 Hrs	397/5–397/07 MSG/IGD	Wash away 155 m length × 1.75 m length × 1.75 m width × 1.50 m depth.	Section was closed to traffic.	NA	Boulders were used to strengthen the formation.
GLW/ACC/16/2013 15/12/2013 09.00 Hrs	372/4–372/6.5 GLW/MSG	372/4–372/4.25 ballast and formation washed away 30 m length × 1 m width × 1 m depth. 372/4.25–372/4.3 ballast and formation washed away 32 m length × 3 m width × 1 m depth. 372/5–372/5.3 ballast and formation washed away 72 m length × 25 m width × 1 m depth.	Section was closed to traffic.	6:15	Boulders were used to strengthen the formation

<b>Date and Time of Floods</b>	<b>Location</b>	<b>Damage</b>	<b>Impact</b>	<b>Duration of closing the line (Hour: Min.)</b>	<b>Measures</b>
		372/5.5–372/9.5 ballast and formation washed away 38 m length × 9 m width × 0.5 m depth.			
GLW/ACC/17/2013 15/12/2013 17.00 Hrs	349/3B–349/6B GLW/GGD	Ballast and formation washed away, 40 m length × 2.5 m width × 0.5 m depth and 48 m length × 2.75 m width × 2.5 m depth.	Section was passable at restricted speed.	7:30	Speed restricted to 15 km/h from km 349/9A–km 349/0C.
IGD/ACC/08/2013 19/03/2013 22.15 Hrs	KM 397/6–397/7 IGD/MSG	397/6 1/2 boulders washed away, 15 m length × 0.5 m depth. 397/2 1/2–397/7 ballast and formation washed away 36 m length × 2 m width × 0.75 m depth.	Section was closed to traffic.	7:20	NA
GLW/ACC/06/2013 19/03/2013	365/5 1/2–365/6	365/5 1/2–365/6 within station limit, ballast was washed about 11 sleepers both sides.	Section was closed to traffic.	9:05	NA
GDD/ACC/02/2013 11/03/2013 17.30 Hrs	349/6 GLW/GDD	Down stream of 13 m length × 1.5 m width × 1 m depth	Section was closed to traffic.	NA	1 HLB loaded with boulders and 30 permanent way staff to open the line.
KID/ACC/02/2013 11/03/2013 15.30 Hrs	324/5–6	Falling boulders.	Section was closed to traffic.	6:00	Civil staff removed falling boulders.
KID/ACC/01/2013 19/02/2013 02.00 Hrs	324/6 MZZ/KID	Big boulders lying on track caused by heavy rain.	Section was closed to traffic.	4:00	Permanent way staff removed the boulders.
GLW/ACC/03/2013 19/02/2013 00.15 Hrs	336/6–338/5 KID/GDD	NA	Section was closed to traffic.	40:05	3 HLBs loaded with boulders are offloaded to open the line.
GLW/ACC/03/2012 23/03/2012	365/2 1/2 365/6 1/2 within GLW STN limit.	NA	Section was closed to traffic.	39:00	Refilled with earth and boulders. 16 rails replaced, 7 BHBs of ballast and 1 BHB of quarry dust offloaded. 102 sleepers replaced.
IGD/ACC/04/2012 14/03/2012	402/9–402/4	NA	Section was closed to traffic.	3:00	Two HLBs of quarry dust offloaded.
GDD/ACC/02/2012 16/01/2012	349/4B 349/5B 349/8B	349/4B–349/6B ballast washed away, formation washed away, track shifted 4 m. 349/5B Culvert ballast wall broken down stream. 349/8B–349/9 1/2 formation washed.	Section was closed to traffic.	168:00	Ballast wall replaced. Formation refilled. Track restored.

Date and Time of Floods	Location	Damage	Impact	Duration of closing the line (Hour: Min.)	Measures
GDD/ACC/06/2011 23/12/2011	349/4C 349/7-8C	Ballast and formation washed away. 15 m × 8 m × 14 m. 15 m × 9 m × 28 m	Section was closed to traffic.	85:00	Refilled with earth 13 m × 8 m × 14 m, 15 m × 9 m × 14 m, Replaced three AMCO (steel) culverts.
GLW/ACC/21/2011 23/12/2011	372/4-372/5 1/2 and 372/1-372/2	Ballast and formation washed away, 10 m × 2 m × 0.5 m	Section was closed to traffic.	1:00	2 BHB of ballast, 10 m <sup>3</sup> of boulder.
GLW/ACC/22/2011 22/12/2011	365/6-365/6 1/2	2 rails of 80 lbs damaged.	Section was closed to traffic.	95:00	2 rails of 80 lbs replaced.
GLW/ACC/20/2011 18/12/2011	365/5-6 1/2	Ballast and formation washed away. 6 rails of 80 lbs damaged.	Section was closed to traffic.	40:00	6 rails and 102 sleepers replaced. Supply of ballast 6 BHBs, boulders 8 BHBs and quarry dust 5 BHBs.
GLW/ACC/18/2011 12/12/2011	365/2 1/2-365/6 1/2	Ballast and formation washed away, 8 m × 5 m × 2 m. Ballast & formation washed, 72 m × 0.7 m	Section was closed to traffic.	15:00	Refilled with earth and boulders 8 m × 3 m × 2 m and 72 m × 2 m × 0.75 m.
GLW/ACC/16/2011 10/12/2011	365/6-365/6 1/2	Ballast washed away 20 m.	Section was closed to traffic.	11:00	Recouped from the nearest area.
GLW/ACC/17/2011 10/12/2011	349/8B-9B GGD/GLW	Ballast washed away. Cess scoured from one rail downstream.	Section was closed to traffic.	6:00	Ballast and earth replaced 5 m × 2 m × 0.5 m

Notes:

- 1) Time of floods: The time shown in column "Date and Time of Floods" is either the time when the dangerous situation started or the matter was reported to the Controller.
- 2) Section was closed to traffic: means an order was issued to stop train movements into that section. Trains approaching the section are stopped at a convenient station before the section.
- 3) "Formation" means the subgrade on which the ballast and sub-ballast is laid. In the washaway reports from TRL, sometimes there is loose use of the term "formation".
- 4) Cess: A cess is the narrow pathway between the ballast shoulder and the top edge of the formation on each side of the track.

Abbreviations:

Stations: DOM = Dodoma, DSM = Dar es Salaam, GLW = Gulwe, GGD = Godegode, IGD = Igandu, KID = Kidete, KLO = Kilosa, MOR = Morogoro, MGA = Munisagara, MSG = Msagali, MZZ = Mzaganza

Initial of wagons: BHB = Ballast Hopper Bogie, HLB = High-sided Large Bogie, LSB = Low-sided Bogie

Other Abbreviations: ACC = Accident, SDG = Siding, STN = Station, NA = Data not available.

Source: TRL

## **APPENDIX B**




### **FLOODS PREVENTION SURVEYS/ PLANNING/ DESIGN/ CONSTRUCTION IN THE PAST**








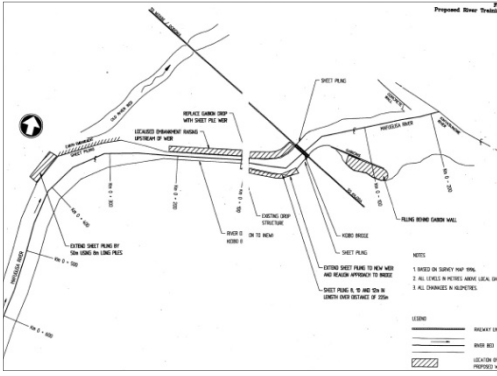


There are three major activities conducted by the international consultants.






### 1. Flood prevention Works on TRC Central Line Contract Nr 3806 Additional Works, April 1997


- Client: Tanzania Railways Corporation (TRC)
- Sponsor: the Commission of the European Communities
- Consultants: Mott MacDonald in association with Inter-Consult, Ltd.
- Outline of the activities: As part of a strategy to improve cross-drainages of the Central Line, the European Union (EU) is funding improvement works between Kilosa and Gulwe. This Additional Works focused on Km 288, Km 315, Km 349, Km 355, and Km 365.

Location	Activities	Photos, Maps, etc.
<p>Km 288 Mkadage Bridge</p>	<p>➤ Problems:</p> <ul style="list-style-type: none"> <li>• Due to siltation, the bridge blocked the river.</li> </ul> <p>➤ Countermeasure:</p> <ul style="list-style-type: none"> <li>• Demolition of the old center pier &amp; abutments currently buried under the existing bridge deck</li> <li>• Excavation and re-alignment of the river channel over 625m length</li> </ul> <p>(Comments by JICA Study Team) It is recommended to re-conduct the excavation and re-alignment of the river channel.</p>	<p>Year 1997 (Toward downstream)</p>  <p>Year 2014 (Toward Kidete)</p> 
<p>Km 315.6 Gully Erosion</p>	<p>➤ Problems:</p> <ul style="list-style-type: none"> <li>• Cross drainage (culvert) under the railway is eventually undermined causing collapse of the structure</li> </ul> <p>➤ Countermeasure:</p> <ul style="list-style-type: none"> <li>• Excavation of the river channel to form an embankment</li> <li>• Excavation of river channel to spoil areas</li> <li>• Gabion works</li> <li>• Geotextile works</li> </ul>	<p>Year 1997 (Toward upstream)</p> 

Location	Activities	Photos, Maps, etc.
		<p>Dec. 2014 (Toward downstream) A new Cross drainage due to the relocation of the railway</p> 
<p>Km 349/4b, 4c Maswala Cross Drainage</p>	<p>➤ Problems:</p> <ul style="list-style-type: none"> <li>• Inadequate Cross drainage (culverts) under the railway</li> </ul> <p>➤ Countermeasure:</p> <ul style="list-style-type: none"> <li>• Track raising by 1.25 m</li> <li>• Provision of 9 nr 2.0 x 2.0 precast Culverts</li> <li>• Minor stream training and protection works</li> <li>• Demolition the existing culverts</li> <li>• Excavation in river channels</li> <li>• Gabion works, etc.</li> </ul> <p>(Comments by JICA Study Team) Currently, flood waters still go over the railway, when it rains at the mountain side. It is recommended to conduct sustainable countermeasures, such as a relocation of the railway toward the mountain side.</p>	<p>Year 1997 (Toward downstream)</p>  <p>Maswala section: Google map Year 2012</p>  <p>11 Feb. 2015</p> 

Location	Activities	Photos, Maps, etc.
<p>Km 355 Kidibo Mafugusa River Crossing</p>	<p>➤ Problems:</p> <ul style="list-style-type: none"> <li>• Due to tree felling and land reclamation, runoff has been increased significantly.</li> <li>• The former crossings tended to silt up and major flooding of the railway line was experienced at a depth of over 0.5 m at the site.</li> <li>• In 1991, the new Kidibo Bridge was constructed approximately 350 m up-line of the old crossing at Km 355.4.</li> </ul> <p>Design by Gauff Consulting Eng. Construction by Riepl</p> <ul style="list-style-type: none"> <li>• In 1995, the report on Mafugusa River Rehabilitation of Bridge Km 355.446 by Technical University Munich, Hydraulic Laboratory (TUM/HRO) for Deutsche Eisenbahn-Consult proposed the stabilization of the river channel and bridge structure, including sheet piling.</li> <li>• However, the design of the bridge appears to have greatly underestimated the flood impact.</li> </ul> <p>➤ Countermeasure:</p> <ul style="list-style-type: none"> <li>• Sheet piling for drop structure and bed protection</li> <li>• Excavation in river channel and form embankments</li> <li>• Excavation from an approved borrowing area to form an embankment</li> <li>• Concrete for pile capping</li> </ul>	<p>Mafugusa River toward Kidibo Bridge Year 1997</p>  <p>Proposed River Training Works</p>  <p>Dec. 2014 Kidibo Bridge</p> 
<p>Km 365 Mzase Crossing</p>	<p>➤ Problems:</p> <ul style="list-style-type: none"> <li>• The Mzase catchment is relatively small but very steep and thus has high peak floods with substantial velocities.</li> <li>• Over the past several years, a large area has been cleared for agricultural use. This results in intensified erosion in the upper catchment and siltation in the lower floodplains.</li> <li>• The erosion of the upstream catchment has been increasing, despite the river training and erosion protection at the upstream of the railway.</li> </ul> <p>➤ Countermeasure:</p> <ul style="list-style-type: none"> <li>• Catchment management planning and implementation</li> <li>• Further river training</li> </ul>	<p>30 March 2014 Mzase Bridge</p> 

Location	Activities	Photos, Maps, etc.
Further Requirements	<p>1) Km 291: Bridge abutment It is suggested that the bridge structure be raised by raising the level of the abutment. (Note) The rail has been raised with thick wood sleepers. (refer to the photo at right)</p> <p>2) Km 295.6: Kinyasungwe River The riverbank has approached the railway line within 28 m. With continued erosion, the river will undermine the railway embankment.</p> <p>(Comments by JICA Study Team) Currently, the riverbank at 295.6 km is not very close to the railway. In this section, the riverbank at 297.3 km is the closest to the railway.</p> <p>3) Km 303.1: Kinyasungwe River/Cliff erosion The outer bank of the floodplain is within 10 m of the railway embankment.</p> <p>(Comments by JICA Study Team) Currently, the riverbank at 303.1 km is not very close to the railway. In this section, the riverbank at 302.75 km is the closest to the railway. The railway at 302.km was damaged by a flood on March 30, 2014.</p>	<p>1) Km 291.0: Bridge (Dec. 2014)</p>  <p>2) Km 295.6: (Dec. 2014) (Toward Kidete)</p>  <p>(Km 297.3: Dec.2014) (Toward Kidete)</p>  <p>3) Km 303.2: (Dec. 2014) (Toward Kidete)</p>  <p>(Km 302.75: Dec. 2014) (Toward Kidete)</p> 

