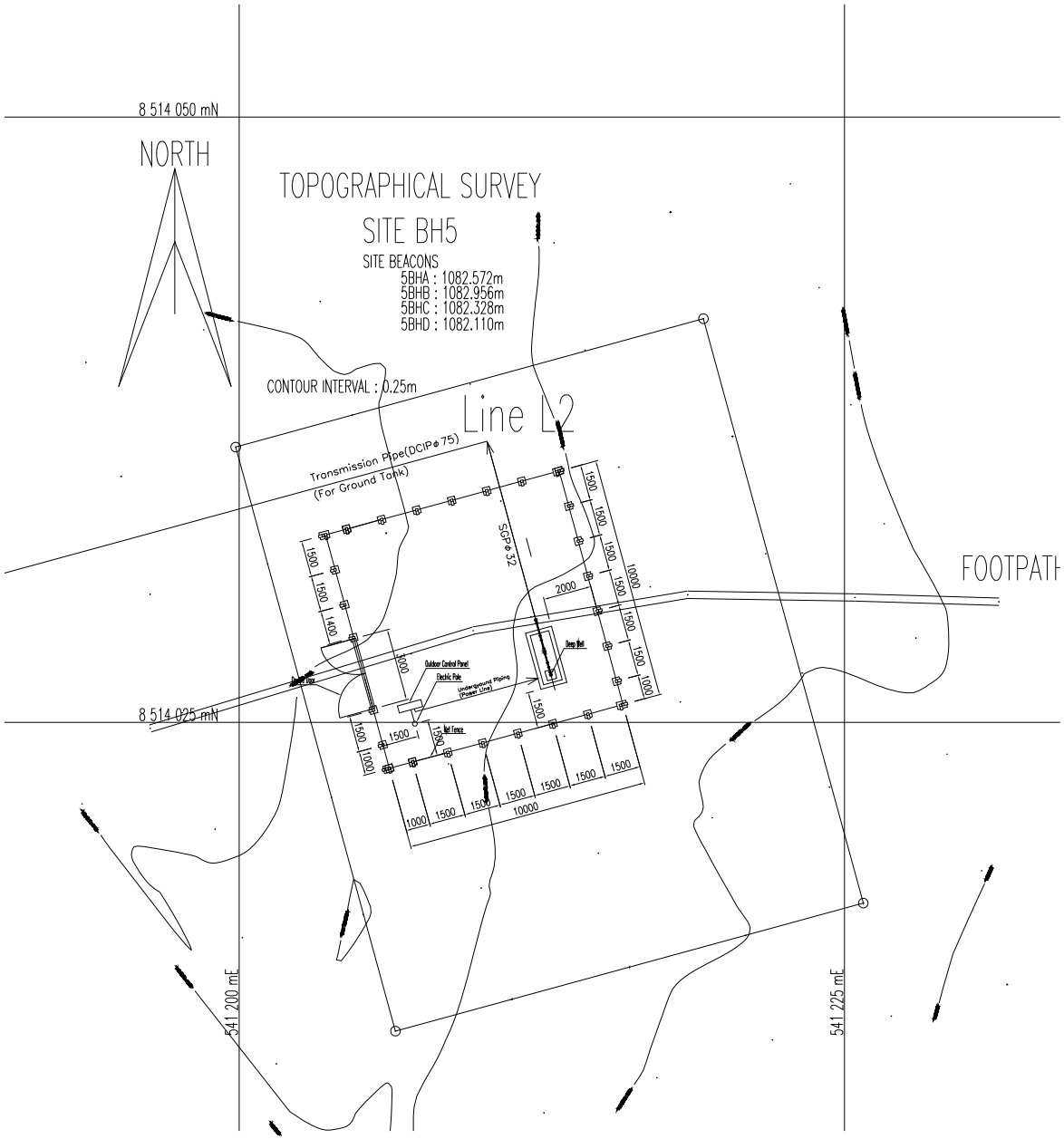
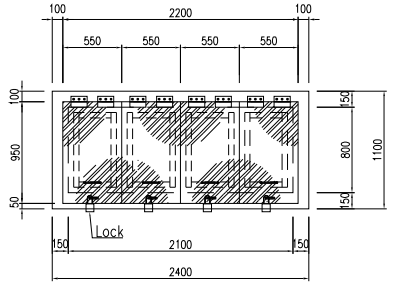
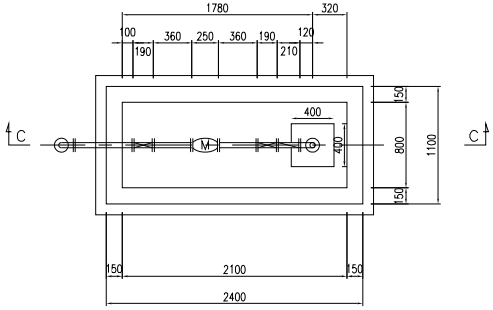
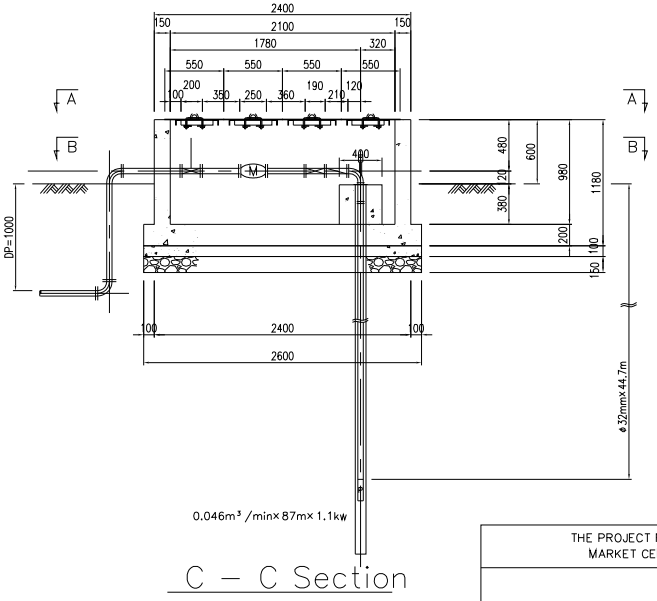


Intanke Well ST−5 General Layout
(Santhe)
S=1:100(A1) 1:200(A3)







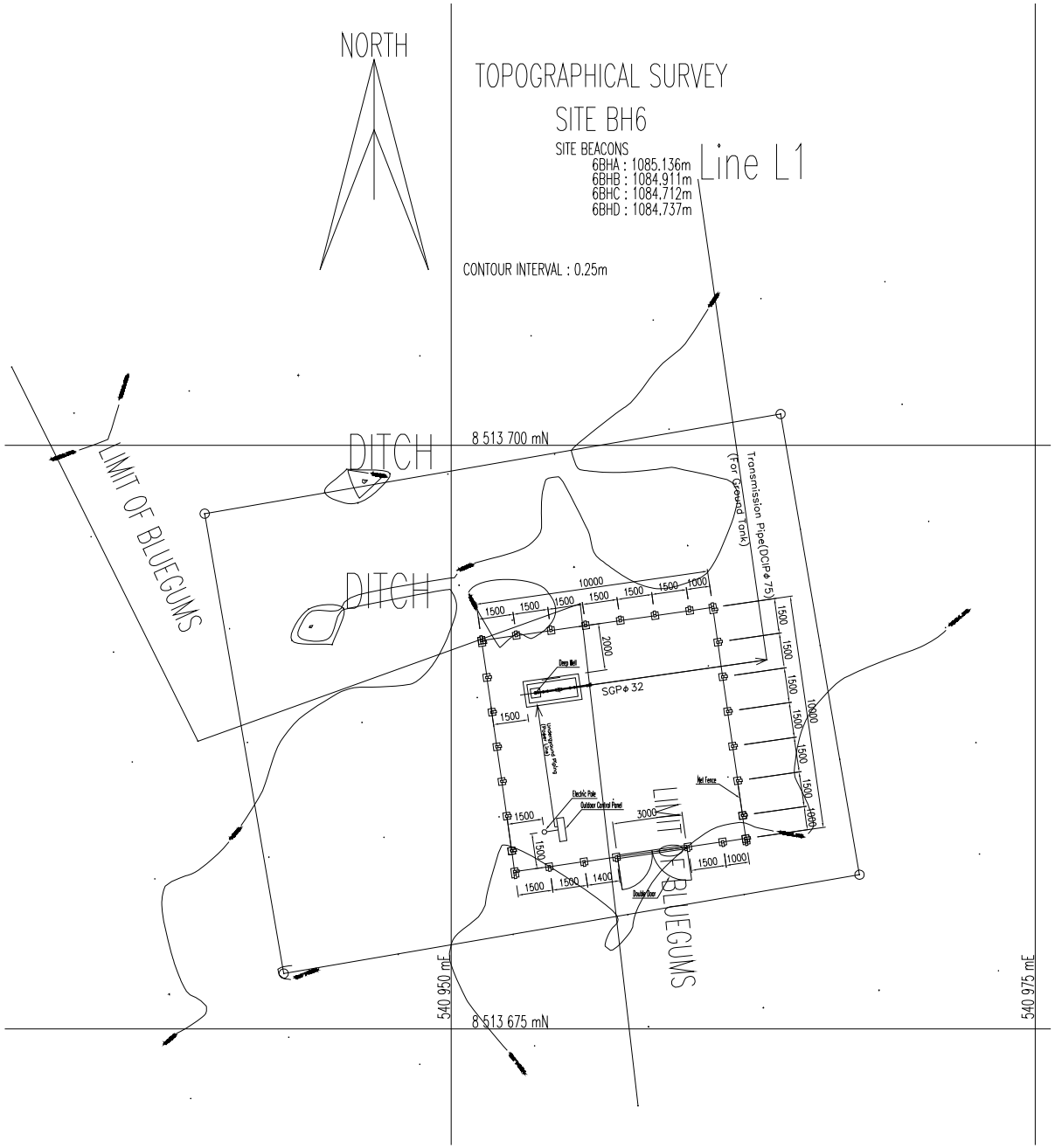
Intanke Well Structure
S=1:25(A1) 1:50(A3)

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

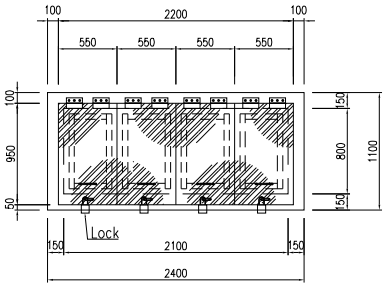
Intake Well ST−5
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S006

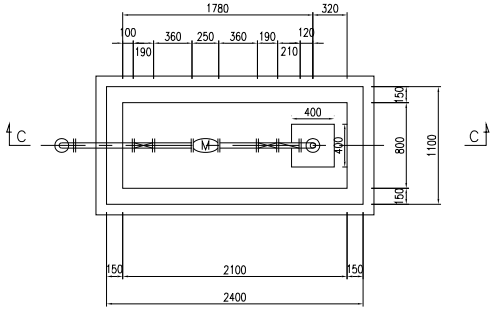
EIGHT−JAPAN ENGINEERING CONSULTANTS INC.



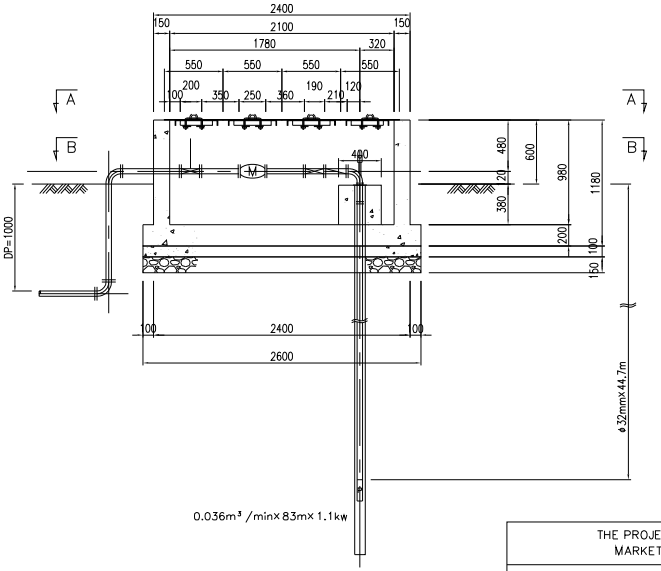
Intanke Well ST−6 General Layout
(Santhe) S=1:100(A1) 1:200(A3)



A − A Section



B − B Section



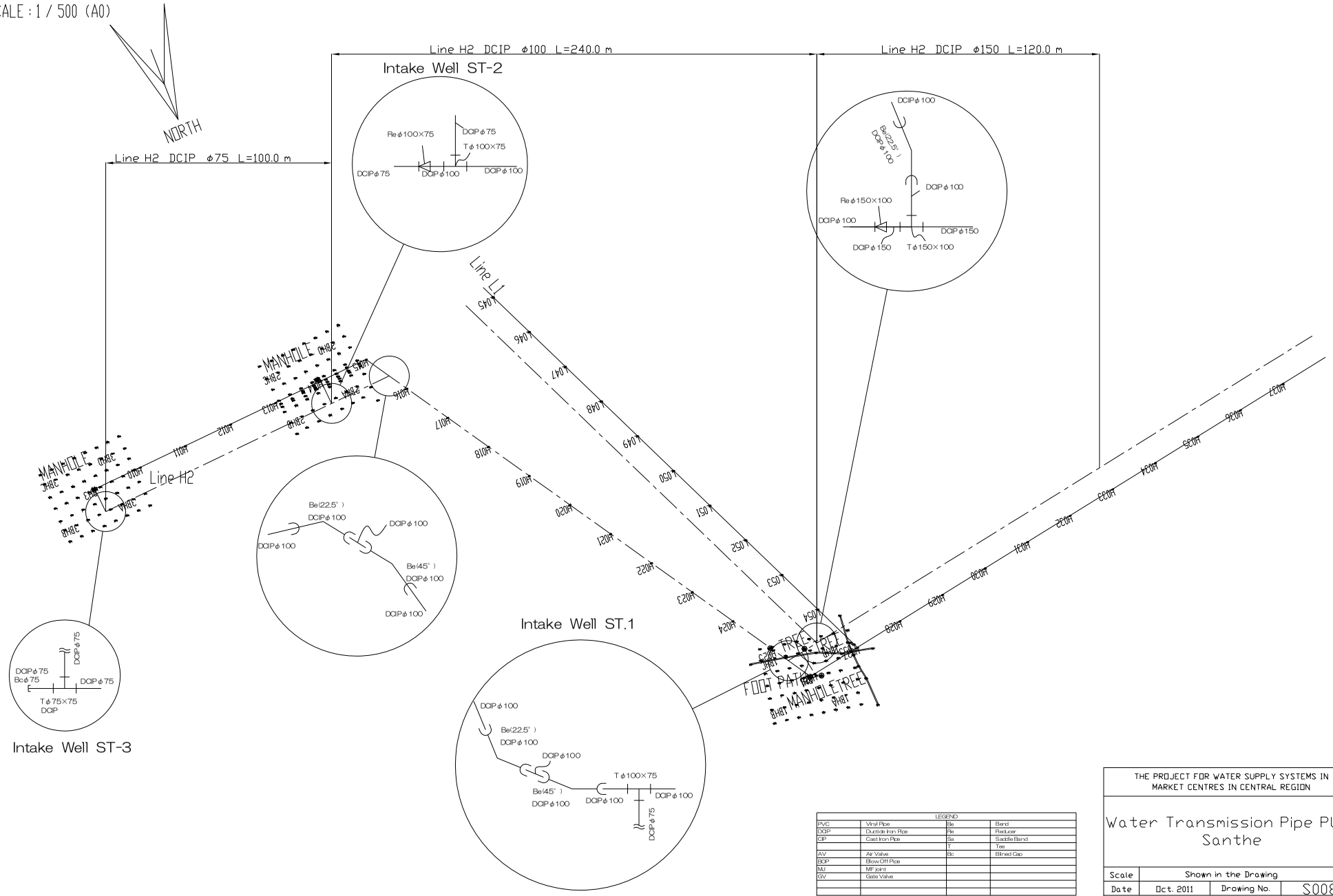
C − C Section

Intanke Well Structure
S=1:25(A1) 1:50(A3)

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION	
Intake Well ST−6 Santhe	
Scale	Shown in the Drawing
Date	Oct. 2011
Drawing No.	S007
EIGHT−JAPAN ENGINEERING CONSULTANTS INC.	

SANTHE WATER SUPPLY SCHEME
LINE H2 : 0.00m to 500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

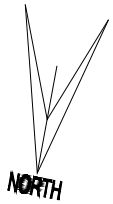
Water Transmission Pipe Plan Santhe

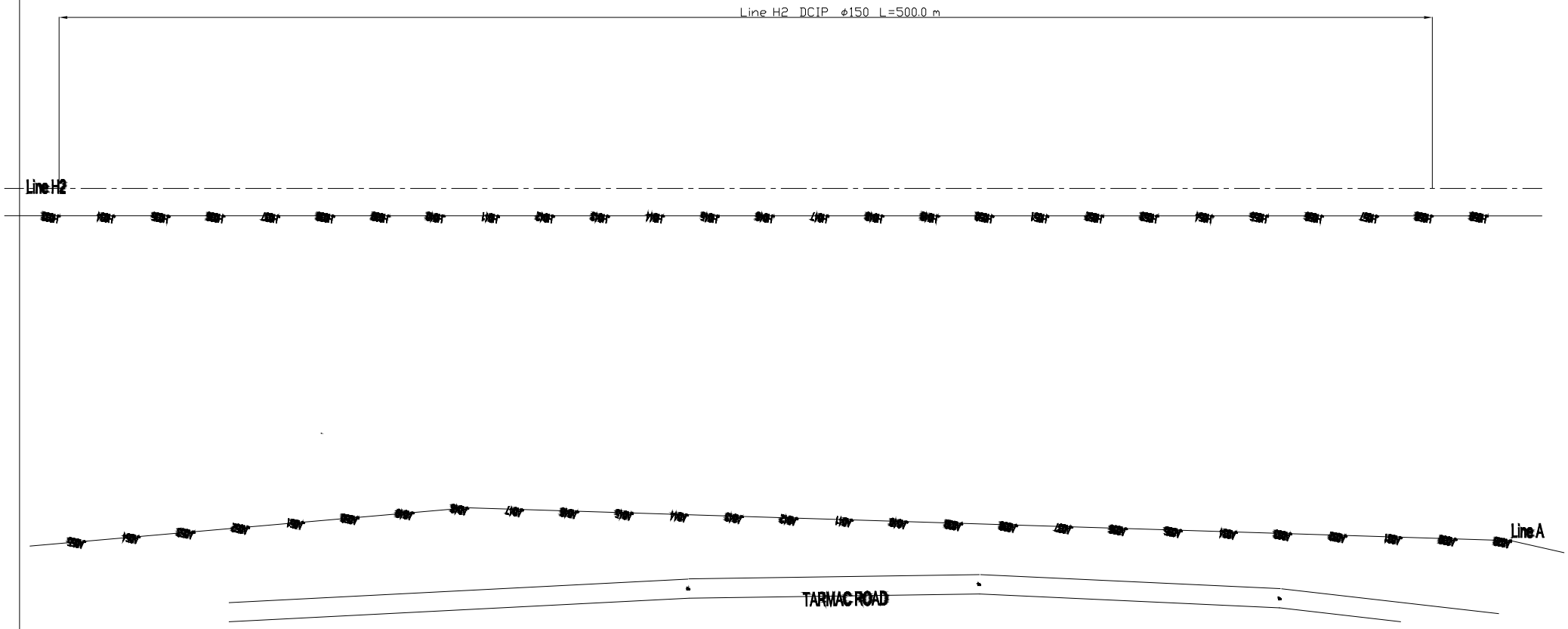
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S008

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE H2 : 500m to 1,000m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

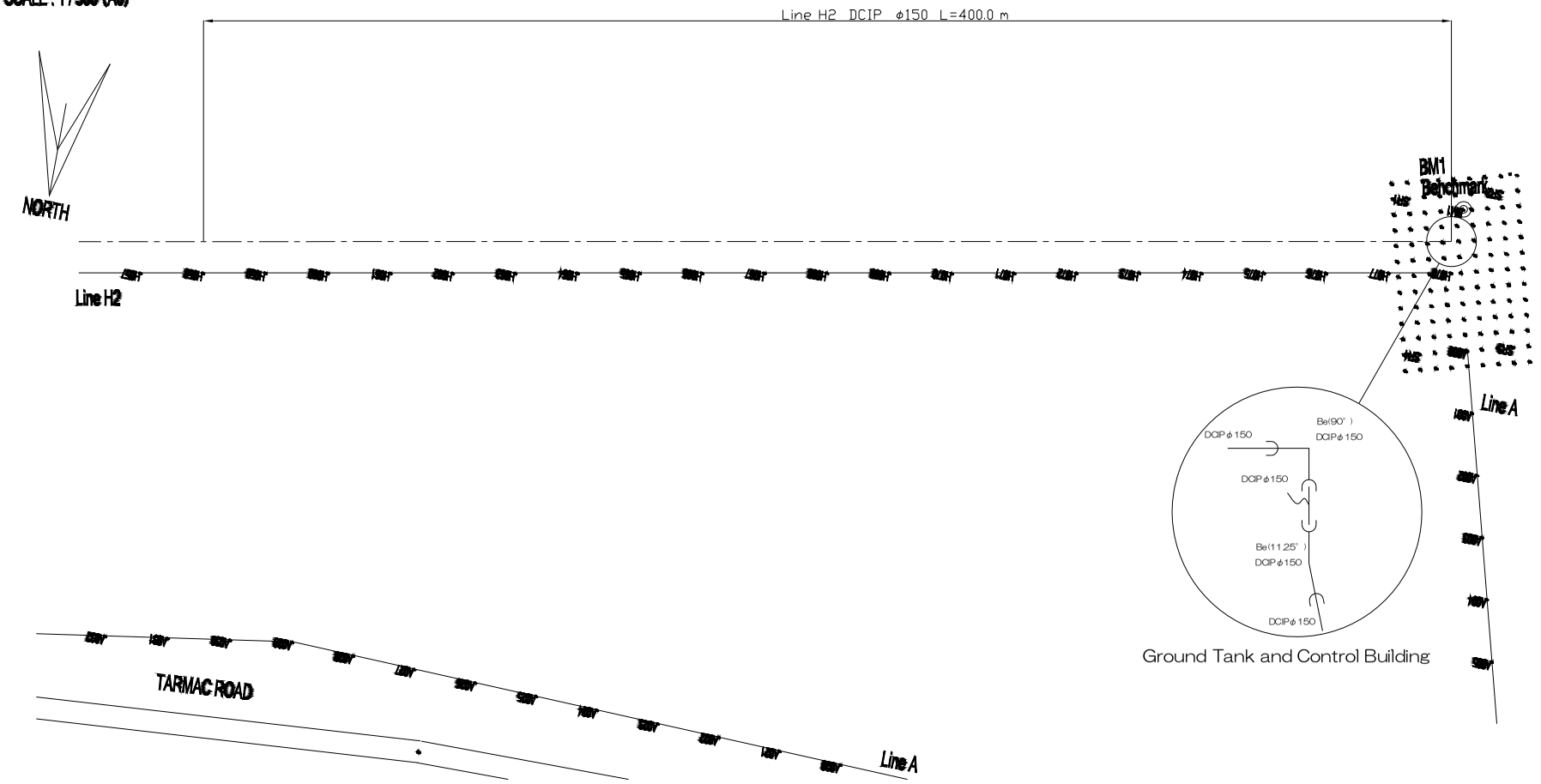
Water Transmission Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S009

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE H2 : 1,000m to 1,380.20m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

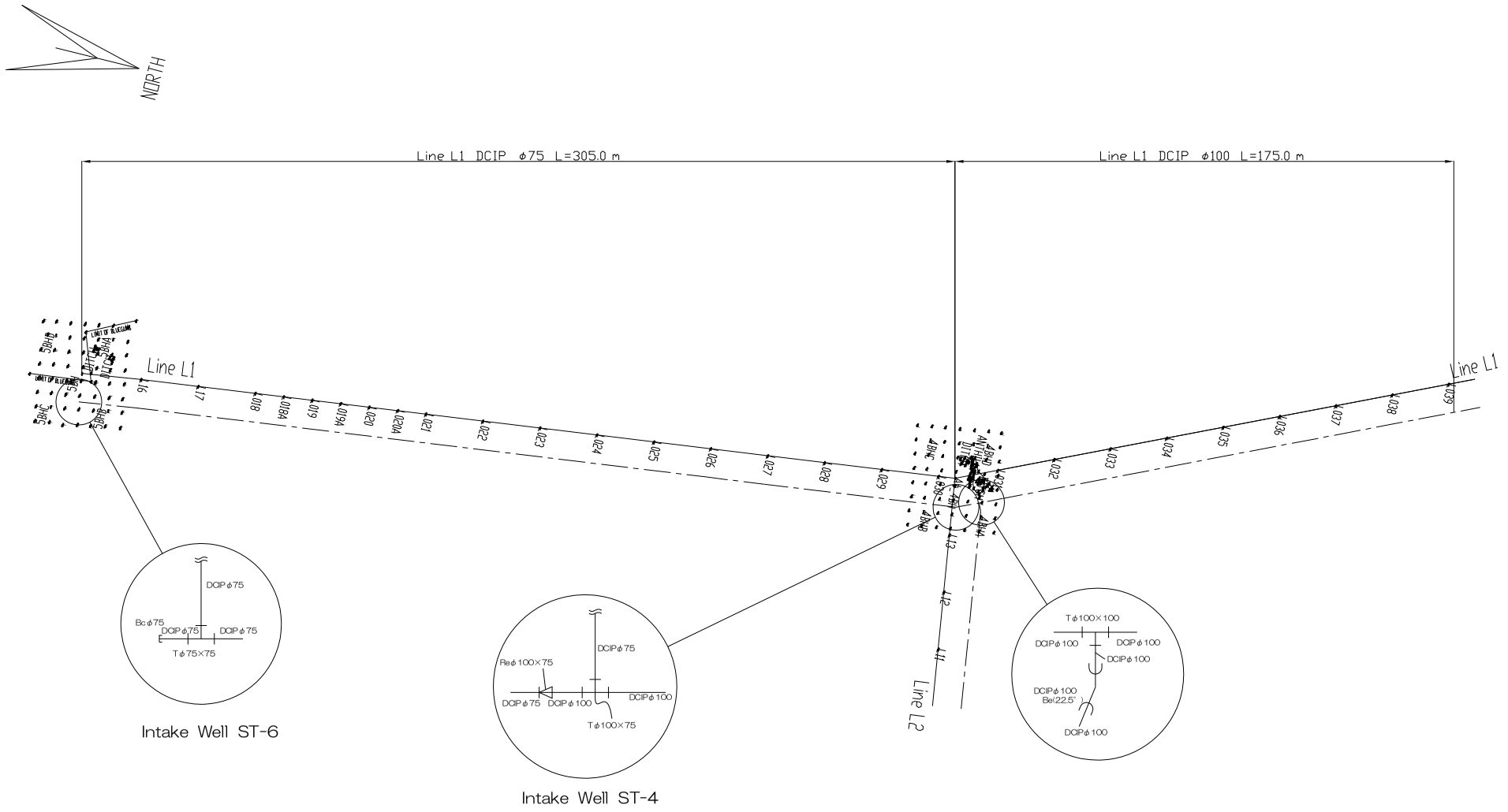
Water Transmission Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S010

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE L1 : 0.00m to 500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

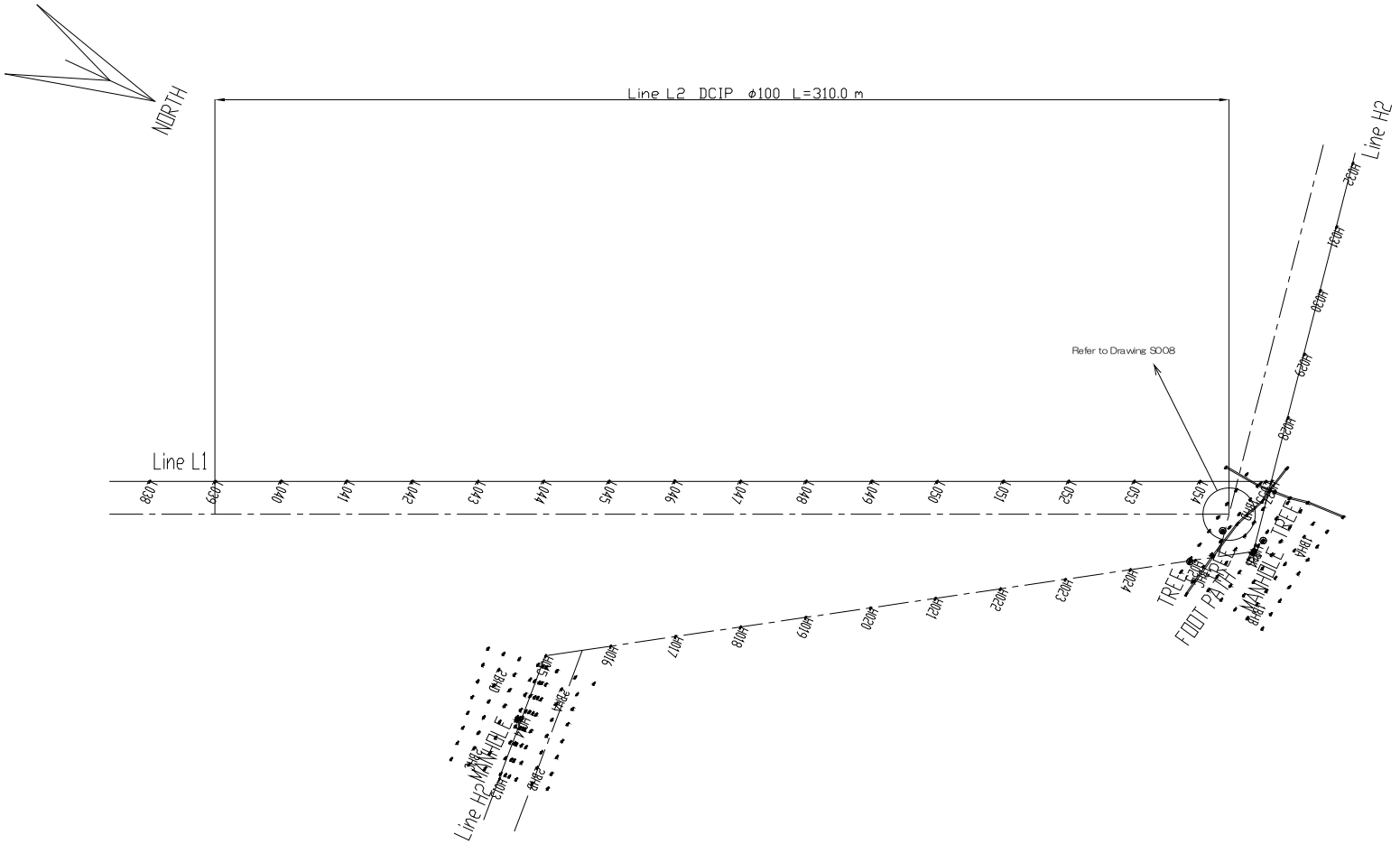
Water Transmission Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S011

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE L1 : 500m to 803.70m

SCALE : 1 / 500 (A0)

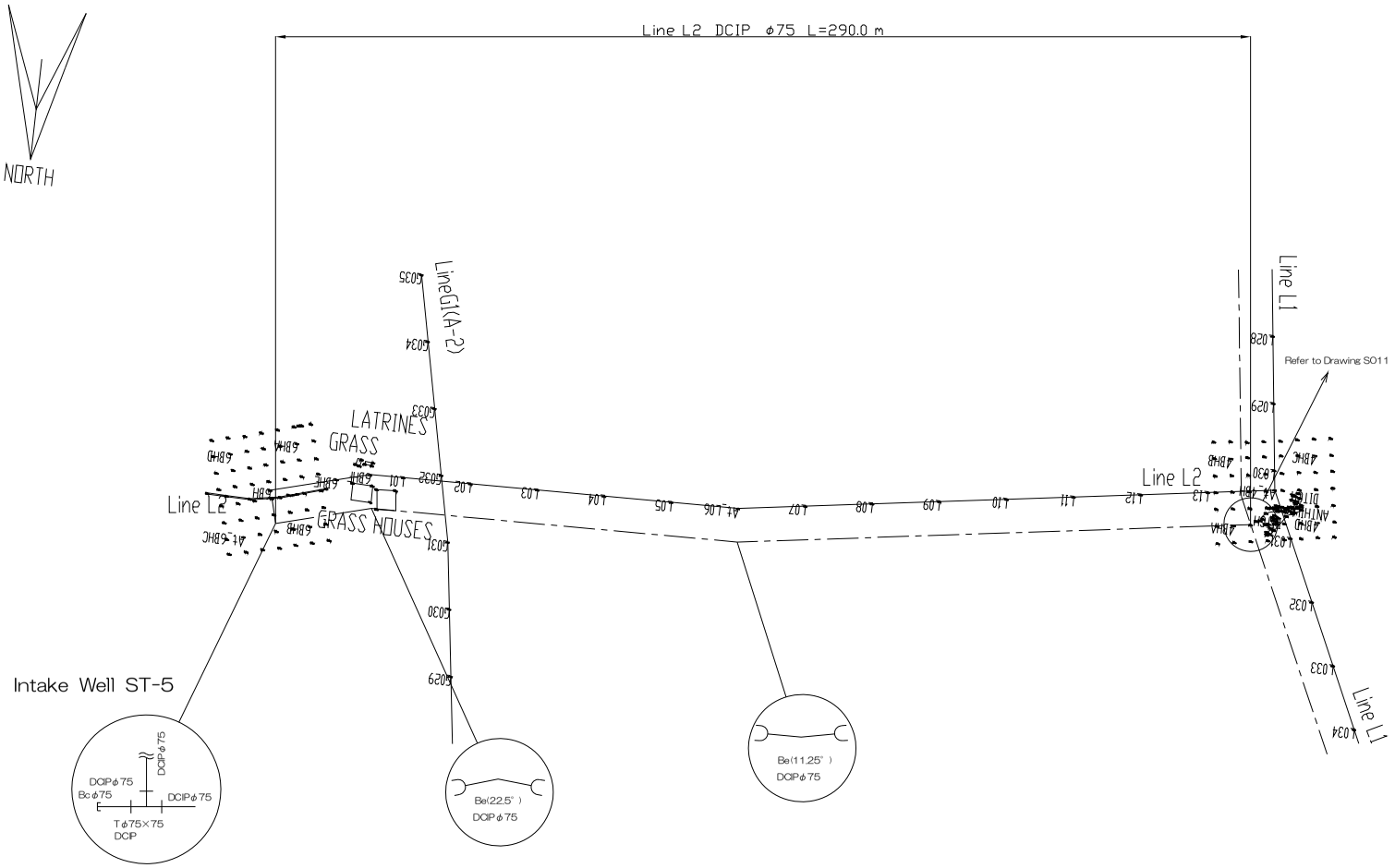


LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION			
Water Transmission Pipe Plan Santhe			
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S012
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.			