Location	Activities	Photos, Maps, etc.
	4) Km 345.6 and Km 346: Inadequate Cross Drainage Capacity	4) Km 346.1: Dec.2014 (Toward mountain side) 

## 2. Tanzania Railway Restructuring Project IDA CR 2267 T.A.: Emergency Assistance for Flood Damage “Assessment of Flood damages on Railway Line between Kilosa and Kidete”, March 1998

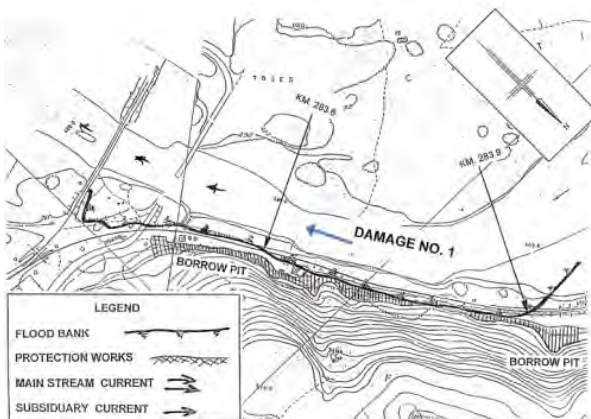
- Client: Tanzania Railways Corporation (TRC)
- Sponsor: World Bank (IDA) (US\$3 million)
- Consultants: Gauff Ingenieure Consulting Engineers, DE-Consult
- Outline of the activities: During Dec. 1997 and Jan. 1998, unseasonably heavy rains occurred. This caused a lot of damage to the Central Railway, especially in the section between Kilosa and Kidete. This project inspected the damages and proposed the actions.

Location	Activities	Record of Damages and Proposed Actions
Observations outside Project area	1) Lake Gombo–Kidete Dam <ul style="list-style-type: none"> <li>• Kidete Dam was washed away between 10–15 January 1998.</li> <li>• Prior the breach of the dam, the maximum water level was around 2 m. The storage volume was a minimum of 2–3 million m<sup>3</sup>.</li> <li>• The Lumuma railway bridge was damaged by the flood wave after the breach of the dam.</li> </ul> 2) Hombolo Dam <ul style="list-style-type: none"> <li>• If Hombolo Dam is broken, a water quantity much greater than the one of Kidete Dam would discharge down the river.</li> </ul>	1. <u>Km 283.6 (300 m)</u> : high bank eroded by parallel flow *Foot protection to be improved 2. <u>Km 288.4 (300 m)</u> : high bank eroded by river meander to about 80 m beyond the track. *Re-routing has already been initiated by TRC. 3. <u>Km 289.9 (100 m)</u> : high bank eroded by parallel flow, old bridge underscoured & collapsed, regressing erosion along the tributary *Re-construction of embankment, bridge, protection alongside river and in the tributary 4. <u>Km 290.3 (40 0 m)</u> : The first 100 m was washed out beyond the track, the remaining section high bank eroded, 2 culverts underscoured and collapsed *Protection along the foot of the section 5. <u>Km 292.3 (350 m)</u> : high bank eroded by river meander to 100 m beyond the track *Re-construction of 1 culvert, extensive protection 6. <u>Km 293.1 (60 m)</u> : eroded & loss of protection *Re-construction & protection works 7. <u>Km 293.4 (500 m)</u> : high bank eroded by parallel river, 1st half erosion to 20 m beyond the track *Re-routing is recommended 8. <u>Km 297.3 (80 m)</u> : erosion parallel to the track
Typical Construction Measures	1) Re-construction of embankment 2) Re-routing of the track 3) Temporary drainage structures 4) Protection measures, such as gabions, rip rap, etc.	

Location	Activities	Record of Damages and Proposed Actions
		<p>*Re-construction &amp; protection works</p> <p>9. <u>Km 301.8 (300 m)</u>: washed out by parallel flow</p> <p>*re-construction &amp; protection. (Re-routing may be an option during permanent works.)</p> <p>10. <u>Km 302.5 (500 m)</u>: washed out by parallel flow</p> <p>* Re-construction of 1 culvert, extensive protection</p> <p>11. <u>Km 303.8 (400 m)</u>: erosion around bridge foundations</p> <p>*Re-construction &amp; protection works</p> <p>12. <u>Km 305.3 (30 m)</u>: Short washput</p> <p>*Re-construction &amp; protection works</p> <p>13. <u>Km 306.9 (200 m)</u>: high bank eroded by flow directed towards the track</p> <p>* Re-construction 1 bridge &amp; protection works</p> <p>14. <u>Km 308.9 (60 m)</u>: Short washput</p> <p>* Re-construction &amp; protection works</p> <p>15. <u>Km 314.2 (450 m)</u>: high bank eroded by flow directed towards the track</p> <p>*It is proposed to re-route the track</p>

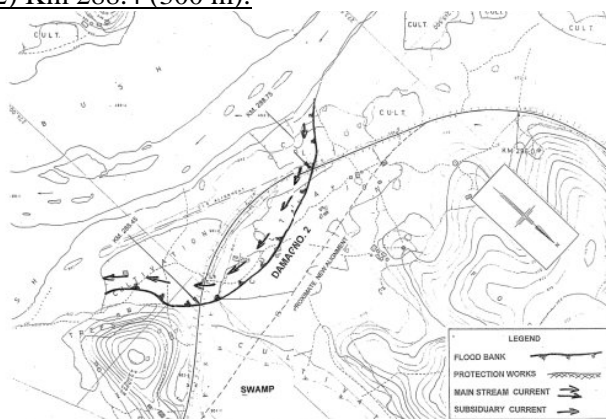
1) Km 283.6 (300 m):

Km 283.65 (5 Dec. 2014) (Toward Kidete)  
This section was relocated to the mountain side.

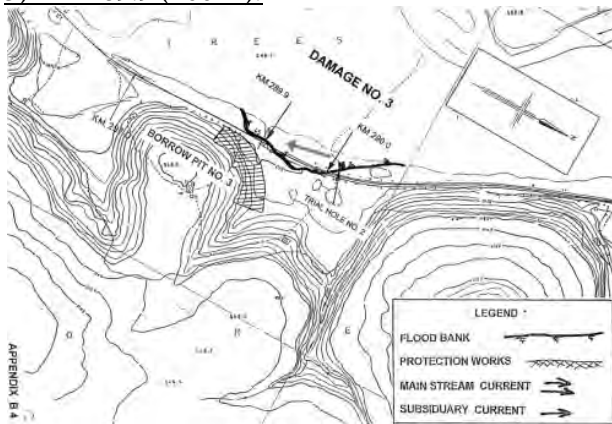


2) Km 288.4 (300 m):

Km 288.5 (Dec. 2014) (Toward Kidete)



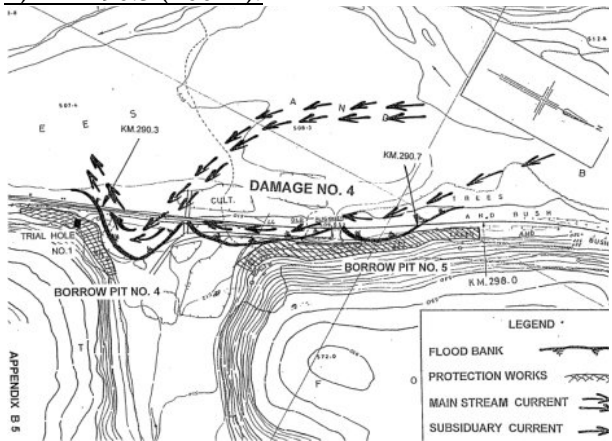
3) Km 289.9 (100 m):



Km 289.8 (Dec. 2014) (Toward Kidete)



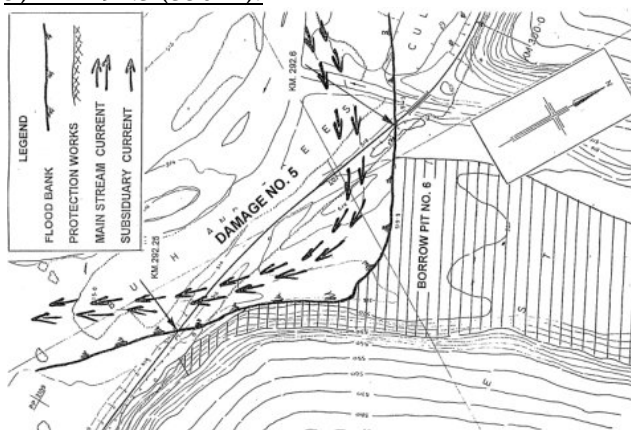
4) Km 290.3 (400 m):



Km 290.3 (Dec. 2014) (Toward Kidete)



5) Km 292.3 (350 m):

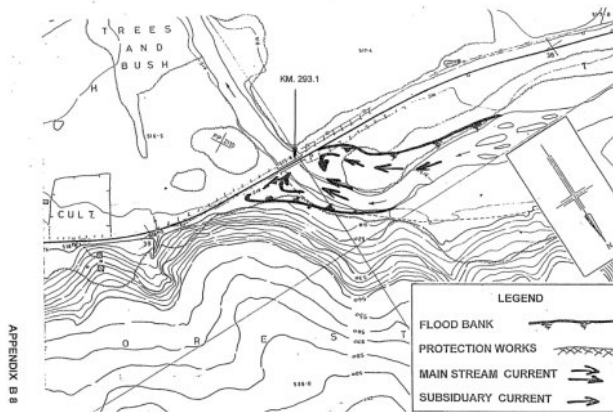


Km 293.1 (Dec. 2014) (Toward Kidete)



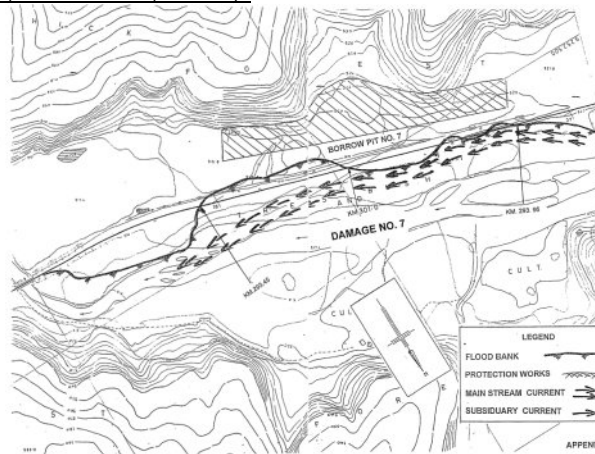
6) Km 293.1 (60 m):

Km 293.1 (Jul. 2014) (Toward Kidete)



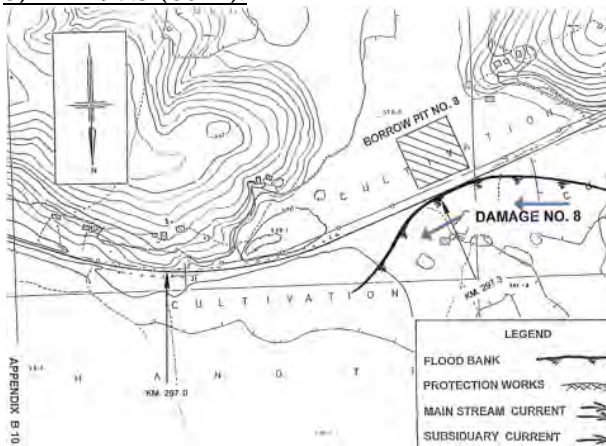
7) Km 293.4 (500 m):

Km 293.3 (Jul. 2014) (Toward Kidete)



8) Km 297.3 (80 m):

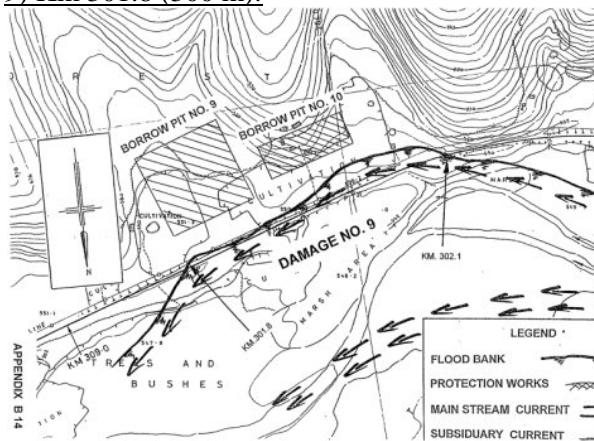
Km 297.3 (Jul. 2014) (Toward Kidete)





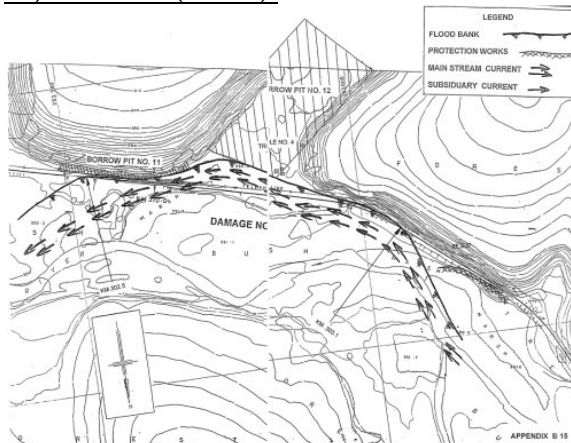
9) Km 301.8 (300 m):

Km 302.0 (Jul. 2014) (Toward Kidete)



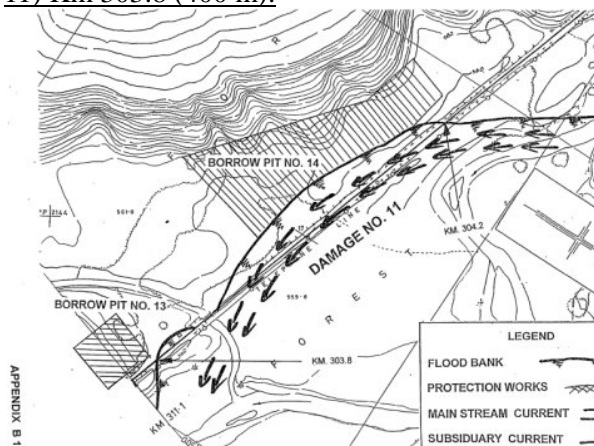
10) Km 302.5 (500 m):

Km 302.7 (Jul. 2014) (Toward Kidete)



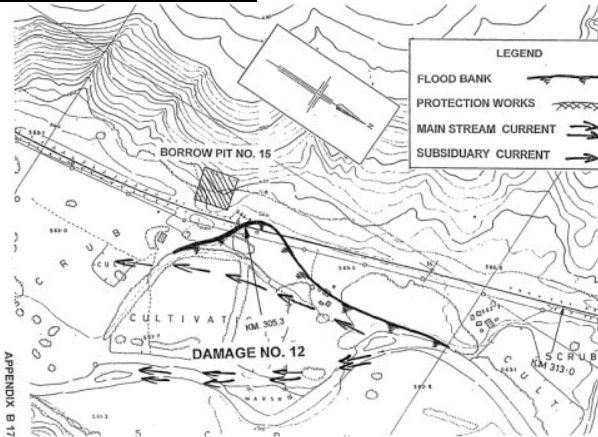
11) Km 303.8 (400 m):

Km 303.4 (Jul. 2014) (Toward Kidete)



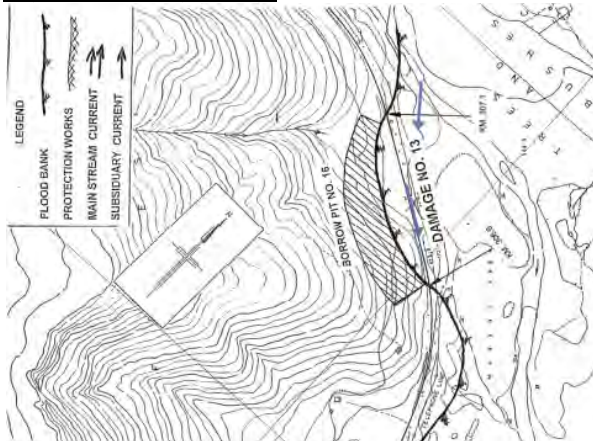
12) Km 305.3 (30 m):

Km 305.3 (Jul. 2014) (Toward Kidete)



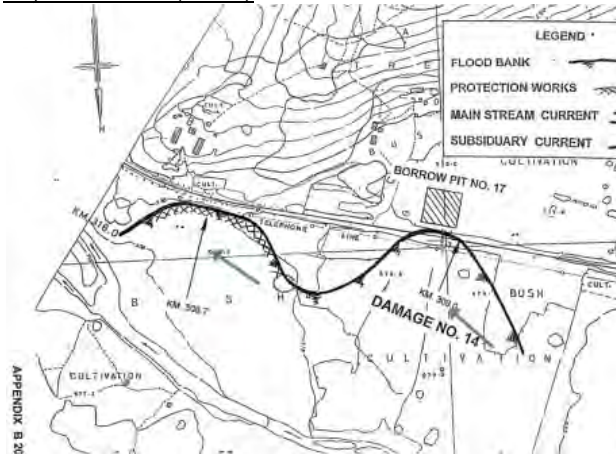
13) Km 306.9 (200 m):

Km 370.0 (Dec.2015) (Toward Kidete)

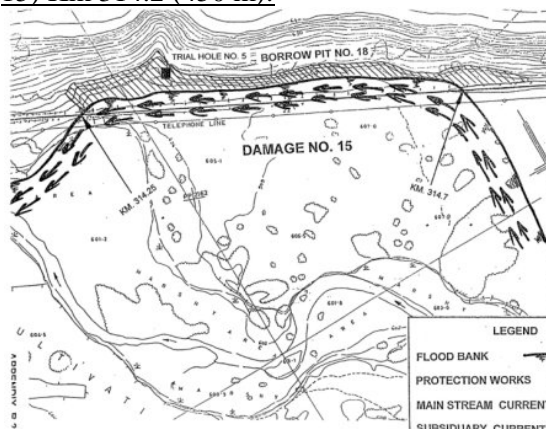


14) Km 308.9 (60 m)

Km 308.9 (Jul. 2014) (Toward Kidete)



15) Km 314.2 (450 m):



Km 314.4 (Dec. 2014) (Toward Kidete)



### 3. Railway Restructuring Project (RRP) IDA CR 2267 T. A: Design and Supervision of Permanent Structures and River Training Works on Kilosa–Kidete Section (Contract No. 029811), December 1999

- Client: Tanzania Railways Corporation (TRC)
- Sponsor: World Bank (IDA)
- Consultants: WSP international (UK) in association with Ambicon Engineering
- Outline of the activities
  - 1) To review the reports below:
    - The 1998 Gauff/DE-Consult Report (1)
    - The following 1998 COWI Report (2)
 WSP commented that “it is regrettable that neither these reports properly appreciated the erosion mechanism which exists at the embankment toe.”
  - 2) To carry out the inspections of the existing 144 structures
  - 3) Hydrology and Hydraulic Study

**Table B.1: Estimated Water Depths and Velocities**

Line km	Slope	50-year Flood			100-year Flood			Estimate for 1997/1998		
		Flow m <sup>3</sup> /s	Depth m	Velocity m/s	Flow m <sup>3</sup> /s	Depth m	Velocity m/s	Flow m <sup>3</sup> /s	Depth m	Velocity m/s
284.4	0.0029	179	1.5	1.2	202	1.6	1.3	1500	3.5	2.6
288.0	0.0029	179	1.6	1.2	202	1.7	1.3	1500	3.3	1.8
289.4	0.0029	164	1.7	1.4	186	1.8	1.5	1400	3.7	2.5
290.7	0.0029	164	1.5	1.2	186	1.6	1.3	1400	3.6	2.7
291.7	0.0029	164	1.6	1.2	186	1.7	1.3	1400	3.7	2.5
292.7	0.0029	164	1.4	1.3	186	1.5	1.4	1400	3.7	2.5
293.7	0.0029	164	1.3	1.4	186	1.4	1.5	1400	3.7	2.7
296.5	0.0029	164	1.0	1.0	186	1.0	1.0	1400	2.4	2.2
298.3	0.0029	164	1.0	1.1	186	1.1	1.2	1400	3.2	2.4
302.2	0.005	160	1.0	1.3	181	1.1	1.4	1300	2.6	3.0
303.0	0.005	160	1.3	1.5	181	1.4	1.6	1300	3.2	3.3
304.4	0.005	160	1.2	1.4	181	1.3	1.5	1300	2.9	2.9
305.3	0.005	160	0.8	1.2	181	0.9	1.3	1300	2.2	2.8
306.8	0.005	160	1.1	1.2	181	1.2	1.3	1300	2.4	2.6
308.8	0.005	160	1.0	1.1	181	1.1	1.3	1300	2.2	2.5
314.6	0.005	160	1.0	1.3	181	1.1	1.3	1300	2.3	2.8

Source: Design and Supervision of Permanent Structures and River Training Works on Kilosa–Kidete Section (Contract No. 029811), December 1999

**Table B.2: Flow Estimate for Replacement or Additional Culverts**

Line km	Drainage area km <sup>2</sup>	50-year Flow based on TRRL method		Runoff using TRC nomograph	Required Cross Section
		m <sup>3</sup> /s	in/hour	in/hour	m <sup>2</sup>
323.838	25.3	63.8	0.34	0.50	n/a
315.558	72.7	176	0.34	0.30	n/a
314.366	0.15	0.43	0.41	2.25	1.0
305.815	68.4	169	0.35	0.35	n/a
302.600	1.53	4.35	0.40	1.20	5.2
298.149	6.05	16.9	0.39	0.85	15.2
295.672	0.12	0.34	0.41	2.25	0.77
294.260	0.35	0.99	0.41	1.70	1.67
293.902	0.15	0.43	0.41	2.20	0.94
290.420	1.56	4.40	0.40	1.20	5.3
289.906	0.32	0.93	0.41	1.70	1.63
288.385	0.93	2.62	0.40	1.30	3.51
288.062	14.4	38.3	0.38	0.60	n/a
283.597	0.02 – 0.04	0.16	1.1	3.00	0.2

Source: Design and Supervision of Permanent Structures and River Training Works on Kilosa–Kidete Section (Contract No. 029811), December 1999

#### 4) Scour Protection

WSP commented below (excerpts from the report):

- ✓ Only by a major re-rerouting of the line at a higher level in the valley sides would protection against erosion and flooding be achieved.
- ✓ While it is considered very unlikely that 100% access to the Kilosa to Kidete line can be achieved in terms of flood risk, at least at acceptable economic cost, it is considered that various measures can be undertaken to reduce both the risk of closure and the cost of damage.
- ✓ There are 3 river-associated problems, which are prioritized as below:
  - 1st Priority: Risk of damage to or loss of a bridge or major culvert
  - 2nd Priority: Erosion of the track formation either by the river current attacking the toes and slopes of the raised embankments or as a result of water overtopping the embankment (\*This is relatively easily and quickly repaired either by rebuilding the embankment or by realignment of the track.)
  - 3rd Priority: Submergence of the track due to inadequate drainage (\*TRC staff and direct labor can quickly and easily undertake this.)

#### 5) Detailed Design

#### 6) Cost Estimate

#### 7) Environmental Management Plan

## **APPENDIX C**

# **THE TEMPORARY URGENT PROTECTION WORK AND OUTLINE OF THE SITE CONDITIONS AT MASWALA AND KIDIBO IN DECEMBER 2014**

**(1) Km 302.6 km – Km 302.8**

The track of this section was washed away on 30 March 2014.

30 March 2014 (Toward Kidete)



1 December 2014

To prepare for the coming rainy season, the temporary urgent protection work has been conducted by TRL

The excavated soil, on the right side of the photo, was land filled at the riverbank.

1 December 2014 (Toward Kidete)



16 December 2014

Land filling was on-going at the riverbank.

Gabion works at the riverbank were prepared.

16 December 2014 (Toward Kidete)



**(2) Km 315**

21 July 2014

The erosion of the riverbank was very close to the track.

21 July 2014 (Toward Kidete)



1 December 2014

The track was re-routed toward the mountain side (max. 18 m) by TRL in December 2014, as the erosion of the river embankment was close to the track.

The work was conducted by TRL staff (the track maintenance gang living along the railway).

1 December 2014 (Toward Kidete)



1 December 2014 (Toward Kidete)



9 December 2014 (Toward Kidete)



16 December 2014 (Toward Kidete)



16 December 2014 (Toward Kilosa)



18 December 2014 (Toward Kilosa)



18 December 2014 (Toward Kilosa)



18 December 2014 Rail cutting



18 December 2014 (Toward Kilosa) Trial Run



### Km 349–Km 349.8c (Maswala River Section)

This section is the alluvial fan of the Maswala River, where the track has been damage at almost all culvert locations in this section every rainy season due to inadequate cross drainage.