SANTHE WATER SUPPLY SCHEME
LINE L2 : 0.00m to 299.97m

SCALE : 1 / 500 (A0)



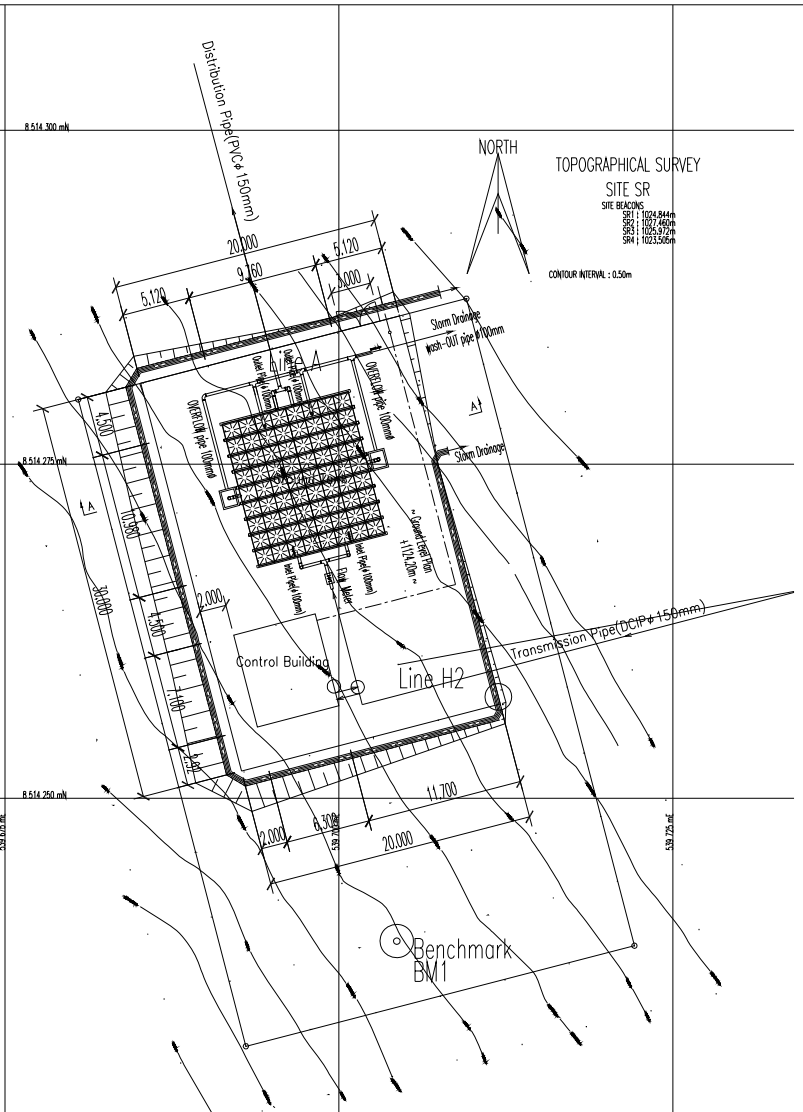
LEGEND			
PVC	Vinyl Pipe	Bx	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

Water Transmission Pipe Plan
Santhe

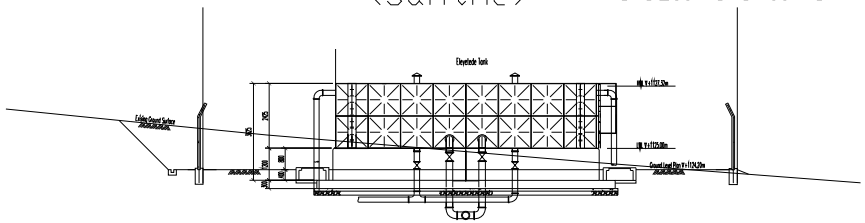
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S013

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.



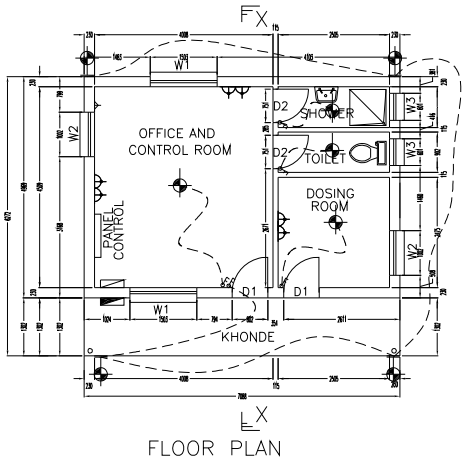
nd Tank and Control Building General Layout (Santhe)

S=1:200(A1) 1:400(A3)

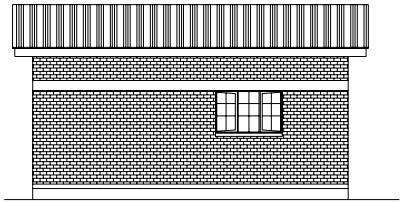


A-A Section

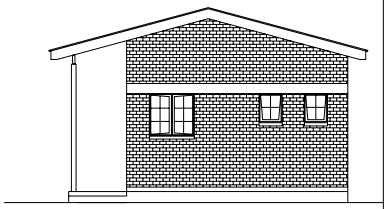
S=1:100(A1) 1:200(A3)



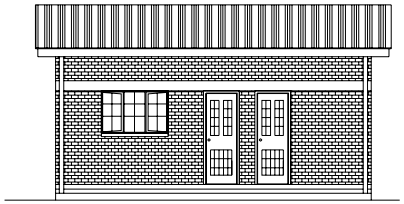
FLOOR PLAN



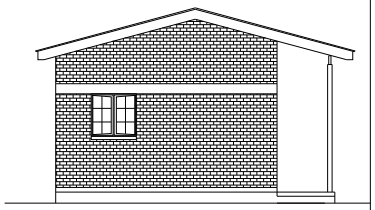
REAR ELEVATION



SIDE ELEVATION



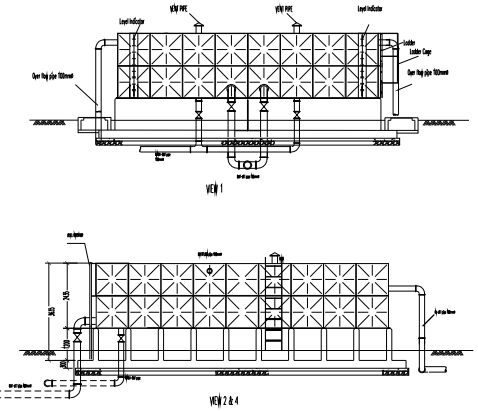
FRONT ELEVATION



SIDE ELEVATION

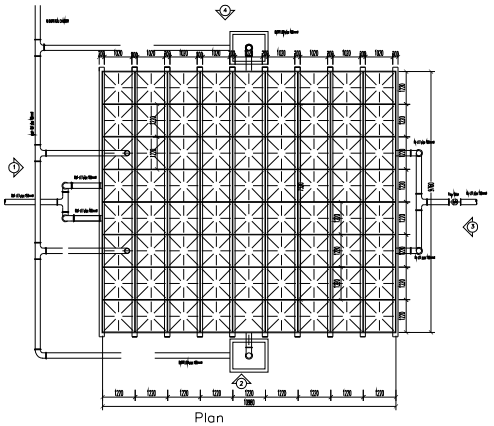
Control Building Layout

S=1:60(A1) 1:120(A3)



Ground Tank Layout

S=1:100(A1) 1:200(A3)

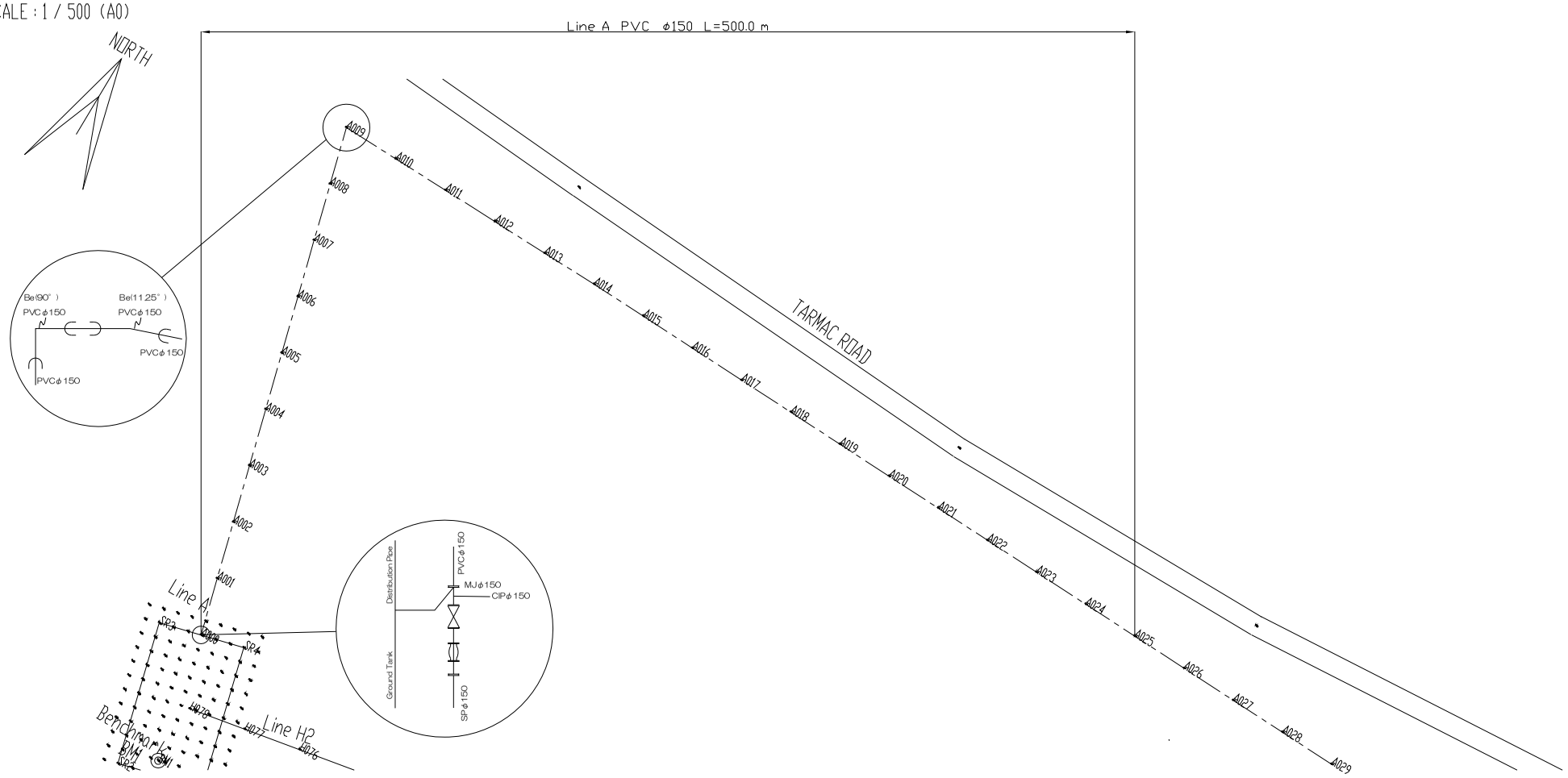


Plan

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION			
Ground Tank and Control Building Layout Santhe			
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S014
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.			

SANTHE WATER SUPPLY SCHEME
LINE A : 0.00m to 500.00m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

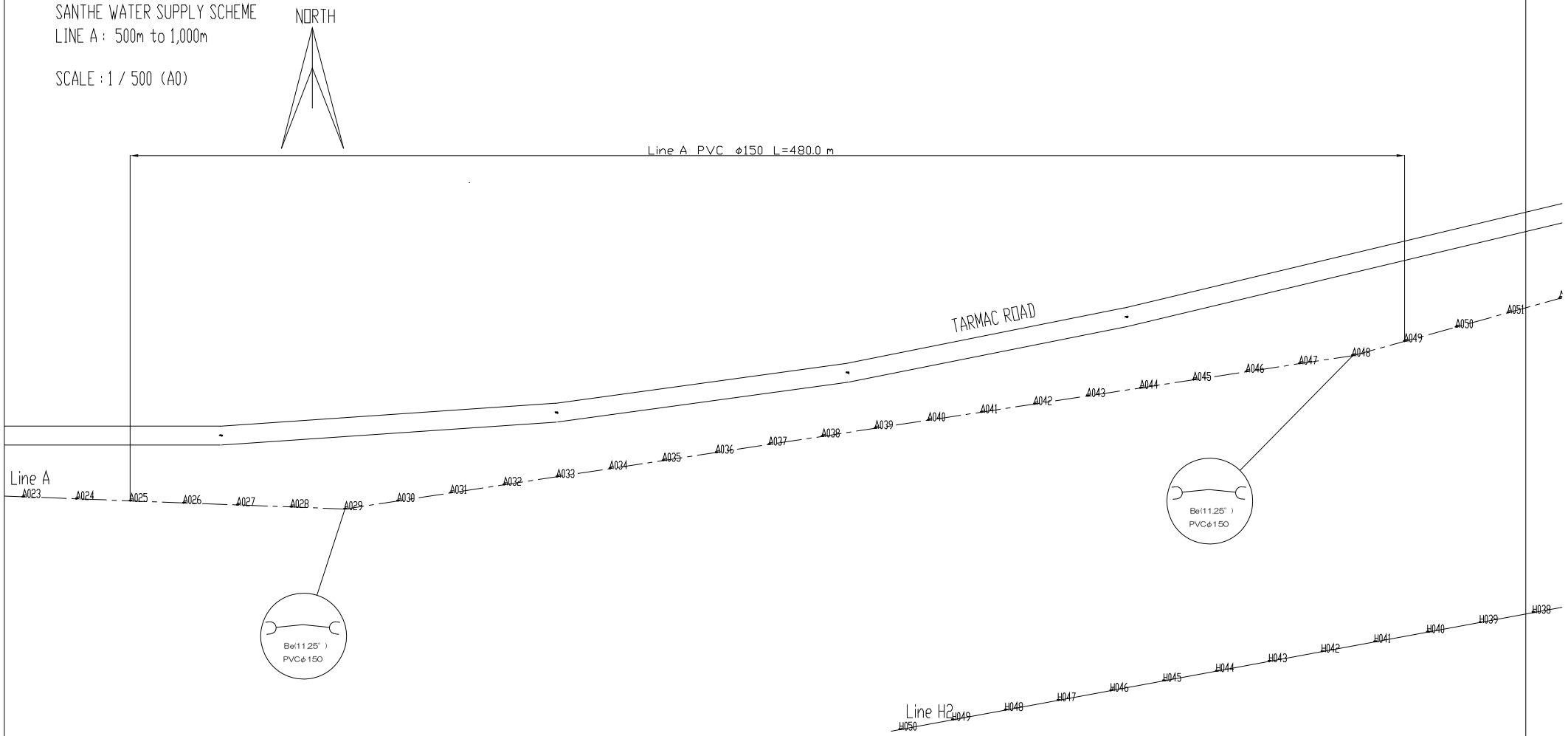
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S015

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 500m to 1,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

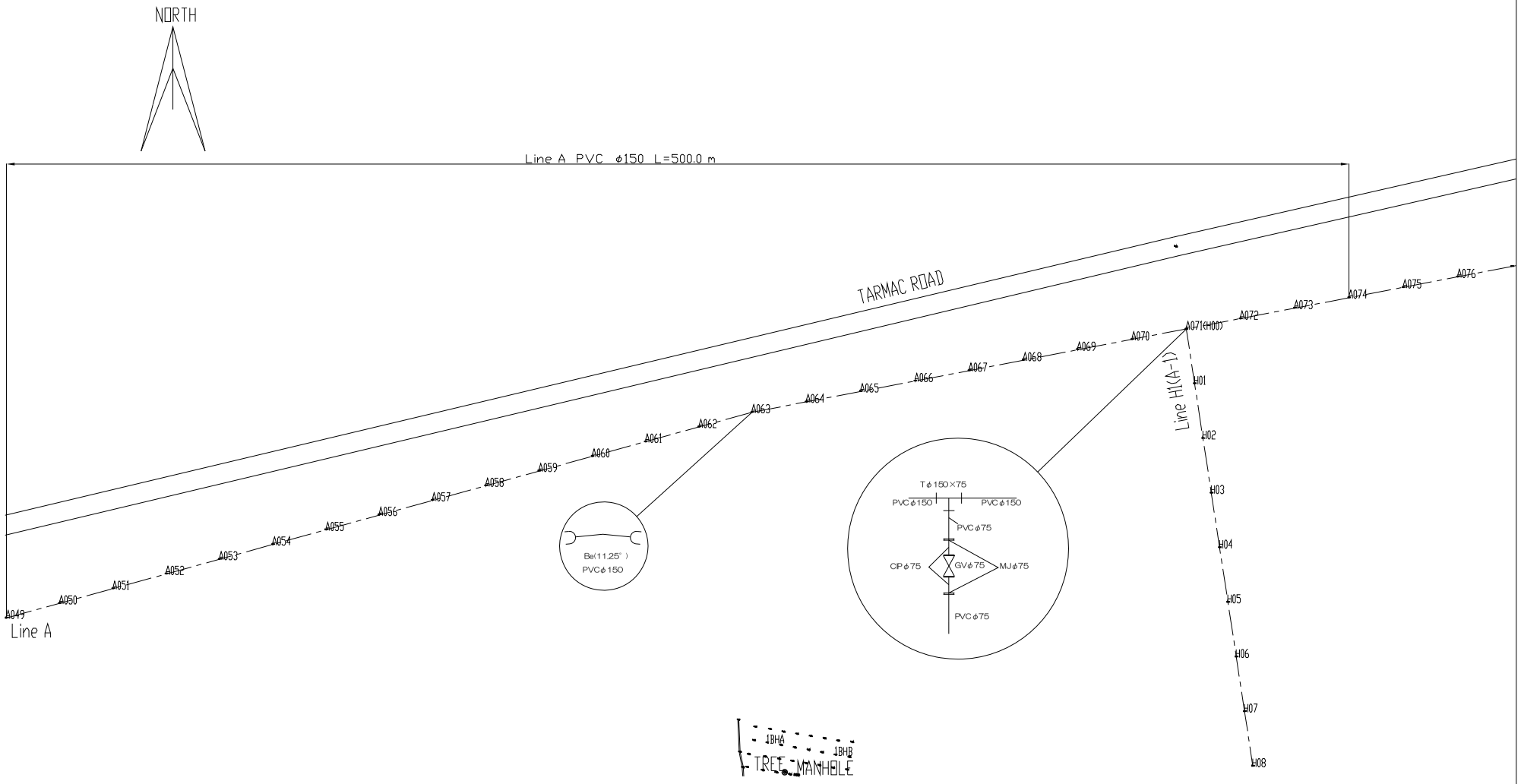
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S016

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 1,000m to 1,500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

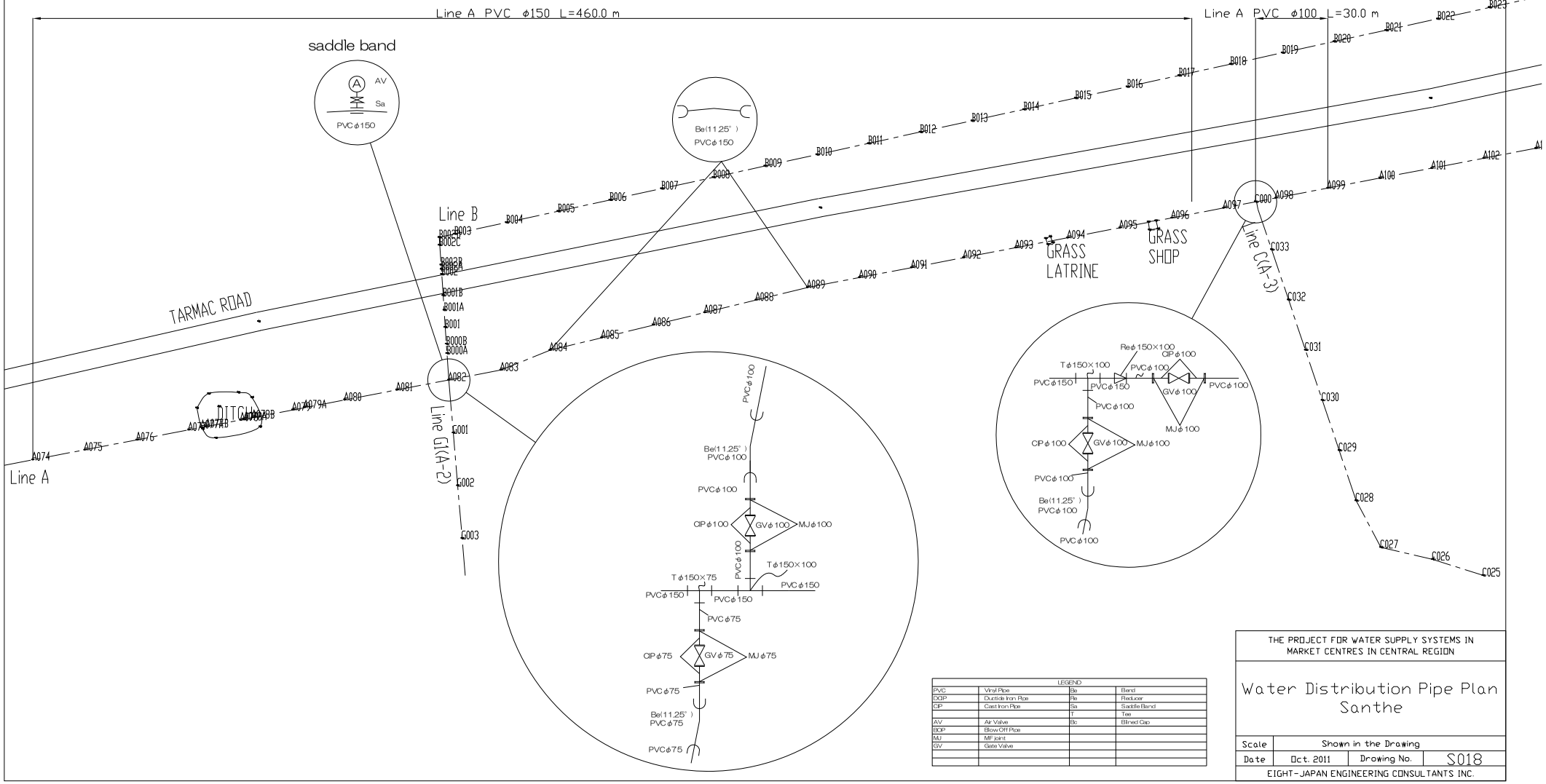
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S017

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 1,500m to 2,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductcile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

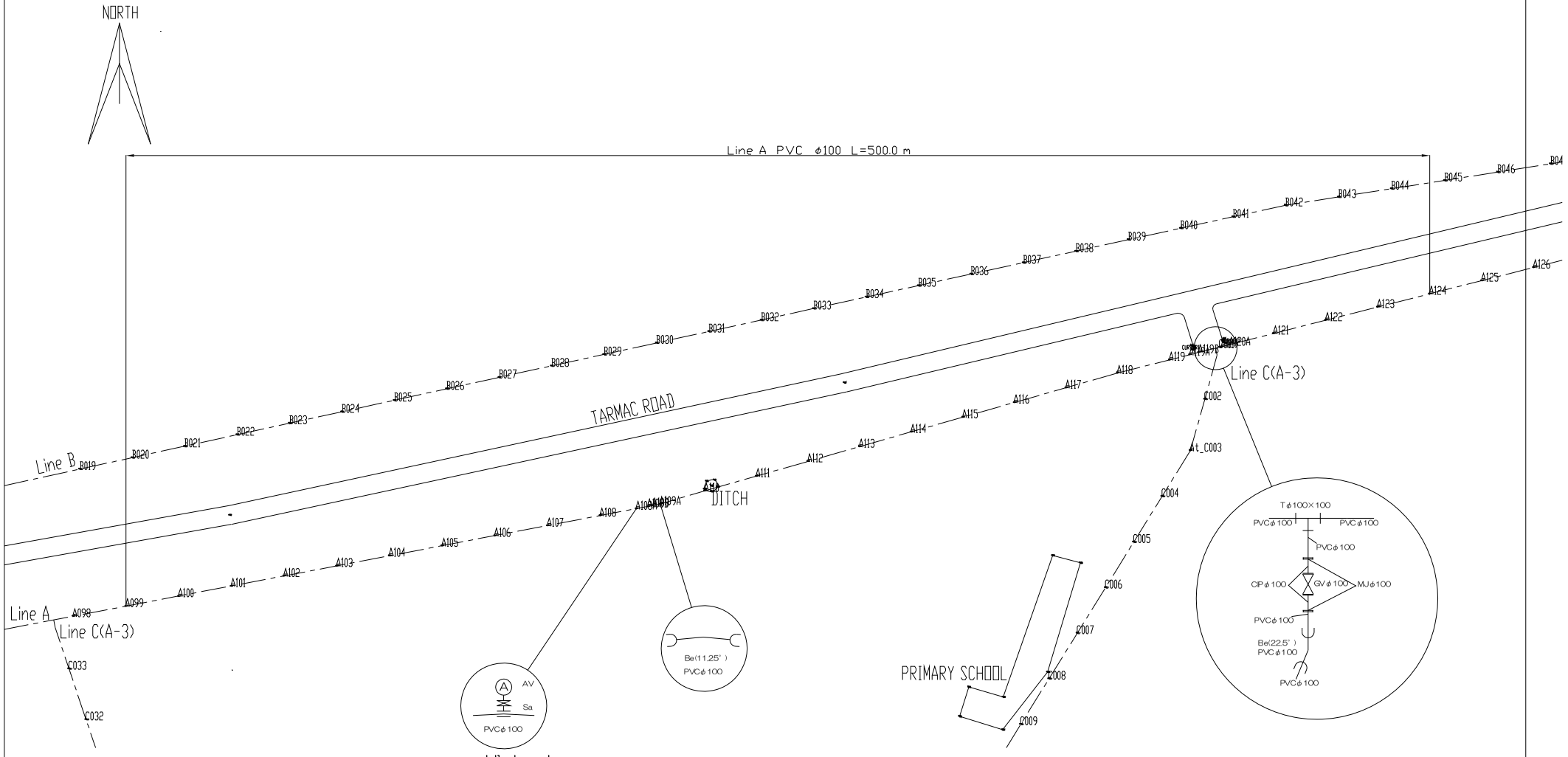
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S018

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 2,000m to 2,500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

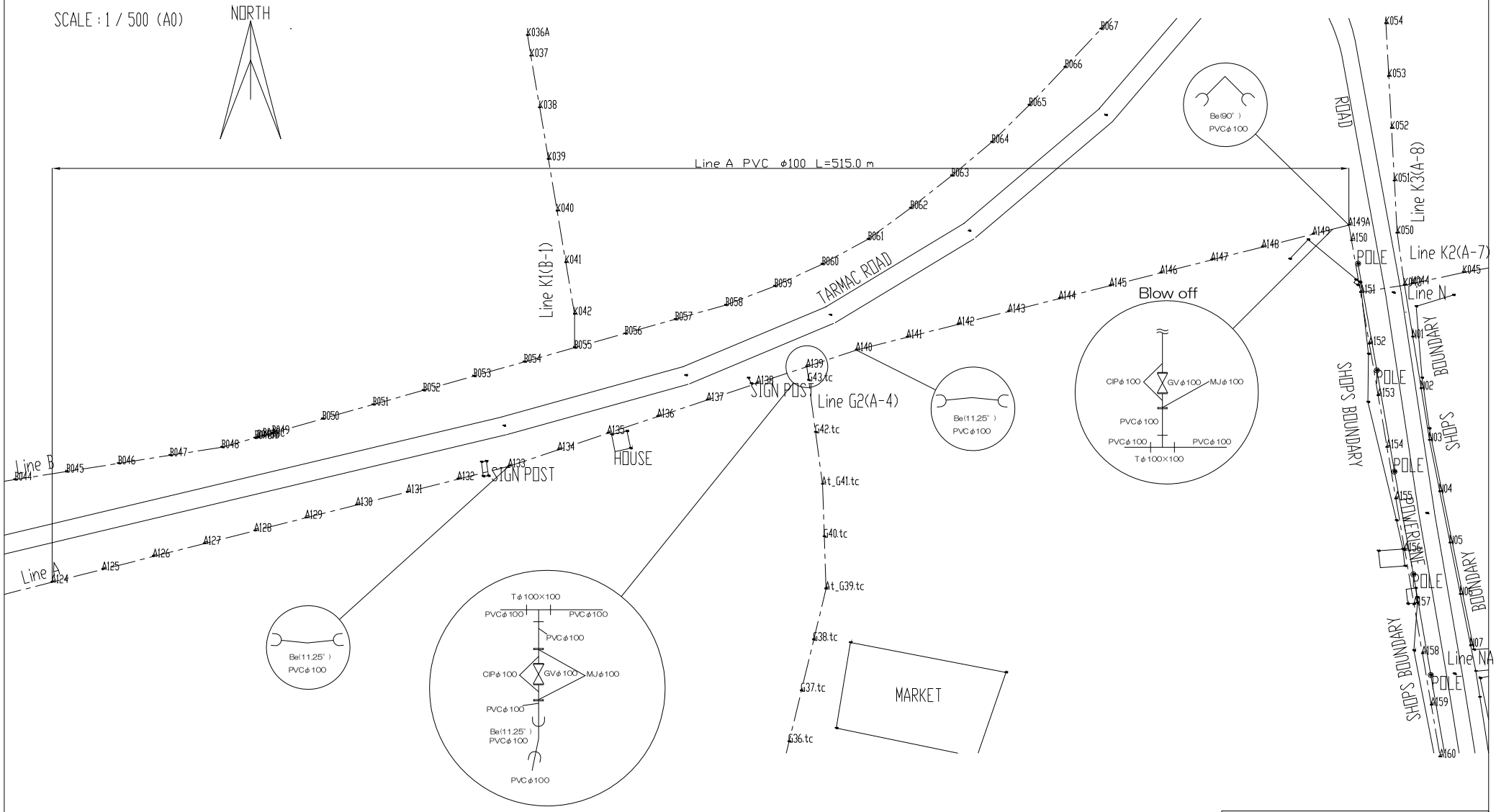
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S019

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 2,500m to 3,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

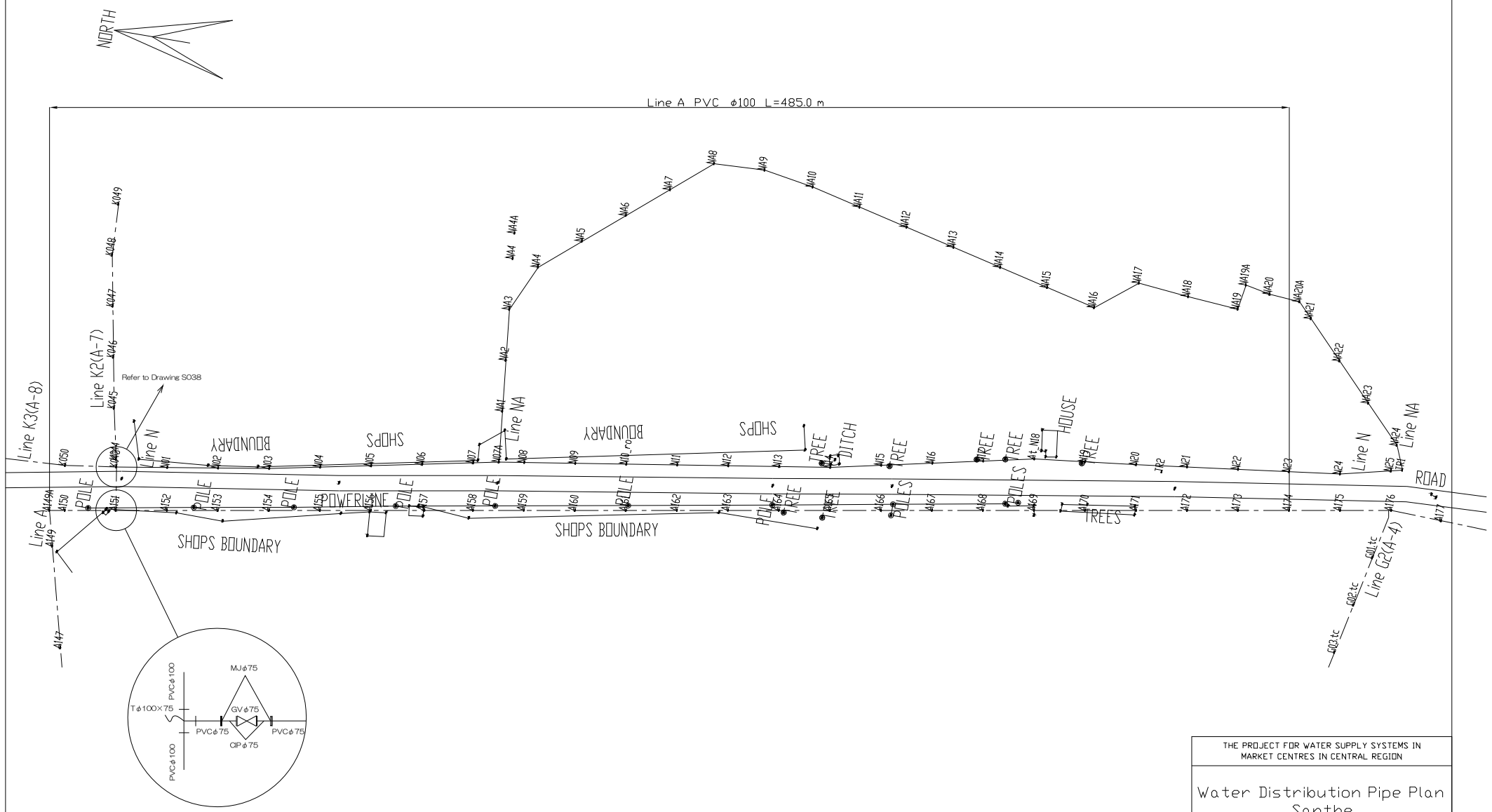
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S020

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 3,000m to 3,500m

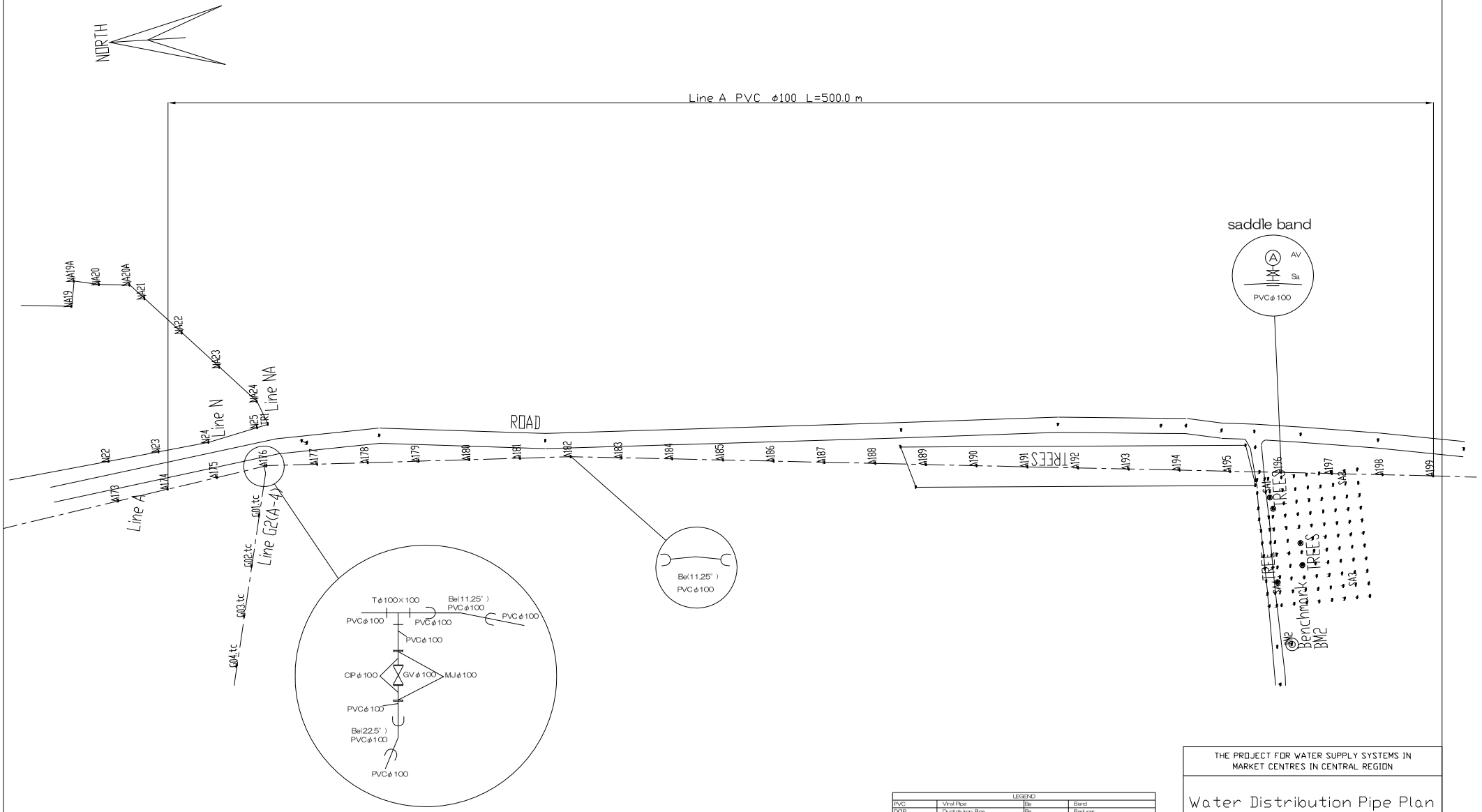
SCALE : 1 / 500 (A0)



THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION	
Water Distribution Pipe Plan Santhe	
Scale	Shown in the Drawing
Date	Oct. 2011 / Drawing No. S021
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.	

SANTHE WATER SUPPLY SCHEME
LINE A : 3,500m to 4,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

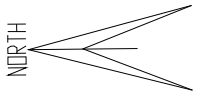
Water Distribution Pipe Plan Santhe

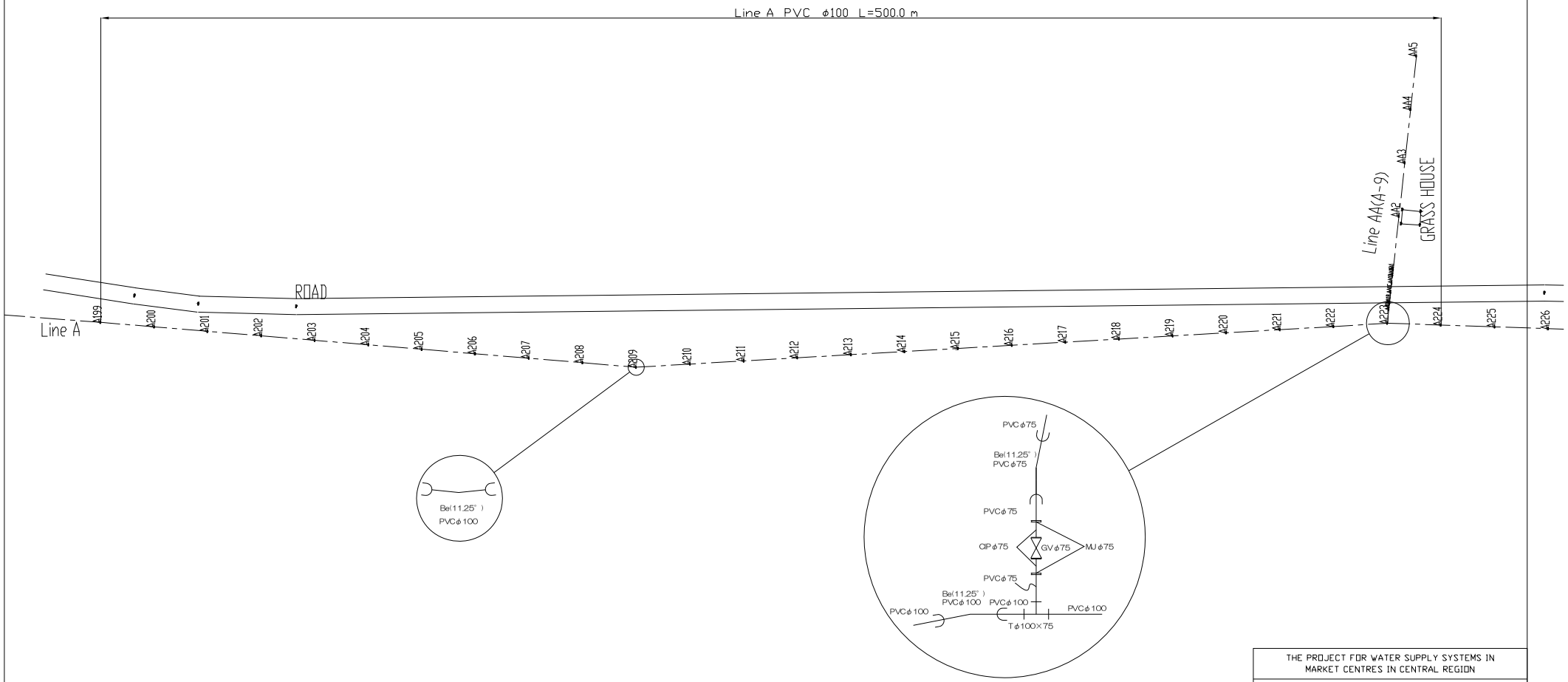
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S022

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 4,000m to 4,500m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

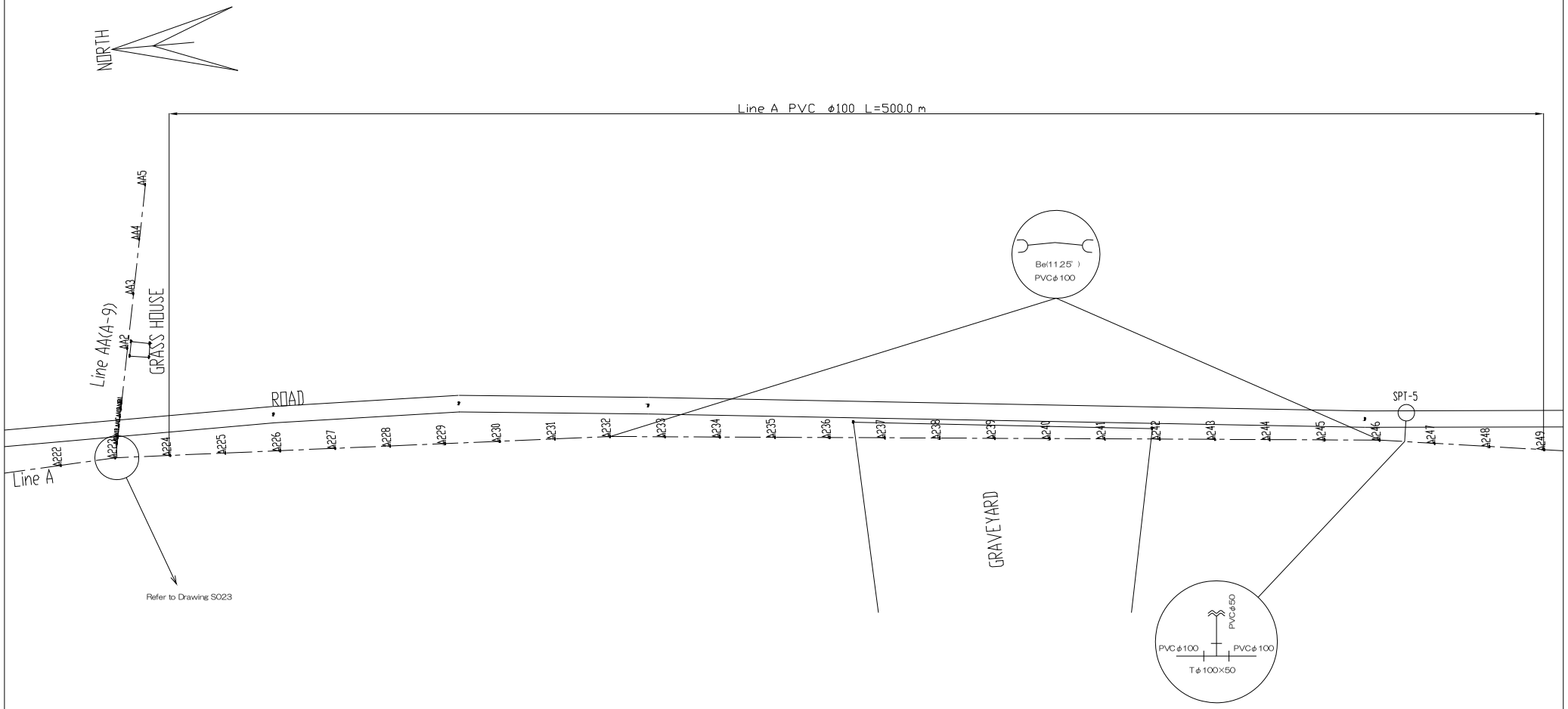
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S023

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 4,500m to 5,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

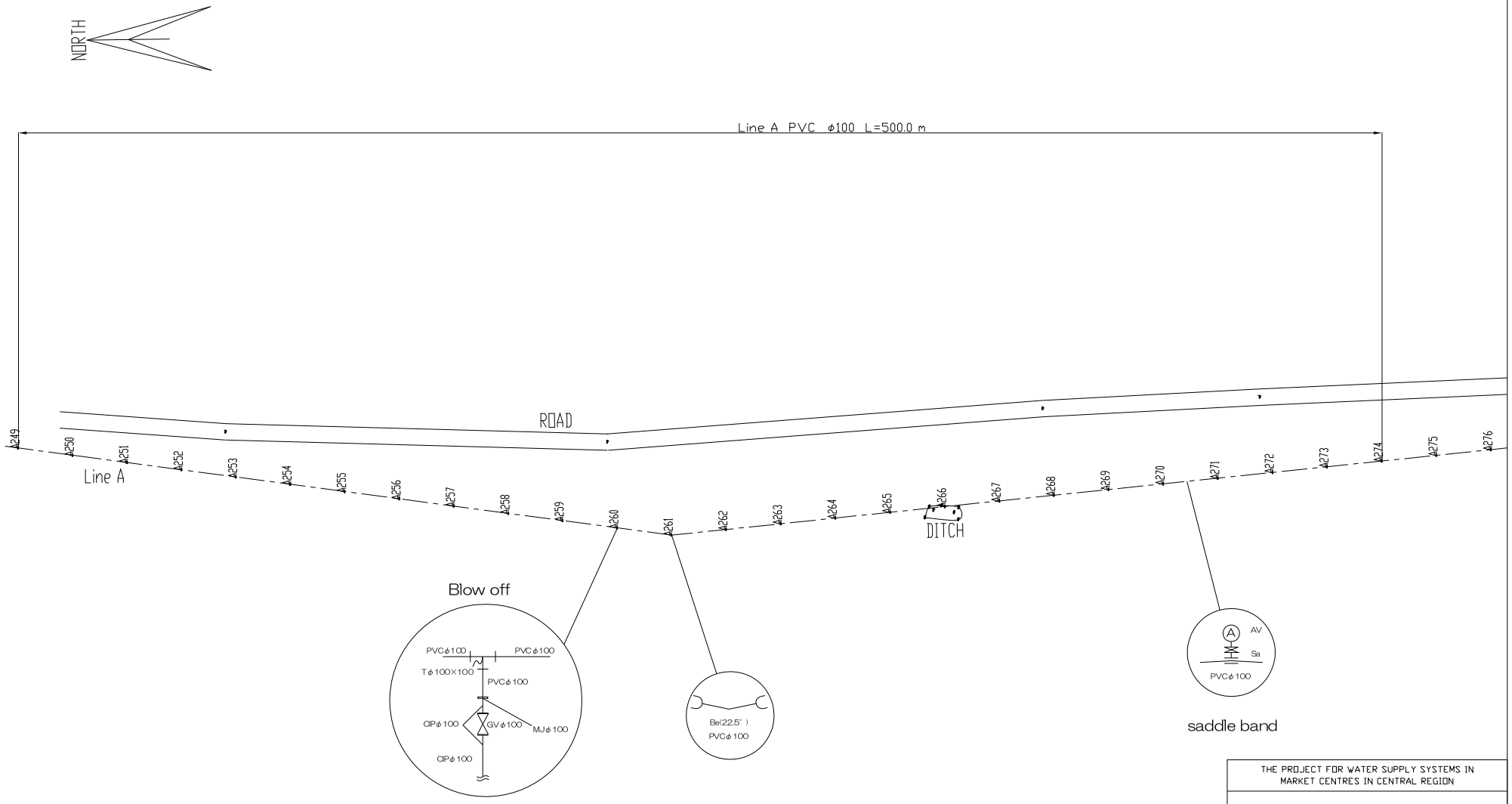
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S024

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 5,000m to 5,500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

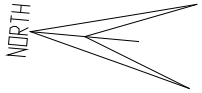
Water Distribution Pipe Plan
Santhe

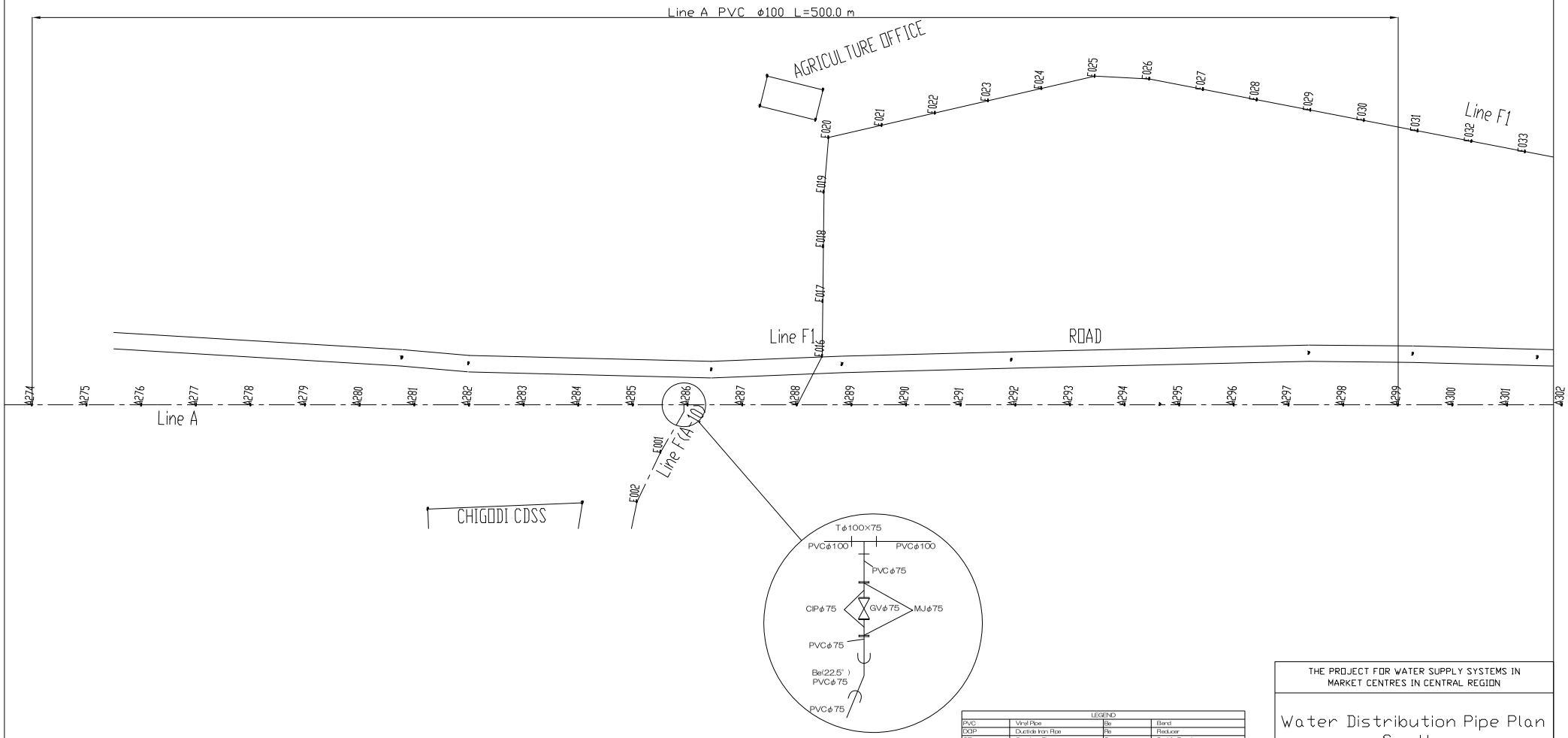
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S025

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 5,500m to 6,000m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductcile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

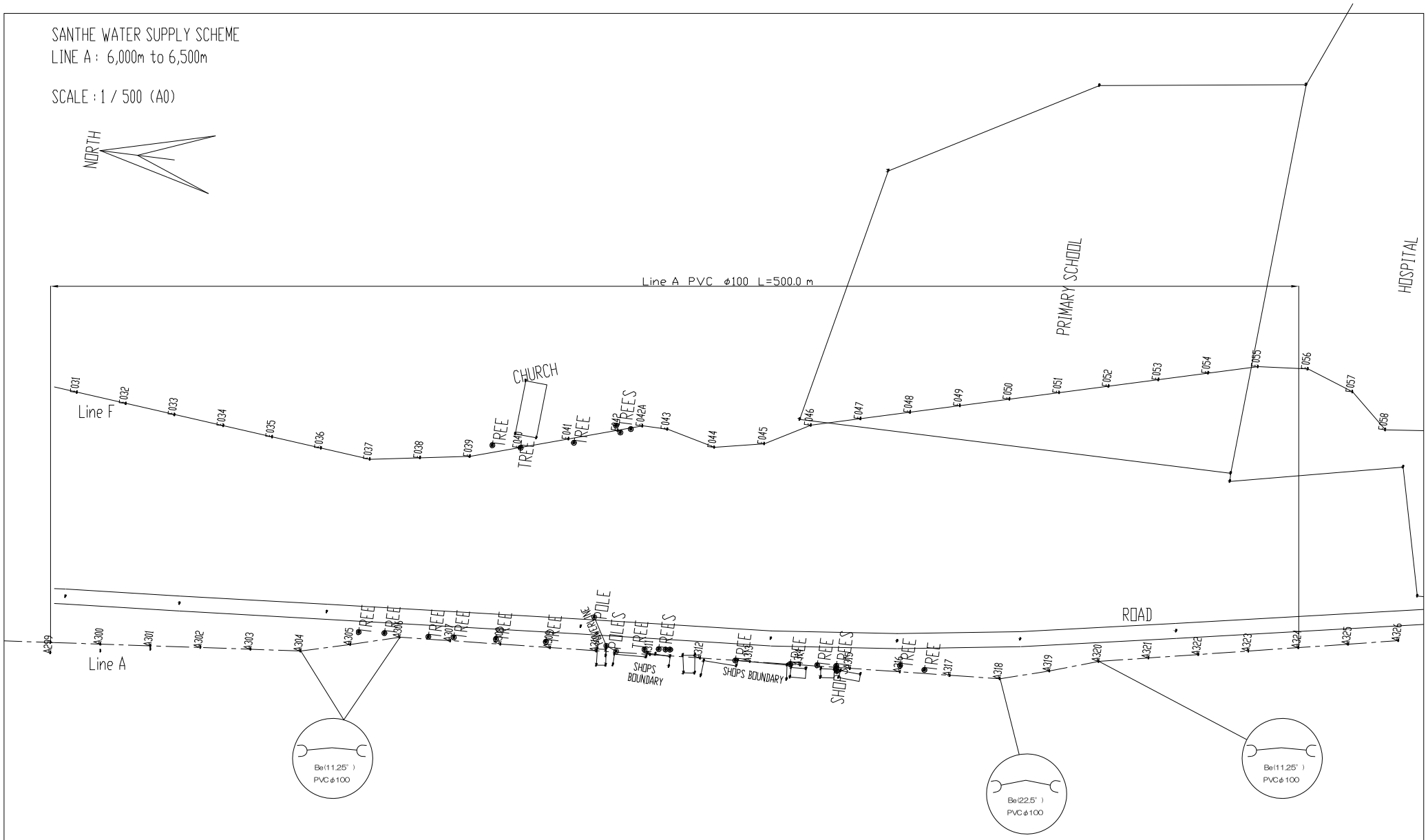
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S026

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 6,000m to 6,500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

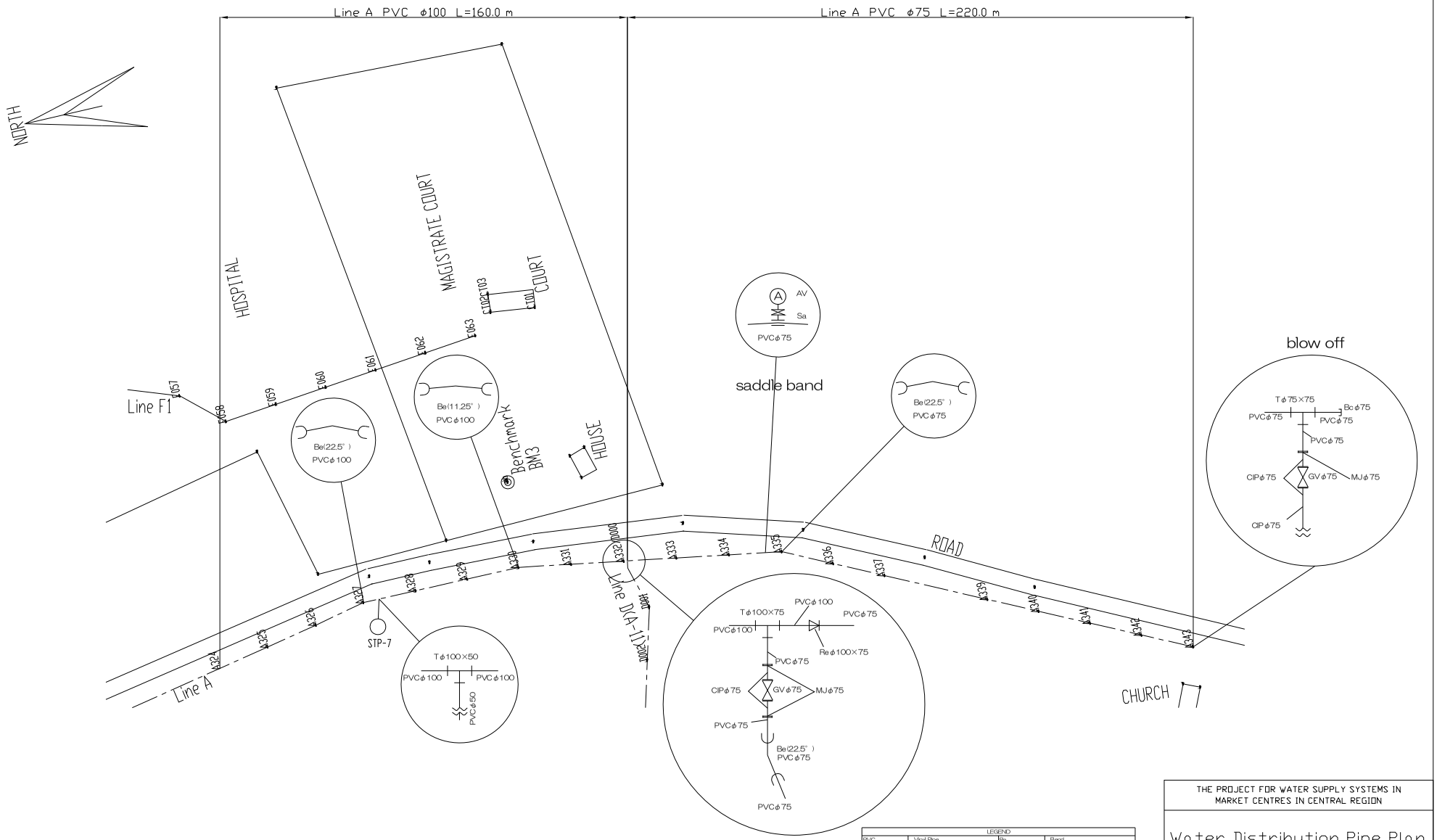
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S027

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE A : 6,500m to 6,861.80m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

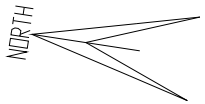
Water Distribution Pipe Plan
Santhe

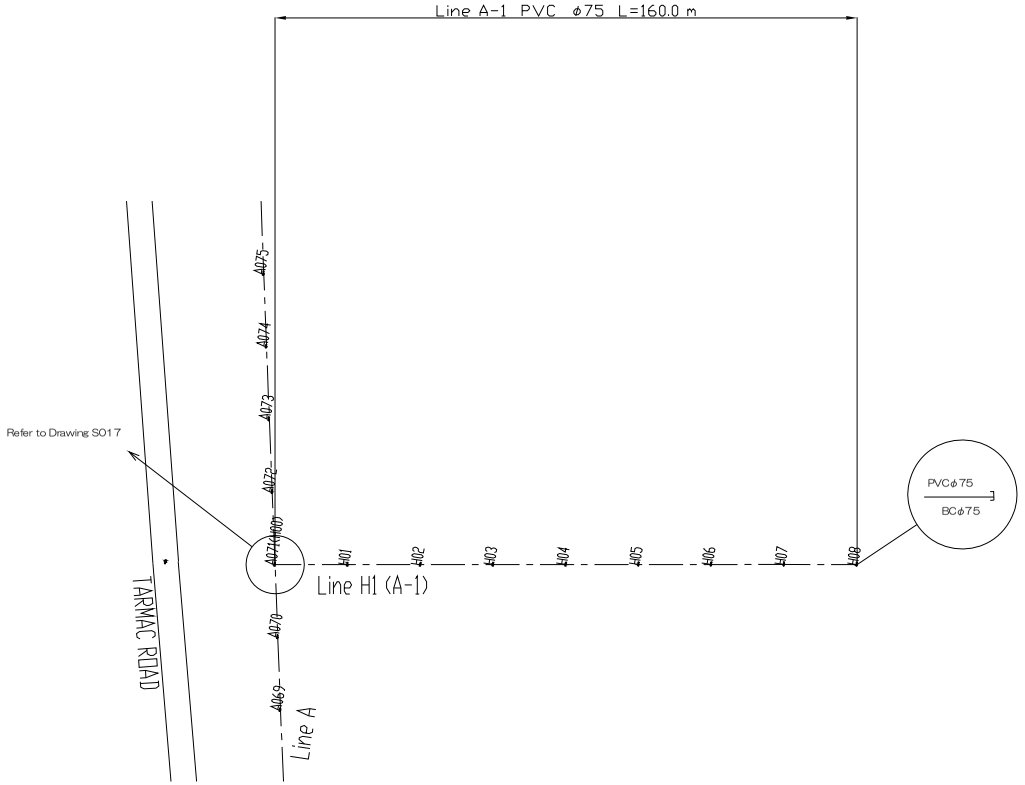
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S028

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE H1(A-1) : 0.00m to 160.06m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

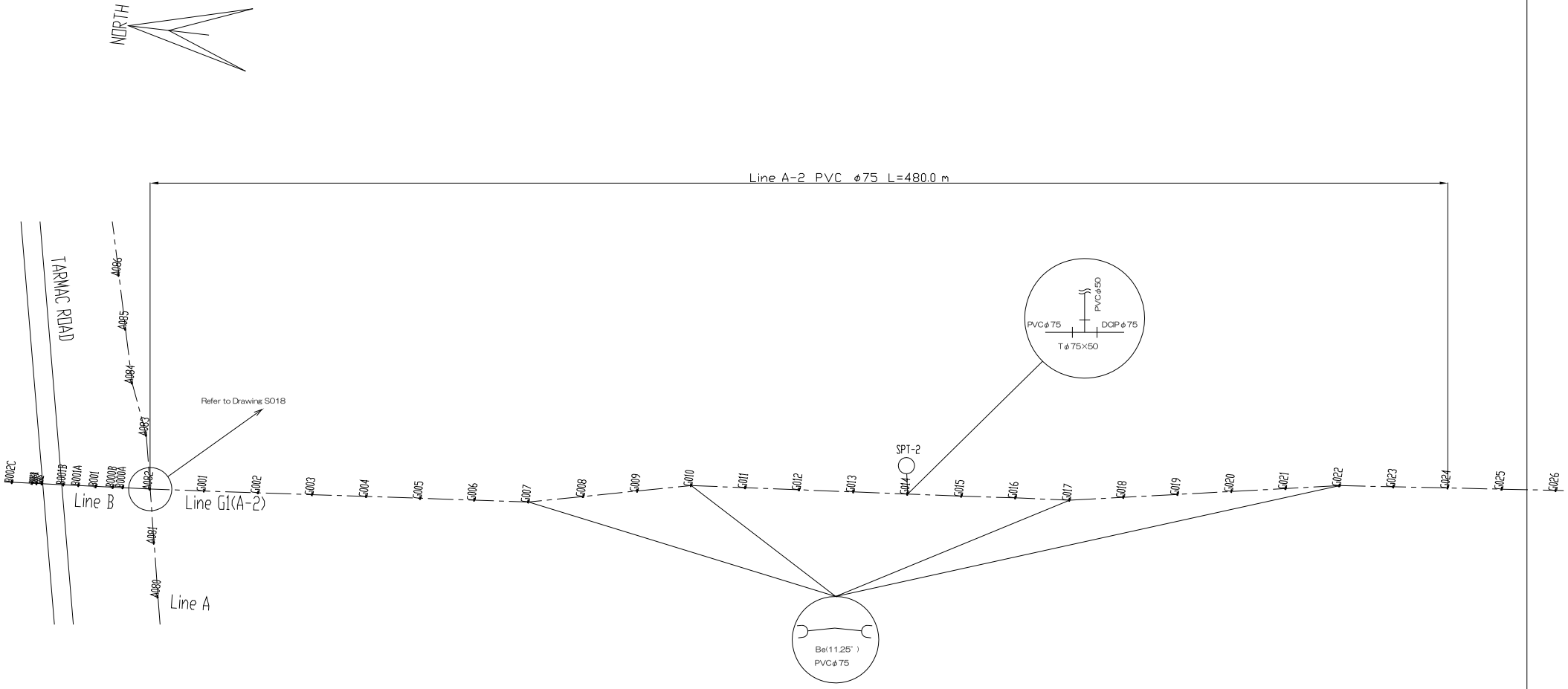
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S029

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE G1(A-2) : 0.00m to 500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

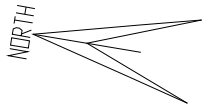
Water Distribution Pipe Plan
Santhe

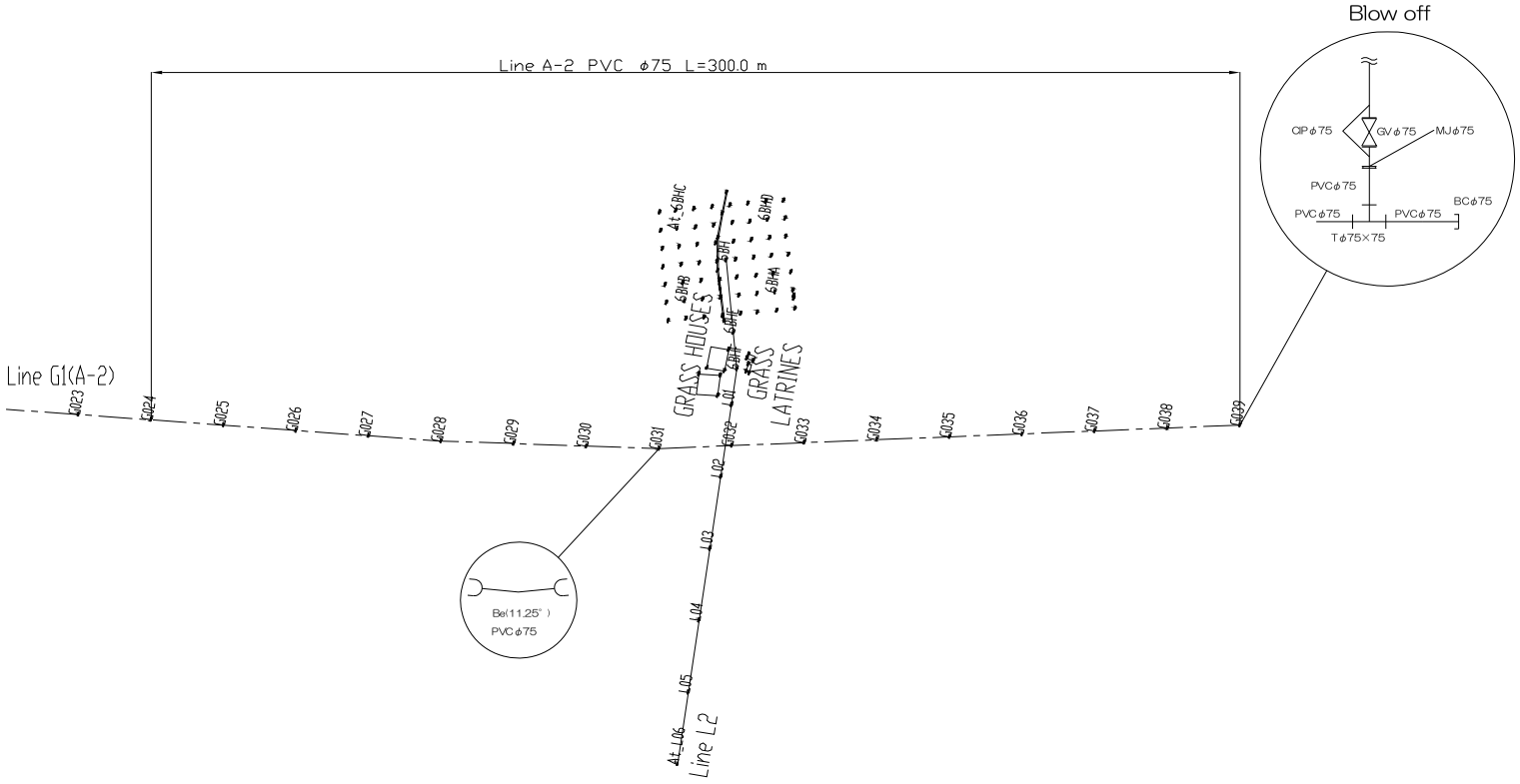
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S030

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE G1(A-2) : 500m to 780.74m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

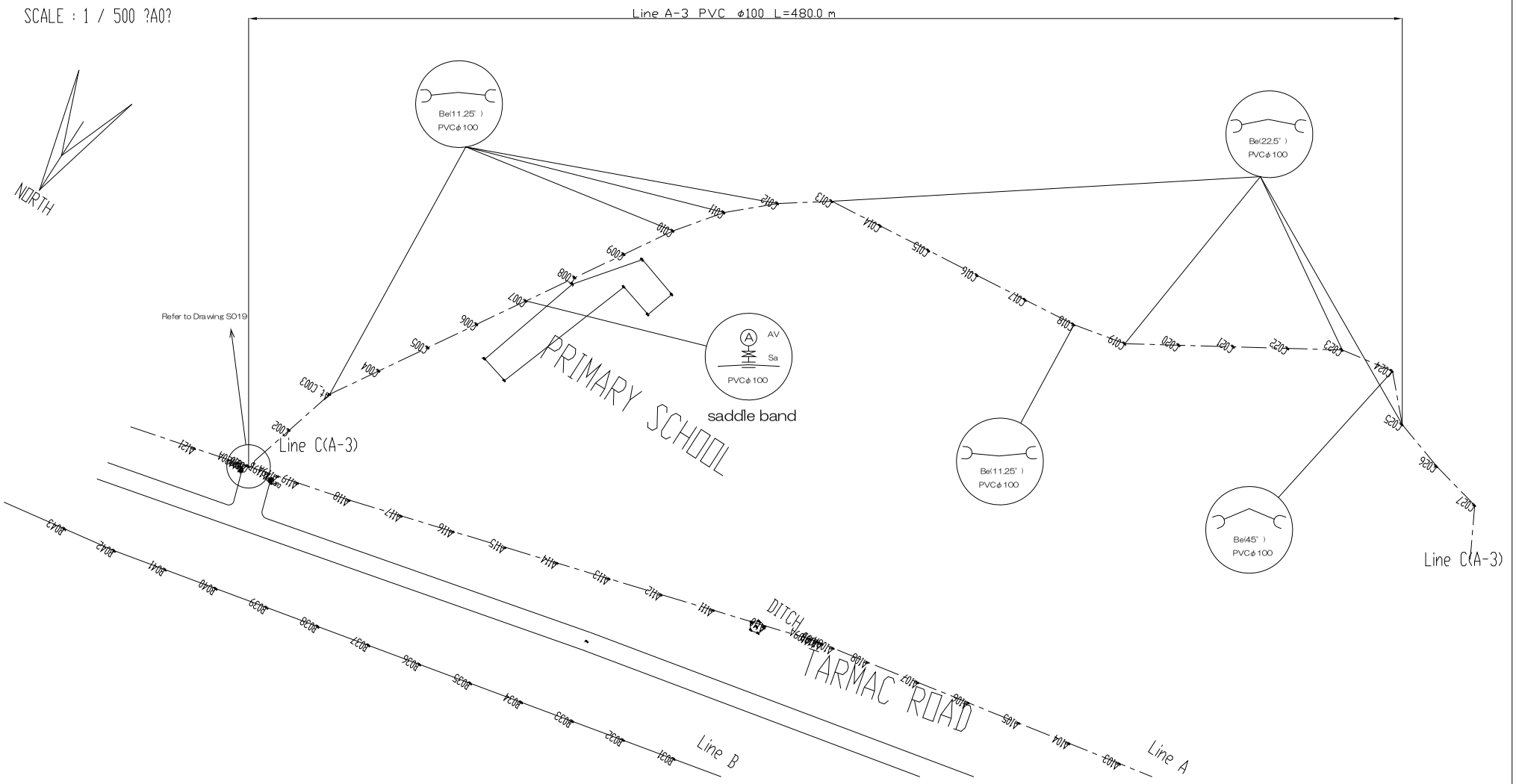
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S031

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE C(A-3) : 0.00m to 500m

SCALE : 1 / 500 ?A0?