Location-1



Location-1 (Toward Godegode)



Location: Between 1 and 2 (Km 349.6c)



Location: Between 1 and 2





Location-2



Location-2 (Km 349.4c)



Location-3



Location: Between 3 and 4



Location: Between 3 and 4 (Km 349.2c)



Location-4



Location-5



Location-6



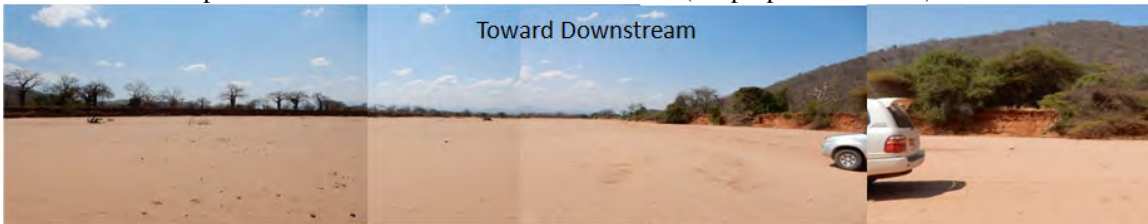
Location-7



Location-8



Upstream of Location-8 in the Maswala River (the proposed dam site)



Upstream of Location-8



Upstream of Location-8



### (3) Km 355.5 (Mafugusa River and Kidibo Bridge)

Kidibo Bridge



Mafugusa River joining the main stream

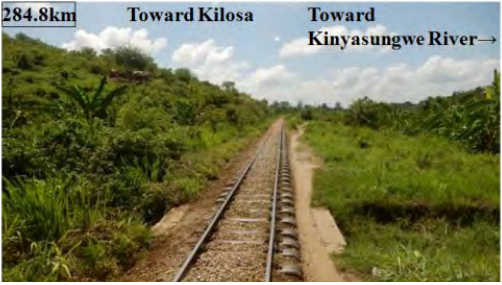






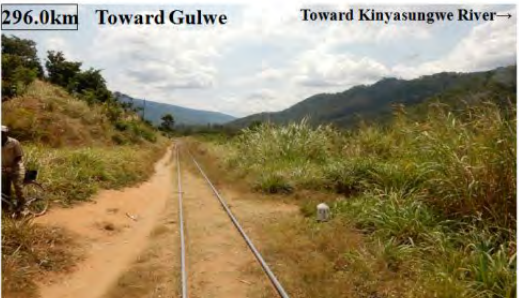
Upstream of the Mafugusa River

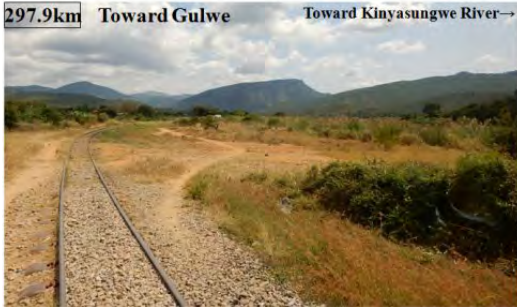

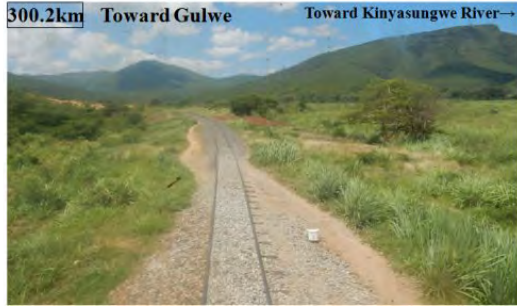


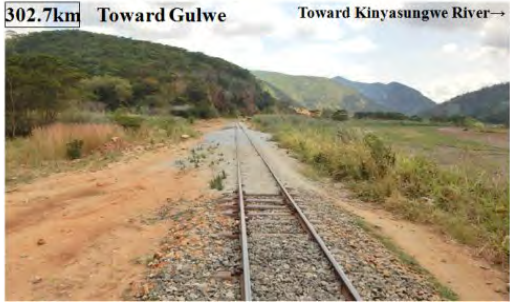
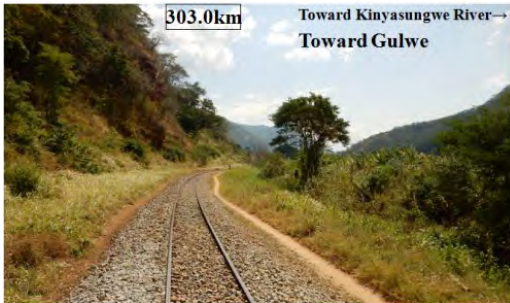

## **APPENDIX D**

### **OUTLINE OF EACH SECTION, THE 1<sup>ST</sup> SITE SURVEY (KILOSA–DODOMA) IN DECEMBER 2014**

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 283 Kilosa– Km 288.5	Pattern 2-1, 2-2	<ul style="list-style-type: none"> <li>• Re-routing,</li> <li>• Excavation and realignment of the stream channels crossing the track</li> <li>• Gabion works</li> </ul>	40 m–400 m	2.0m – 4.0m		<ul style="list-style-type: none"> <li>• Sustainable excavation of the stream channels crossing the track</li> </ul>	Low
Km 288.5	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Re-routing,</li> <li>• Construction of a new bridge</li> <li>• Excavation and re-alignment of the river channels</li> <li>• Gabion works</li> </ul>	400 m	4.0 m		<ul style="list-style-type: none"> <li>• Sustainable excavation of the stream channel crossing the track</li> </ul>	Low
Km 288.5– Km293.6	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Re-routing, (Km 289 – Km 291)</li> <li>• Excavation and re-alignment of the stream channels crossing the track</li> <li>• Gabion works</li> </ul>	60 m–200 m  *60 m: around Km 290	3.0 m – 4.0 m		<ul style="list-style-type: none"> <li>• Sustainable excavation of the stream channels crossing the track</li> </ul>	Low

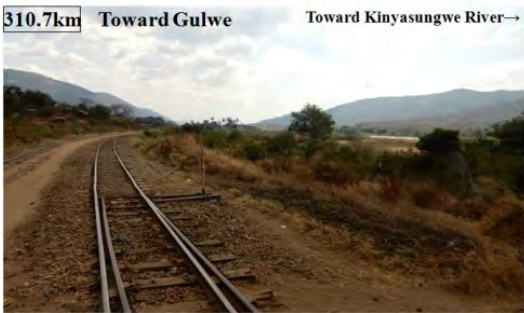
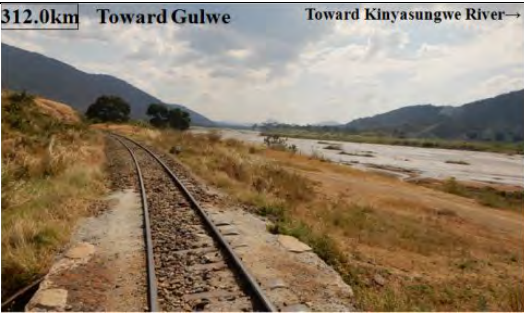

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 293.6	<ul style="list-style-type: none"> <li>• Pattern 1-1, 1-2</li> </ul>	<ul style="list-style-type: none"> <li>• A new bridge with a longer span was constructed (2014), as the old bridge was washed away in 2010.</li> <li>• Gabion works</li> </ul>		2.0 m	 <p>293.2km Toward Kilosa Kinyasungwe River</p>	<ul style="list-style-type: none"> <li>• Expansion of the bridge</li> <li>• Additional gabion works to protect the riverbank</li> <li>• Sustainable excavation of the riverbed</li> </ul>	Medium
Km 293.6– Km 294.4	<ul style="list-style-type: none"> <li>• Pattern 1-3</li> </ul>		6 m–80 m	2.0 m	 <p>293.8km Toward Kidete Toward Kinyasungwe River →</p>	<ul style="list-style-type: none"> <li>• Re-routing toward the mountain side</li> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium - High
Km 294.4– Km 297.1	<ul style="list-style-type: none"> <li>• Pattern 1-3</li> </ul>	<ul style="list-style-type: none"> <li>• Restoration of the washed- away track</li> </ul>	130 m–400 m	2.0 m	 <p>296.0km Toward Gulwe Toward Kinyasungwe River →</p>	<ul style="list-style-type: none"> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium



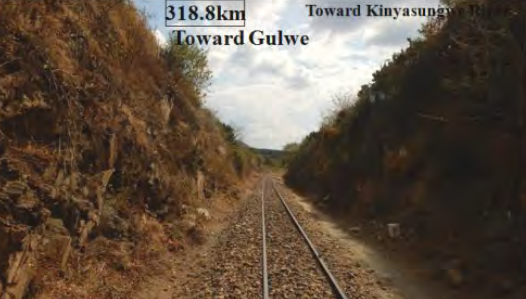
Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 297.1– Km 298.3	• Pattern 1-3	• Restoration of the washed-away track	10 m–70 m	2.0 m		<ul style="list-style-type: none"> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium - High
Km 298.3– Km 299.3	• Pattern 1-3	• Restoration of the washed-away track	30 m–100 m	2.0 m		<ul style="list-style-type: none"> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium
Km 299.3– Km 302.6	• Pattern 1-2, 1-3	<ul style="list-style-type: none"> <li>• Restoration of the washed- away track</li> <li>• Repair of the ballast</li> </ul>	20 m–170 m	2.0 m		<ul style="list-style-type: none"> <li>• Re-routing toward the mountain side</li> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium - High

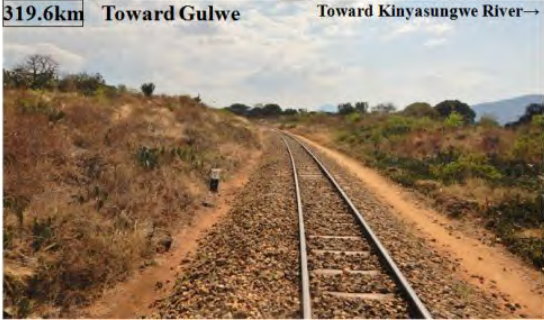

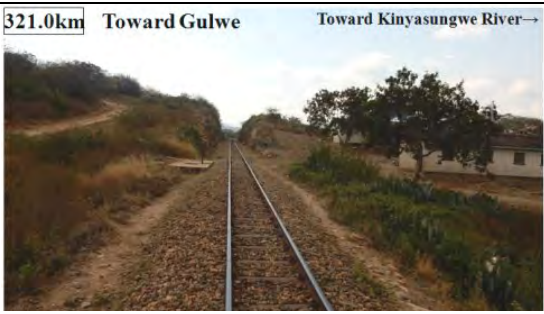
Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 302.6– Km 302.8	• Pattern 1-2, 1-3	• Restoration of the washed-away track	4 m–10 m	2.0 m		<ul style="list-style-type: none"> <li>• Re-routing toward the mountain side</li> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• River training works</li> </ul>	High
Km 302.8– Km 303.4	• Pattern 1-3	• Restoration of the washed-away track	30 m–150 m	2.0 m – 2.5 m		<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium
Km 303.4– Km 303.7	• Pattern 2-1		150 m	2.5 m		<ul style="list-style-type: none"> <li>• Rock Cutting and Embankment stabilization</li> </ul>	Low

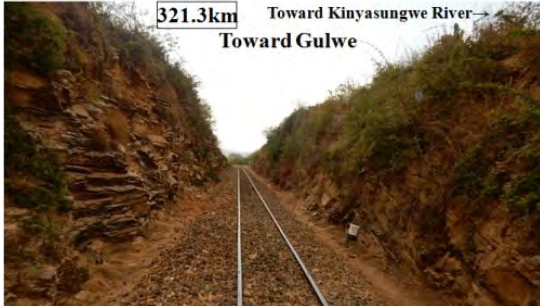
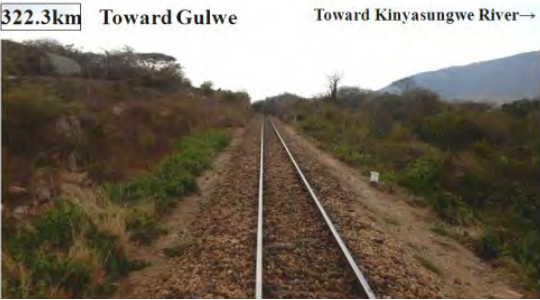



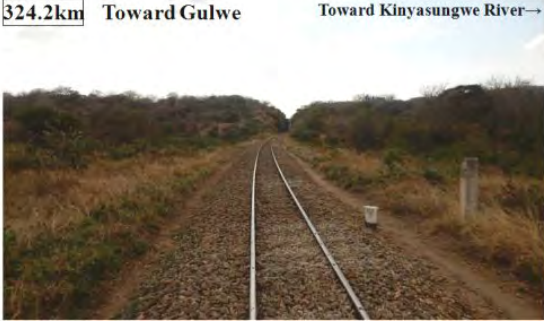
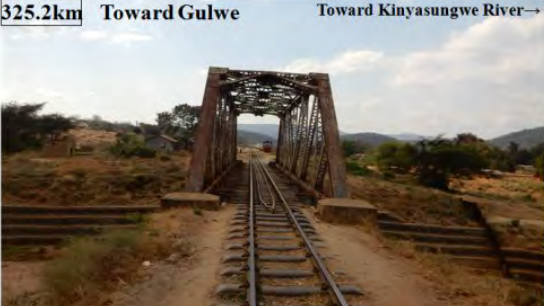

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 303.8	<ul style="list-style-type: none"> <li>• Pattern 1-1, 1-2 to the old bridge</li> <li>• Pattern 2-1, 2-2 to the new bridge</li> </ul>	<ul style="list-style-type: none"> <li>• A new bridge was constructed at the mountain side (2014), as the old bridge close to the Kinyasungwe River was washed away in 2008.</li> </ul>	100 m	2.5 m		<ul style="list-style-type: none"> <li>• Protection from the erosion of the tributary bank, etc.</li> </ul>	Medium
Km 303.9– Km 307.0	<ul style="list-style-type: none"> <li>• Pattern 1-1, 1-2, 2-1, 2-2</li> </ul>		6 m–100 m	3.0 m		<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium
Km 307.0– Km 309.0	<ul style="list-style-type: none"> <li>• Pattern 1-3</li> </ul>		20 m–40 m	2.0 m – 3.0 m		<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium