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

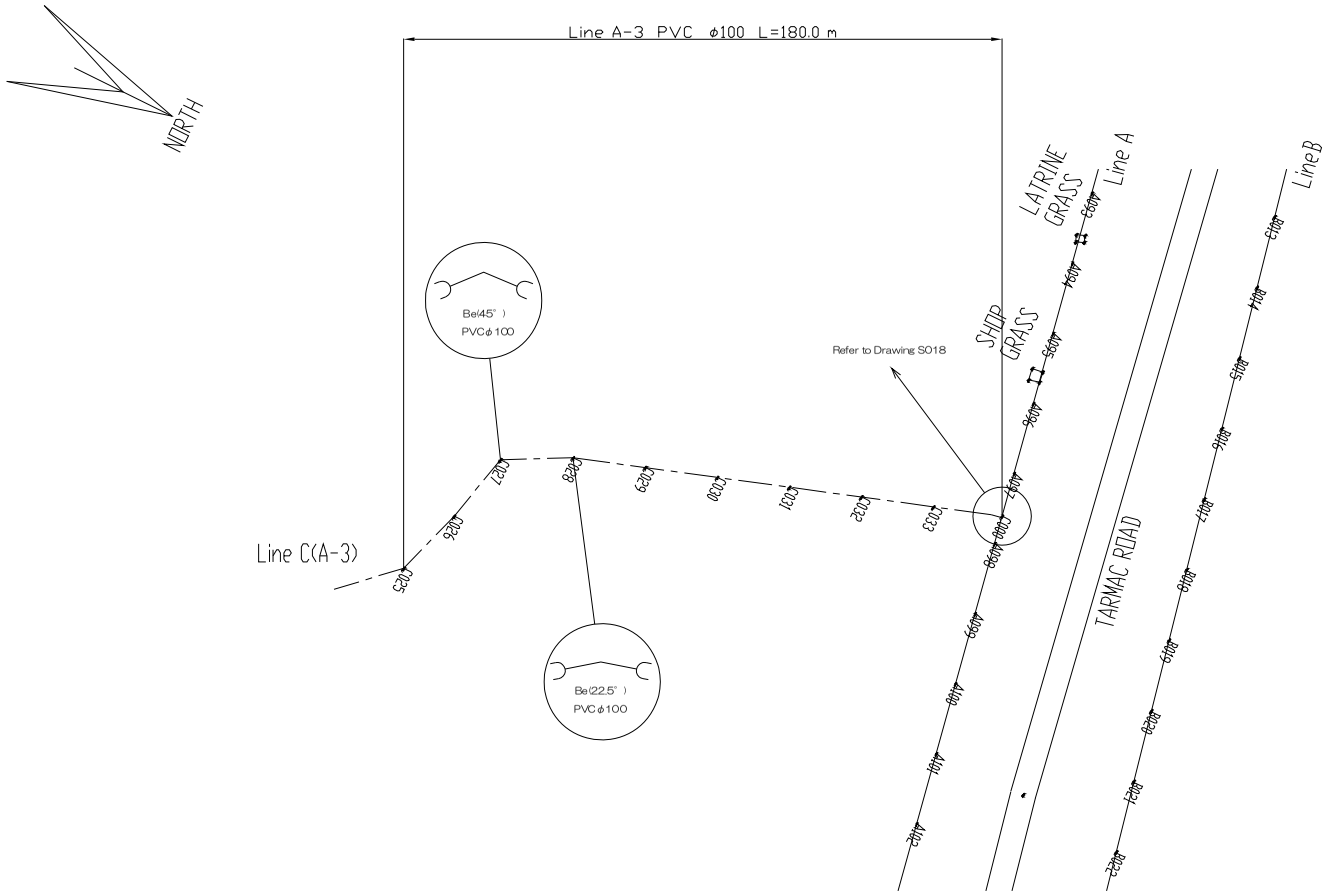
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S032

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE C(A-3) : 500m to 659.28m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

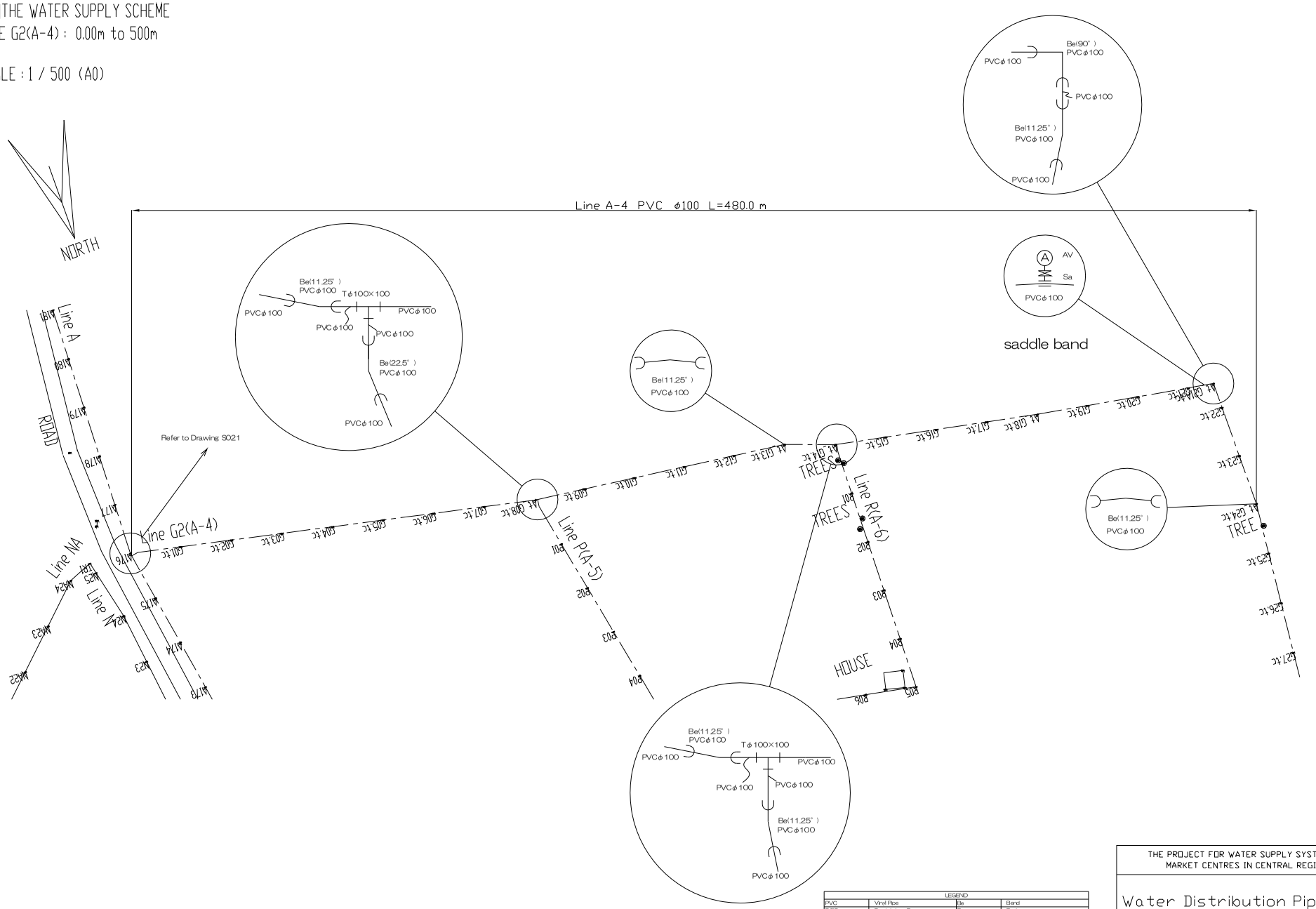
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S033

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE G2(A-4) : 0.00m to 500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

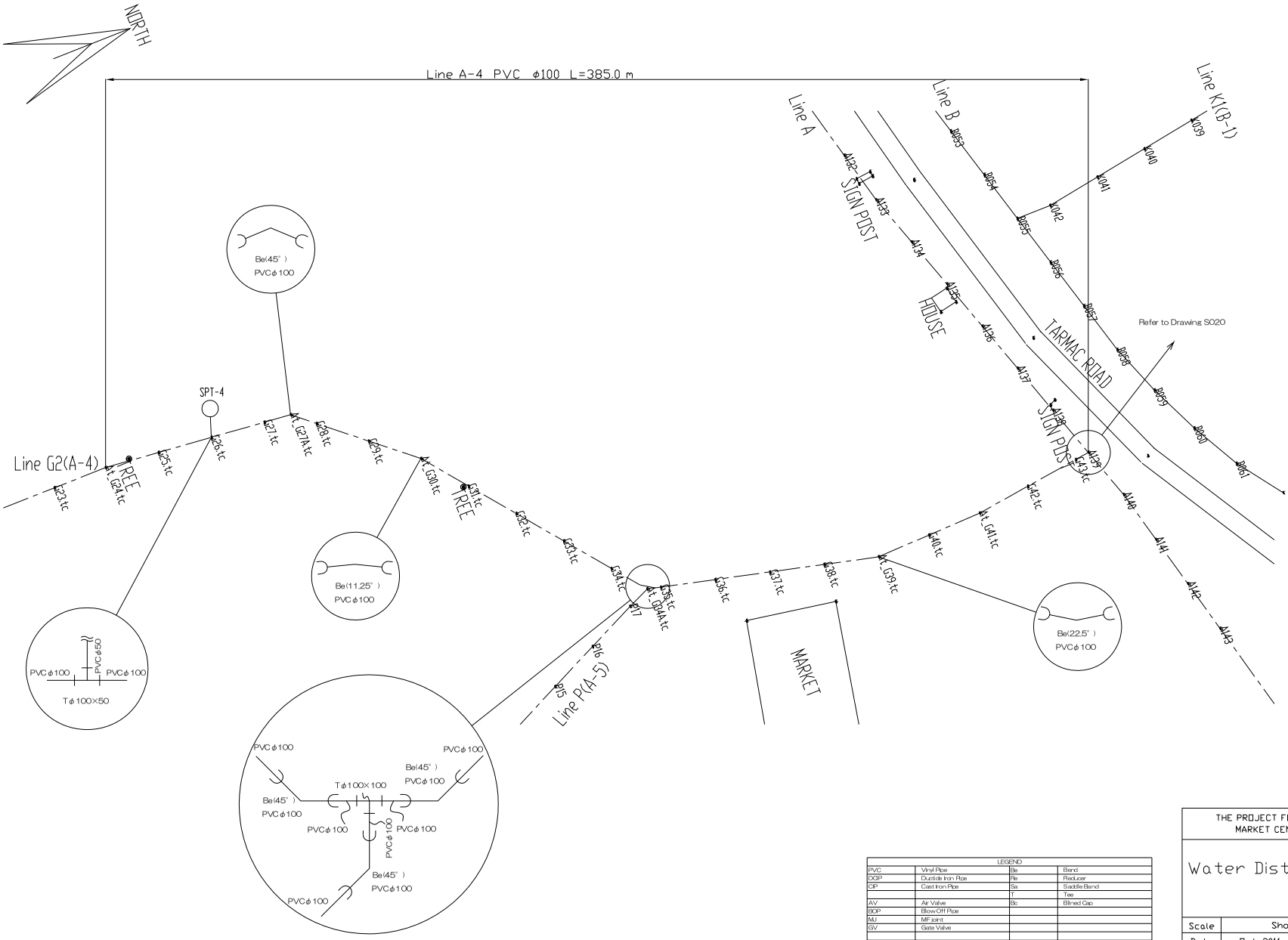
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S034

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE G2(A-4) : 500m to 865.60m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

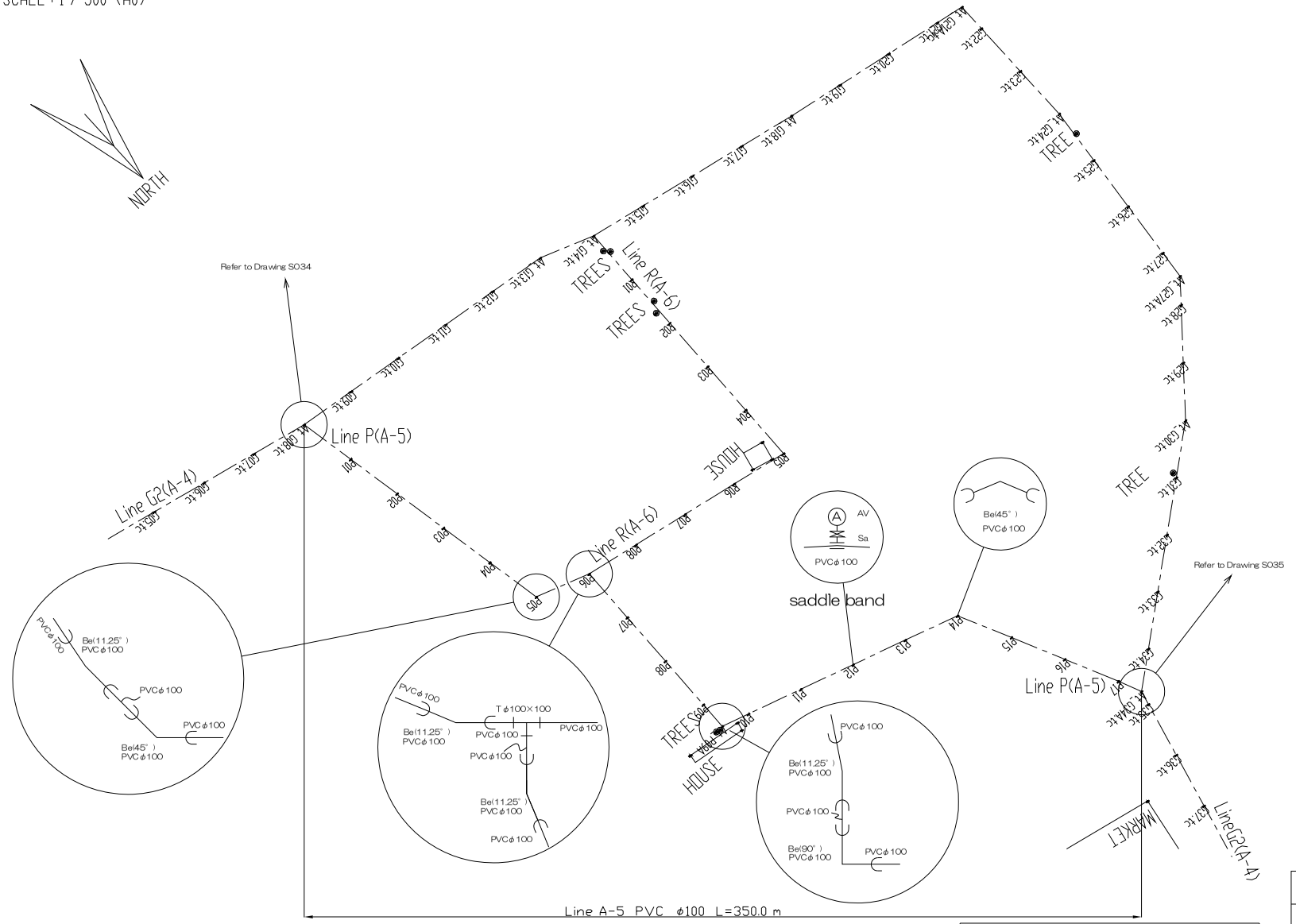
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S035

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE P(A-5) : 0.00m to 490.26m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

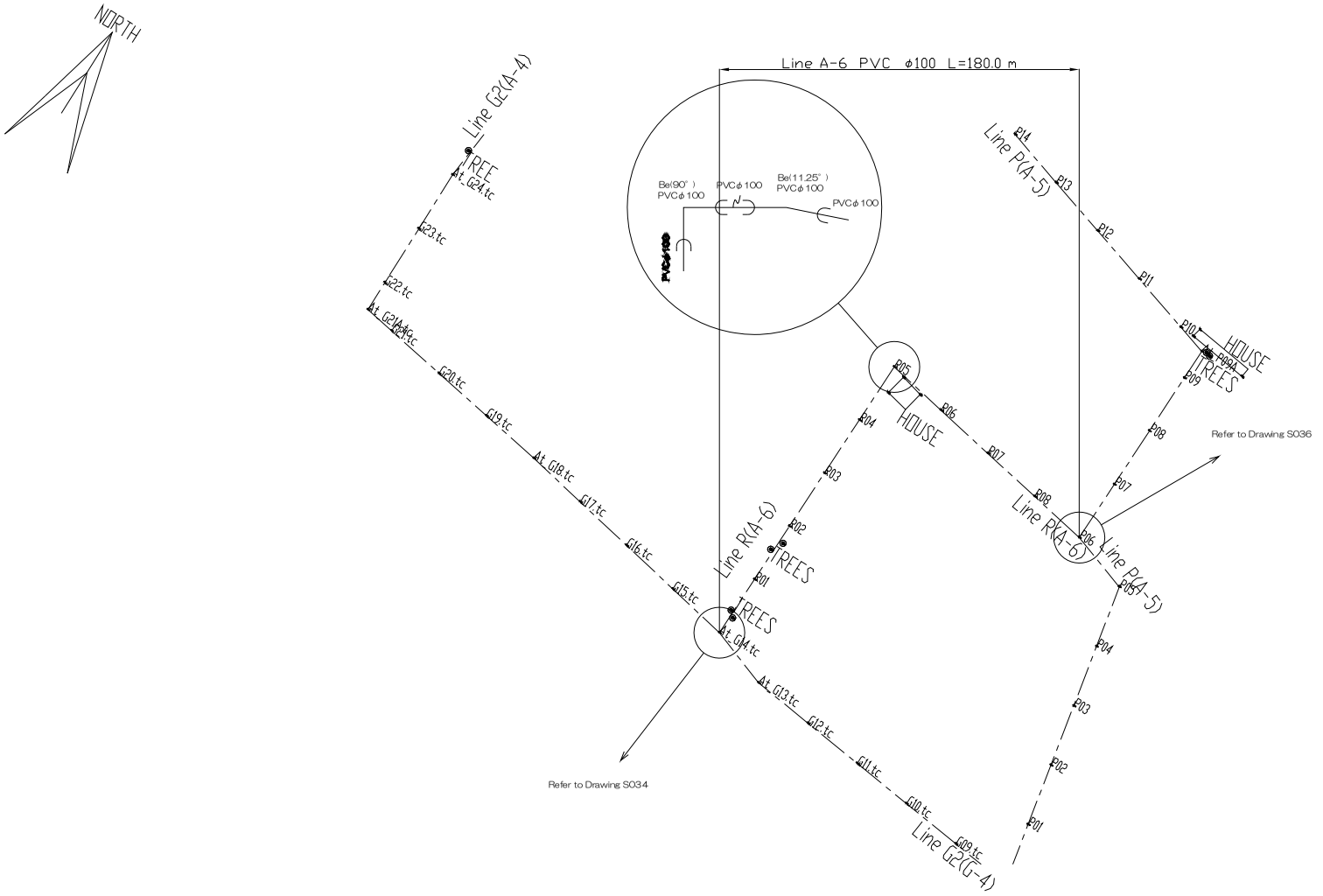
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S036

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE R(A-6) : 0.00m to 179.09m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

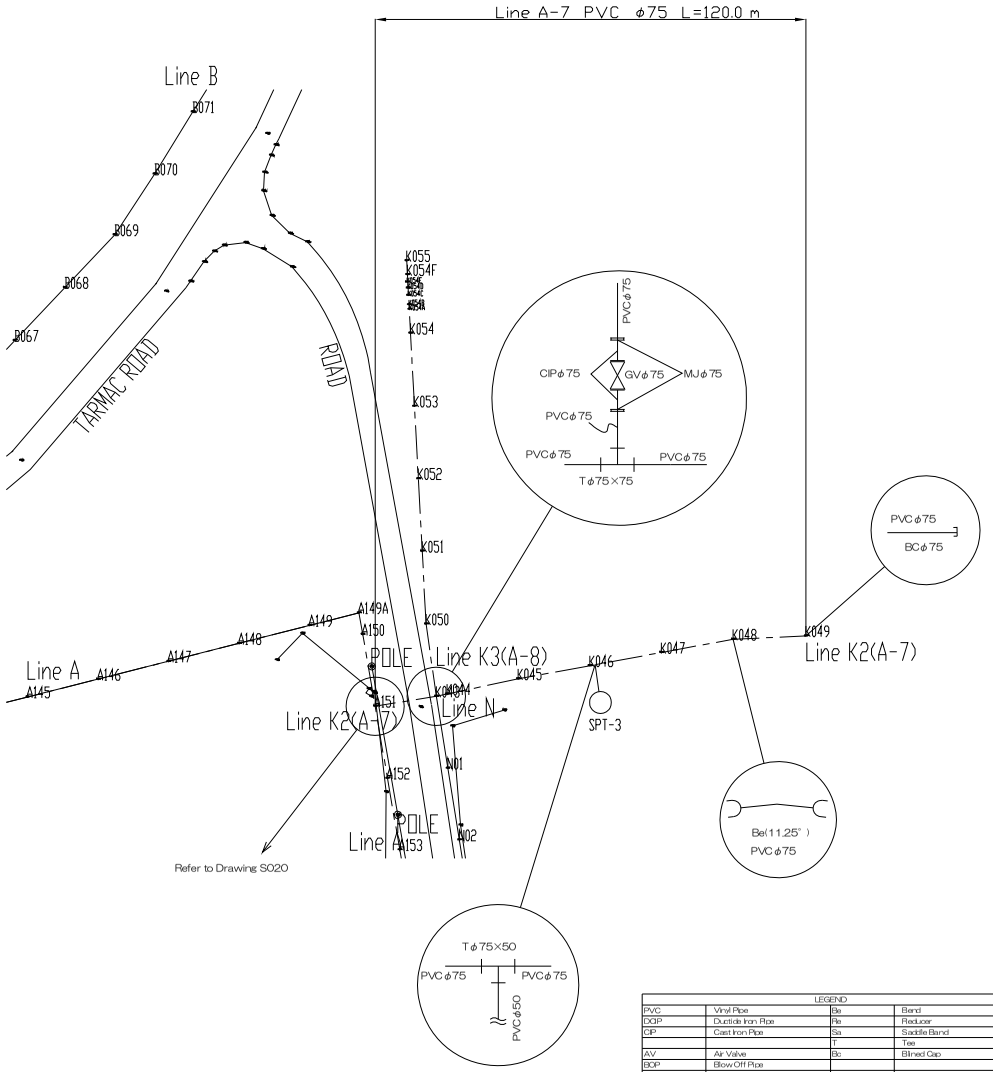
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S037

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE K2(A-7) : 0.00m to 120.16m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

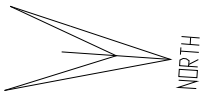
Water Distribution Pipe Plan Santhe

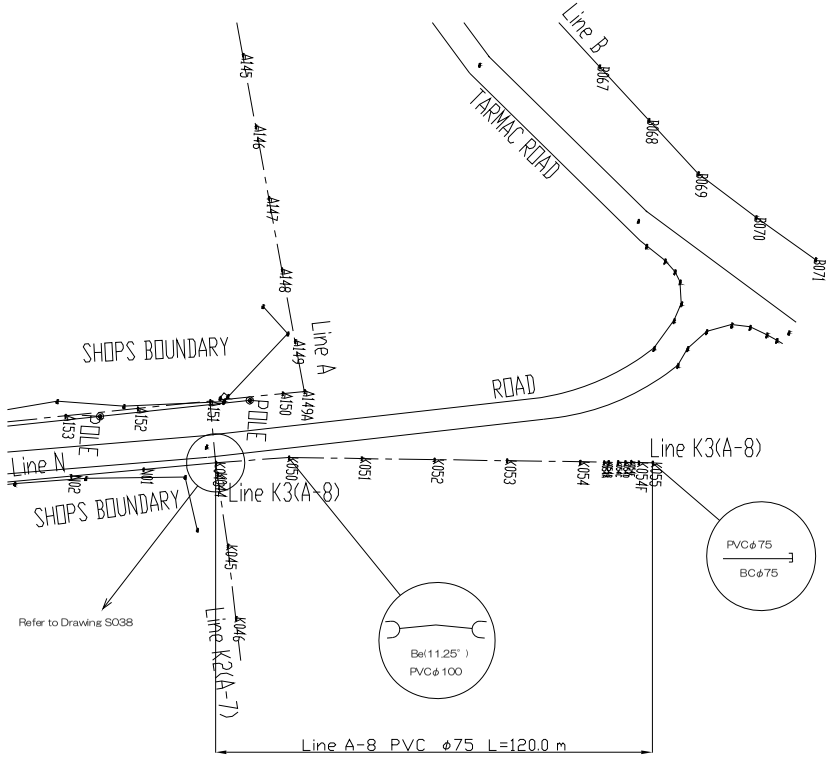
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S038

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE K3(A-8) : 0.00m to 120.20m

SCALE : 1 / 500 (A0)





LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

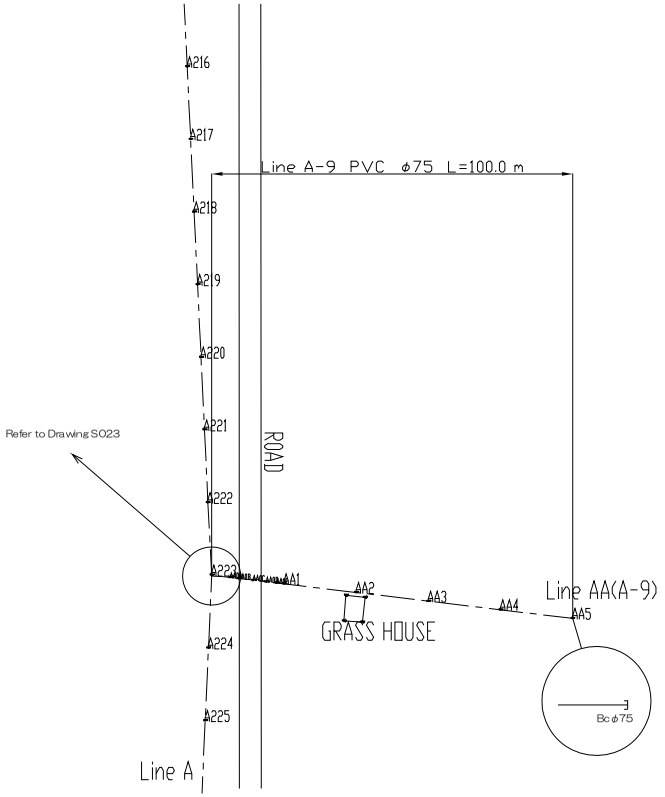
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S039

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE AA(A-9) : 0.00m to 100.03m

SCALE : 1 / 500 (A0)

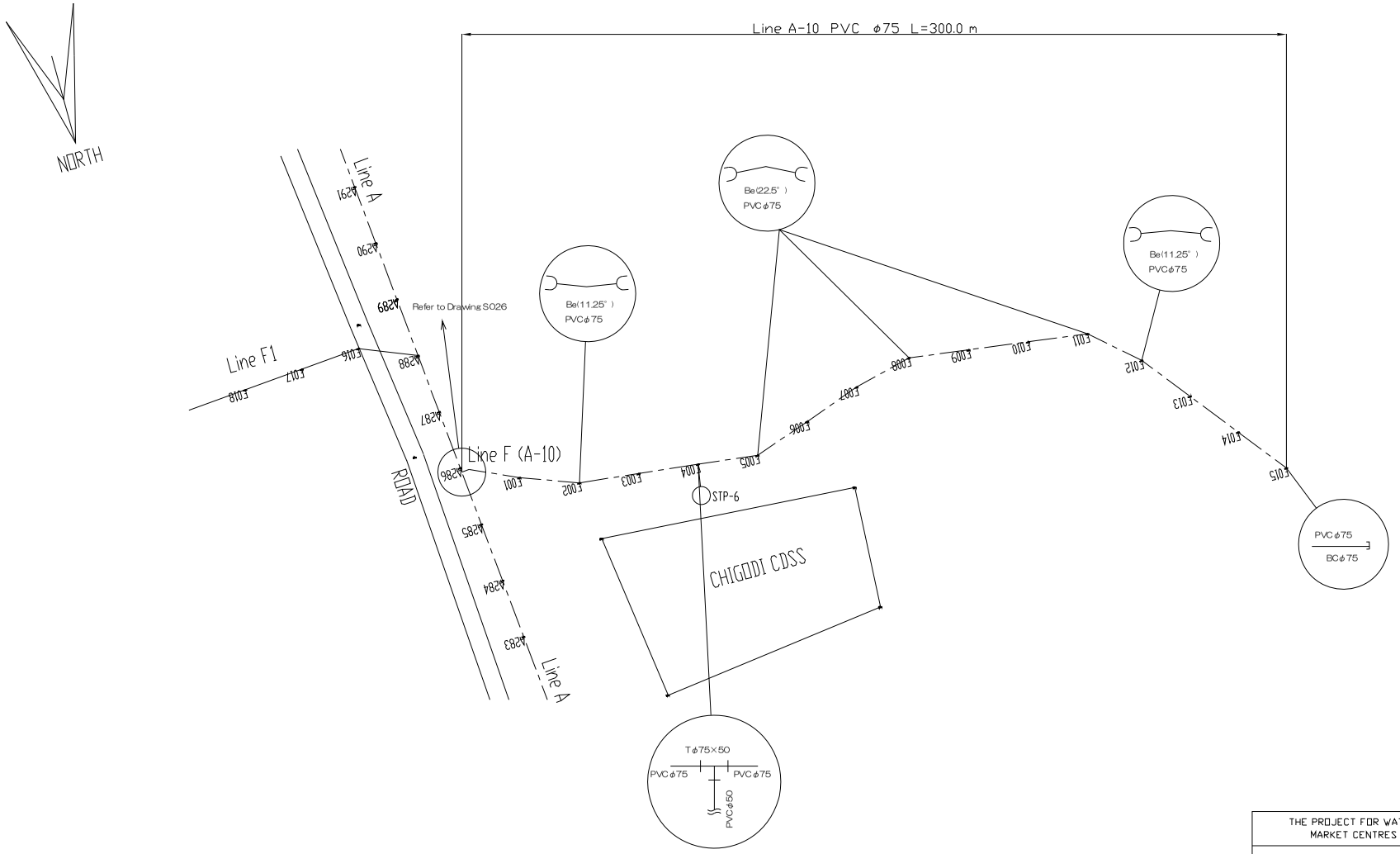


LEGEND			
PVC	Vinyl Pipe	Bx	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION			
Water Distribution Pipe Plan Santhe			
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S040
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.			

SANTHE WATER SUPPLY SCHEME
LINE F(A-10) : 0.00m to 300.34m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

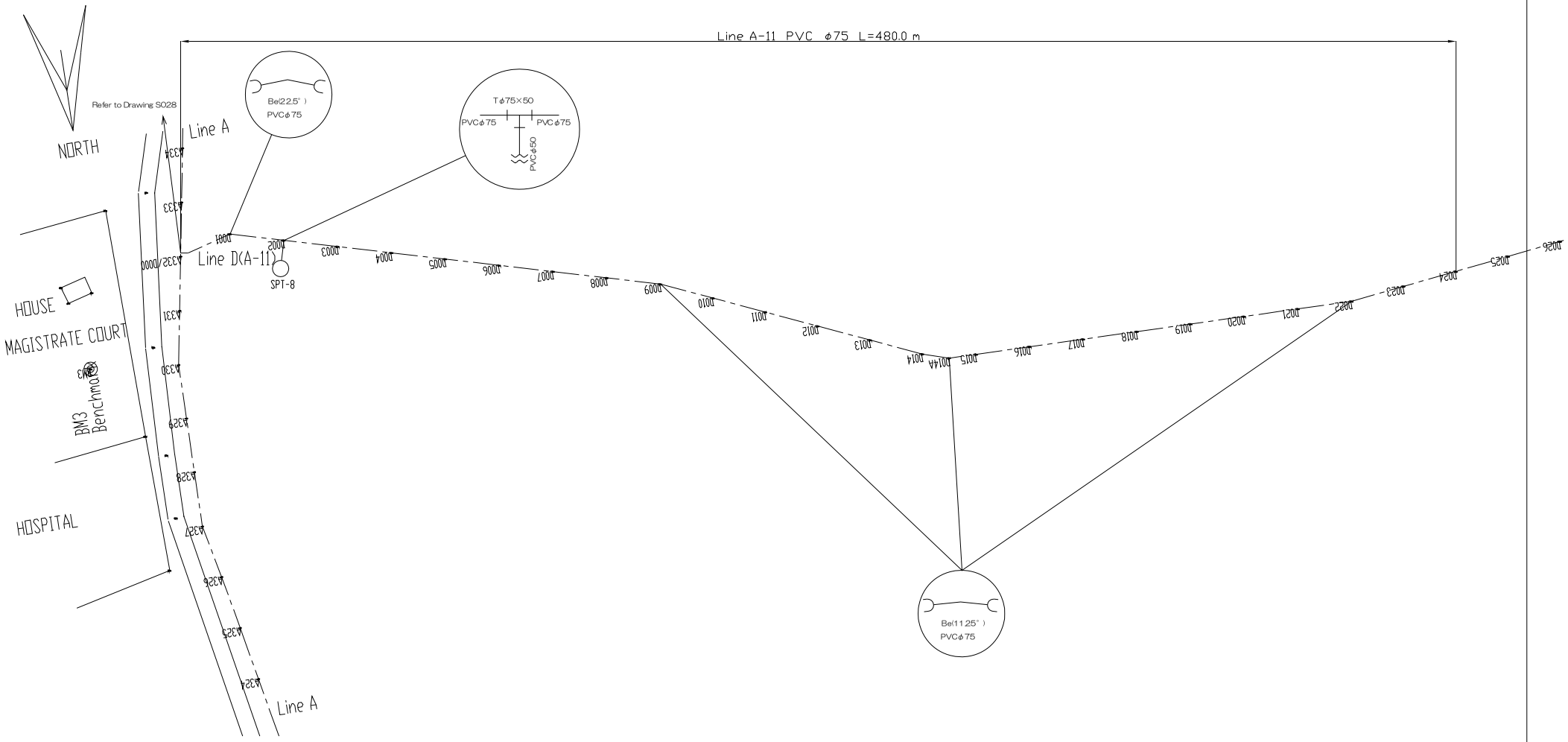
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S041

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE D(A-11) : 0.00m to 500.00m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

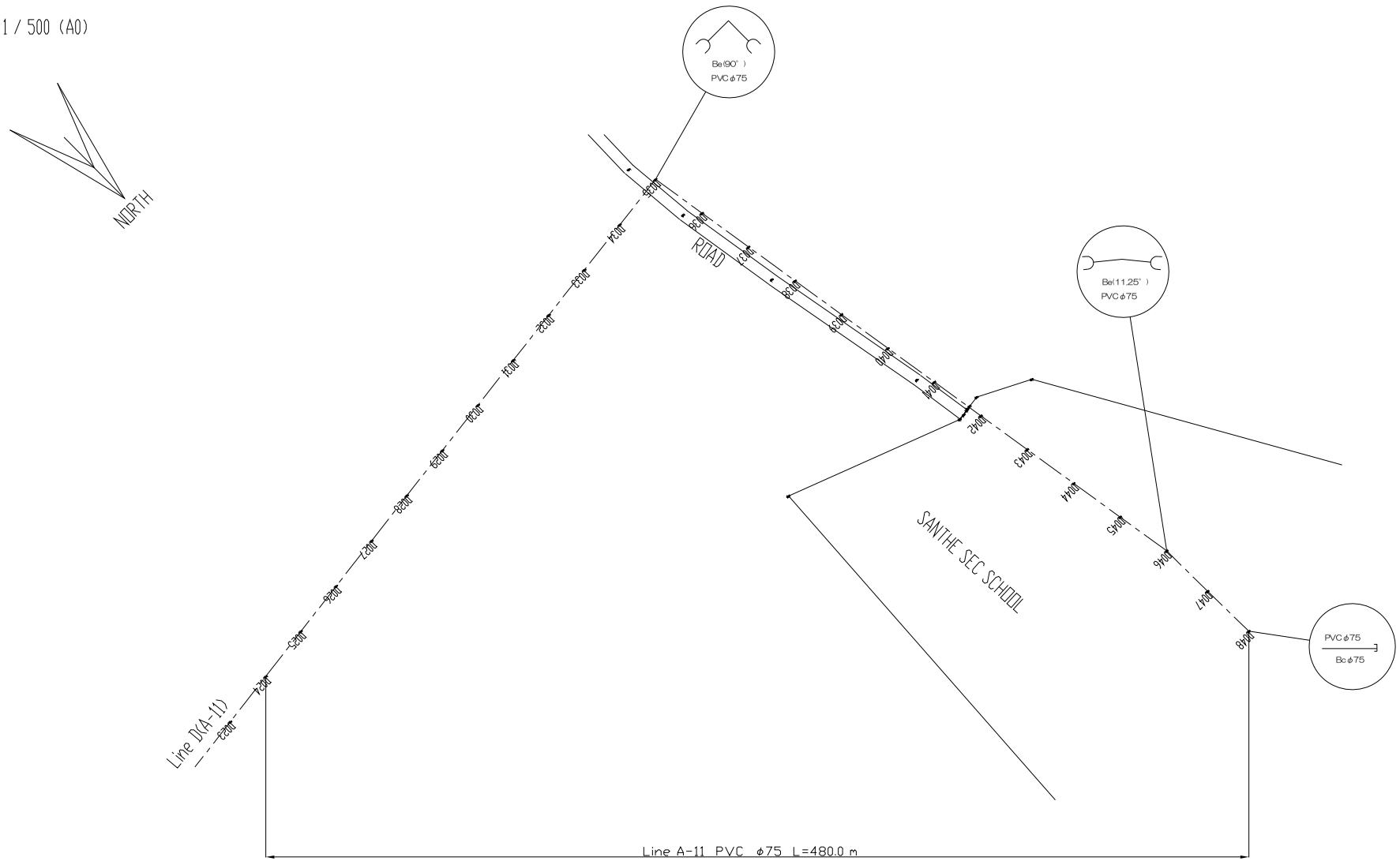
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S042