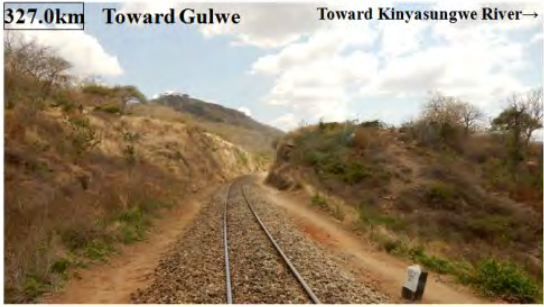
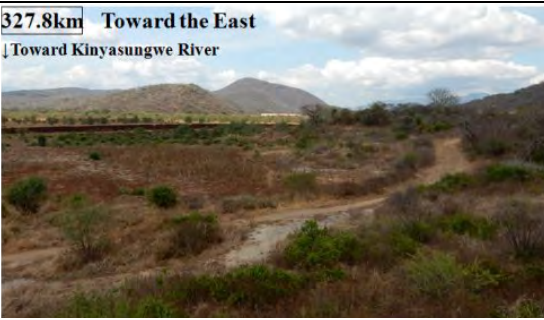
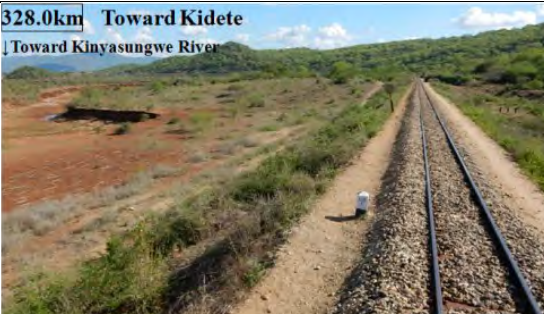
Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 309.0– Km 311.8	• Pattern 1-3		60 m–300 m	3.0 m – 4.0 m	 <p>310.7km Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium
Km 311.8– Km 312.8	• Pattern 1-2, 1-3	• Restoration of the washed-away track	20 m–70 m	3.0 m – 4.0 m	 <p>312.0km Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Re-routing toward the mountain side</li> <li>• Track raising by embankment</li> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• River training works</li> </ul>	Medium - High
Km 312.8– Km 314.8	• Pattern 1-2, 1-3	• Restoration of the washed-away track	30 m–130 m	3.0 m – 4.0 m	 <p>313.9km Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Re-routing toward the mountain side</li> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• River training works</li> </ul>	Medium - High


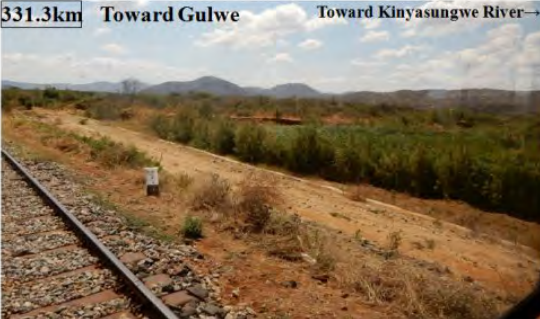

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 314.8– Km 317.7	• Pattern 1-2	<ul style="list-style-type: none"> <li>Restoration of the washed-away track</li> <li>The track was re-routed toward the mountain side (max. 18 m) in Dec. 2014, as the erosion of the river embankment was close to the track.</li> </ul>	15 m–80 m	4.0 m		<ul style="list-style-type: none"> <li>Further re-routing toward the mountain side</li> <li>Protection from the erosion of the riverbank, etc.</li> <li>River training works</li> </ul>	High
Km 317.7– Km 318.7	• Pattern 1-3, 2-1		120 m–600 m	4.0 m		<ul style="list-style-type: none"> <li>Protection from the erosion of the riverbank, etc.</li> </ul>	Low
Km 318.7– Km 318.9	• Pattern 2-1		600 m–900 m	4.0 m		<ul style="list-style-type: none"> <li>Rock Cutting and Embankment stabilization</li> </ul>	Low

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 318.9– Km 320.9	• Pattern 2-1		900 m	4.0 m	<p>319.6km    Toward Gulwe    Toward Kinyasungwe River→</p> 	• Improvement of cross-drainage	Low
Km 320.9	• Pattern 2-1, 2-2		900 m	4.0 m	<p>320.9km    Toward Kinyasungwe River→ Toward Gulwe</p> 	• Protection from the erosion of the tributary bank, etc.	Low
Km 320.9– Km 321.1	• Pattern 2-1		900 m	4.0 m	<p>321.0km    Toward Gulwe    Toward Kinyasungwe River→</p> 	• Improvement of cross-drainage	Low




Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 321.1– Km 321.4	• Pattern 2-1		400 m – 900 m	4.0 m		• Rock cutting and embankment stabilization	Low
Km 321.4– Km323.3	• Pattern 2-1		350 m–400 m	4.0 m – 7.0 m		• Improvement of cross-drainage	Low
Km 323.3– Km323.7	• Pattern 2-1		400 m	7.0 m		• Rock cutting and embankment stabilization	Low




Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 323.7– Km 325.2	<ul style="list-style-type: none"> <li>• Pattern 2-1</li> </ul>		600 m–500 m	6.0 m – 8.0 m	<p>324.2km Toward Gulwe Toward Kinyasungwe River→</p> 	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 325.2 Lumuma Bridge	<ul style="list-style-type: none"> <li>• Pattern 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Repair works was conducted in 1998, as the bridge downstream was scored, gabions were washed away by the flood wave after the failure of Kidete Dam.</li> </ul>	900 m	8.0 m	<p>325.2km Toward Gulwe Toward Kinyasungwe River→</p> 	<ul style="list-style-type: none"> <li>• Repair of the gabion works</li> </ul>	Low
Km 325.2– Km 325.5 Kidete Station	<ul style="list-style-type: none"> <li>• Pattern 2-1</li> </ul>		480 m	7.0 m	<p>325.3km Toward Gulwe Toward Kinyasungwe River→</p> 		Low

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 325.5– Km327.3	<ul style="list-style-type: none"> <li>• Pattern 1-3 in the past</li> </ul>	<ul style="list-style-type: none"> <li>• The track was re-routed to the mountain side from the river side during UK rule.</li> </ul>	40 m–480 m	6.0 m–7.0 m	<p>327.0km Toward Gulwe      Toward Kinyasungwe River→</p> 	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 327.3– Km 328.0	<ul style="list-style-type: none"> <li>• Pattern 1-3 in the past</li> </ul>	<ul style="list-style-type: none"> <li>• Same as above</li> </ul>	30 m	4.0 m–5.0 m	<p>327.8km Toward the East ↓ Toward Kinyasungwe River</p> 	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 328.0	<ul style="list-style-type: none"> <li>• Pattern 1-2</li> </ul>	(Note) The erosion of the riverbank is close to the track	30 m	4.0 m	<p>328.0km Toward Kidete ↓ Toward Kinyasungwe River</p> 	<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium

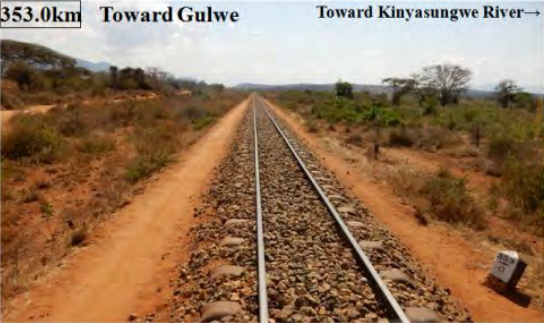

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 328.0– Km 329.3	• Pattern 1-2, 1-3	<ul style="list-style-type: none"> <li>• Restoration of the washed-away track</li> <li>• Repair of the ballast damaged by flood overtopping</li> </ul>	30 m–40 m	4.0 m	 <p>328.6km Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 329.3– Km331.8	• Pattern 1-2, 1-3	<ul style="list-style-type: none"> <li>• Restoration of the washed-away track</li> <li>• Repair of the ballast damaged by flood overtopping</li> </ul>	10 m–130 m	3.0 m–4.0 m	 <p>331.3km Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 331.8– Km 337.1	• Pattern 1-2, 1-3	<ul style="list-style-type: none"> <li>• In the past, re-routing was conducted 7 times</li> <li>• Improvement of cross-drainage</li> </ul>	80 m–500 m	2.0 m–3.0 m	 <p>334.7m Toward Gulwe Toward Kinyasungwe River→</p>	<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> </ul>	Low




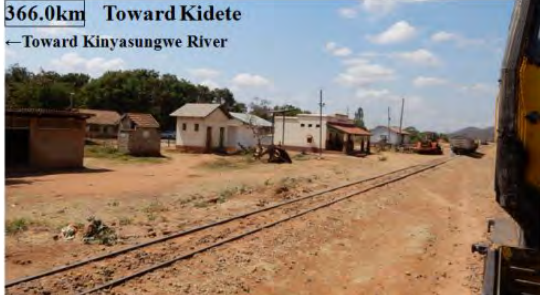

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 337.1	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Repair of the ballast, many times a year</li> <li>• Improvement of cross-drainage</li> </ul>	100 m	2.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> </ul>	Medium
Km 337.1– Km 337.8	<ul style="list-style-type: none"> <li>• Pattern 1-2</li> </ul>	<ul style="list-style-type: none"> <li>• The riverbank was washed away on Mar.6, 2015. The re-routing &amp; protection of riverbank is on-going.</li> </ul>	3 m	3.0 m		<ul style="list-style-type: none"> <li>• Protection from the erosion of the riverbank, etc.</li> <li>• Re-routing the track</li> </ul>	High
Km 337.8– Km 339.5	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Repair of the ballast, many times a year</li> </ul>	100 m–380 m	3.5 m – 5.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> </ul>	Medium

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 339.5– Km 340.0	• Pattern 1-3, 2-1		120 m–200 m	2.0 m – 3.5 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Low - Medium
Km 340.0– Km 340.8	• Pattern 1-3	• Repair of the track In 2009, flood damaged the track.	120 m–190 m	2.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> </ul>	Low
Km 340.8– Km 348.2	• Pattern 1-3	• Restoration of the washed-away track • Improvement of cross-drainage (Note) 2014/1/22 Water passed over Km 341.2– Km 341.9.	30 m–300 m	2.0 m – 6.5 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium - High



Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 348.2 Godegode	• Pattern 1-3, 2-1		450 m	7.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 349– Km 349.8c Maswala River Section	• Pattern 2-1, 2-2	<ul style="list-style-type: none"> <li>• Excavation of the stream channels crossing the track</li> <li>• Gabion works</li> <li>• Improvement of cross-drainage</li> <li>• Repair of the ballast</li> </ul>	50 m	6.5 m		<ul style="list-style-type: none"> <li>• Re-routing the track toward the mountain side</li> <li>• Protection from the erosion of the tributary bank, etc.</li> <li>• Improvement of cross-drainage</li> <li>• Sustainable excavation of the stream channel crossing the track</li> </ul>	High
Km 349.8c– Km 350.0	• Pattern 1-3, 2-1		50 m–180 m	6.0 m – 6.5 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low - Medium

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 350.0– Km 355.1	<ul style="list-style-type: none"> <li>• Pattern 2-1</li> </ul>		30 m–500 m	2.0 m – 5.5 m	<p>353.0km    Toward Gulwe    Toward Kinyasungwe River→</p> 	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 355.1 Mafugusa River Kidibo Bridge	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Re-routing the Mafugusa River</li> <li>• Excavation in the river channel and forming embankment</li> <li>• Sheet piling with anchor bolts to protect the riverbanks</li> <li>• Gabion works</li> </ul>	30 m	4.5 m	<p>355.1km    Toward Gulwe    Toward Kinyasungwe River→ Kidibo</p> 	<ul style="list-style-type: none"> <li>• Re-routing the track</li> <li>• Track raising</li> <li>• Protection from the erosion of the tributary bank, etc.</li> <li>• Improvement of cross-drainage</li> <li>• Sustainable excavation of the stream channel crossing the track</li> </ul>	Medium

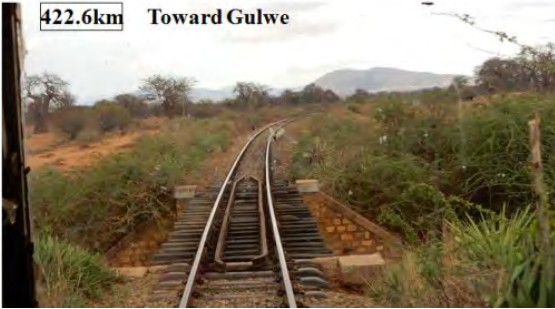


Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 355.1– Km 360.8	• Pattern 1-2, 2-1	• Restoration of the washed-away track at Km 360.1, etc.	10 m–100 m	2.0 m – 4.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Track raising</li> <li>• Protection from the erosion of the riverbank, etc.</li> </ul>	Medium
Km 360.8– Km 364.2	• Pattern 3	• Track raising by ballast (25cm) to avoid submergence of the track	30 m–260 m	2.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Improvement of drainage to avoid submergence of the track</li> </ul>	Medium
Km 364.2– Km 365.7	• Pattern 2-1	<ul style="list-style-type: none"> <li>• Excavation of the river channel (Note)</li> <li>- 2014/1/26: Water passing over Km 363.0–Km 363.9</li> <li>- 2014/1/20: Track buried by sand at Km 363.2 – Km 363.8</li> </ul>	50 m–300 m	2.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low




Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 365.7  Mzase River  Mzase Bridge	• Pattern 2-1	<ul style="list-style-type: none"> <li>The ballast was solidified with cement, as the track on the Mzase Bridge was washed away on Mar. 30, 2014.</li> <li>Gabion works</li> <li>Re-routing the Mzase River</li> </ul>	300 m	2.0 m		<ul style="list-style-type: none"> <li>Re-routing the track toward the mountain side</li> <li>Tack raising</li> </ul>	High
Km 366.0  Gulwe Station	• Pattern 2-1	<p>(Sometimes, if the space under the bridge is full of mud, Gulwe Station floods.)</p> <ul style="list-style-type: none"> <li>Restoration of the washed-away track</li> </ul>	100 m	2.0 m		<ul style="list-style-type: none"> <li>Relocation of the station toward the mountain side, together with the track</li> </ul>	Low - Medium
Km 366– Km 367	• Pattern 1-2	***A new road was constructed over Kinyasungwe River at Km 366.4 in 2014	60 m – 100 m	2.0 m		<ul style="list-style-type: none"> <li>Protection of the track against the flood. (Note) Due to the new road bridge with very much inadequate drainage, the track will be flooded</li> </ul>	Medium

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 367– Km 380.0	• Pattern 1-2	<ul style="list-style-type: none"> <li>Improvement of cross-drainage</li> <li>Repair of the track embankment</li> </ul> (Note) <ul style="list-style-type: none"> <li>2014/1/18: Track hanging (Km 378.4) &amp; culvert collapsed (Km 388.6)</li> <li>2013/12/15: Track washed away at Km 372.4– Km 272.6</li> </ul>	20 m–600 m *From Km 379.5, the Kinyasungwe River goes away from the railway, toward the north.	2.0 m		<ul style="list-style-type: none"> <li>Improvement of cross-drainage</li> <li>Track raising</li> </ul>	Low
Km 380.0– Km 385.0	• Pattern 2-1, 2-2	<ul style="list-style-type: none"> <li>Improvement of cross-drainage</li> </ul>	10 m–300 m to the tributary (Hodwiku River)	2.0 m		<ul style="list-style-type: none"> <li>Improvement of cross-drainage</li> </ul>	Low
Km 385.0 Hodwiku River (Tributary)	• Pattern 2-1, 2-2	<ul style="list-style-type: none"> <li>Improvement of cross-drainage</li> </ul>	The Hodwiku River goes under the track.	3.0 m		<ul style="list-style-type: none"> <li>Gabion works, etc. to protect the bridge against erosion</li> </ul>	Low

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 385.0– Km 403.0	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Protection works of the ballast</li> <li>• Improvement of cross-drainage, including replacement of collapsed culverts</li> <li>• Gabion works</li> <li>• Excavation of drainage trench</li> <li>• Repair of the ballast</li> <li>• Repair of bridge abutment</li> <li>• Restoration of the washed-away track, etc.</li> </ul>		2.0 m – 3.0 m		<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 403.0– Km 415.0  Hodwiku River (Tributary)  Igandu	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Excavation and of the stream channels crossing the track</li> <li>• Gabion works</li> <li>• Improvement of cross-drainage</li> <li>• Repair of the ballast</li> </ul>		2.0 m		<ul style="list-style-type: none"> <li>• Re-routing the track toward the mountain side</li> <li>• Tack raising</li> </ul>	Low - Medium



Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 415.0– Km 426.0	<ul style="list-style-type: none"> <li>• Pattern 2-2</li> </ul>	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> <li>• Gabion works</li> </ul>	*There are some streams crossing under the track.		 <p>422.6km Toward Gulwe</p>	<ul style="list-style-type: none"> <li>• Improvement of cross-drainage</li> </ul>	Low
Km 426.0  Meyundi River (Tributary)  Kikombo	<ul style="list-style-type: none"> <li>• Pattern 2-1, 2-2</li> </ul>		A tributary of the Kinyasungwe River crosses under the track		 <p>426.5km Toward Gulwe</p> <p>Kikombo Station</p> <p>Meyundi River</p>	<ul style="list-style-type: none"> <li>• Gabion works, etc. to protect the bridge against erosion</li> </ul>	Low
Km 426.0– Km 440.0	<ul style="list-style-type: none"> <li>• Pattern 2-1</li> </ul>				 <p>430.5km Toward Gulwe</p>	<ul style="list-style-type: none"> <li>• Improvement of drainage along the track</li> </ul>	Low

Location	Pattern of Damage	Temporary Remedial Works in the past	Distance between track and river * <sup>1</sup>	Difference of elevation between track and river * <sup>2</sup>	Photos of the section	Possible Flood Protection Measures	Priority for Flood Protection
Km 440.0 Mwitikira River (Km 440) (Tributary) Ihumwa	• Pattern 2-1				<b>440.0km Toward Gulwe</b> 	• Improvement of drainage along the track	Low
Km 440.0– Km 455.0	• Pattern 2-1				<b>447.1km Toward Gulwe</b> 	• Improvement of drainage along the track	Low
Km 455.8 Dodoma	Pattern 2-1				<b>455.8km Dodoma Station Toward Tabora</b> 	• Improvement of drainage along the track	Low

(Note-1) Distance between track and river is measured with the detailed aerial photographs taken by the aerial survey.

(Note-2) Difference of elevation between track and river is measured with the topographical maps with 2.0m contours.

## **APPENDIX E**

### **INVENTORY SHEET OF CHANNEL**

# INVENTORY SHEET OF CHANNEL

S/N	STATION KM	SHEET NUMBER
1	283 - 284	CH-KM 283
2	284-285	CH-KM 284
3	285-286	CH-KM 285
4	286-287	CH-KM 286
5	287-288	CH-KM 287
6	293-294	CH-KM 293
7	294-295	CH-KM 294
8	300-301	CH-KM 300
9	301-302	CH-KM 301
10	302-303	CH-KM 302
11	303-304	CH-KM 303
12	304-305	CH-KM 304
13	305-306	CH-KM 305
14	306-307	CH-KM 306
15	307-308	CH-KM 307
16	308-309	CH-KM 308
17	310.9	CH-KM 310
18	312.1-312.4	CH-KM 312.1
19	312.8-313.3	CH-KM 312.8
20	314.3	CH-KM 314.3
21	315-316	CH-KM 315
22	325-326	CH-KM 325
23	326-327	CH-KM 326
24	327-328	CH-KM 327
25	328-329	CH-KM 328
26	329-330	CH-KM 329
27	330-331	CH-KM 330
28	331-332	CH-KM 331
29	332-333	CH-KM 332
30	337-338	CH-KM 337
31	344.8	CH-KM 344.8
32	349.1A-349.9B	CH-KM 349.1A
33	349.4B-349.9B	CH-KM 349.4B
34	349.9B-349.9C	CH-KM 349.9B
35	349.9C-350	CH-KM 349.9C
36	350-351	CH-KM 350
37	351-352	CH-KM 351
38	355.1	CH-KM 355.1
39	355.2	CH-KM 355.2

## Inventory Sheet for River/Channel

**Station: From KM283 to KM284**      **Sheet No.: CH- KM 283**

1. General			
1-1	Name of Inspector	T. Kawaguchi , Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 5, 2014	
1-4	Location	Lat	6° 49' 52" 02'''
1-5		Long	36° 58' 39" 55'''

### 2. Characteristics of Physical Condition of River Channel

2-1	Length of Objective Area		
2-2	Nos. of River Facility	2 culverts , 1 Bridge	
2-3	River Channel Alignment	Meandering , Water Hit Area	
2-4	River Cross Section	Compound Section	
2-5	River Width	Wf:      m, Wr:      m Bl:      m, Bc: 46 m, Br:      m	
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hl: 5 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10		Vegetation	
2-11	Estimated Flow Velocity	normal:      m/s, flood      m/s	
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	Residence	
2-14	Soil Type		
2-15	Topography	left: ← , right →	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	d=32 m	

2-18	Damaged Record, if any (year/month)	A flood overflowed from left bank of Mkondoa bridge to Kilosa City in 2014.
2-19	Reason of	Overflow the Bank
2-20	Pattern of Riverbed	

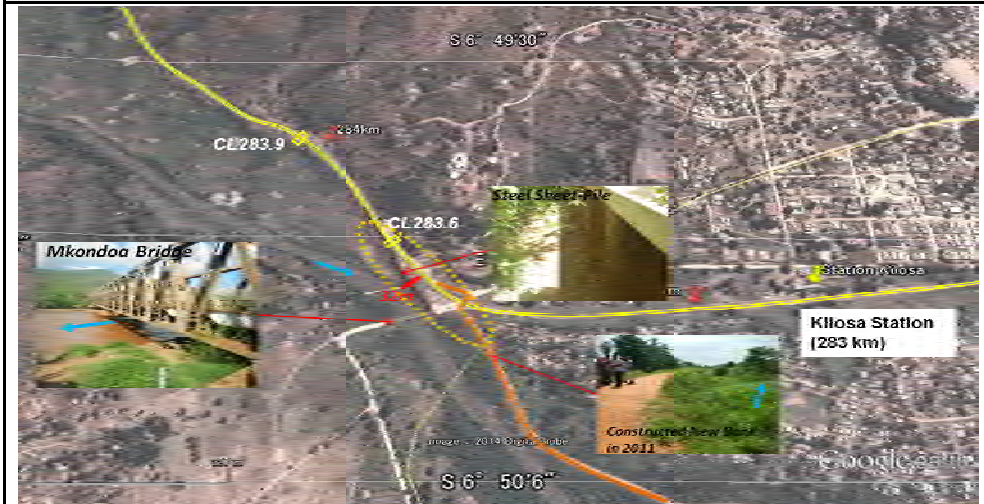
Photo Upstream



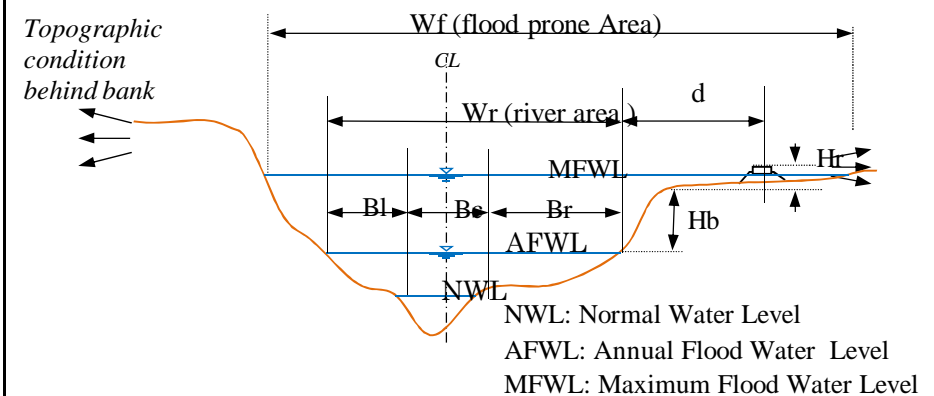
Photo Downstream



Location



Cross Section



## Inventory Sheet for River/Channel

**Station: From KM284 to KM285**      **Sheet No.: CH- KM 284**

1. General			
1-1	Name of Inspector	T. Kawaguchi , Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 5, 2014	
1-4	Location	Lat	6° 49' 40" 93'''
1-5		Long	36° 58' 20" 76'''

2. Characteristics of Physical Condition of River Channel			
2-1	Length of Objective Area		
2-2	Nos. of River Facility		1 culvert
2-3	River Channel Alignment		Meandering , Water Hit Area
2-4	River Cross Section		Compound section
2-5	River Width	Wf:      m, Wr:      m	Bl:      m, Bc: 26 m, Br: m
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10	River Bank	Vegetation	
2-11		Estimated Flow Velocity	normal:      m/s, flood      m/s
2-12	Characteristic of environmental condition of river channel		Riverside forests, Sandbar, Pool, shoal, fishes, etc
2-13	Land Use		Cultivation
2-14	Soil Type		
2-15	Topography		left: ←      , right →
2-16	Structures/Houses, road		none
2-17	Location of Railway		d = 240 m

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

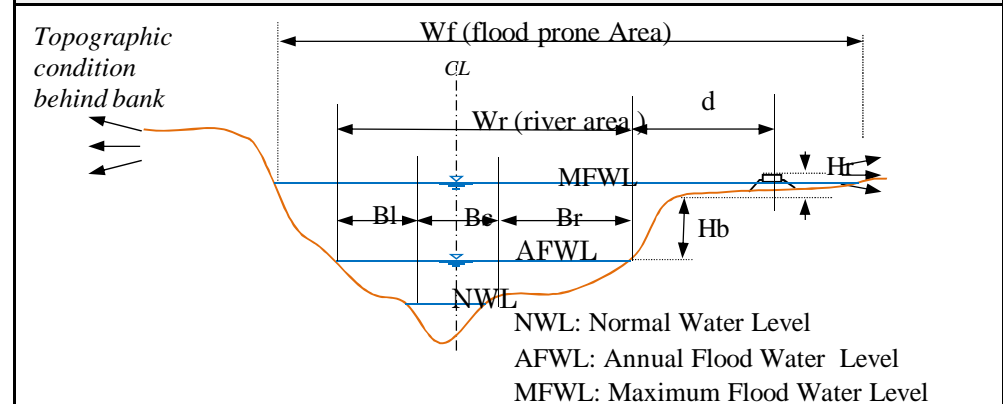
Photo Upstream

Photo Downstream

### Location



### Cross Section



## Inventory Sheet for River/Channel

**Station: From KM285 to KM286**      **Sheet No.: CH- KM 285**

<b>1. General</b>			
1-1	Name of Inspector		T. Kawaguchi ,, Hussein , Abiud
1-2	Organization of Inspector		River Group D
1-3	Date/Time of Inspection		Dec. 5, 2014
1-4	Location	Lat	6° 48' 54" 35'''
1-5		Long	36° 57' 54" 90'''

**2. Characteristics of Physical Condition of River Channel**

2-1	Length of Objective Area		
2-2	Nos. of River Facility		2 culverts
2-3	River Channel Alignment		Meandering , Water Hit Area
2-4	River Cross Section		Coompound section
2-5	River Width		Wf:      m, Wr:      m Bl:      m, Bc: 50 m, Br: m
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8		Bank Height	Hl: 3 m
2-9	River Bank	Side Slope	Sl: 1v:      , Sr: 1v:
2-10		Vegetation	
2-11	Estimated Flow Velocity		normal:      m/s, flood      m/s
2-12	Characteristic of environmental condition of river channel		Riverside forests, Sandbar, Pool, shoal, fishes, etc
2-13	Land Use		Cultivation
2-14	Soil Type		
2-15	Topography		left: ← ,right →
2-16	Structures/Houses, road		none
2-17	Location of Railway		d=220 m

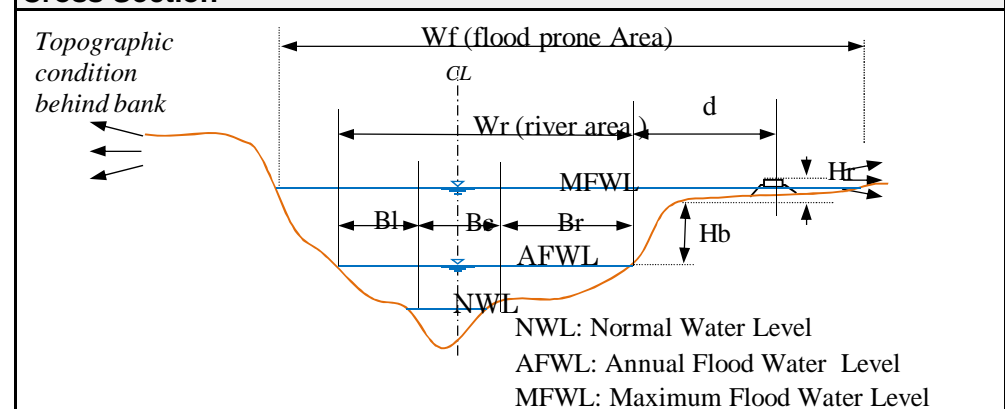
2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

<b>Photo Upstream</b>	<b>Photo Downstream</b>

**Location**



**Cross Section**



E-4

## Inventory Sheet for River/Channel

**Station: From KM 286 to KM287**      **Sheet No.: CH- KM 286**

1. General			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 5, 2014	
1-4	Location	Lat	6 °48' 46" 60'''
1-5		Long	36° 57' 56" 27'''

### 2. Characteristics of Physical Condition of River Channel

2-1	Length of Objective Area	
2-2	Nos. of River Facility	4 culverts
2-3	River Channel Alignment	Meandering , Water Hit Area
2-4	River Cross Section	Compound section
2-5	River Width	Wf:     m, Wr:     m Bl:     m, Bc: 60 m, Br:   m
2-6	Riverbed Slope	
2-7	Riverbed Material	Material
2-8	Bank Height	Hl: 3 m
2-9	River Bank	Side Slope Sl: 1v:     , Sr: 1v:
2-10	Vegetation	
2-11	Estimated Flow Velocity	normal:     m/s, flood     m/s
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc
2-13	Land Use	Cultivation
2-14	Soil Type	
2-15	Topography	left: ←     , right →
2-16	Structures/Houses, road	none
2-17	Location of Railway	d = 170 m

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	Bank erosion
2-20	Pattern of Riverbed	

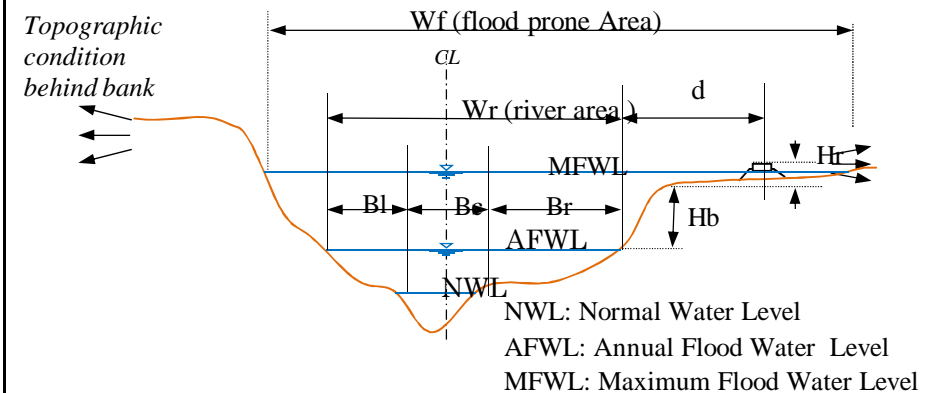
Photo Upstream

Photo Downstream

### Location



### Cross Section





## Inventory Sheet for River/Channel

**Station: From KM287 to KM288**      **Sheet No.: CH- KM 287**

1. General			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 5, 2014	
1-4	Location	Lat	6° 48' 05" 27'''
1-5		Long	36° 57' 33" 33'''

2. Characteristics of Physical Condition of River Channel			
2-1	Length of Objective Area		
2-2	Nos. of River Facility	4 culverts	
2-3	River Channel Alignment	Meandering , Water Hit Area	
2-4	River Cross Section		
2-5	River Width	Wf:      m, Wr:      m	
		Bl:      m, Bc: 36 m, Br:      m	
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10	River Bank	Vegetation	
2-11		Estimated Flow Velocity	normal:      m/s, flood      m/s
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	Cultivation	
2-14	Soil Type		
2-15	Topography	left: ← , right →	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	d = 400 m	

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

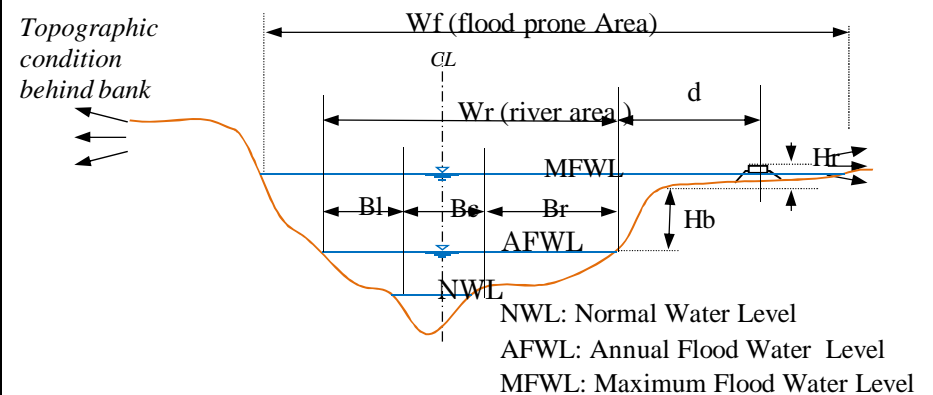
Photo Upstream

Photo Downstream

### Location



### Cross Section



## Inventory Sheet for River/Channel

**Station: From KM293 to KM294**      **Sheet No.: CH-293**

### 1. General

1-1	Name of Inspector	T.Fukuda, Mr. Kido, Mr. Philipo	
1-2	Organization of Inspector	Team B	
1-3	Date/Time of Inspection	Dec. 5, 2014 11:20	
1-4	Location	Lat	S 06° 45'42.5"
1-5		Long	E 36° 55'56.8"

### 2. Characteristics of Physical Condition of River Channel

2-1	Length of Objective Area	Km 293 Bridge	
2-2	Nos. of River	Gabion (3 steps) on both banks	
2-3	River Channel Alignment	meandering, water hit area	
2-4	River Cross Section	compound section	
2-5	River Width	Wf:      m, Wr: 90 m at bridge	
		Bl:      m, Bc: m, Br: 0 m	
2-6	Riverbed Slope	Gentle (i=1/      )	
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hb: 4.5 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v: ?
2-10		Vegetation	none
2-11	Estimated Flow Velocity	normal: 0.7 m/s, flood      m/s	
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	none	
2-14	Soil Type	Laterite	
2-15	Topography	left: ↙ , right ↘	
2-16	Structures/Houses, road	a railway bridge	
2-17	Location of Railway	right, d= 12.7 m	

2-18	Damaged Record, if any (year/month)	Construction of the new bridge and bank protection of gabion was completed on Jul.21, 2014 (Chinese Contractor)
		2008 flood: overtopped from left upstream bank o the bridge resulting wash out of the bridge

2-19	Reason of	Bank erosion, Overflow, Sliding,
2-20	Pattern of Riverbed	Rising of riverbed in long distance

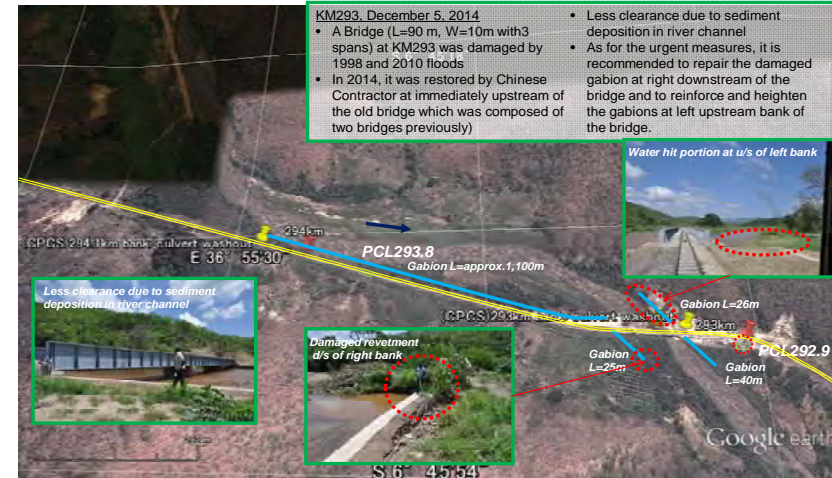
### Photo Upstream



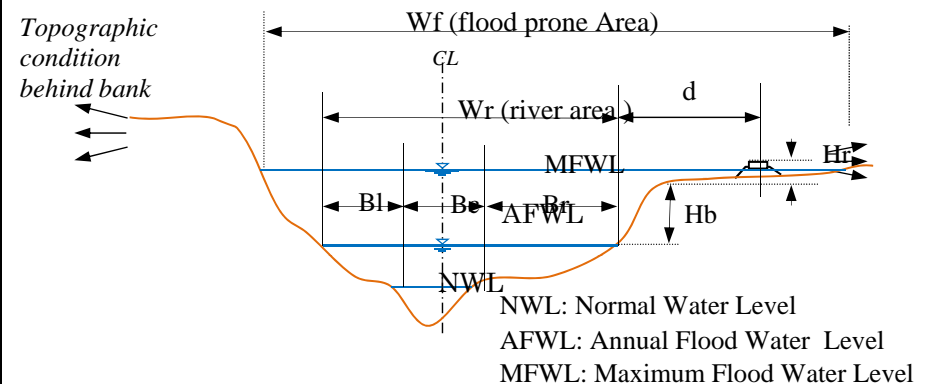
### Photo Downstream



### Location



### Cross Section



## Inventory Sheet for River/Channel

<b>Station: From KM294 to KM295</b>		<b>Sheet No.: CH-294</b>	
<b>1. General</b>			
1-1	Name of Inspector	T.Fukuda, Mr. Kido, Mr. Philipo	
1-2	Organization of Inspector	Team B	
1-3	Date/Time of Inspection	Dec. 5, 2014 11:20	
1-4	Location	Lat	S 06° 45' 35.8"
1-5		Long	E 36° 55' 32.8"
<b>2. Characteristics of Physical Condition of River Channel</b>			
2-1	Length of Objective Area	400m (Km293.8-294.1)	
2-2	Nos. of River	Gabion (3 steps) on right bank	
2-3	River Channel Alignment	meandering, water hit area	
2-4	River Cross Section	compound section	
2-5	River Width	Wf:       m, Wr: 90 m at bridge	
		Bl:        m, Bc: 13 m, Br: 0 m	
2-6	Riverbed Slope	Gentle (i=1/ )	
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hb: 2.3 m
2-9		Side Slope	Sl: 1v:0.5 , Sr: 1v: ?
2-10		Vegetation	tall grasses
2-11	Estimated Flow Velocity	normal: 0.7 m/s, flood	m/s
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	none (cultivated before 2010 flood)	
2-14	Soil Type	Laterite	
2-15	Topography	left: ↖ , right ↗	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	right, d= 14.7 m @Km293.9	
2-18	Damaged Record, if any (year/month)	2010 Flood: overtopped of the track resulting damage on ballasts. After that, gabion were installed for bank protection of low water channel. 1998 Flood: All were washed away. It was planned to divert the track but not realized.	
2-19	Reason of	Bank erosion, Overflow, Sliding,	
2-20	Pattern of Riverbed	Rising of riverbed in long distance	