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE D(A-11) : 500m to 960.44m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

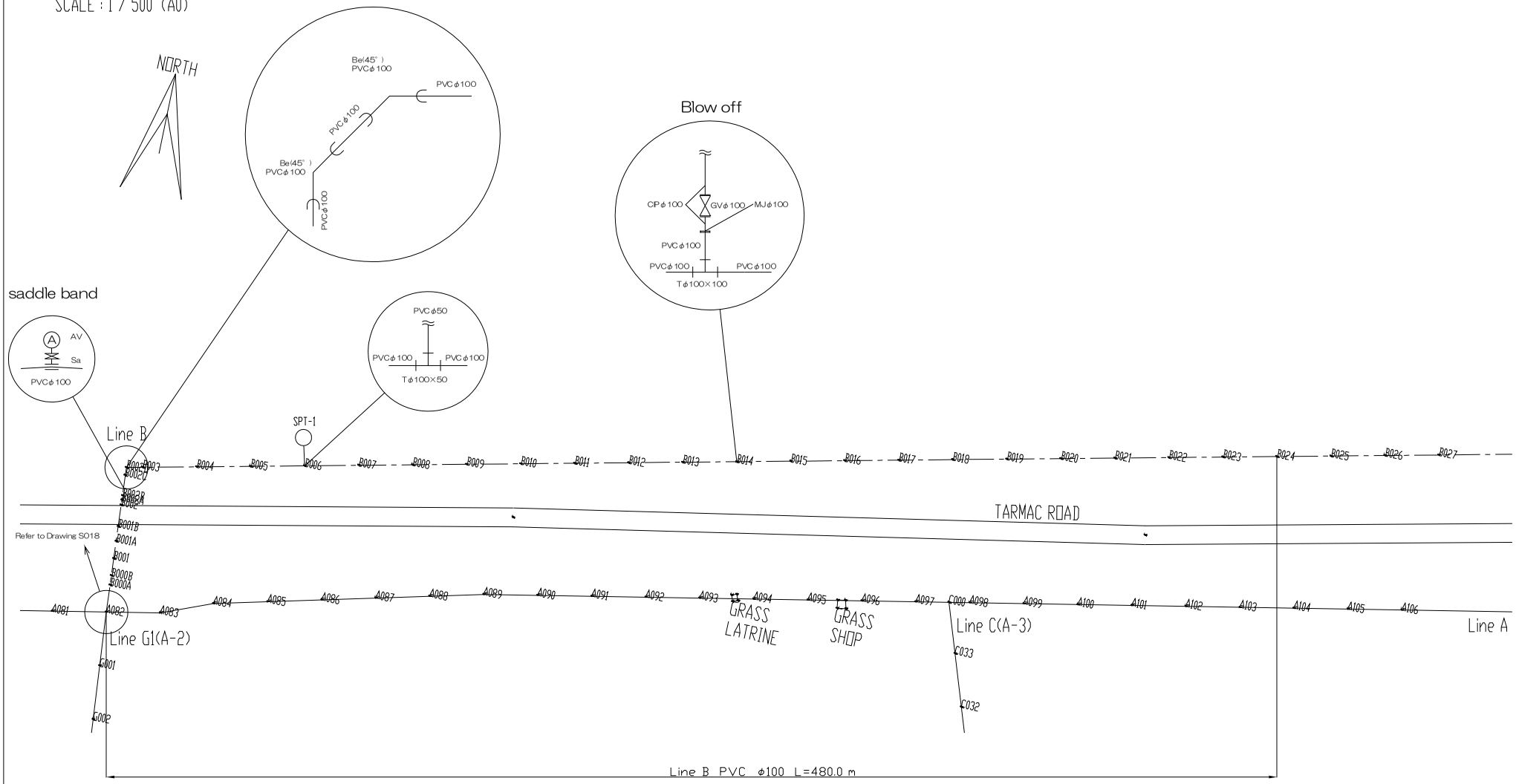
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S043

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 0.00m to 500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

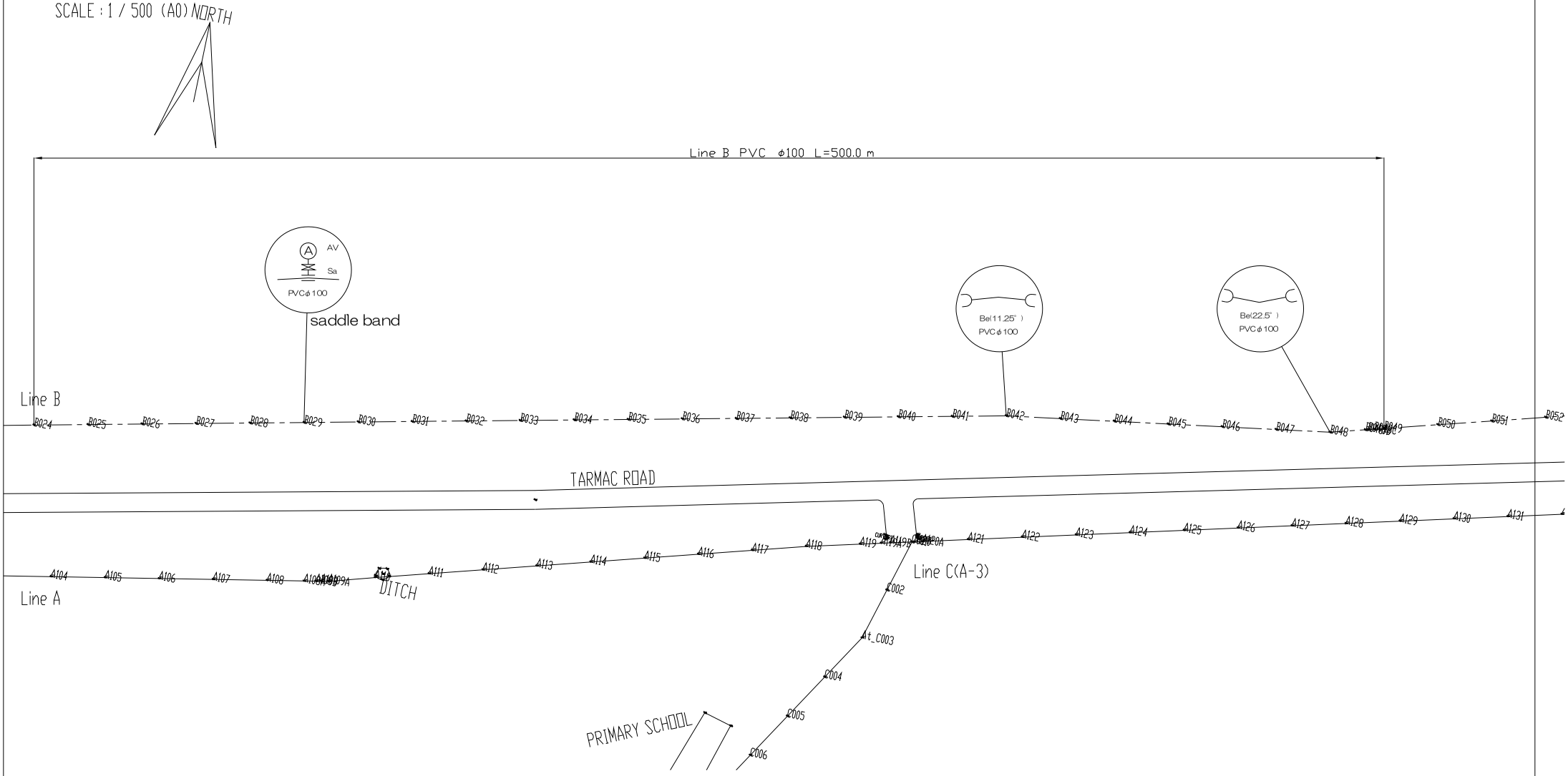
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S044

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 500m to 1,000m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

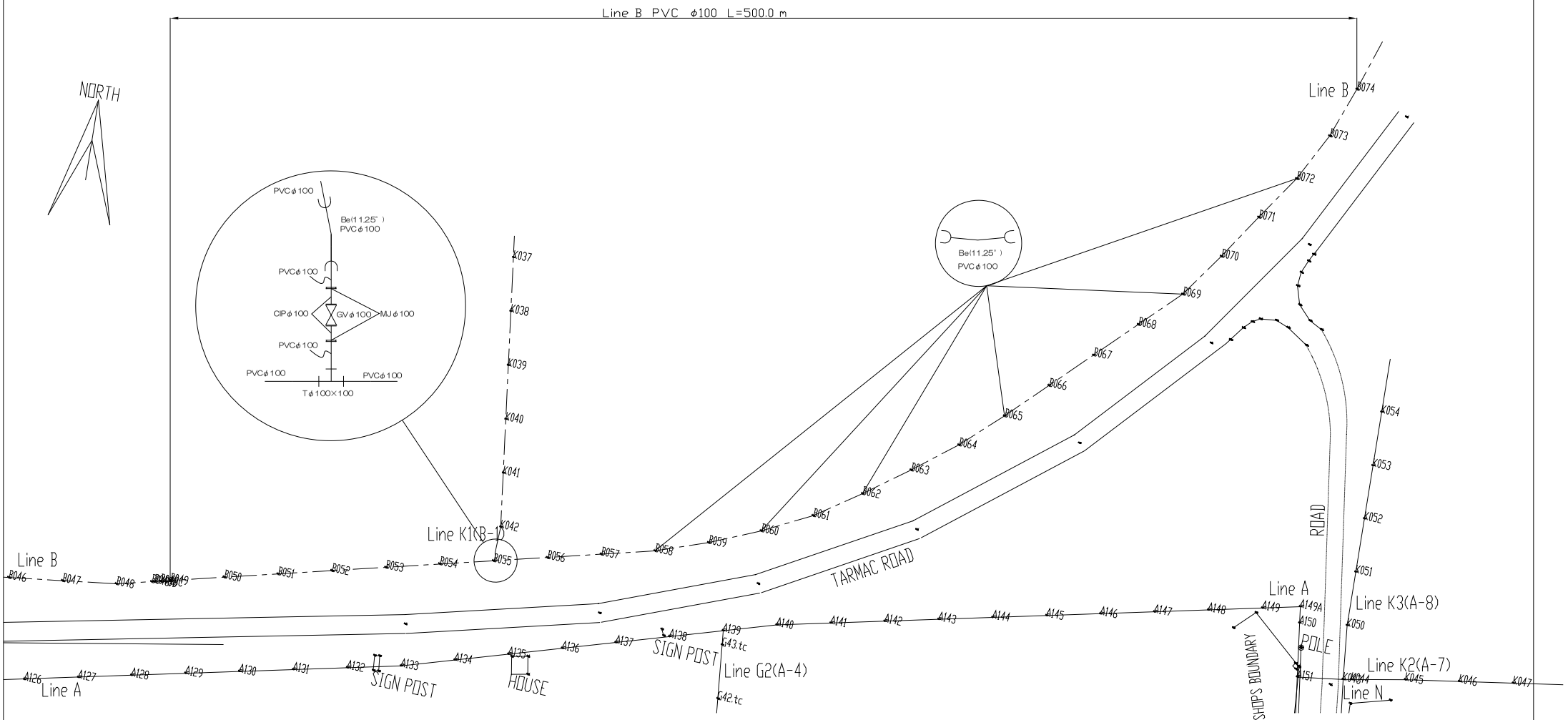
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S045

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 1,000m to 1,500m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

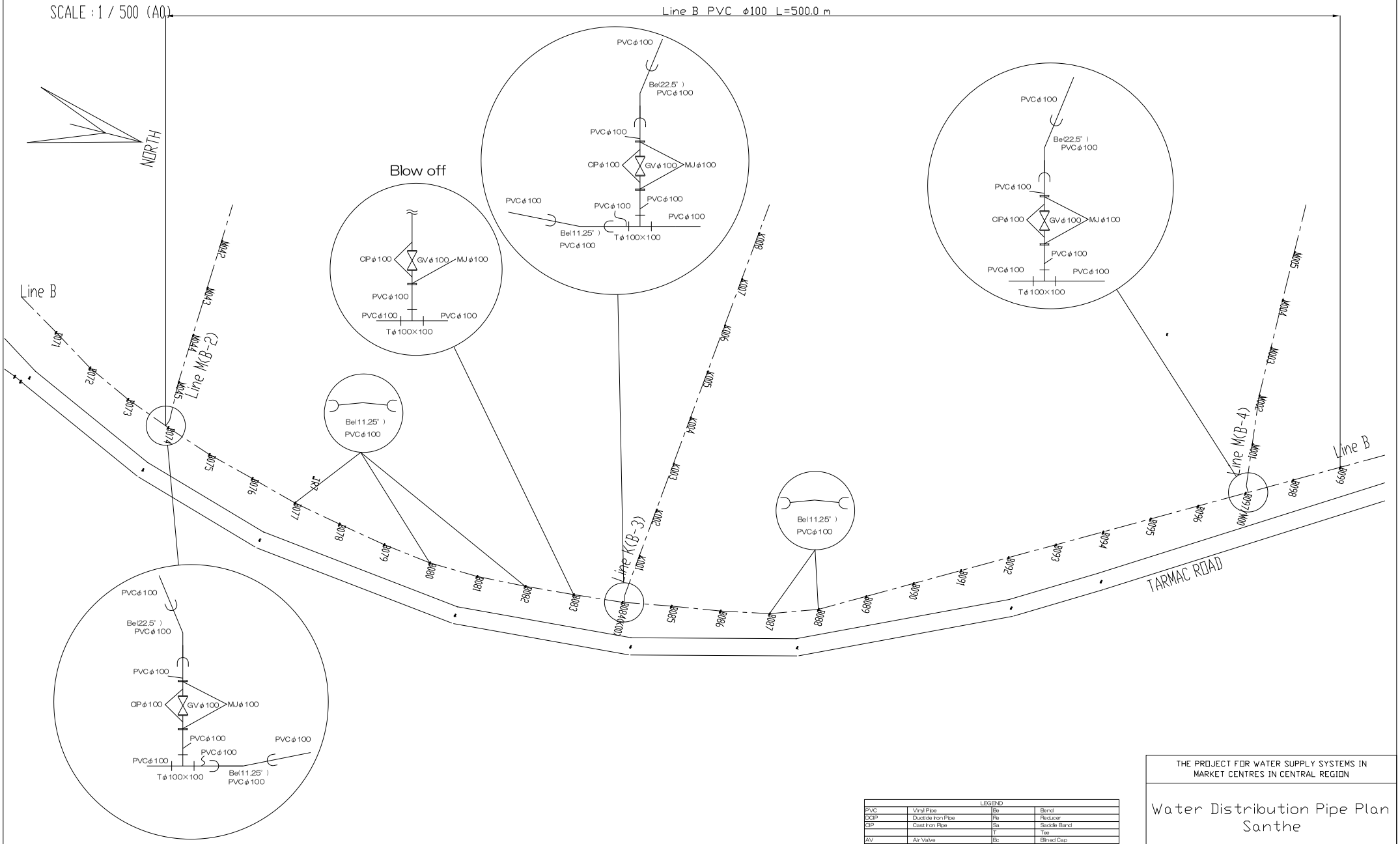
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S046

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 1,500m to 2,000m

SCALE : 1 / 500 (A0)



LEGEND			
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CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

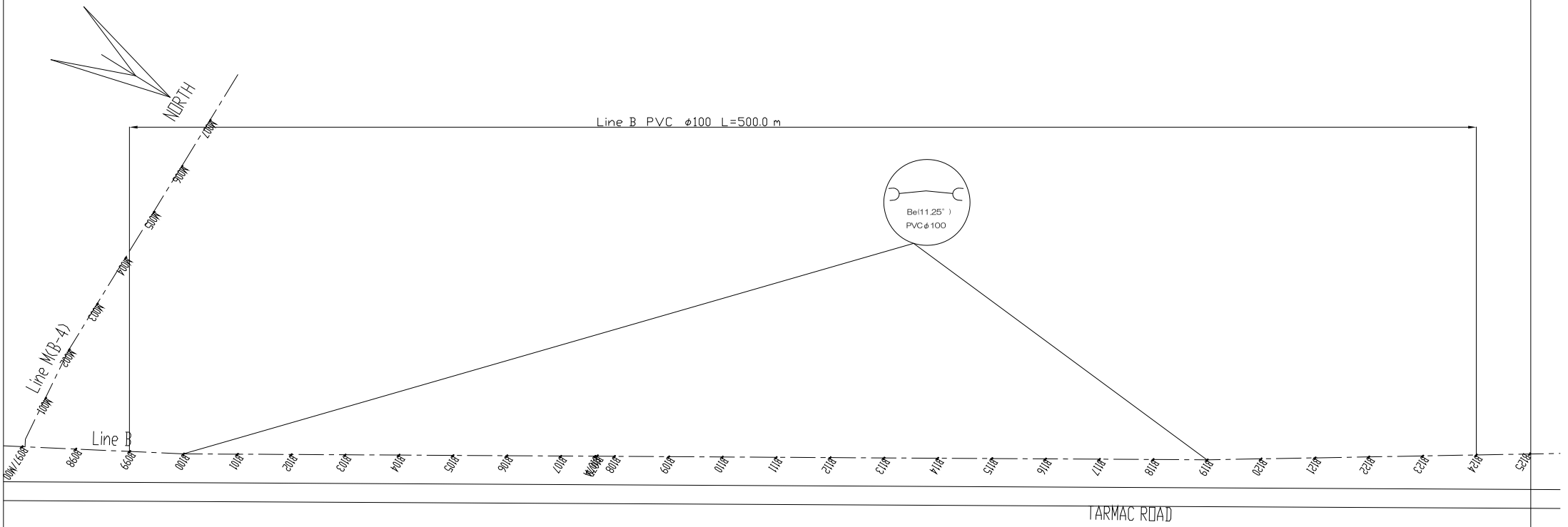
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S047

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 2,000m to 2,500m

SCALE : 1 / 500 (A0)



LEGEND			
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DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

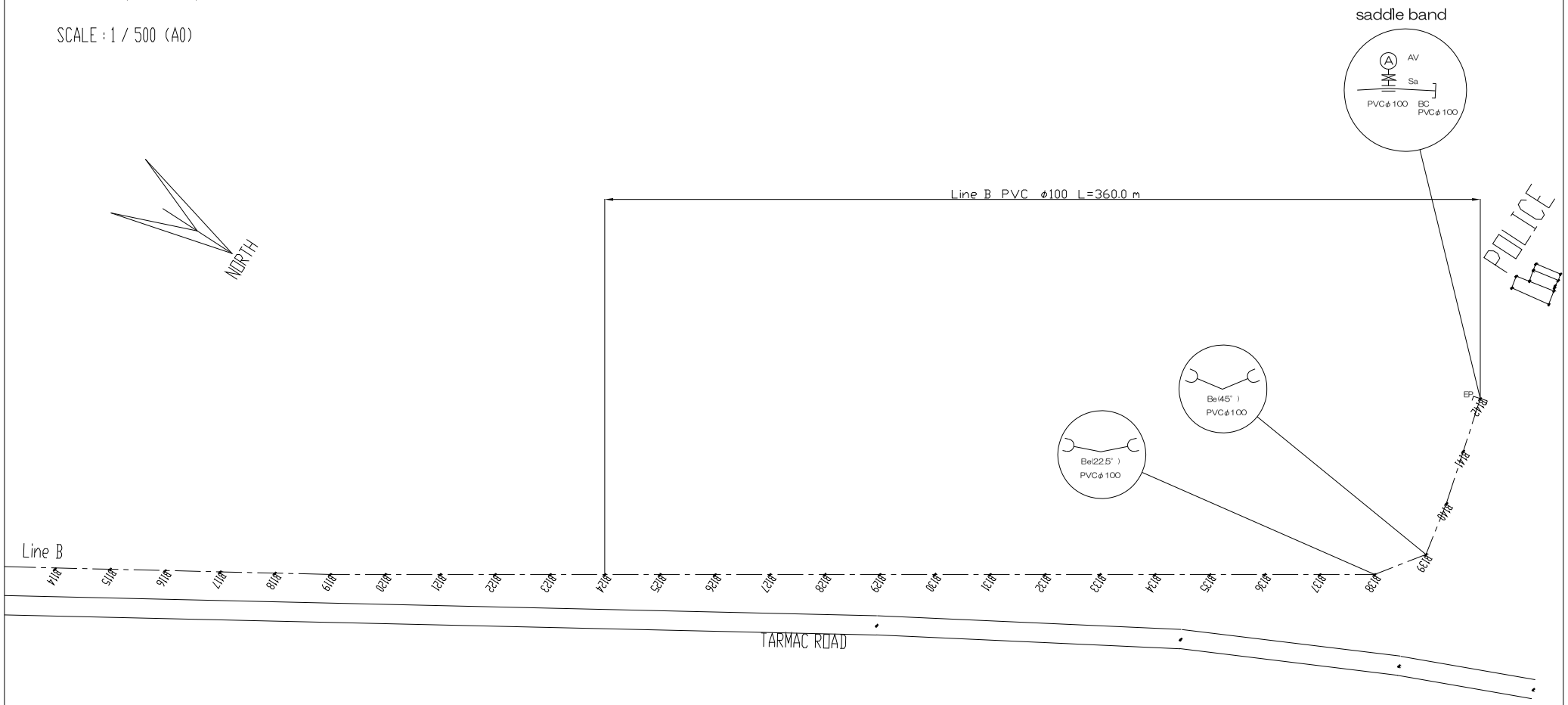
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S048

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE B : 2,500m to 2,840.95m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

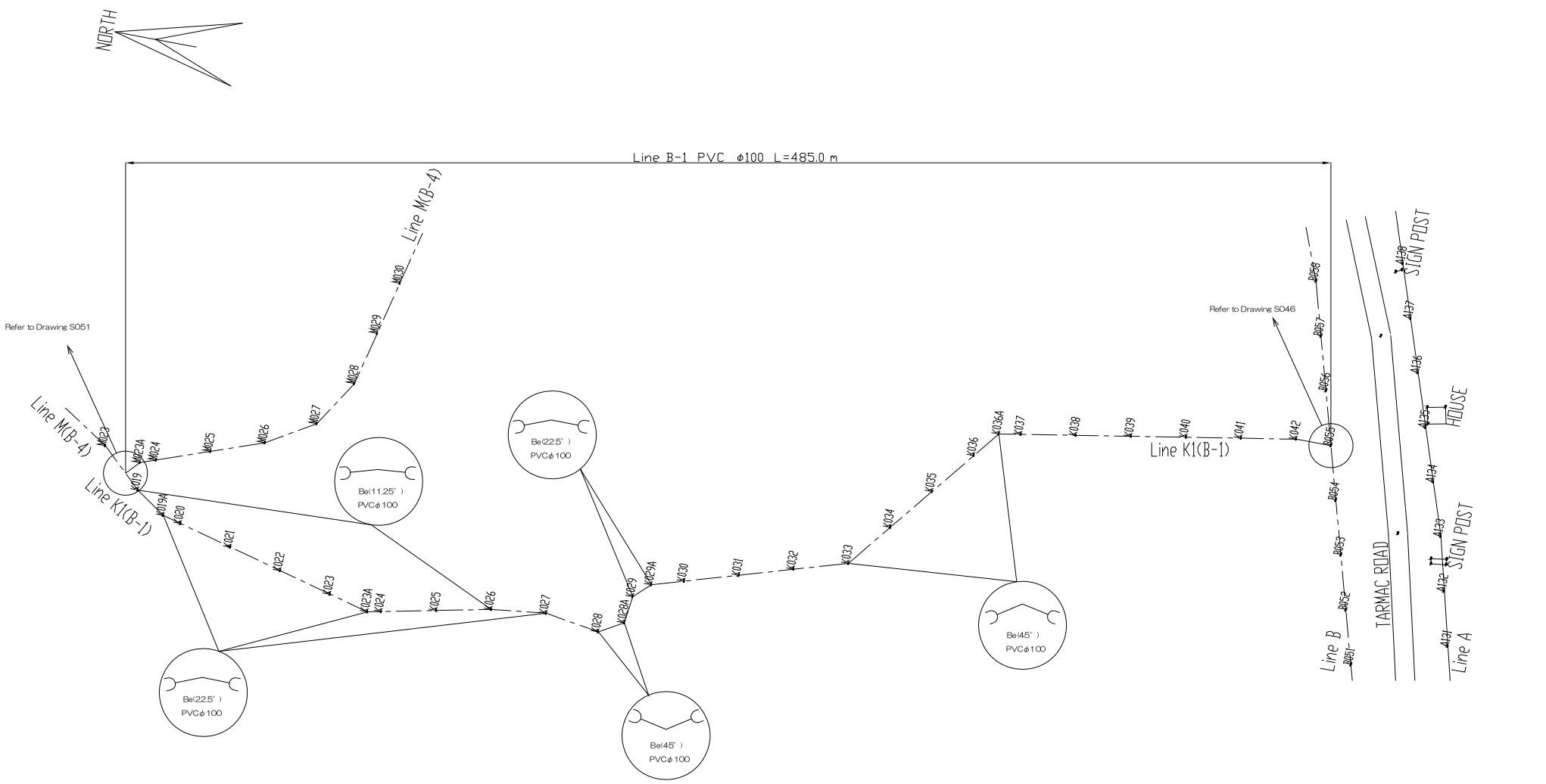
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S049

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE K1(B-1) : 0.00m to 493.13m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

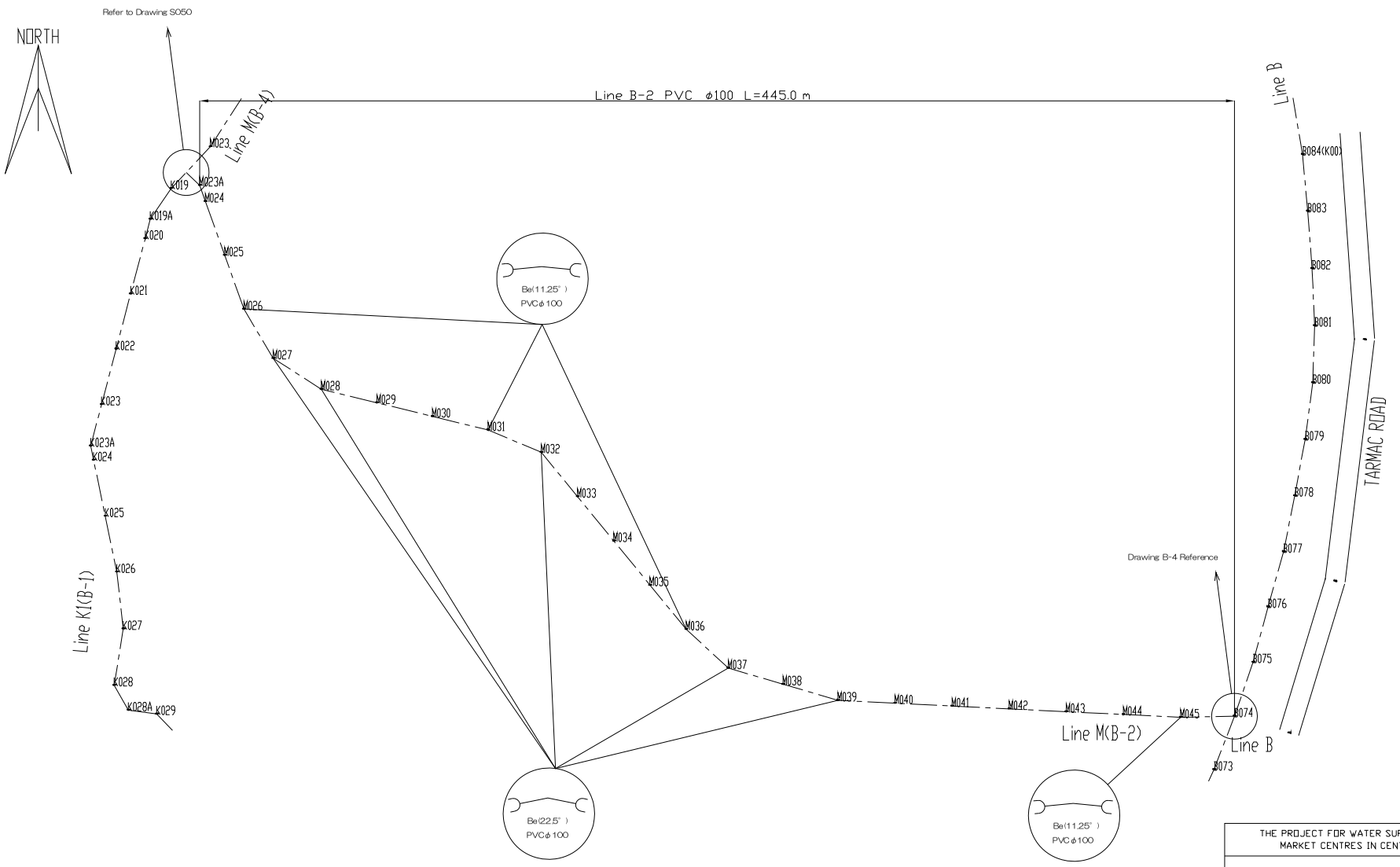
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S050

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE M(B-2) : 500m to 919.43m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

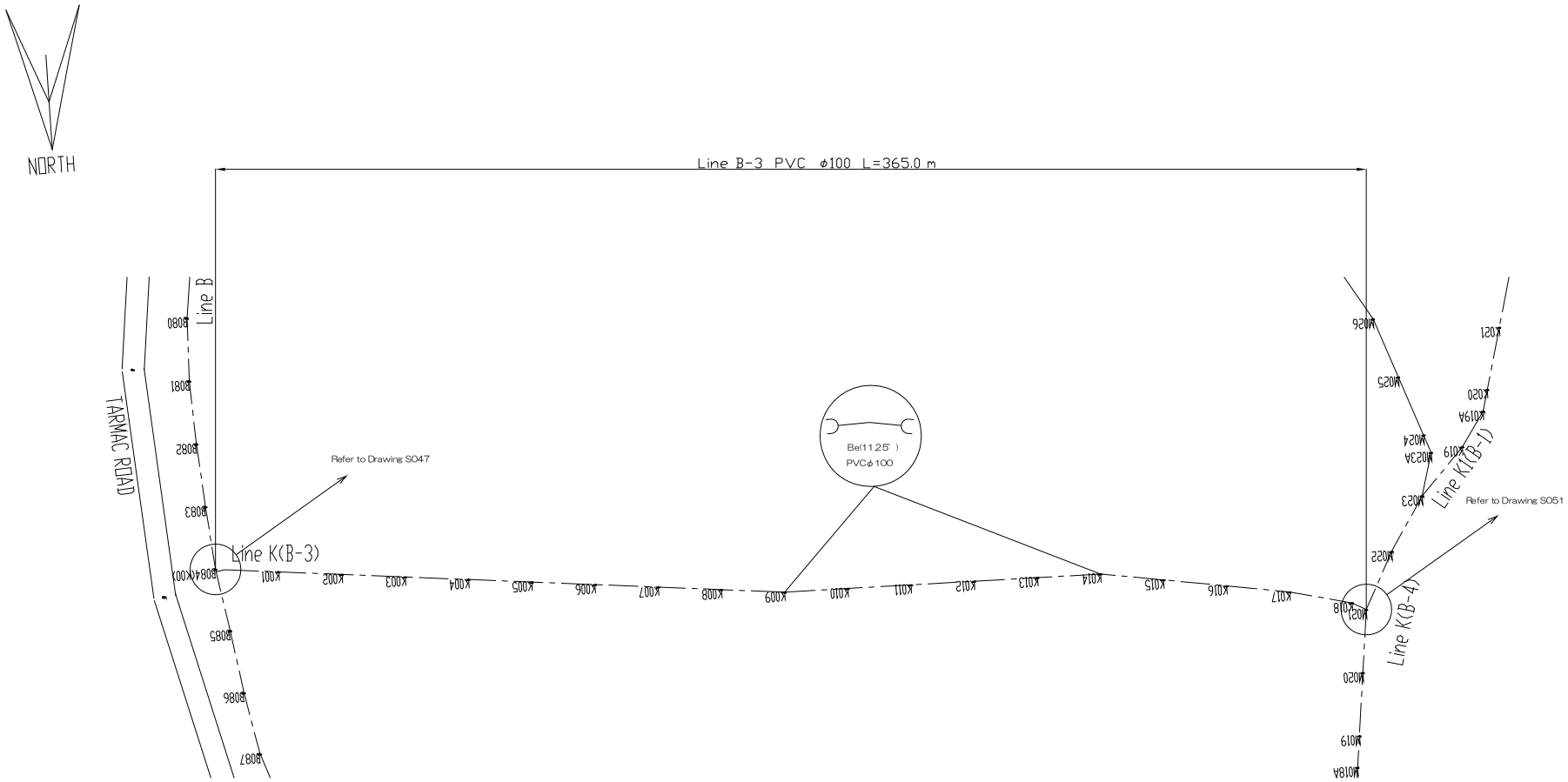
Water Distribution Pipe Plan
Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S051

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE K(B-3) : 0.00m to 365.07m

SCALE : 1 / 500 (A0)



LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductide Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

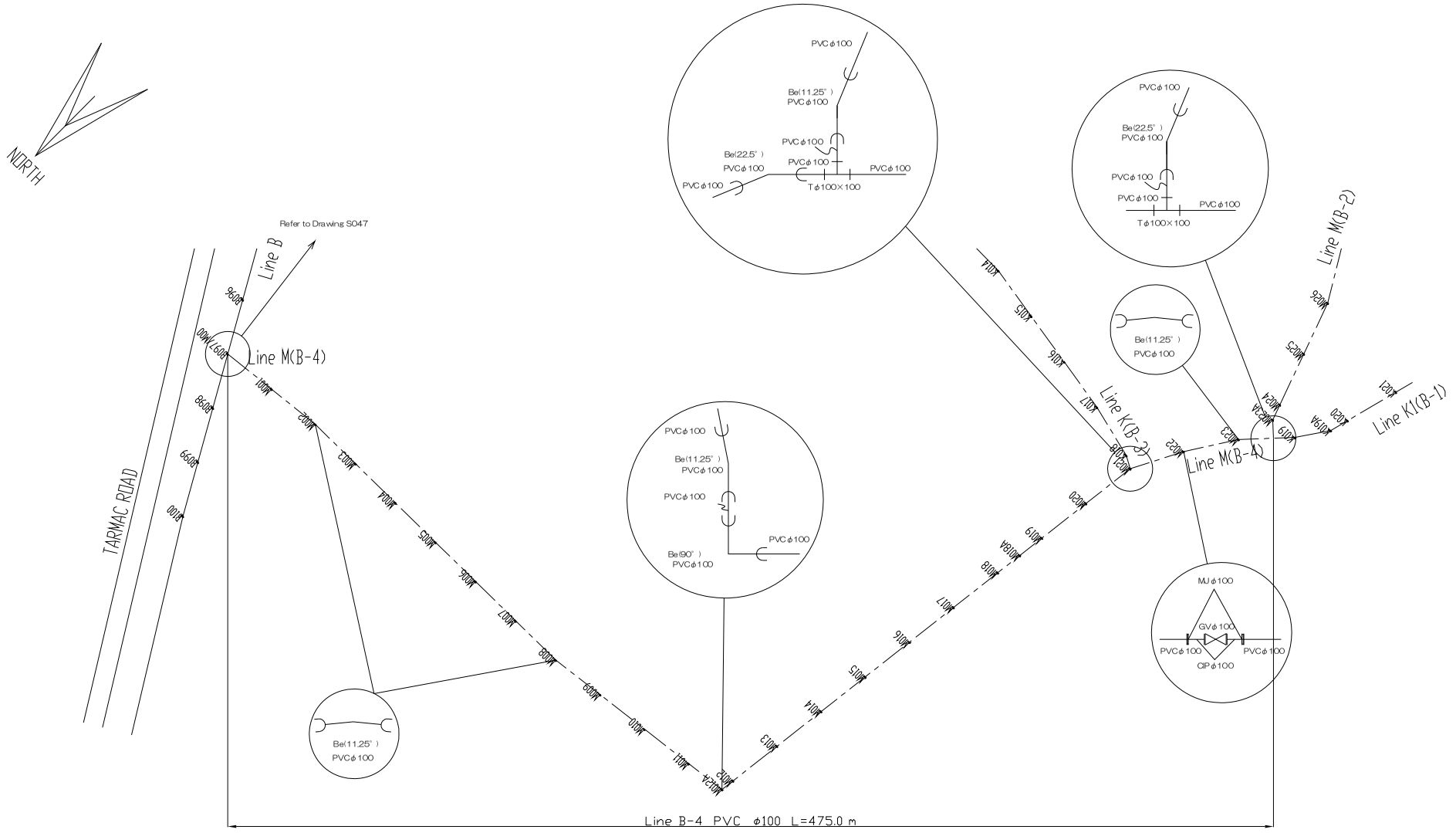
Water Distribution Pipe Plan Santhe

Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S052

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

SANTHE WATER SUPPLY SCHEME
LINE M(B-4) : 0.00m to 500m

SCALE : 1 / 500 (A0)



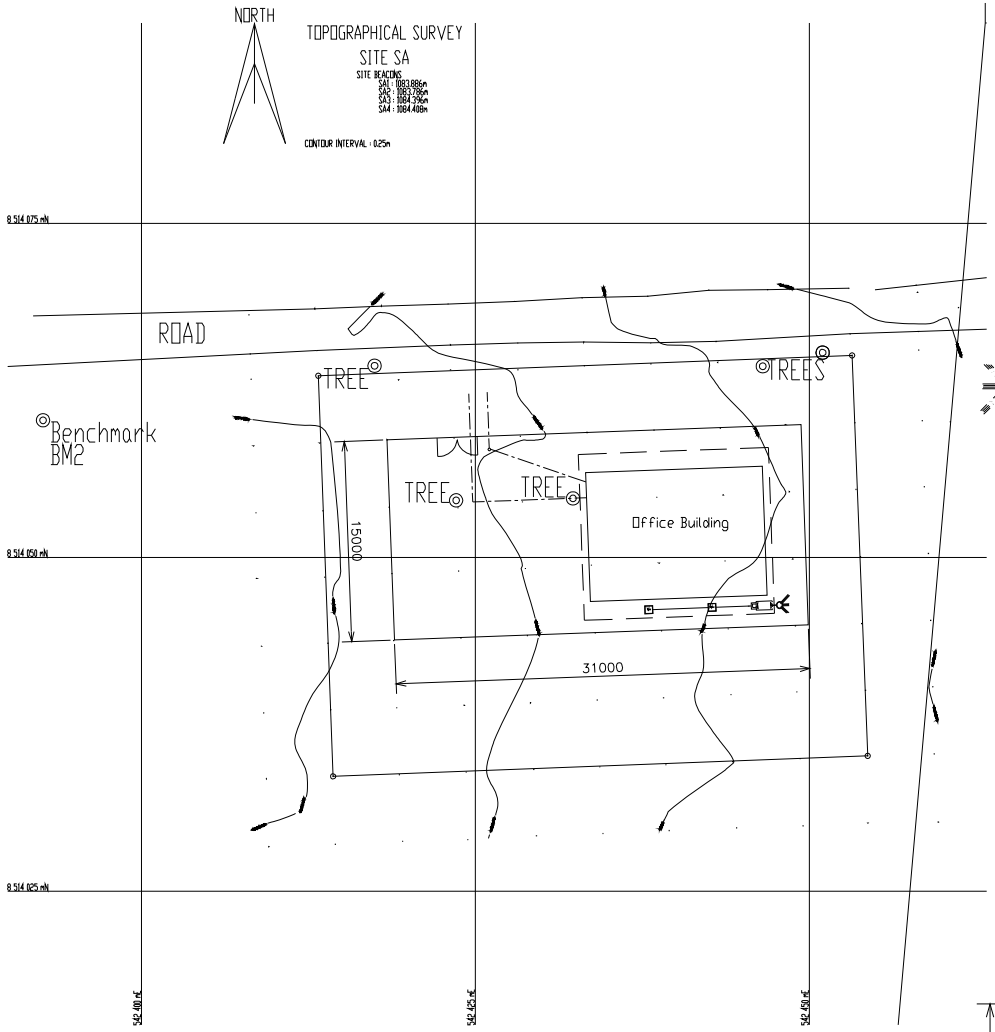
LEGEND			
PVC	Vinyl Pipe	Be	Bend
DCIP	Ductile Iron Pipe	Re	Reducer
CIP	Cast Iron Pipe	Sa	Saddle Band
		T	Tee
AV	Air Valve	Bc	Blined Cap
BOP	Blow Off Pipe		
MJ	MF Joint		
GV	Gate Valve		

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

Water Distribution Pipe Plan Santhe

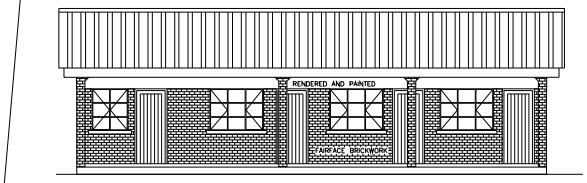
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S053

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

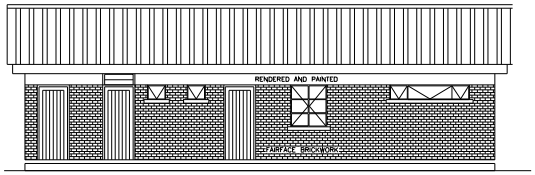


Office Building General Layout
(Santhe)

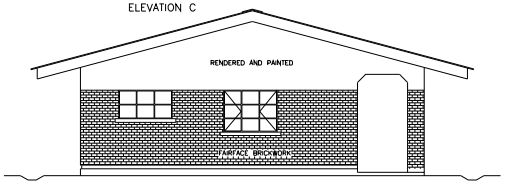
S=1:200(A1) 1:400(A3)



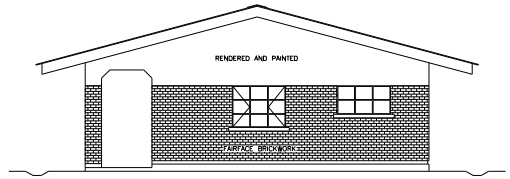
ELEVATION A



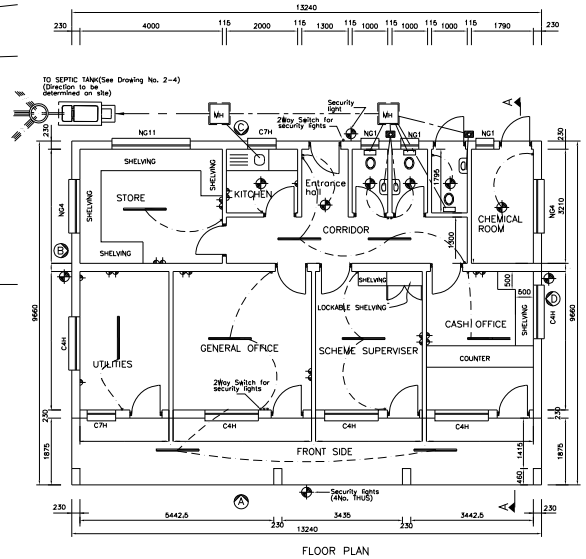
ELEVATION C



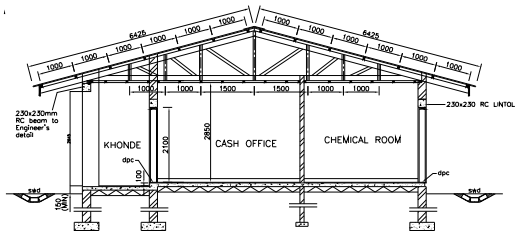
ELEVATION B



ELEVATION D

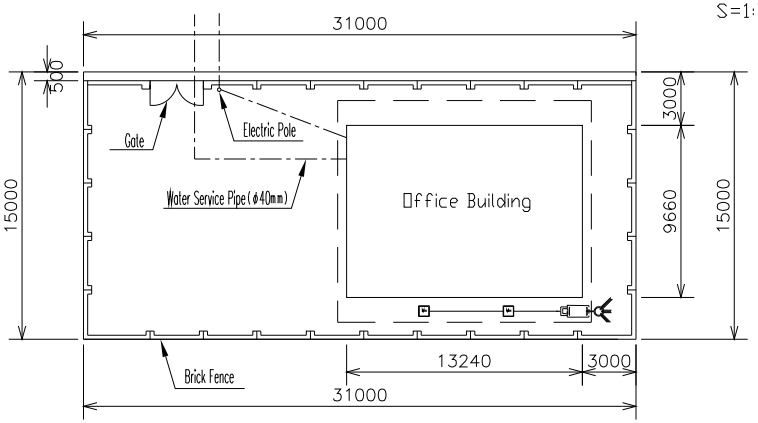


FLOOR PLAN



Office Building Layout

S=1:75(A1) 1:150(A3)



Brick Fence Layout

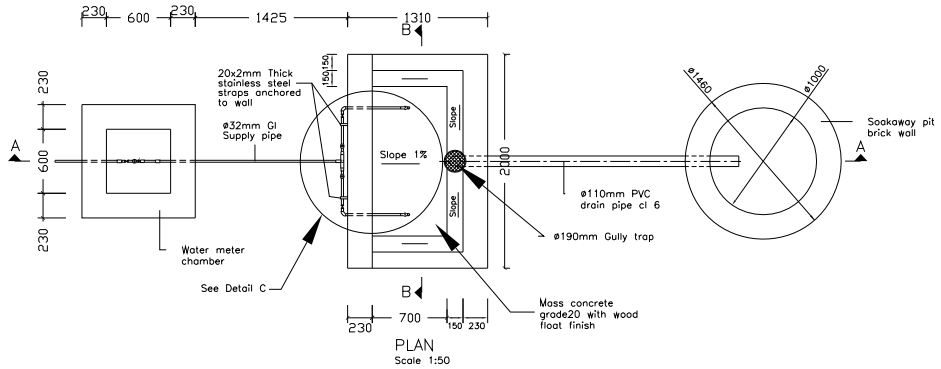
S=1:150(A1) 1:300(A3)

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION

Office Building Layout
Santhe

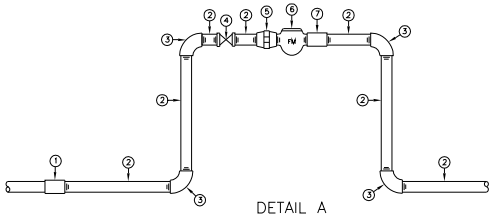
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	S054

EIGHT-JAPAN ENGINEERING CONSULTANTS INC.

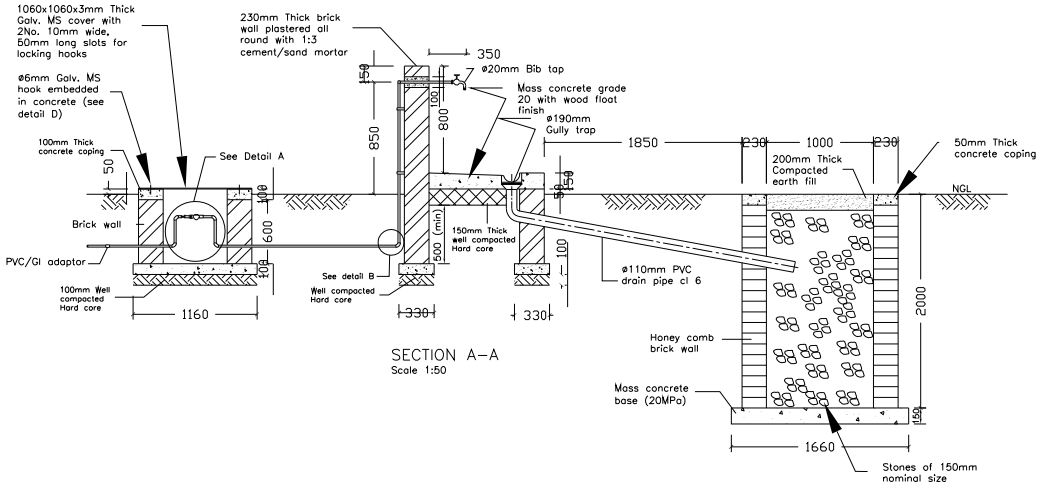


PLAN
Scale 1:50

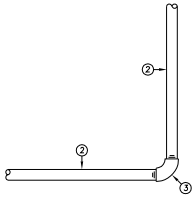
LIST OF FITTINGS FOR COMMUNAL WATER POINT				
FITTING	DESCRIPTION	DIAMETER (mm)	QUANTITY	LEGENDS
1	uPVC / GI adaptor	32	1	
2	Threaded GI pieces	32	8	
3	Elbow	32	5	
4	Stop cock	32	1	
5	Union	32	1	
6	Water meter	32	1	
7	GI socket	32	1	
8	GI equal tee	32	1	
9	Reducer	32/25	2	
10	Threaded GI pieces	25	8	
11	Union	25	2	
12	Stop cock	25	2	
13	Elbow	25	2	
14	Bib tap	25	2	
15	Supply Pipe	32	2	



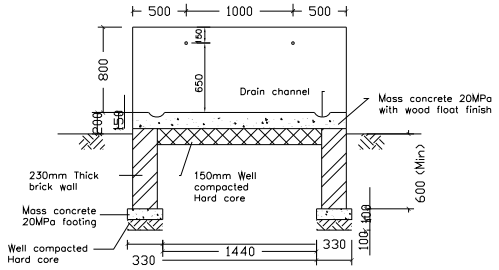
DETAIL A
(NTS)



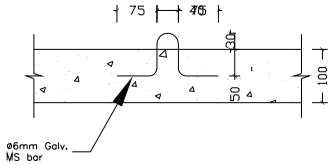
SECTION A–A
Scale 1:50



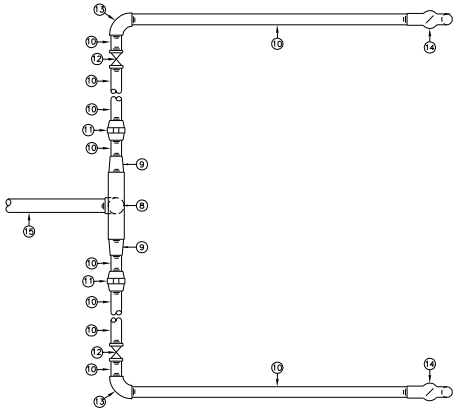
DETAIL B
(NTS)



SECTION B–B
Scale 1:50



DETAIL D
(GALV. MS HOOK)
Scale 1:10



DETAIL C
(NTS)

THE PROJECT FOR WATER SUPPLY SYSTEMS IN MARKET CENTRES IN CENTRAL REGION			
Communal Water Point Details			
Scale	Shown in the Drawing		
Date	Oct. 2011	Drawing No.	C001
EIGHT-JAPAN ENGINEERING CONSULTANTS INC.			

Communal Water Point Details

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Framework of Responsibilities

The responsible agency for the Project consisting of two sub-projects on the Malawi side is the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) while the implementation agency for Sub-Project (1), i.e. Project for Water Supply System for Santhe and Mkanda Market Centres, is the Central Region Water Board (CRWB) which will also be responsible for the O & M of the facilities to be constructed. The agreement with a Japanese consultant and Japanese contractors for the Project will be signed by the MoAIWD which will act as the implementation agency for Sub-Project (2), i.e. Project for Rehabilitation of Boreholes in Mchinji.

A Japanese consultant will be responsible for the detailed design (preparation of design documents), assistance for the tender and supervision of the construction work. Following the signing of the E/N and G/A for Japan's grant aid for the Project, the MoAIWD will conclude a consultancy agreement with a Japanese consultant in relation to the said consultancy services.

The construction work will be conducted by a Japanese construction company which will be selected by the MoAIWD through tender in the presence of the consultant.

(2) Construction Method

The construction method to be employed for Sub-Project (1) will be that with which local workers, equipment and materials can be used to the maximum to facilitate local employment and technology transfer in consideration of the situation and technical level of the local construction industry.

(3) Dispatch of Engineers and Skilled Workers

The water supply facilities to be constructed under Sub-Project (1) are complex facilities involving civil engineering work, building work and electrical equipment and machinery installation work. For the successful completion of the work while satisfying the specifications and quality demanded of a Japanese grant aid project, the dispatch of Japanese engineers will be necessary to provide guidance for local engineers on quality control and other crucial aspects of the work.

In addition to engineers (one civil engineer and one architect) dispatched by the contractor, the dispatch of Japanese workers who are highly skilled in piping work and mechanical/electrical installation work will be

necessary to supervise local workers for the proper construction of the planned various water supply facilities under Sub-Project (1).

(4) Use of Local Subcontractors

A Japanese construction company is generally selected as the main contractor by the government of the recipient country for a Japanese grant aid project. However, the participation of local construction companies (as subcontractors) is almost essential to ensure the smooth implementation of the work in a foreign country where the weather conditions, legal system, customs and sense of values may vastly differ from those in Japan. There are many local construction companies in Malawi which are judged to be capable of conducting the necessary work of constructing the planned water supply facilities under the guidance and supervision of the Japanese contractor. These local companies will, therefore, be actively used for Sub-Project (1), partly for the purpose of transferring construction technologies and techniques to these companies.

2-2-4-2 Implementation Conditions

The construction work under Sub-Project (1) will be conducted with due consideration of the site conditions, equipment and material procurement conditions, labour conditions, social conditions and other relevant aspects as described next.

(1) Important Points for Main Components of the Construction Work

1) Temporary Work

The height of the facilities to be constructed under Sub-Project (1) will be less than 5 m, excluding the elevated tank. The excavation depth for the foundations will be approximately 1 ~ 1.5 m. Given these structural conditions, none of the planned facilities will require large-scale temporary work. Meanwhile, access to the planned construction sites can be provided by existing roads which are passable by large vehicles. This will make the construction of temporary roads to serve construction vehicles unnecessary. The crossing of any rivers or swamps will be unnecessary and, therefore, temporary work for water shielding or diversion will be unnecessary.

2) Earth Work

Excavation, backfilling and compaction associated with the construction work and pipe installation work will, in principle, be conducted using suitable machinery. In regard to the some 2.5 km long section where rock excavation is required to create a trench for the laying of the pipes, a giant breaker along with an excavator will be used.

3) Foundation Work

The geological survey results indicate the viability of adopting spread foundations because of the favourable ground conditions at the planned water supply facility sites and the small facility load of approximately 50 kN/m^2 or less.

4) Concrete Work

There is no plant producing ready-mixed concrete in or around the project sites, making it necessary to set up an on-site concrete mixing plant. Although the introduction of an on-site simplified batcher plant would be ideal to ensure the uniform and proper quality of the concrete, its use for Sub-Project (1) appears excessive given the size of the planned facilities which is small and for which the expected maximum daily concrete placement volume is 5 ~ 10 m^3 a day at any single site. For this reason, concrete mixers will be used to produce the concrete mix for manual placement.

5) Form Work

Water supply facilities have a relatively intricate structure with an average thickness of the members of up to 30 cm. For form work for this type of structure, the common practice is to use plywood panels. In consideration of the workability and finish of the concrete surface, plywood panels will be used for the form work for the planned water supply facilities under Sub-Project (1).

6) Scaffolding Work

As all of the planned facilities except the elevated tank under Sub-Project (1) are low, no scaffolding work will be required to assist the assembly work of the reinforcing bars or forms or concrete work. At the elevated tank site, however, pipe scaffolding will be erected to assist the assembly work of the steel supports as well as elevated tank and subsequent painting work.

7) Piping Work

The piping work for Sub-Project (1) will, in principle, be conducted using machinery. Given the properties of the local soil, simple digging without trench timbering should be satisfactory for most sections of the pipeline routes. However, a 10 cm thick sand bed will be introduced to smooth out the bottom of the excavated trenches and to prevent point load by stones and gravel on the buried pipes. At the rock excavation section, the pipes will be protected by a sand bed around them so that rock pieces do not damage the pipes during backfilling.

8) Machine and Electrical Equipment Installation Work

The machine and electrical equipment installation work will commence when the delivery and installation of such equipment is feasible towards the end of the civil engineering and building work. Electrical conduit tubes, etc. will be laid prior to concrete placement with due confirmation of the relevant routes.

(2) Safety Measures

The safety of workers and all other personnel at the project sites is as important as quality control. Workers must always wear proper shoes and a helmet as the basic requirement for their own safety. A safety belt must be worn by workers involved in the construction of the elevated tank when some workers will be working at a height of up to 13 m from the ground. A safety net will also be provided if necessary to prevent the scattering of construction materials by wind.

(3) Construction Schedule

1) Preparatory Period in Japan

In general, the contractor will begin to place official orders for the equipment and materials and establish the site offices after approval of the signed contract. In consideration of the time likely to be required for government approval of the contract in question, one month's preparatory period will be set aside in Japan with a view to commencing the actual work in Malawi one month after the signing of the contract.

2) Equipment and Material Procurement Period

Among the materials to be used for Sub-Project (1), it is assumed that the pipes will be procured in Malawi. The overall procurement quantity will be equivalent to a length of some 30 km and the pipes to be procured will be PVC as well as ductile cast iron pipes with a diameter of 75 mm ~ 150 mm. Although the orders for these pipes will be made in Malawi, their import from neighbouring South Africa, etc. will be necessary. Their manufacture is expected to take approximately two months while their land transportation and customs clearance will add another two weeks. In total, therefore, two and a half months will be scheduled for the procurement period.

3) Piping Work Period

The piping work listed below will be conducted under Sub-Project (1).

① Transmission pipelines (intake wells ~ elevated tank/reservoir): DCIP ∅150 mm ~ 75 mm x 2.9 km
② Distribution pipelines (elevated tank/reservoir ~ built-up areas): PVC ∅150 mm ~ 75 mm x 27.4 km

For determination of the piping work period, the necessary calculations were made based on the expected work completion length per day for each type of pipe and pipe diameter. At the same time, a suitable number of work parties will be formed in accordance with the progress of the work.

4) Work Efficiency During the Rainy Season

The rainy season in Malawi lasts for four months from December to March with annual rainfall of approximately 900 mm. During the rainy season, the work efficiency is expected to decline not only for the piping work involving trench excavation work but also for other types of work. Because of this likelihood, the work schedule will take the local rainfall characteristics into full consideration and will incorporate anticipated off-days due to rain.

(4) Compliance with Labour Standards

The contractor will comply with the labour-related laws and regulations in Malawi for the employment of local workers. The statutory requirements concerning the employment of workers in Malawi are outlined below.

Basic working hours:		8 hours/day (40 hours/week)
Overtime allowance :		Overtime hourly wage x 150%
		Public holiday hourly wage x 200%
Tax obligation	:	All waged employees

(5) Observance of Local Customs

For calculation of the required number of working days, public holidays based on religion and custom in Malawi will be taken into consideration. There are 11 public holidays a year in Malawi.

2-2-4-3 Scope of Work

The division of the work between the Japanese and Malawi side for the implementation of Sub-Project (1) is described below.

(1) Scope of Work for the Japanese Side

① Construction of the water supply facilities described in 2-1-2 – Basic Plan
② Maritime transportation of the equipment and materials procured in Japan and/or a third country to a suitable port of landing in a neighbouring country of Malawi
③ Inland transportation of the equipment and materials from the port of landing to the project sites

④ Consultancy services (detailed design, preparation of the tender documents, assistance for the tender and construction supervision)

(2) Scope of Work for the Malawi Side

① Provision of stock yards for the construction materials and equipment
② Expropriation of the land required for the construction of the planned water supply facilities (intake wells, transmission pipelines, elevated tank, reservoir, distribution pipelines, Control Buildings and office buildings) for Sub-Project (1)
③ Electric power supply to the planned water supply facilities (intake wells, Control Buildings and office buildings)
④ Assistance for the prompt customs clearance of the imported equipment and materials at the port of landing and their exemption from all taxes in Malawi
⑤ Taking required procedures related to environmental and social consideration
⑥ Dispatch of counterparts in charge of Sub-Project (1) and payment of their expenses

2-2-4-4 Consultant Supervision

(1) Consultancy Work

Following the conclusion of the consultancy agreement after the signing of the E/N and G/A, the consultant will conduct the detailed design, prepare the tender documents, provide assistance for the tender and conduct the construction supervision of the contractor who has been awarded the construction contract. The main components of the consultancy work are outlined below.

1) Preparation of the Detailed Design and Tender Documents

The consultant will prepare the detailed design documents based on the survey drawings, findings of the exploratory boring survey and findings of the more detailed field survey for the detailed design. The consultant will also prepare the documents required to proceed with the tender and will discuss their contents with the Government of Malawi with a view to obtaining the latter's approval of these documents.

2) Assistance for the Tender

The consultant will provide assistance for the Government of Malawi for such work as notice of the tender, prequalification, distribution of the tender documents, acceptance of bids and analysis as well as evaluation of the bids and will also provide advice for the contract negotiations between the Government of Malawi and the successful bidder. The consultant will witness the signing of the construction contract by the Government of Malawi and the successful bidder.

3) Construction Supervision

In Japan, the consultant will examine the documents submitted by the contractor for their approval by the consultant. In Malawi, the consultant will provide assistance for the Government of Malawi in regard to pre-work consultation meetings and will guide and supervise the contractor in regard to the transportation of the equipment and materials. The consultant will also conduct schedule control, quality control (including the quality inspection to be conducted by the contractor) and material control to ensure the construction of the facilities as planned. The on-site work supervisor of the consultant will report on the monthly progress of the work and other relevant matters to the responsible and implementing authorities for Sub-Project (1) on the Malawi side and the JICA Malawi Office and will conduct the necessary coordination and consultation.

(2) Project Implementation System

To ensure the smooth progress of the detailed design work and subsequent construction supervision, the consultant will establish a project implementation system mainly with those who have participated in the preparatory survey and those who have an in-depth knowledge of Japan's grant aid scheme.

1) Preparation of the Detailed Design and Tender Documents
The persons to be involved in the preparation of the detailed design and tender documents and also in the assistance for the tender work will play the roles listed below.

① Chief Consultant	: Overall supervision of the detailed design and tender
② Water supply engineer	: Detailed design of the water intake facilities, elevated tank, water distribution facilities, all other civil engineering work and related equipment
③ Plumbing engineer	: Detailed design of the transmission and distribution pipelines and ancillary equipment to these pipelines
④ Cost estimator	: Estimation of the prospective bidding prices of the construction work
⑤ Tender coordinator	: Pre-qualification, preparation of the construction agreement and assistance for the tender work

2) Construction Supervision

In consideration of the contents of the construction work, scale and number of sites of Sub-Project (1), the consultant will dispatch a civil engineer with previous experience of Japan's grant aid projects as a full-time on-site supervisor. Given the facts that the Project consists of two sub-projects with

distinctively different construction work, that the scale of each work is relatively large and that the construction supervision standards in Japan categorically state that “a supervising engineer must be exclusive and full-time and cannot perform any other duties concurrently”, each sub-project will be assigned one resident engineer as the construction supervisor. In addition, the consultant will dispatch the Chief Consultant at crucial stages of project implementation for the purpose of coordinating as well as supervising the work. The staff members of the consultant involved in construction supervision and their respective roles are outlined below.

① Chief Consultant	: Coordination and technical control to ensure the smooth progress of the construction work
② Resident engineer	: Daily project management and schedule control of the water supply facility construction work
③ Inspection specialist	: Final inspection of the completed water supply facilities prior to their handing-over to the Malawi side

Of the staff members listed above, the Chief Consultant and inspection specialist will also work for the borehole rehabilitation work in Mchinji (Sub-Project (2)). In the case of the resident engineer for each sub-project, a local engineer will be recruited to assist the said resident engineer to ensure the appropriate supervision of the construction work.

The personnel required for detailed design and construction supervision through the entire Project including Sub-project (2) are shown in Table 2-2-8.

Table 2-2-8 Staff Planning for Consulting Services

Staff	Work	in Malawi	in Japan
Detailed Design Stage			
<Detailed Design Work>			
Chief Consultant (concurrent*)	・ Overall supervision of detailed design ・ Contract out field survey work to local companies ・ Supervision of trial rehabilitation work ・ Over viewing targeted borehole for rehabilitation	○	○
Hydro-geologist (for Sub-Project (2))	・ Site selection for borehole construction through geo-electric survey ・ Assistance to supervision of trial rehabilitation work	○	―
Water supply engineer	・ Detailed design for water supply facilities ・ Supervision of foundation survey work	○	○
Plumbing engineer	・ Site confirmation for land acquisition, obstacles etc. ・ Detailed plumbing design	○	○
Cost estimator (Concurrent*)	・ Estimation of construction cost including data collection	○	○
<Tendering stage>			
Chief Consultant (concurrent*)	・ Preparation of tender document, approval from the client ・ Assistance to tender, tender evaluation, assistance to conclusion of contract	○	○
Tender coordinator (concurrent*)	・ Preparation of tender document, approval from the client ・ Assistance to tender, tender evaluation, assistance to conclusion of contract	○	○
<Construction Supervision / Procurement supervision>			
Chief Consultant (concurrent*)	・ Overall supervision of the work for construction supervision and procurement supervision ・ Final Inspection	○	―
Resident engineer - 1	・ Supervision of construction for Sub-project (1)	○	―
Resident engineer – 2 (for Sub-Project (2))	・ Supervision of construction for Sub-project (2) ・ Supervision of procurement (Acceptance, hand over)	○	―
Inspector (concurrent*)	・ Final inspection for construction	○	―

* Concurrent with Sub-Project (2) Underlined staff will take charge of Sub-Project (1)

2-2-4-5 Quality Control Plan

In regard to the construction of facilities, the consultant will direct the contractor to conduct the analyses and tests outlined in Table 2-2-9 and will ensure that the quality control reflects the results of these analyses and tests.

Table 2-2-9 Analysis and Testing for Quality Control

Classification of Work	Test Item	Test Frequency	Note
1. Concrete Work			
(1) Trial Mixing	Sieve analysis of fine aggregates	Once in the mixing	Sieving method
	Sieve analysis of coarse aggregates	- ditto -	Sieving method
	Chloride ion concentration	- ditto -	With simplified method
	Compression Test	- ditto -	7 days and 28 days strength
(2) Cast-in-place	Slump Test	Once for 50m^3	
	Chloride ion	Once in 2 weeks	With simplified method
	Compression Test	Once for 50m^3	7 days and 28 days strength
2. Re-bar Work	-	In each delivery to the site	With mill sheet
3. Plumbing Work	Water pressure test	After plumbing work completed, once in the section of a gate valve.	
4. Quality Analysis	Water quality items as per WHO Standards	After completion of the treatment facilities, once for the treated water.	To be analysed by MoAIWD's laboratory.

The Contractor will request a local company or laboratory to conduct the test on concrete. In the case of such equipment as pumps and chlorination devices among the range of equipment to be procured for Sub-Project (1), the submission of an inspection certificate or similar issued by the manufacturer will be requested by the Consultant to confirm their compliance with the required quality and functions in advance.

2-2-4-6 Procurement Plan

The main construction equipment and materials to be used in Sub-Project (1) are cement, reinforcing bars, piping materials (ductile cast iron pipes and PVC pipes for water supply, steel-panel type elevated tank/reservoir, submersible motor pumps for borehole use and chlorination devices). The planned procurement methods and other relevant issues regarding this equipment and materials are outlined below, taking the required quality and ease or difficulty of their local procurement into consideration.

In addition, the following procurement plan is based on the local market situation from August, 2010 to May, 2011.

(1) Cement

As there is a cement factory in Malawi, cement can be procured in the local market. In addition, cement produced in Zambia and other neighbouring countries is available in Malawi. As the procurement of

cement in the local market is not thought to be problematic in terms of quality and stable supply, cement will be procured in Malawi.

(2) Reinforcing Bars

Imported reinforcing bars are available in the local market. As their sizes, quality and quantity do not pose any problems for their use in Sub-Project (1), reinforcing bars will be procured in Malawi.

(3) Piping Materials

Although piping materials are not manufactured in Malawi, those imported from South Africa, etc. can be procured in the local market. As their sizes, quality and quantity do not pose any problems for their use in Sub-Project (1), piping materials will be procured in Malawi.

(4) Elevated Tank/Reservoir (Steel Panel Type)

Steel panel type elevated tanks and reservoirs manufactured in South Africa, etc. can be procured in Malawi through local agents. As the quality and delivery of these products are not problematic, suitable products will be procured in Malawi through local agents after rigorous checking and confirmation of the cost advantage of the products to be selected.

(5) Submersible Motor Pumps for Borehole Use

Submersible pumps for borehole use of a European manufacturer can be procured in Malawi through a local agent. As the quality and delivery of these pumps are not problematic, submersible pumps will be procured in Malawi through the said agent.

(6) Chlorination Devices

The common water disinfection process for water supply systems in Malawi is the injection of dissolved high purity bleaching powder using a pump. This chlorination device can be locally procured through an agent. As the maintenance of the device is not problematic, this device will be procured in Malawi through the said agent.

Table 2-2-10 Procurement of Materials and Equipment

Materials and Equipment	Malawi	Japan	Third Country
Cement	○		
Reinforced iron bar	○		
Pipes (PVC)	○		
Pipes (DCIP)	○		
Water Tanks (Steel Panel Type)	○		
Submersible motor pump for borehole	○		
Chlorination devices	○		

2-2-4-7 Initial Operational Guidance Plan

Following the completion of the construction work, an engineer(s) of the contractor will provide guidance/training on how to use the submersible motor pumps, chlorination devices and other independent equipment, which will be procured by the contractor in connection with Sub-Project (1), for the relevant staff members (operators of the CRWB and engineers of the CRWB Head Office).

2-2-4-8 Soft Component Plan

The O & M of the water supply facilities to be constructed under Sub-Project (1) will be conducted by staff dispatched by the CRWB to Mkanda and Santhe Market Centres. Given the facts that these water supply facilities are simple facilities supplying groundwater which has only undergone chlorination treatment and that the CRWB has good experience and know-how of the O & M of water supply facilities as well as the management of the water supply service, no special guidance/training on the O & M of the planned water supply facilities under Sub-Project (1) will be provided as a soft component.

2-2-4-9 Implementation Schedule

The following implementation schedule is based on the local market situation from August, 2010 to May, 2011.

(1) Implementation Schedule

Following the signing of the E/N with the Government of Japan and the G/A with the JICA, the Government of Malawi (MoAIWD) will immediately conclude a consultancy agreement with a Japanese

consultant to commence the detailed design process. The consultant will conduct the necessary work, including a field survey, and prepare the detailed design documents.

The consultant will also provide assistance for the tender organised by the MoAIWD and will conduct a series of tender-related work to select the contractor for Sub-Project (1), ranging from the pre-qualification of Japanese construction companies to the tender and evaluation of bids. When the successful bidder has been selected, a construction agreement will be concluded between the successful bidder (contractor) and MoAIWD after negotiations. The contractor will then commence the work on receipt of a notice to proceed with the work issued by the consultant.

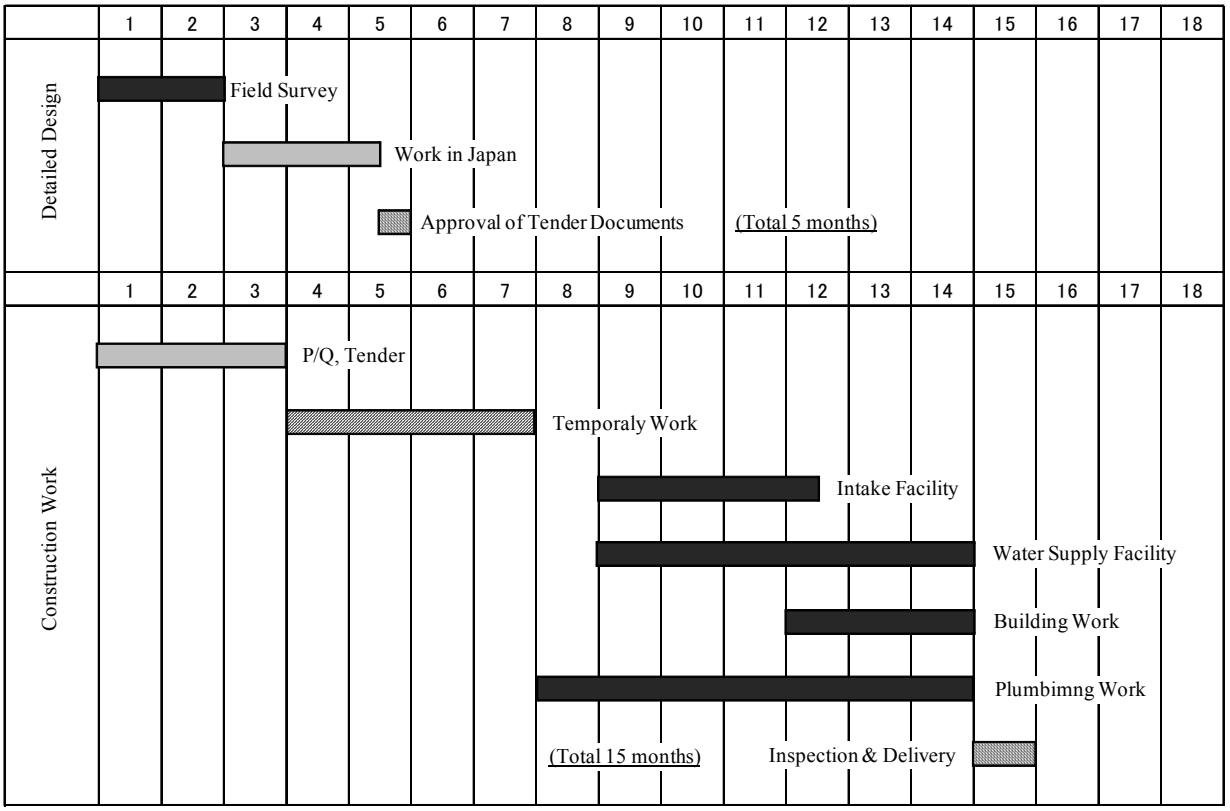
It will take a total of 20.0 months to complete Sub-Project (1) as described below, taking into consideration (i) the types and scales of the planned facilities, required period for the procurement and transportation of the construction equipment and materials and implications of the dry and rainy seasons for the construction work and (ii) requirements of the grant aid scheme of the Government of Japan into consideration.