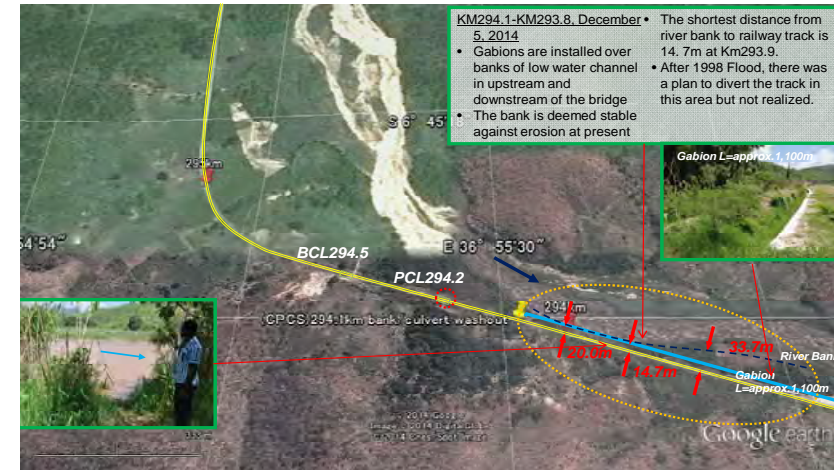
**Photo Upstream**



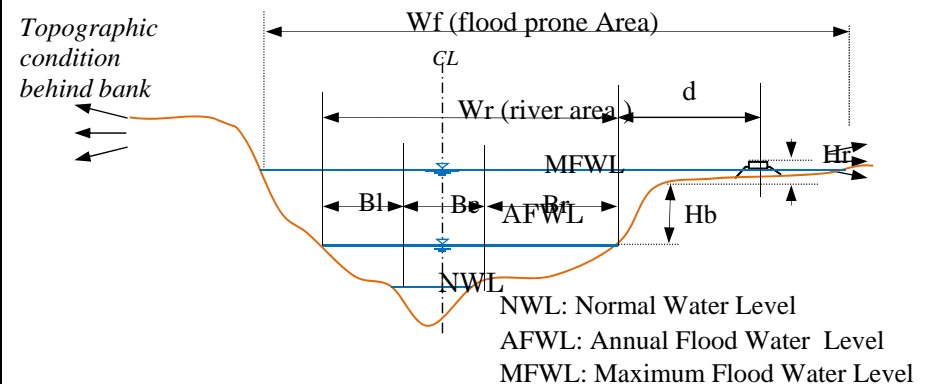
**Photo Downstream**



**Location**



**Cross Section**



## Inventory Sheet for River/Channel

**Station: From KM300 to KM301**      **Sheet No.: CH- KM 300**

1. General			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 4, 2014	
1-4	Location	Lat	6° 44' 31" 01"
1-5		Long	36° 52' 43" 99"

### 2. Characteristics of Physical Condition of River Channel

2-1	Length of Objective Area		
2-2	Nos. of River Facility	4 culverts	
2-3	River Channel Alignment	Meandering , Water Hit Area	
2-4	River Cross Section	Compound Section	
2-5	River Width	Wf:     m, Wr:     m Bl:     m, Bc: 35 m, Br: m	
2-6	Riverbed Slope		
2-7	Riverbed Material	Material Sand	
2-8	River Bank	Bank Height	Hl: 2 m
2-9		Side Slope	Sl: 1v:     , Sr: 1v:
2-10	Vegetation		
2-11	Estimated Flow Velocity	normal:     m/s, flood     m/s	
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	none	
2-14	Soil Type		
2-15	Topography	left: ←     , right →	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	d = 25 m	

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

Photo Upstream



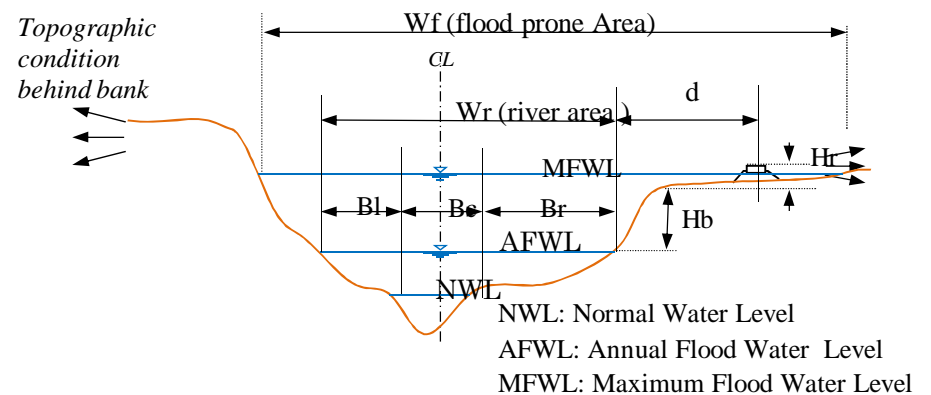
Photo Downstream



Location



Cross Section



## Inventory Sheet for River/Channel

**Station: From KM301 to KM302**      **Sheet No.: CH- KM 301**

1. General			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 4, 2014	
1-4	Location	Lat	6° 44' 33" 60'''
1-5		Long	36° 52' 18" 27'''

2. Characteristics of Physical Condition of River Channel			
2-1	Length of Objective Area		
2-2	Nos. of River Facility		
2-3	River Channel Alignment      Meandering , Water Hit Area		
2-4	River Cross Section      Compound Section		
2-5	River Width	Wf:      m, Wr:      m Bl:      m, Bc: 38 m, Br: m	
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10	River Bank	Vegetation	
2-11		Estimated Flow Velocity	normal:      m/s, flood      m/s
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use      none		
2-14	Soil Type		
2-15	Topography      left: ← , right →		
2-16	Structures/Houses, road      none		
2-17	Location of Railway      d = 180 m		

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

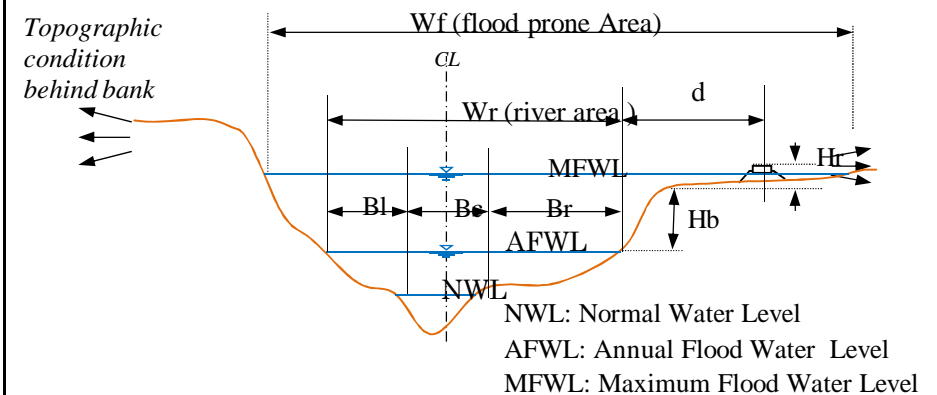
Photo Upstream

Photo Downstream

### Location



### Cross Section



## Inventory Sheet for River/Channel

**Station: From KM302 to KM303**      **Sheet No.: CH- KM 302**

<b>1. General</b>			
1-1	Name of Inspector	T. Kawaguchi , Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 4, 2014	
1-4	Location	Lat	6° 44' 45" 18"
1-5		Long	36° 51' 55" 91"

**2. Characteristics of Physical Condition of River Channel**

2-1	Length of Objective Area		
2-2	Nos. of River Facility	3 culverts	
2-3	River Channel Alignment	Meandering , Water Hit Area	
2-4	River Cross Section	Compound section	
2-5	River Width	Wf:      m, Wr:      m Bl:      m, Bc: 45 m, Br: m	
2-6	Riverbed Slope		
2-7	Riverbed Material	Material      sand	
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10	Vegetation		
2-11	Estimated Flow Velocity	normal:      m/s, flood      m/s	
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	none	
2-14	Soil Type		
2-15	Topography	left: ← , right →	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	d = 5 m	

2-18	Damaged Record, if any (year/month)	One Culvert and Gabion(400 m) had been washed out by a flood in 2014.

2-19	Reason of	Bank Erosion
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2-20	Pattern of Riverbed	
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**Photo Upstream**

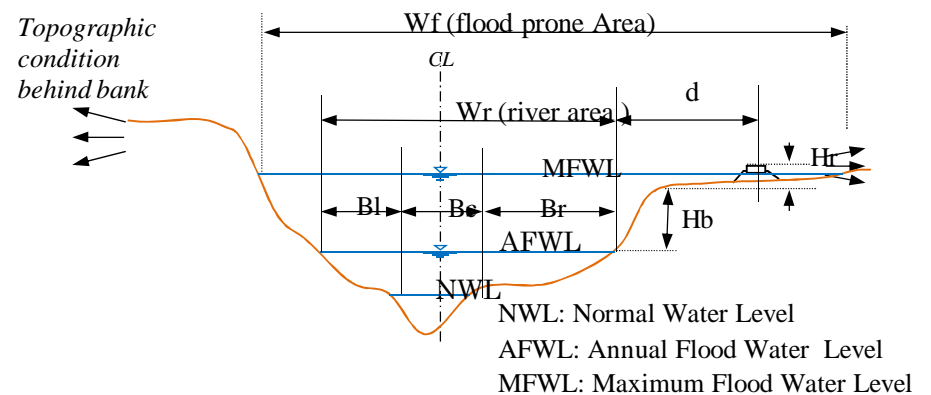


**Photo Downstream**

**Location**



**Cross Section**



## Inventory Sheet for River/Channel

**Station: From KM303 to KM304**      **Sheet No.: CH- KM 303**

<b>1. General</b>			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 4, 2014	
1-4	Location	Lat	6° 44' 24" 26'''
1-5		Long	36° 50' 58" 17'''

**2. Characteristics of Physical Condition of River Channel**

2-1	Length of Objective Area		
2-2	Nos. of River Facility	2 Bridge , 2 culverts	
2-3	River Channel Alignment	Meandering , Water Hit Area	
2-4	River Cross Section	Compound Section	
2-5	River Width	Wf:      m, Wr:      m Bl:      m, Bc: 163 m, Br:      m	
2-6	Riverbed Slope	Sand	
2-7	Riverbed Material	Material	
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10		Vegetation	
2-11	Estimated Flow Velocity	normal:      m/s, flood      m/s	
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use	none	
2-14	Soil Type		
2-15	Topography	left: ← , right →	
2-16	Structures/Houses, road	none	
2-17	Location of Railway	d =80 m	

2-18	Damaged Record, if any (year/month)	The bridge of the right tributary had washed out by a flood in 2010. A new bridge had been completed in 2014 and the railroad line had been moved to the
2-19	Reason of	Flood flow overtopped the bridge
2-20	Pattern of Riverbed	

**Photo Upstream**



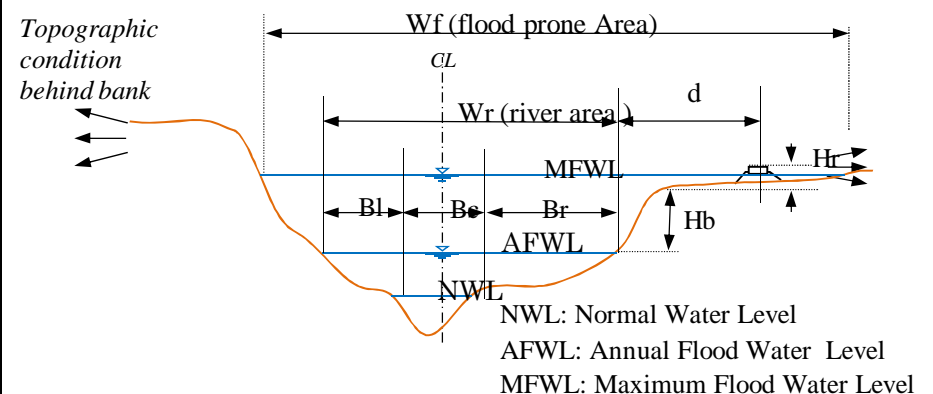
**Photo Downstream**



**Location**



**Cross Section**



## Inventory Sheet for River/Channel

**Station: From KM304 to KM305**      **Sheet No.: CH- KM 304**

1. General			
1-1	Name of Inspector	T. Kawaguchi ,, Hussein , Abiud	
1-2	Organization of Inspector	River Group D	
1-3	Date/Time of Inspection	Dec. 4, 2014	
1-4	Location	Lat	6° 44' 01" 27"
1-5		Long	36° 50' 45" 09"

2. Characteristics of Physical Condition of River Channel			
2-1	Length of Objective Area		
2-2	Nos. of River Facility		
2-3	River Channel Alignment		Meandering , Water Hit Area
2-4	River Cross Section		Compound section
2-5	River Width	Wf:      m, Wr:      m	Bl:      m, Bc: 138 m, Br:      m
2-6	Riverbed Slope		
2-7	Riverbed Material	Material	Sand
2-8	River Bank	Bank Height	Hl: 3 m
2-9		Side Slope	Sl: 1v:      , Sr: 1v:
2-10	River Bank	Vegetation	
2-11		Estimated Flow Velocity	normal:      m/s, flood      m/s
2-12	Characteristic of environmental condition of river channel	Riverside forests, Sandbar, Pool, shoal, fishes, etc	
2-13	Land Use		none
2-14	Soil Type		
2-15	Topography		left: ← , right →
2-16	Structures/Houses, road		none
2-17	Location of Railway		d = 170 m

2-18	Damaged Record, if any (year/month)	
2-19	Reason of	
2-20	Pattern of Riverbed	

Photo Upstream	Photo Downstream

### Location



### Cross Section