①	Detailed design period	:	5.0 months
②	Construction period	:	15.0 months (including 3.0 months for the tender)
	Total	:	20.0 months

(2) Sub-Project (1) Implementation Schedule

The implementation schedule for Sub-Project (1) with due consideration of the various conditions described above is shown in Table 2-2-11.

Table 2-2-11 Project Implementation Schedule (Sub-Project (1))



2-3 Outline Design of the Japanese Assistance (Rehabilitation of Boreholes in Mchinji)

2-3-1 Design Policy

(1) Basic Policy

The responsible agency for the Project for Rehabilitation of Boreholes in Mchinji (hereinafter referred to as Sub-Project (2)) is the MoAIWD while the implementing agency is the Department of Water Resources of the MoAIWD. After the rehabilitation/construction of the boreholes, their daily O & M will be conducted by a WPC which is formed by residents for each borehole.

The original request by the Government of Malawi involved the rehabilitation of 400 boreholes, construction of substitute boreholes for those existing boreholes beyond rehabilitation, provision of training for community on the O & M of boreholes and the procurement of borehole construction equipment and materials. In response to this request, the Survey Team conducted a borehole diagnosis survey, social conditions survey and others and held discussions with the MoAIWD on the findings of these surveys to determine the scope of the Japanese grant aid. Following these discussions, the basic policy for the outline design for Sub-Project (2) was finalised as described below.

① The targets of Sub-Project (2) are 300 boreholes constructed between 1992 and 1995 with Japanese grant aid and the local communities served by these boreholes. The selection of these boreholes is based on the facts that these are the longest serving boreholes among boreholes equipped with an Afridev pump in the Mchinji District and that their construction records are available.

② The borehole rehabilitation work primarily consists of the replacement of the main pump components and the removal of unwanted sediments at the bottom of the borehole. This decision is based on the judgement that the main cause of non-functioning boreholes is deterioration of the pump beyond its expected life together with the fact that the pumping capacity at some existing boreholes will severely decline in the near future with progressive siltation at the bottom of the boreholes.

③ The replacement pump will be the Afridev pump which is the same pump installed when the borehole constructed and the pump will be replaced at the same depth as that of the pump initially installed. However, the rod and plunger will be made of stainless steel and brass respectively. The reasons for these changes are (i) the original mild steel rod is susceptible to corrosion with the deformed or damaged rod damaging the PVC riser pipe and (ii) abrasion of the plunger is one cause of a decline of the pumping discharge.

④ At those boreholes where the pump cannot be lifted for repair, a substitute borehole will be constructed within the boundary of the same community. In the case of those boreholes of which the

viability of rehabilitation is not clearly established, trial rehabilitation work will be conducted during the detailed design study period to make a final decision on their rehabilitation.

⑤ When the size of the local population is too large to be served by a rehabilitated or replaced borehole, one additional borehole will be constructed within the boundary of the said community.

⑥ No borehole drilling equipment will be procured under Sub-Project (2) as the decision to procure such equipment under the Japan's Grant Aid for Environment and Climate Change "the Improvement of Capability to Cope with Natural Disasters Caused by Climate Change" has been made. However, one set of borehole rehabilitation equipment for the principal purpose of removing sediments at the bottom of boreholes as newly requested during the study period in the light of the purpose of Sub-Project (2) will be procured for use in Sub-Project (2) to contribute to the prolongment of the service life of boreholes in the Mchinji District and to the improvement of Malawi's borehole rehabilitation capacity.

As a grant aid project of the Government of Japan, Sub-Project (2) will involve the rehabilitation of boreholes and the construction of substitute boreholes where necessary as described above. Meanwhile, the O & M of these boreholes will, in principle, be the responsibility of the WPC organised by local residents in each community benefiting from a borehole. Because many of the target boreholes of Sub-Project (2) are 15 years old or more, there are cases where the WPC has disappeared or O & M techniques have not been properly passed on. This situation demands (i) community training on the O & M of the boreholes to be either rehabilitated or newly constructed and (ii) the training of trainers who will implement the community training during the implementation period of Sub-Project (2). These activities (CBM programme) will be conducted by the Malawi side. The Japanese consultant will provide assistance to ensure the efficient and effective implementation of these activities during the implementation period of Sub-Project (2) and will assess their outcomes.

The rehabilitation and construction of boreholes will be conducted by local subcontractors under the supervision of the Japanese contractor. Meanwhile, the Japanese consultant will supervise the construction work for the purpose of quality control and schedule control.

(2) Natural Conditions

1) Climate

The local climate is already described in 2-1-1 (2). Access to the target boreholes for rehabilitation by large vehicles will be difficult during the rainy season from December to March as the access route in many areas involves unpaved roads and/or vulnerable bridges over swamps. Because of the large number of boreholes, the construction period will be largely confined to the dry season from April to

November to ensure the efficiency of the rehabilitation/construction work except for such work as the preparation of stock yards for the construction equipment and materials.

2) Water Quality

When the water quality check at each borehole concludes that the groundwater available at the said borehole is not safe enough in view of the WHO guidelines for drinking water quality, the borehole in question will be removed from the scope of Sub-Project (2).

3) Topographical and Hydrogeological Conditions

The target area is generally flat with gentle undulations. The outline design and detailed design studies for previous grant aid projects have determined that aquifers suitable for hand-pump operated boreholes with a small pumping volume are widely distributed in the weathered zone of bedrock (gneiss) with an irregular thickness. While the original borehole drilling sites were selected by means of the electric prospecting of aquifers, the records show that unsuccessful boreholes occurred due to undetected localised irregularities of the weathered zone of the presence of intrusive rock.
For the drilling of substitute boreholes against the irreparable boreholes and additional boreholes for increased population, 12 L/min is adopted for the standard discharge for successful drilling according to the current standards in the Department of Water Resources, while 10 L/min was applied for the standard discharge in the construction stage (1993- 1995). The success ratio for these drilling works can be estimated 71 % on the current standard as shown in Table 2-3-1, while actual ratio was 85% against the previous standard at that construction stage.

Table 2-3-1 Success Ratios based on the standard quantity of yield

Standard Water Quantity for Successful borehole: Q (L/min)	Number of Successful BH	Number of Drilled BH	Success ratio(%)
Q=10 or more (Standard as of construction stage)	300*	354	85
Q=12 or more (Current standard in DWR/ MoAIWD)	252	354	71

*: some boreholes which had less discharge than 10 L/min were included after consideration of the social condition and the borehole structure

For Sub-Project (2), the locations of the substitute and additional boreholes will be determined based on electric prospecting to be conducted as part of the detailed design study, taking their preferred locations by residents into consideration. The overall success rate is expected to be similar to that of previous projects.

Because of concern in regard to contaminated groundwater as mentioned earlier, the selected locations of the substitute and additional boreholes will be at least 30 m upstream in terms of the groundwater flow from possible sources of contamination, such as pit latrines.

(3) Socioeconomic Conditions

The matters to be taken into consideration for the planning of borehole rehabilitation and construction include the size of the user population, current usage situation of the target boreholes, local willingness to continue or re-establish the WPC, local willingness to bear the borehole O & M cost and situation of water supply facilities other than boreholes constructed under Japan's grant aid scheme.

The population size of each target community will be determined based on an interview surveys as part of the social conditions survey and/or an average number of family members per household of 5.0 persons. For those communities where the head man cannot be directly interviewed, the population size will be estimated by means of regarding the number of pit latrines as the number of households and/or by other methods. The target year of Sub-Project (2) is 2015 which is two years after the completion of the rehabilitation/construction work.

(4) Necessity for and Principles of Equipment Procurement

1) Past Performance of Borehole Rehabilitation Work and Relevant MoAIWD Policy

Apart from the repair or replacement of the pump, borehole rehabilitation work may include the removal of sediments at the bottom and/or the clearance of a clogged screen. Such work requires a method and equipment suitable for the structure and state of deterioration of individual boreholes. In the case of a borehole equipped with a hand pump which is a popular choice for rural water supply in Malawi, a PVC filter screen pipe is used. To avoid damage to the screen, air lifting is judged to be the most suitable method of cleaning the inside of the borehole. Air lifting is also conducted at the development (cleaning) stage of borehole construction after the completion of drilling and the MoAIWD has been used the pumping test equipment provided as part of the borehole drilling equipment under previous grant aid projects for the rehabilitation of boreholes.

In FY 2010/11, the MoAIWD rehabilitated 41 boreholes using part of the borehole construction budget of 110 million KM. The approved borehole construction budget for the current FY 2011/12 is MK. 125 million. Although the exact proportion of this budget to be allocated to borehole rehabilitation is undecided, the MoAIWD is considering the rehabilitation of 15 boreholes to start with. The MoAIWD is well aware of the need to significantly increase this number if the ratio of non-functioning boreholes is to be reduced from the current 30% to 25% nationwide by 2016. In addition to the MoAIWD budget, the Local Development Fund assisted by the UNICEF in individual districts has been a minor funding source for borehole rehabilitation. Borehole rehabilitation is conducted by the district authorities as part of the new borehole construction work awarded to private companies but the actual number of boreholes rehabilitated in this manner is very small.

2) O & M System for Borehole Rehabilitation Equipment

While six sets of drilling rigs were procured under the four Japanese grant aid projects in the past, two units have been not working, leaving the remaining four sets as the main drilling rigs utilised by the Government of Malawi. These rigs are currently operated and maintained by the borehole construction team with approximately 50 staff members of the Department of Water Resources of the MoAIWD. The rehabilitation of boreholes requiring special equipment because the required work is beyond the technical capability of a WPC or an area mechanic is funded by the Department of Water Resources which possesses such special equipment. The actual types of rehabilitation work in this category include the dredging of boreholes and the removal of fallen objects from boreholes. The new equipment to be procured under Sub-Project (2) will, therefore, be operated and maintained by the Borehole Construction Section of the Department of Water Resources.

3) Policy for procurement of equipment

In order to implement the Project smoothly and to enhance MoAIWD's capacity for borehole rehabilitation, a set of borehole rehabilitation equipment is procured for them. The equipment consist of a set of air lifting equipment (combination of air compressor and tools), bailer for dredging sediments in borehole, a set of pumping teat equipment (combination of generator, submersible motor pump and tools) for checking performance of rehabilitation, an electric winch for lifting tools, a truck for transporting these equipment and supporting vehicle. These equipment are necessary to be mounted on the truck as a package for effective usage, and also required to be performed consistently. Therefore, the procurement of these equipment is desirable to be a package except a supporting vehicle. On the other hand, as the scale of procurement is much smaller than the construction work, it is reasonable to be procured from Japan through the Japanese contractor for rehabilitation work.

(5) Construction and Procurement Conditions

In Malawi, about 10 borehole drilling companies and many more construction companies are involved in the construction of water supply facilities and these local companies will be actively used for Sub-Project (2). As borehole rehabilitation work basically resembles borehole finishing work, the expertise of existing borehole drilling companies can be effectively utilised.

Most of the construction materials required for the rehabilitation work (cement, aggregates, bricks, reinforcing bars, casings, screen pipes, riser pipes, packing gravel and others) are available in the local market and will be actively used. Hand pumps (Afridev type) imported from India are available in the local market and procurement in the local market will be the first priority. If the stock level is insufficient, however, it will be necessary to initiate the importation procedure using a local agent of the manufacturer. Most of the necessary equipment for the rehabilitation or construction of boreholes is either owned by

local companies or can be leased in Malawi. Such equipment will, therefore, be arranged in Malawi in principle except for administrative vehicles.

(6) Operation and Management of Sub-Project (2)

With the on-going process of decentralisation, there is a mechanism for the planning and coordination of district-level water supply and sanitation activities under the leadership of the district coordination team (DCT). In the Mchinji District, however, one of NGOs is continuing to assist the activities of 19 area mechanics appointed in 2008 under the Government's project funded by UNICEF. The operational status, including the situation of breakdown and repair, is monitored by regular monthly meetings involving representatives of the NGO, area mechanics and staff members of the District Water Development Office.

However, the district-level project implementation system is not sufficient in terms of both the technical capability and manpower and the technical assistance of the MoAIWD and Regional Water Development Office (Central) is necessary.

In view of the capability of local agencies, Sub-Project (2) will be implemented with the MoAIWD acting as the counterpart. The Regional Water Development Office (Centre) and the District Water Development Office will also be invited to participate. Guidance on the maintenance of the rehabilitated or newly constructed boreholes by WPCs will be jointly provided by the RWDO (Central), District Water Development Office and District Coordination Team (water and sanitation) under the supervision of the Department of Water Supply Service of the MoAIWD.

A technical cooperation project of the JICA featuring the operation and maintenance of rural water supply facilities is currently in progress with the aim of reinforcing the existing framework of O & M in Mchinji District. The Project will coordinate with the technical cooperation through the activities of soft component.

(7) Grade of Facilities and Equipment

1) Rehabilitation and Construction of Water Supply Facilities

All of the hand pumps installed at the 300 target boreholes for rehabilitation are Afridev pumps of an early model which were introduced in large numbers after the declaration by the Government of Malawi to make this type of hand pump the standard hand pump in the country. They have now all passed their official service life and show signs of abrasion and/or corrosion. Under Sub-Project (2), the hand pump installed at those boreholes which can be rehabilitated will be replaced with a new Afridev hand pump.

At those boreholes where sounding was conducted, sediments (so called “siltation”) were observed at the bottom. As far as the findings of this sounding exercise are concerned, these sediments are not yet hampering the pumping capacity of the boreholes at present. In view of the likelihood that the thickness of these sediments will gradually increase, not only at the surveyed boreholes but also at other boreholes, it has been decided to dredge the existing siltation at all of the target boreholes for the purpose of prolonging their service life.

The target grade for the borehole rehabilitation work under Sub-Project (2) is, in principle, the grade adopted for the boreholes constructed under the Groundwater Development Project in Mchinji (1992 ~ 1995), another grant aid project of the Government of Japan. The anticipated level of rehabilitation under Sub-Project (2) is described in more detail below.

① Damage to and the deterioration of ancillary facilities will not be included in the scope of rehabilitation.

② All of the pumps will be replaced except for pump stands. However, when damaged foundations of a pump cause concern in regard to contamination, the pump stand will also be rehabilitated.

③ The length of the riser pipe and pump rod will be restored to the original length if they have been shortened.

④ As corrosion of the pump rod is a cause of frequent pump breakdown, the specification for the new rods will be stainless steel rods.

⑤ The largest population size served by one borehole will be set at 400 ~ 500 persons (as in the case of the Groundwater Development Project in Mchinji).

⑥ However, there is a chance that the pumping capacity of a borehole may not be fully restored even after dredging “siltation”. In view of this possibility, the standard pumping rate is set at 12 (litres/min) in accordance with the capacity of the Afridev pump to be installed.

In the case of those boreholes which are judged to be beyond rehabilitation due to blocking by sediments or the impossibility of removing fallen objects in the borehole, a substitute borehole (with ancillary facilities) will be constructed to match the grade of the boreholes for rehabilitation.

For the Groundwater Development Project in Mchinji, the upper limit for the design service population per borehole was set taking the pumping capacity and daily operating hours of the pump and the per capita water supply volume per day into consideration. At those sites where the service population of a rehabilitated or substitute borehole is expected to exceed 450 because of a population increase after the implementation of the earlier project, an additional borehole will be constructed.

2) Grade of Equipment for Procurement

In consideration of the technical capability of the Department of Water Resources and the suitability of the planned borehole rehabilitation work, the equipment will be selected to ensure the implementation of such work with good mobility and efficiency.

The actual borehole rehabilitation work will consist of cleaning of the screen and dredging of the sediments at the bottom of the borehole. Boreholes with a hand pump in Malawi use a fragile PVC screen and, therefore, the careful selection and application of a suitable method is essential. In view of the facts that the field survey has not discovered any serious clogging of the screen, it will be appropriate to conduct the screen cleaning and dredging work by means of airlifting using a bailer. The compressor to be procured for airlifting will be capable of discharge from the anticipated maximum depth of the rehabilitation operation of 70 m among the target boreholes and will be fully complemented by the necessary pipes and other tools. Meanwhile, the pumping test equipment to verify the rehabilitation effect will have a capacity which is comparable to that of pumping test equipment procured in the past. One crane truck of which the lifting capacity is comparable to the total weight of the equipment (approximately four tons) will be procured to transport and install all of the necessary equipment at boreholes. Another support vehicle will also be procured for administrative purposes.

When airlifting has been required for borehole rehabilitation, the MoAIWD has used the existing pumping test equipment or drilling equipment. In FY 2010/2011, the MoAIWD rehabilitated 60 boreholes in this manner. As the MoAIWD plans to rehabilitate a further 900 non-functioning boreholes in five years by the end of FY 2016/2017, it can reasonably anticipated that any equipment procured this time will be effectively used for the planned rehabilitation work in the coming years.

(8) Construction and Procurement Methods and Period

1) Construction Method

The rehabilitation work will involve the dredging of boreholes and the renewal of pumps.

In regard to dredging, the airlifting method which is used at the finishing stage of borehole construction work will be employed as this method has been commonly used in similar cases in Malawi. Local borehole construction companies possess the basic technical expertise required to conduct this airlifting work. This work can, therefore, be appropriately conducted provided that the Japanese contractor supervises the selection of the airlifting tools, adjustment of the compressor pressure and other technical details. As the thickness, etc. of the sediments at the bottom of a borehole can vary from one borehole to another, the depth of the borehole will be measured before

and after dredging for comparison with the original depth to verify the dredging effect. The range of equipment to be procured under Sub-Project (2) includes that for dredging with a bailer will be conducted as part of the initial operational guidance for members of the borehole development team in Malawi at those sites where the newly procured equipment is used.

As it is inferred that the borehole sediments have not yet reached the screen depth at many sites, the planned dredging work does not particularly aim at improving the pumping capacity. However, as part of the dredging work using the procured equipment, a step draw-down pumping test will be conducted before and after dredging to check if the pumping capacity has improved or not.

Replacement of the pump will involve the dismantling and removal of the old pump and the installation of a new pump. Both types of work can, in principle, be manually conducted. However, there may be cases where lifting of the pump may be difficult due to fallen foreign objects, etc., necessitating the use of a truck-mounted crane to hoist the pump up.

In regard to four boreholes where the possibility of lifting the pump could not be verified by the preparatory study, the drilling of a substitute borehole is provisionally planned. During the detailed design study period, the consultant will request a local borehole construction company to try to lift the pump at these boreholes. If this trial concludes that lifting is possible, the planned construction of a substitute borehole will be changed to rehabilitation of the borehole in question.

The borehole construction work will involve the construction of substitute boreholes and additional boreholes of which the construction method will be the same.

The drilling depth for substitute boreholes and additional boreholes is planned to be the same based on the construction records for the Groundwater Development Project in Mchinji. However, as the actual depth of the aquifer significantly varies from one site to another, electric prospecting will be conducted as part of the detailed design study to decide the drilling locations and depth. This decision will take the borehole locations proposed by the WPCs formed through CMB activities as preferred locations into consideration. The decision on the final location based on the electric prospecting results will seek the approval of the relevant WPC.

In consideration of the work efficiency and the prevention of wall collapse, the borehole drilling method will be mud rotary drilling (protection by a temporary casing) through the surface sediment layer and DTH hammer drilling through the weathered rock and bedrock layers. The drilling diameter (171 mm) will incorporate a sufficient margin to secure the placement of gravel around the casting (ϕ 110 mm). The actual drilling tool will be capable of conducting mud rotary drilling with a drilling diameter of 210 mm to enable the accommodation of any increase of the sediment thickness.

The aquifer is assumed to lie in the weathered bedrock layer which is subject to DTH hammer drilling. The depth of the screen casing will be determined based on the measurement of the mean yield at various depths of a specified interval. The actual drilling depth will be determined to allow the additional drilling of some 5 m to create a sediment pit inside the casing hole after reaching the lower end of the aquifer.

In regard to the pumping test, a step draw-down pumping test will be provisionally conducted to determine the pumping volume for the continuous pumping test. The reference pumping volume will be that which allows the maximum pumping operation of an Afridev pump. In regard to the water quality test, a simple water quality test will be conducted at each site. If the site test suggests non-compliance with the reference water quality values for the supply of untreated water in Malawi, a detailed laboratory test will be conducted.

Ancillary facilities will follow the relevant design adopted by previous grant aid projects (including the Groundwater Development Project in Mchinji) as the standard in Malawi. They will be constructed by a local subcontractor and quality control will be applied to concrete and other areas of the work. At the time of pump installation, representatives of the residents (WPC) will be invited to a briefing on the structure of the borehole and pump to facilitate their understanding in view of the proper implementation of the subsequent O & M of the borehole by the WPC.

The construction schedule will be set within the maximum period of eight (8) months with due consideration of the following matters.

- As site access by truck or drilling machine will be difficult during the rainy season (December to March) at many sites, the borehole rehabilitation/construction work, excluding the preparatory work, will be conducted during the dry season (April to November).

- The borehole rehabilitation work will commence with two teams using equipment owned by local companies. After the arrival of the newly procured equipment, an additional team to use this equipment will be formed by staff members of the MoAIWD. In view of the cycle time of each team, the work should be completed in a single dry season (April to November).

- In consideration of the cycle time and local conditions, the borehole construction work will initially use two sets of drilling rigs. The ancillary facility construction starting two weeks later will be conducted by three times. All of the work will be completed within a single dry season.

- Because of the larger volume of work to be conducted, part of the District Water Development Office premises will be rented free of charge and a construction base primarily consisting of a stock yard for equipment and materials will be established prior to the commencement of the rehabilitation and drilling work.

- The completion of certain preparatory activities prior to the commencement of the drilling work is necessary. These activities include the provision of training for trainers who will be responsible for CBM-related activities, the establishment of WPCs which will be responsible for the maintenance of the rehabilitated or newly constructed boreholes by these trainers and the selection of drilling locations with due consideration of the preferences of each WPC.

The construction plan is described in more detail in 2-2.

2) Procurement Method

The new equipment will, in principle, be procured in Japan to ensure the compatibility with and coordinated operation of the existing and new equipment. A pick-up truck (with a single cabin) which can be independently procured from other types of equipment will be procured in Malawi. When considering the likely manufacturing and transportation periods, the overall procurement period for the equipment related to borehole rehabilitation will be approximately eight months.

In regard to the transportation of equipment, the cheapest route among the feasible routes for smooth and reliable transportation will be selected with due consideration of the various conditions for self-propelled transportation (pick-up truck) and container transportation (other equipment). These conditions include the distance for maritime and inland transportation, facilities at possible ports of landing, road conditions of the viable routes and any special requirements for the equipment in relation to transportation.

2-3-2 Basic Plan (Construction Plan / Procurement Plan)

2-3-2-1 Overall Plan

Table 2-3-2 through Table 2-3-4 show the contents of Sub-Project (2) and the O & M system, following the findings of the field survey.

Table 2-3-2 Outline of Facilities (Rehabilitation/Construction) – Sub-Project (2) -

Work Item	Target boreholes*	Outline of Work		Quantities	
Rehabilitation of Borehole	The boreholes which are able to be rehabilitated and/or extended its lifetime by replacing pump parts and dredging.	Dredging of Boreholes Replacement of the pump part or renewal of pump		280 sites	
Construction of Borehole	The irreparable boreholes	Substitute Borehole	Construction of boreholes and ancillary structures	15	Max.54 sites in total Average drilling depth :39m
	The overloaded borehole due to increased population (approx. 450 persons/borehole or more).	Additional Borehole		39	
Exclusion	The following boreholes are excluded from the target sites after a careful evaluation. - Its surrounding groundwater is contaminated with Faecal Coliform or Faecal Streptococci: 2sites - The borehole abandoned and not desired to be rehabilitated by the users:1 site - The boreholes located in the planed service area of water supply system for Mkanda Market Centre : 2sites	-		5 sites	

* Target boreholes: All of target sites are selected from the 300 boreholes constructed under the Project for Mchinji Groundwater Development (1992-1994)

Table 2-3-3 Procurement of Equipment (Equipment for borehole rehabilitation)

No.	Items	Quantities
(1)	Truck with crane	1 unit
(2)	Air compressor	1 unit
(3)	Generator	1 unit
(4)	Electric winch	1 unit
(5)	Submersible motor pump (with standard accessories)	1 unit
(6)	Tools for development (for bailer and air lift)	1 unit
(7)	Portable water quality meter	1 lot
(8)	Supporting vehicle (pick-up truck single cabin)	1 unit
(9)	Tools for pumping test	1 lot

Table 2-3-4 Operation & Maintenance (O & M) System

Target	O & M System
Borehole facilities	VWHCs and/or WPCs take responsibility of O & M for the rehabilitated or constructed boreholes. MoAIWD carries out training of above community based organisations to improve their capacity of O & M though the Project. The DWDO provides the communities the guidance for social activity and technical support in corporation with the District Coordination Team. The DWDO also monitor the activities of Area Mechanics.
Equipment for borehole rehabilitation	Equipment for borehole rehabilitation is operated and maintained by the drilling crew members under the Department of Water Resources of MoAIWD

2-3-2-2 Facilities Plan

(1) Target Sites for Borehole Rehabilitation

[Breakdown of Pumps]

The survey on existing boreholes found that many non-functioning pumps can be rehabilitated by the replacement or addition of suitable parts except in those cases where the borehole is blocked by sediment and/or pump parts. However, the pumps at all of the target boreholes are generally deteriorated as they have now exceeded their official service life, resulting in a cycle of frequent breakdown and repair. The severe corrosion of the mild steel pump rod which was popularly used when these boreholes were originally constructed is especially noticeable and the damage to this rod has prompted further damage to the riser pipe and other parts of the pumping mechanism. The pumping depth at many of the boreholes is now shallower than the original depth due to shortening of the riser pipe, in turn caused by shortening of the overall rod length as a result of cutting of a corroded section or cutting of a damaged section of the riser pipe.

Table2-3-5 Outline of Condition of Targeted Boreholes (October 2010)

Borehole Condition	Quantities	Judgement	Quantities	%
Functioning (yield ≧10 L/min)	201	Functioning	211	70
Functioning (yield<10L/min)	10			
Non-functioning (repairable*)	69	Not functioning	89	30
Non-functioning (possibility of repair is not clear**)	6			
Clogged borehole	14			

* Boreholes which may be recovered by removal of obstacles and/or replacement of riser pipes, pump rods and other consumable parts.

** In those boreholes, the possibility of repair is not clear until trying rehabilitation work using machinery including fishing tools, winch. (Two of them have been repaired by June 2011)

The field survey was conducted twice, i.e. in October, 2010 and in June, 2011. Between these two surveys, it was apparent that broken down pumps had been repaired at approximately 10 sites while new pump breakdowns occurred at approximately 10 sites. This situation appears to suggest that many of the non-functioning boreholes, which are thought to account for 20% ~ 30% of all boreholes, are actually awaiting repair, implying that they are repairable. It may well be the fact that the existing boreholes break down at a rate of once every few years. As the service life of an Afridev pump is said to be 10 ~ 15 years[3], the pumps installed under the Groundwater Development Project in Mchinji have uniformly reached the time for replacement which is the main reason for their frequent breakdown. Even though the rural water supply policy in Malawi states that the maintenance responsibility for hand pump-operated boreholes falls on the users and users' organisations (WPCs), it does not specifically state that the renewal of the pump is also the responsibility of users. Because of this, no WPC has made arrangements for the necessary funds to cover the expensive cost of replacing the entire pump system, including replacement of the corroded rod with a highly corrosion-resistant stainless steel rod and replacement of the riser pipe and pump head.

The findings of the field survey strongly suggest that it is generally necessary to renew the existing pump in order to decrease the non-functioning rate of existing boreholes. The use of improved pump parts, particularly such highly durable parts as stainless steel pump rods were not widely used at the time of construction of these boreholes, is particularly important. On the other hand, hardly any pump stands are found to be damaged, presumably because the lower half of such stands is positioned inside the concrete apron. Replacement of the pump stand is, therefore, only planned at eight sites where the concrete foundations are damaged.

[3] SKAT-RWSN (2007); Installation and Maintenance Manual for the Afridev Handpump (Revision 2), Annex III Replacement Intervals of Afridev Wearing Parts (http://www.rwsn.ch/documentation/skatdocumentation.2005-11-15.6036171875/file)

[Deterioration of Boreholes]

As a result of the use of boreholes for a long period of time, the phenomenon of siltation where fine sediments are deposited at the bottom of the borehole is observed at many of the boreholes visited during the field survey. Even though the state of siltation has not yet reached the stage of hampering pumping operation, work to dredge the existing sediments in boreholes is required to maintain proper borehole functioning for years to come. Test cleaning of the screen by means of airlifting was conducted to estimate the state of screen clogging but no significant improvement of the pumping capacity was observed after this airlifting exercise. This finding suggests that no special method is required to clear the present clogging apart from dredging of the borehole bottom sediments by means of the method (development) usually conducted at the time of borehole construction.

[Scope of Rehabilitation Responsibility of the Malawi Side]

The Government of Malawi has maintained a stance of making users pay for the maintenance cost of hand pump-operated boreholes even though it is ready to provide technical advice and assistance for serious repair work.

In view of this official policy, the types of repair work listed below which are within the financial capability of local residents and which can be conducted by a local repairer in the private sector or a government trainer from the technical point of view should be conducted by local residents (WPCs) at their own expense under the guidance of and with the advice of a government trainer.

- Replacement of consumable parts (seals, centraliser, bobbins, plungers and others)
- Repair of the pumping system, including damage to the rod and leakage from the riser pipe which may occur in the future.
- Repair of damaged or worn concrete apron
- Prevention of erosion around the apron and repair of eroded areas

Through its CBM programme, Sub-Project (2) intends to clearly convey the responsibility of borehole users to maintain and repair the boreholes they use and to strengthen the capacity of residents' organisations (WPCs) to maintain their boreholes independently.

Meanwhile, the district government will be responsible for the monitoring of borehole operation and guidance on the required repair to be conducted by water monitoring assistants (WMAs) and other trainers during and after Sub-Project (2).

The district government will also be responsible for monitoring of the activities and skills of local independent repairers and for the spread of a good contractual relationship with WPCs.

At present, the district government does not have sufficient manpower or funds and an increase of the staff strength and their training will be implemented by the MoAIWD which has central jurisdiction for the water supply sector with a view to developing an environment for a sustainable maintenance system for boreholes.

(2) New Borehole Construction Sites

[Blocking of Existing Boreholes]

Those boreholes of which the pump head has been removed and which are blocked by sediments cannot be rehabilitated. These boreholes tend to be located some distance from a residential area and theft of the pump head and/or rod has led to deterioration of the borehole while awaiting repair. While the provision of guidance on how to deal with the theft of key parts is essential for communities with this type of non-functioning borehole, the Survey Team has concluded that it is necessary to construct a new substitute borehole at a site within the boundary of the community concerned where monitoring and O & M is easier than at the existing borehole location.

[Overloaded Borehole Due to Increased Population]

Of the villages (communities) targeted by the Groundwater Development Project in Mchinji, some are currently experiencing the excessive use of their boreholes (in view of the estimated population based on the number of households established by interviews and the number of safe water supply facilities). The lessons learned from previous projects suggest that even if the boreholes are properly repaired, they will tend to experience further breakdowns under the heavy load of an excessive number of users. The construction of an additional borehole is, therefore, necessary to alleviate the future burden on the boreholes to be rehabilitated under Sub-Project (2) in those communities with an excessively large number of users. To be more precise, in accordance with the design population per borehole under the Groundwater Development Project in Mchinji, the design population, i.e. users, per rehabilitated borehole is set at 450 persons and the construction of one additional borehole is planned for those communities where the borehole to be rehabilitated is expected to be used by more than 450 persons.[4]

Under the circumstances described above, the absence of the urgent rehabilitation of boreholes by means of replacement of the pump and cleaning of the borehole as well as the construction of the additional boreholes required in the target communities in which a borehole was constructed under the Groundwater Development Project in Mchinji will lead to more frequent pump breakdowns and an increase of the number of boreholes beyond rehabilitation. The planned borehole rehabilitation under Sub-Project (2) will

[4] The number of users of the boreholes to be rehabilitated under Sub-Project (2) is calculated by dividing the estimated population of the community in 2015 (number of households x 5 persons/household with an annual population growth rate of 3.5%) by the number of safe water supply facilities. The standard user size of 450 persons per borehole is set so as not to reduce the number of users per borehole in the community but to disperse the likely number of users of the target borehole for rehabilitation by means of constructing an additional borehole.

be highly effective to reduce the ratio of non-functioning boreholes and the urgent implementation of Sub-Project (2) is essential to improve the actual water supply ratio in the Mchinji District.

(3) Excluded Sites from the Borehole Rehabilitation Plan

[Groundwater Contamination nearby Borehole]

The water quality test conducted at the time of construction and during the field survey for the present study revealed that although the local groundwater does not show any problems in terms of its chemical properties, it tends to have a high level of acidity with a pH value ranging from 5.4 to 8.0 (average of 6.6). The water quality standards in Malawi (MS 733:2005) stipulate a pH value of between 6.5 and 8.5. The relevant WHO guidelines do not set a standard pH value as the pH value is not considered to be a direct indicator for human health. However, water with a pH value of less than 6.0 severely corrodes iron and has a distinct taste. Under Sub-Project (2), all of the new pump rods will be made of stainless steel.

Meanwhile, the borehole environment survey found faecal coliform (FC) and faecal streptococci (FS) at one borehole each even after the sterilisation of these boreholes, implying the likely contamination of the groundwater. As contamination of the groundwater cannot be remedied by the rehabilitation of the borehole, including replacement of the pump, these two boreholes are excluded from the scope of the planned rehabilitation work.

The possible sources of contamination are leaching pits accessible by animals, pit latrines near the borehole, animal sheds and waste disposal sites. All of these potential sources can be observed near boreholes which have not been contaminated. It is necessary to approach local residents (WPCs) to prevent unwanted access by animals and to abolish sanitation facilities near boreholes through the CBM programme and continual monitoring. All of the communities with the target boreholes of Sub-Project (2), including those with contaminated boreholes, are included in the scope of the CBM programme as the soft component of Sub-Project (2).

FC is an indicator of contamination originating from human faeces and the water quality standards in Malawi allows its presence up to 50 counts/100 ml. However, as users of the borehole where FC was found believe that they suffer from diarrhoea too often, the groundwater from this borehole cannot be said to be clean. In contrast, FS is strongly associated with animal faeces and both the water quality standards in Malawi and the WHO guidelines stipulate that no FS should be found in water for drinking.

Table 2-3-6 Result of Microbial Water Test on Site (May – June, 2011)

	By Central Water Laboratory (Before chlorination)	By Survey Team (Before chlorination)		By Survey Team (Two days after chlorination)
	1st survey for cross checking		2nd survey	3rd survey
Faecal Coliform (FC)				
No. of sample	13	13	223	6
Not detected	11	13	219	5
Detected	2	0	4	1
(/100ml)	(1)		(1～44)	(30)
Faecal Streptococci (FS)				
No. of sample	13	13	7	6
Not detected	8	10	6	5
Detected	5	3	1	1
(/100ml)	(1～47)	(1～51)	(11)	(46)

Number of borehole which is able to obtain water sample : 236
Number of borehole which is not able to obtain water sample : 64
Standards for water quality MS 733 (borehole) : FC < 50/100ml, FS = 0/100ml
WHO (drinking water) * : FC, FS = 0/100ml
(*: Under the conditions that faecal contamination is wide spread such as in many of developing countries, medium-term targets for the progressive improvement of water supplies should be set.)

[Abandonment of Borehole by Users]

At one borehole located on the premises of a hospital, when the pump head was removed for maintenance in 2006, the well was used as a toilet by senseless persons, resulting in abandonment of the repair work as well as the borehole itself. As the hospital subsequently constructed a substitute borehole nearby, the abandoned original borehole is excluded from the scope of Sub-Project (2).

[Duplication with Sub-Project (1) Area]

Under Sub-Project (1), a piped water supply system will be constructed at Mkanda Market Centre in Mchinji District. Two boreholes constructed under the Project for Mchinji Groundwater Development are located in the service area of this new system. To avoid duplication, these boreholes are excluded from the scope of Sub-Project (2).

Table 2-3-7 The borehole exclude from subject of rehabilitation

Borehole	Name of village	T.A.	Reason
3-043	Chalunda T.C.	Dambe	Surrounding groundwater is contaminated by faecal Coliform (30/100ml). This value is not exceeds the Malawi Standards , however a symptom of diarrhea occurs frequently from users.
3-102	Chitonde	Dambe	Surrounding groundwater is contaminated by faecal streptococci (48/100ml). This value is over the MS 733 and WHO guideline. The soak pit has changed to a pool and pigs enter it frequently.
3-059	Kapiri Hospital	Dambe	Repair work was abandoned because some one defecated inside of the borehole. After that, the hospital constructed a substitute borehole around 10m distance.
3-079	Mkanda	Mkanda	Those sites are duplicated with project for water supply systems for Mkanda Market Centre.
3-080	Mkanda	Mkanda	

(4) Brief Contents of the Borehole Rehabilitation/Construction Plan

Based on the policy for the intended borehole rehabilitation and construction as described above, a concrete plan has been formulated (further details of the planned work are contained in the Annex). The brief contents of the planned work and number of target boreholes are shown in Table 2-3-8.

Table 2-3-8 Plan for Borehole Rehabilitation / Construction

Classification of plan		Target and measure	Number of borehole	Number of village
Borehole constructed by project for Mchinji groundwater development			300	276
	Exclusion from rehabilitation	Microbial contamination in surrounding water (2) Abandonment and substitute drilling by users (1) Duplication with project for water supply systems (2)	5	4
	Construction of substitute borehole	Irreparable borehole by blockage and borehole which possibility of repair is not clear. Substitute borehole is constructed inside same village.	Max. 15	Max. 15
	Trial of rehabilitation work (at detailed design stage)	Trial of rehabilitation work such as fishing obstacle is carried out for boreholes not clear the possibility of rehabilitation If the rehabilitation is successful, the borehole will be excluded from substitute drilling sites.	4 of above	4 of above
	Rehabilitation work	Re-development (dredging), Renewal of pump except of pump stand	272	250
		Re-development (dredging), Renewal of pump including pump stand	8	8
Village in which the targeted borehole will be overloaded due to increased population				
	Construction of additional borehole	Construction of one additional borehole in villages where the service population is estimated to be more than 450 per borehole	39	39

2-3-2-3 Plan for Procurement of Equipment

To implement smoothly and effectively the borehole rehabilitation work, not only for this Project but also in future projects in Malawi, the borehole rehabilitation equipment are selected and procured taking into account of the effectiveness for dredging of siltation in boreholes. The items of equipment are shown in Table 2-3-9.

Table 2-3-9 Specification and Quantity of Equipment (1/2)

Name of Equipment and Specification			Quantity
1. Cargo Truck with 3 t crane			1 unit
(1) Cargo Truck			
Type	:	Heavy Duty Truck, 4WD, Right Hand Steering	
Engine	:	Water-cooled Diesel Engine, Max. Output: not less than 147kw（200PS）	
G.V.W. / Load Capacity	:	Not less than 10 t/ not less than 4 t	
Carrier Length	:	Not less than 4,500mm	
(2) Crane			
Type	:	3 t crane for truck	
Lifting Capacity	:	Not less than 3 tons at 2.5m boom / not less than 1 ton at 5.0 m boom	
Working Radius	:	Approx. 0.65m～7.50m	
Boom	:	Three-section box beam type telescopic boom	
(3) Standard Accessories		Spare Tyre, Hydraulic Jack, Standard Tools	
2. Air Compressor			1 unit
Type	:	Water-cooled Diesel Engine, Rotary Screw High Pressure Type	
Free Air Delivery/ Rated Operation Pressure/ Service Air Valve	:	Not less than 2.1m^3/min/ 0.69MPa(7.0kgf/cm2)/ φ20mm x 2 nos.	
3. Diesel Engine Generator			1 unit
Type	:	Water-cooled Diesel Engine, Sound-proof type	
Out put	:	3 phase/ 220V/ 50Hz	
Rated Capacity	:	Capable of required power for starting the electric winch, and the submersible motor pump respectively	
4. Electric Winch			1 unit
Type	:	Portable and fixable type	
Rated Weight/ Lifting Speed/ Wire	:	500 – 600 kg（50Hz）, not less than 18m/min at max., φ10 m×100m	
Output / Element/ Electricity	:	Approx. 2.2kW/ 4 P/ 3 phase /220V/9A/50Hz	
5. Submersible Pump and Standard Accessories			1 unit
1) Submersible pump			
Type	:	Submersible motor pump	
Capacity/ Electricity/ dia.	:	Not less than 50L/min at 50mH, 3 phase/220V/50Hz, φ100mm for 4” well	
Power Cable	:	Submersible Cable Approx. 1.25sq×75m	
2) Control Panel			
Type/ Electricity/ Protection Device etc.	:	Outdoor Self Standing type, 3 phase/220V/50Hz, ELB、with WL, Water Level Control Relay with terminal block	
3) Riser Pipe			
Type and Length	:	Screw or flange joint, Approx. L = 75m	
4) Accessories			
Well Head	:	SS400, for 4” well	
Check Valve	:	Screw or flange joint	
Sluice Valve	:	Screw or flange joint	
MA Electrode and cable	:	Approx. L = 70m	

Table 2-3-9 Specification and Quantity of Equipment (2/2)

Name of Equipment and Specification			Quantity
6. Tools for Development (Bailer & Air Lift Tools)			1 lot
a) Bailer	:	Approx. OD: 90mm, Length: 2m	1 no.
b) Tools for Air Lift			
Riser pipe	:	NQ rod (OD70mm x ID60mm) or equivalent, 3m per pipe	>70 m
Band/ Hoisting swivel/ Holder	:	For riser pipe	1 no. each
Bent Pipe for well head	:	For riser pipe with insertion to air pipe	1 lot
Air Pipe	:	SGP（20A）or equivalent, L=4m per pipe	>70m
Air pipe elevator	:	For Air Pipe	2 nos.
Air hose, Air Swivel, Band	:	For Air Pipe	1 no. each
c) Hand Tools		For installation and dismantling of air lift and bailer	1 lot
7. Equipment for water analysis			1 lot
a) pH meter		1 no.	
Type	:	Portable, Digital indicator	
Range/ Resolution/ Precision	:	pH 0.00 to14.00 / 0.01 / ±0.02 pH	
Power source	:	Dry battery	
Accessories	:	pH Standard Solution for calibration	
b) Electric Conductivity meter		1 no.	
Type	:	Portable, Digital indicator	
Measuring range / precision	:	1 μS/cm～100 mS/cm / ±0.5% F.S.	
Range of indication	:	Significant digit :4 digits (0～2.000mS/cm, 0～20.00mS/cm 0～200.0mS/cm)	
Power Source	:	Dry Buttery	
Accessories	:	EC Standard Solution for calibration	
8. Other Equipment for Pumping Test			1 lot
1) Water Level Meter			
Type	:	Rope method water level meter	
Alarm	:	Electric sound and red lamp	
Measuring Depth and Scale	:	100m / not more than 1cm pitch scale	
Electrode	:	Diameter: approx. 13-20mm, Length: approx. 100-130mm	
2） Flow Measuri g Box (V notch)			
Dim nsion	:	Approx. 0.6m x 1.2m x 1.0m, 2 partation	
Measuring Capacity	:	0～450 L/min	
9. Supporting Vehicle (Pick-up Truck Single Carbine)			1 no.
ype	:	Pick Up Truck, Single Cabin, 4x4 drive, Right hand steering	
Engine	:	Diesel ngine	
Max. Output	:	Approx. 85kw	
Max. Torque	:	Approx. 285 Nm	
Payload	:	Approx. 1000kg	
Accessories		Spare Tyre (1 no.), Hydraulic Jack, Standard Accessories	

2-3-3 Outline Design Drawings

The outline design drawings for Sub-Project (2) are provided below. These include a location map of the target communities by type of planned work, a conceptual drawing of the borehole rehabilitation work and the standard structures of the borehole and ancillary facility.

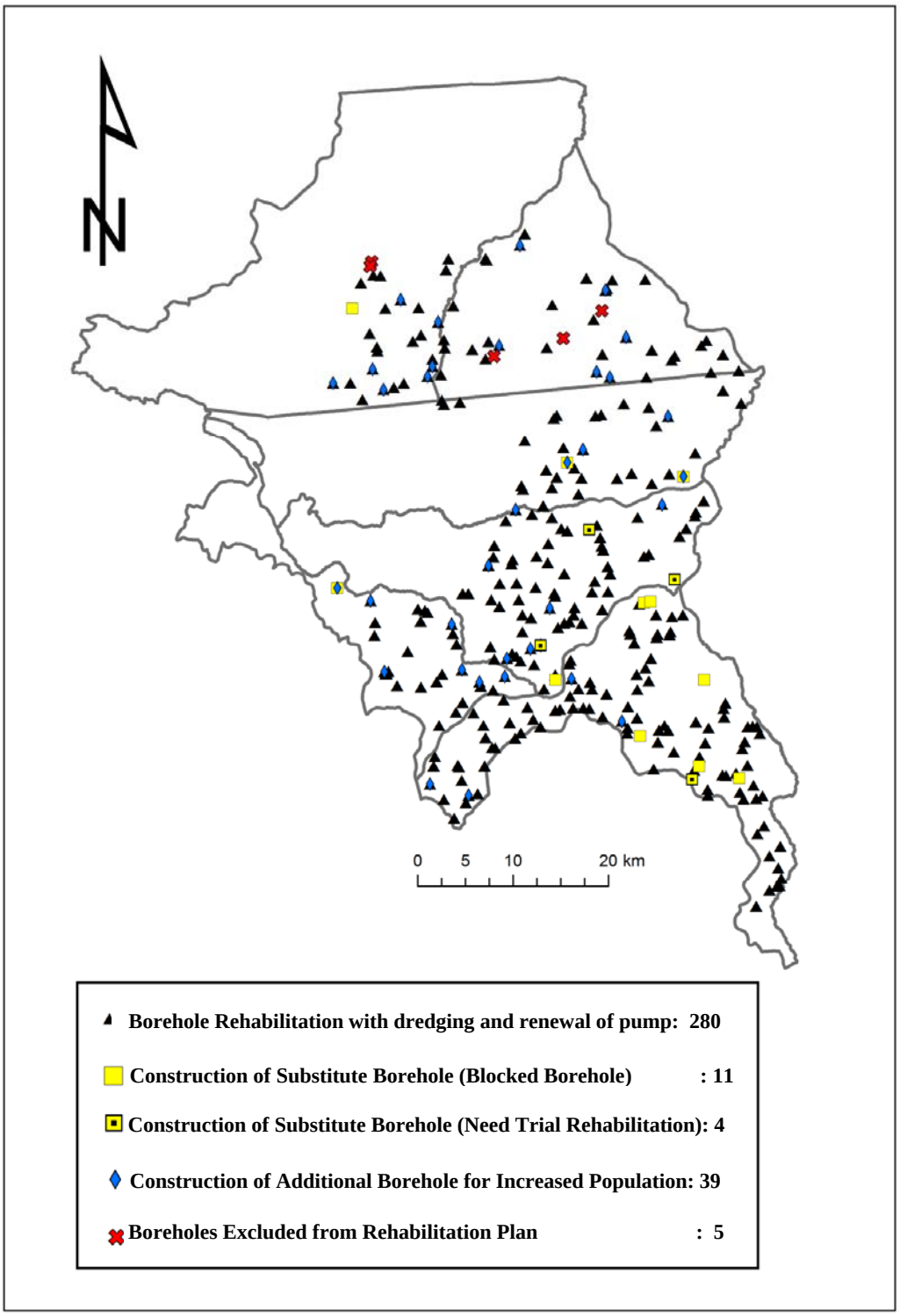


Fig. 2-3-1 Location of Target Borehole by Type of Planed Work

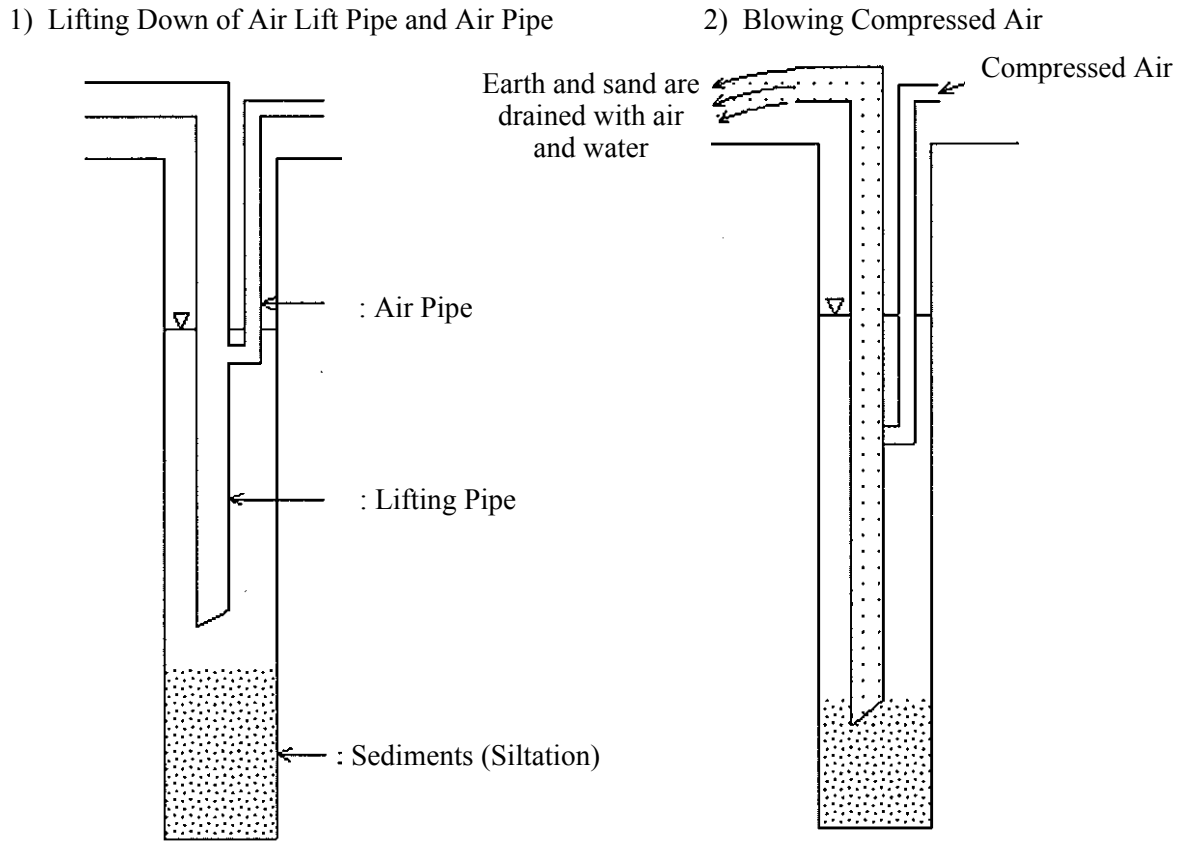


Fig. 2-3-2 Conceptual Drawing of Borehole Rehabilitation Work by Air Lifting

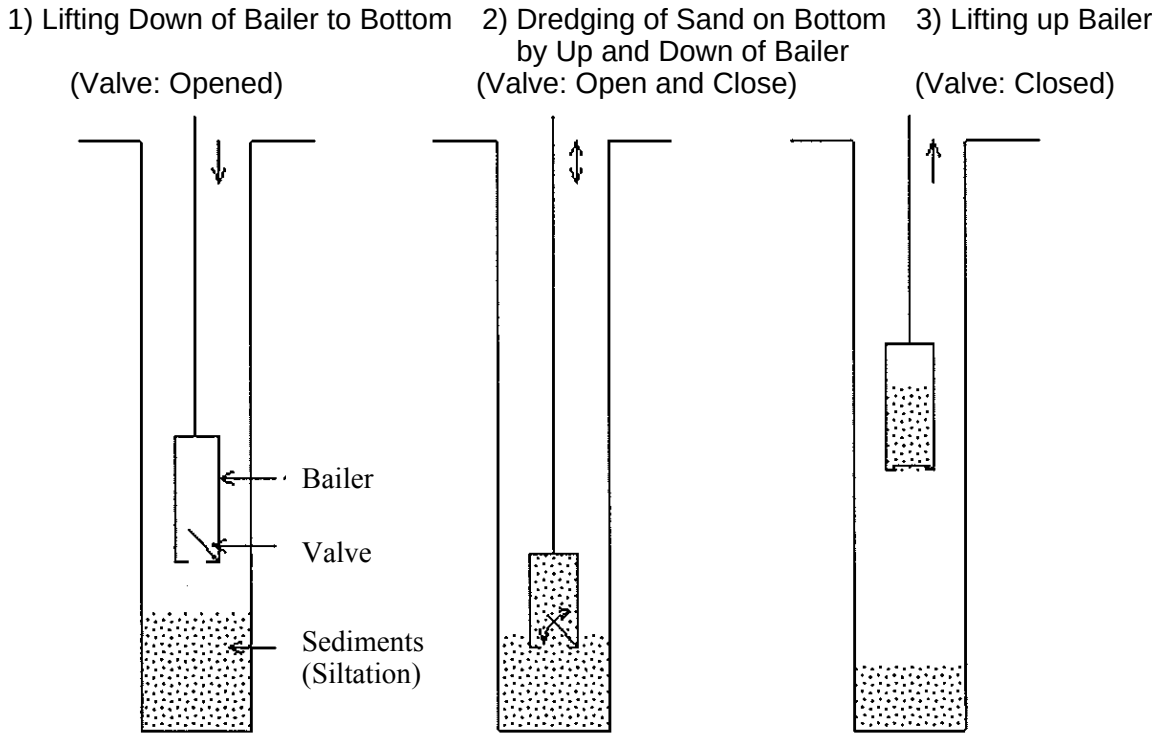


Fig. 2-3-3 Conceptual Drawing of Borehole Rehabilitation Work by Bailer
(only for the sites rehabilitated with newly procured equipment)

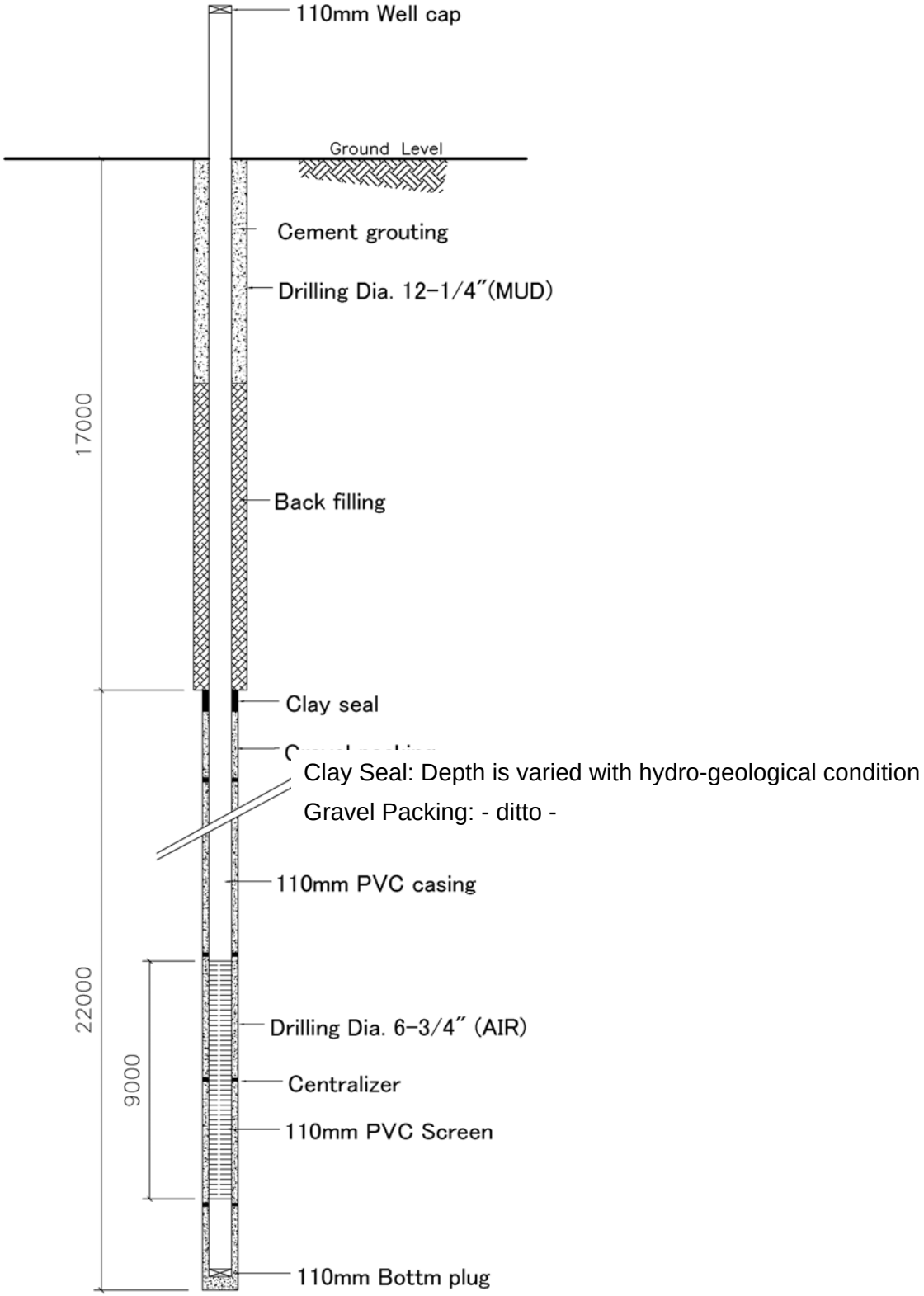


Fig. 2-3-4 Typical Borehole Structure

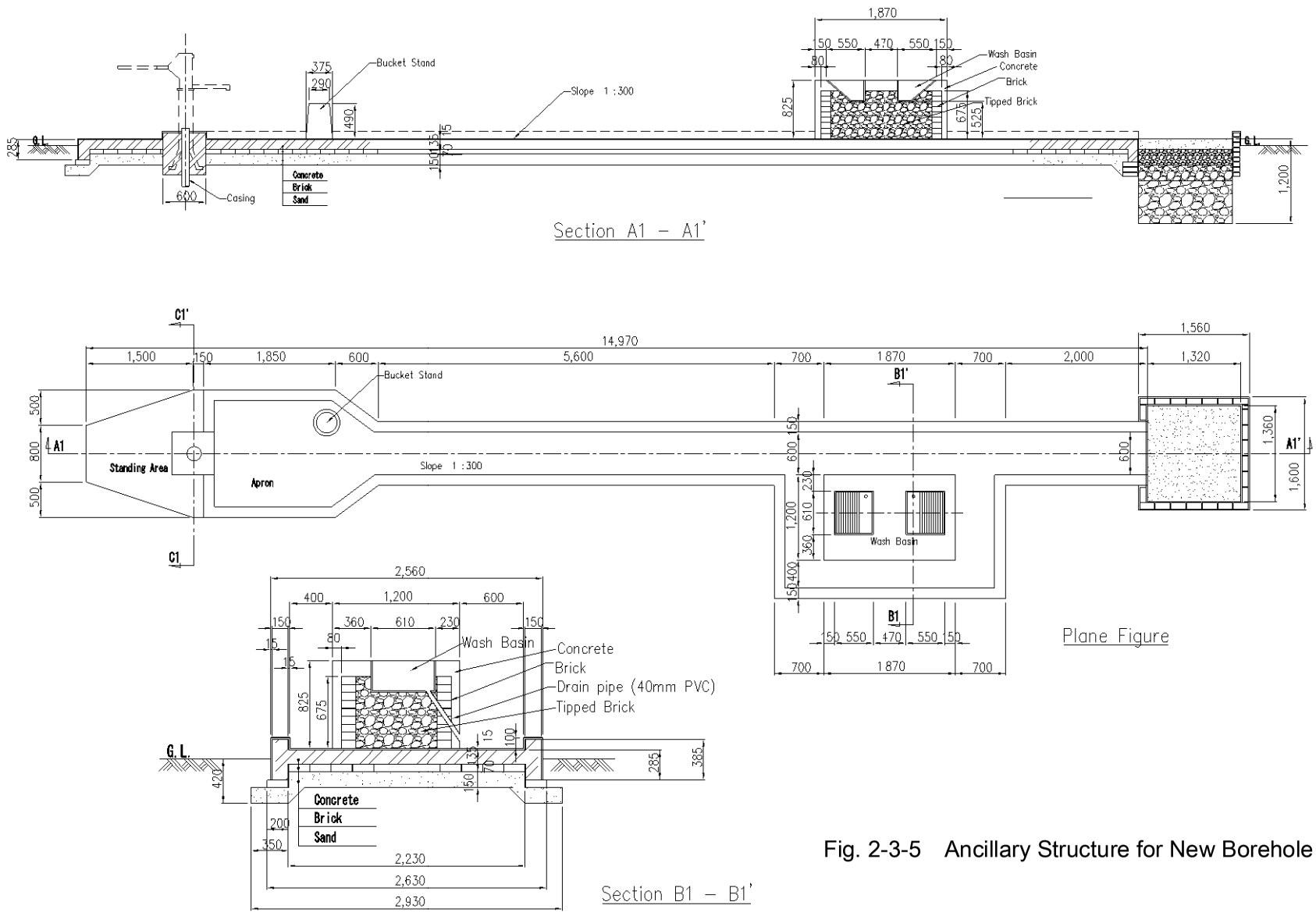


Fig. 2-3-5 Ancillary Structure for New Borehole

2-3-4 Implementation Plan

2-3-4-1 Implementation Policy

(1) Framework of Responsibilities

Following the signing of the E/N and G/A for Japan's grant aid for the Project, i.e. the two sub-projects, the MoAIWD will conclude a consultancy agreement with a Japanese consultant. The Japanese consultant will then provide consultancy services, including the detailed design (preparation of the design documents, assistance for the tender and supervision of the rehabilitation/construction work.

The rehabilitation/construction work will be conducted by a Japanese construction company which will be selected by the MoAIWD through tender in the presence of the consultant.

(2) Rehabilitation/Construction Method

1) Timing

Because of the impassable road conditions in rainy season (December to March) around the target sites except main national roads, the work involving heavy vehicles is planned to be executed in the dry season (April to November).

2) Target Sites

The target sites are those community sites where a borehole was constructed between 1993 and 1995 under the Groundwater Development Project in Mchinji (total number of boreholes: 300).

3) Work Implementation System

- Borehole Rehabilitation Work

  This work shall be carried out by three (3) teams. While out of 3 teams 2 teams will be local private construction companies, a third team shall consist of MoAIWD staff members for OJT on the newly procured and provided equipment to the Malawi side.

- Borehole Construction Work

  Four sets of drilling rigs owned by the MoAIWD are used to drill some 80 new boreholes a year. Because these government owned drilling rigs will be used for other projects, private drilling companies possessing such drilling rigs will be used for Sub-Project (2).

4) Planned Contents of the Work

4-1) Rehabilitation Work

- Rehabilitation of Boreholes

As it is believed that there are no non-functioning boreholes due to a damaged or clogged screen among the target boreholes, airlift dredging or bailer dredging will be conducted to remove the sediments inside the boreholes. Neither the airlift dredging method nor the bailer method directly cleans the screen and airlift operation will hardly affect the pumping volume in the case where the screen is not blocked by sediments. For this reason, no pumping tests will be conducted at those boreholes to be rehabilitated by the private company teams. In the case of the MoAIWD team, however, the pumping test will be conducted as part of the OJT of the new equipment.

In the case of some ancillary facilities, damage and/or erosion around these facilities has been observed but their repair is not included in the scope of the rehabilitation work.

- Pumps

There are several likely causes for the non-functionality of boreholes.

① Corrosion and/or deformation of the iron rod
② Abrasion of the inner face of the riser pipe due to deformation of the rod
③ Damage to the foot valve and/or plastic plunger
④ Deterioration of the seals (O-ring and U-seal)
⑤ Shortening of the riser pipe and/or rod at the time of repair due to the lack of funding for their replacement
⑥ Deformation of and/or damage to the pump head, head cover and/or handle because of their use well beyond their expected service life

While the pump at most boreholes is damaged, the cost of replacing the entire system is prohibitively high for the community. As partial replacement is ineffective, the entire system except for the pump stand which is embedded in concrete foundations will be replaced under Sub-Project (2).

As part of this rehabilitation (replacement) work, the specifications of the new Afridev pump will be changed from the previous iron rod to a stainless steel rod and from a plastic plunger to a brass plunger.

At eight sites where the pump stand has been severely damaged, however, the pump stand will be replaced, including the work to remove and reconstruct the concrete foundations.

4-2) Borehole Construction Work

- Drilling of Boreholes

The proposed drilling depth for the new boreholes, drilling success rate and other specifications of the new boreholes are determined based on corresponding data for the Project for Mchinji Groundwater Development (1993 ~ 1995). The specifications of the new boreholes are shown in Table 2-3-10.

Table 2-3-10 Specification of Borehole

Item		Setting	Remarks
Number of success borehole		54 sites	
Success Ratio		71%	According to the construction records of the Project for Groundwater Development in Mchinji (1993-1995)
Number of total drilling		77 sites	54 sites / 0.71
Drilling depth		39.5 m	According to the records of drilling through the Project for Ground Water Development in Mchinji. Refer to the typical structure of borehole
Expected Soil Classification	Clay and Silt	8.5 m	
	Sand	10.5 m	
	Weathered rock (Soft rock)	20.5 m	
Screen length		9 m	
Sand pocket		6 m	Plane pipe below the lowest screen
Cementation		4 m	For protection of intake water against the intrusion of surface water. Sealing with bentonite pellet or impermeable clay above the top of gravel packing, and grouting with cement on the top of borehole
Clay seal		2 m	
Standard yield		Not less than 12 L/min	
Water quality standard		Malawi Standard of water quality	MS733 : 2005; Borehole and Shallow Well Water Quality

- Ancillary Facilities

The field survey found that significant erosion around the ancillary facility (apron) has revealed the blocks below the concrete structure at some sites.

Based on this observation and associated lessons, the structure of the ancillary facilities for the boreholes to be newly constructed under Sub-Project (2) will have deep foundations around the apron, which is the common structural design in Malawi, to resist scouring.

- Hand Pumps

The type of hand pump to be installed at the new boreholes will be the Afridev pump as stipulated in Malawi. In the Mchinji District, there are 19 area mechanics supported by InterAide with UNICEF (Support for Operation and Maintenance of Rural Water Supply in Malawi), six spare parts partner shops and four Chipiku Stores, creating a local system where residents can procure the necessary spare parts. The specifications of the planned Afridev pump are given below.

AFRIDEV HANDPUMP

- Length of Spout : 580 mm
- Pump Rods : Stainless Steel (AISI30A), Eye-Hook Joint
- Plunger : Brass made
- Foot Valve : Plastic made
- Pump Stand : Tripod Type
- Rising Pipe : PVC, L = 27 m on average

(3) Procurement Method

1) Construction Equipment

A number of borehole drilling companies and construction companies operate in Malawi and it is possible to recruit the types and levels of workers required for Sub-Project (2). Many of these companies own their own construction equipment, making the import of construction equipment from Japan virtually unnecessary. All of these companies have been involved in previous projects and their technical capability has reached a certain standard. However, construction defects and failure to observe the construction schedule have been observed in some cases, suggesting that these companies cannot assume full responsibility for the required work under a Japanese grant aid project. To ensure the proper implementation of Sub-Project (2), local companies will be used as subcontractors under the supervision of the Japanese contractor.

2) Construction Materials

Construction materials which meet the design specifications under Sub-Project (2) can be procured in Malawi. In regard to Afridev pumps which have been imported from India for previous projects, the development of a local agent network means that these pumps are now available in Malawi to meet large orders. The pumps will, therefore, be procured in Malawi although the commemorative ODA plates will be procured in Japan.

3) Equipment for Procurement

The MoAIWD has some 50 staff members engaged in borehole drilling and drilling rigs, support vehicles, pumping test vehicles and other equipment are controlled by the Chief Driller. Any new equipment to be provided under Sub-Project (2) will be similarly controlled through the reorganisation of the borehole drilling team after the completion of the Sub-Project (2).

All of the new equipment will be used for part of the borehole rehabilitation work and the MoAIWD team members will learn the necessary O & M through OJT.

The MoAIWD plans to rehabilitate 60 boreholes in FY 2010/2011 and a further 900 non-functioning boreholes in five years by the end of FY 2016/2017.

(4) Dispatch of Japanese Engineers

Each borehole to be rehabilitated or constructed under Sub-Project (2) consists of the borehole itself and its civil engineering facilities. In order to conduct the required work while meeting the specifications and quality demanded by Japan's grant aid scheme, the dispatch of Japanese engineers to Malawi will be necessary to provide guidance for local engineers in relation to the implementation of quality control and other aspects of the required work.

To be more precise, it will be necessary to dispatch a highly skilled Japanese drilling worker to supervise local workers in addition to engineers of the contractor (one hydrogeological engineer for the control of the rehabilitation work and one hydrogeological engineer and one civil engineer for the control of the construction work).

(5) Subcontract to Local Contractor

A Japanese construction company is generally selected as the main contractor by the government of the recipient country for a Japanese grant aid project. However, the participation of local construction companies (as subcontractors) is almost essential to ensure the smooth implementation of the work in a foreign country where the weather conditions, legal system, customs and sense of values may vastly differ from those in Japan. There are many local construction companies in Malawi which are judged to be capable of conducting the necessary work of constructing the planned water supply facilities under the guidance and supervision of the Japanese contractor. These local companies will, therefore, be actively used for Sub-Project (2), partly for the purpose of transferring construction technologies and techniques to these companies.

2-3-4-2 Implementation Conditions

The construction work under Sub-Project (2) will be conducted with due consideration of the site conditions, equipment and material procurement conditions, labour conditions, social conditions and other relevant aspects as described next.

- As many local roads become impassable for large vehicles in the rainy season, the work schedule will be prepared to avoid any adverse impacts of such road conditions.

- In the case of those boreholes which are judged to be beyond rehabilitation, a substitute borehole will be constructed for each existing borehole. In the case of those boreholes of which the viability of rehabilitation has not been clearly established, rehabilitation work will be conducted during the detailed design study period if possible. If this work proves to be successful, the borehole(s) concerned will be removed from the drilling plan for substitute boreholes.

- As there is a possibility that a breakdown of a borehole which cannot be repaired will occur after the preparatory study and during the detailed design study period, the detailed design will incorporate such boreholes as much as possible in the final selection of the target boreholes for rehabilitation or replacement.

- There is a further possibility of a new breakdown of a borehole which cannot be repaired at no fault of the contractor during the rehabilitation/construction period. Replacement of the pump or dredging of the borehole will not be conducted in the case of such boreholes and they will not be included in the scope of the drilling of replacement boreholes.

- The local supply of petrol or light oil may be unstable at times. In preparation for such an eventuality, the arrangement of appropriate measures to secure the necessary quantity of petrol and light oil will be necessary.

2-3-4-3 Scope of Work

(1) Scope of Work for the Japanese Side

① Consultancy services regarding the detailed design and tender
② Implementation and supervision of the borehole construction work (including the procurement of related equipment and materials)
③ Assistance for the implementation of the CBM programme for communities as the soft component of Sub-Project (2) (both administrative and technical assistance)

(2) Scope of Work for the Malawi Side

① Acquisition and levelling of the land to establish a base camp
② Improvement of the access roads from the base camp to each borehole site

③ Provision of partial labour by residents
④ Assistance for the prompt customs clearance of the imported equipment and materials
⑤ Dispatch of counterparts in charge of Sub-Project (2) and payment of their expenses
⑥ Implementation of a programme of education and training related to the self-reliant maintenance of the water supply facilities by local residents (WPC) under the CBM Programme

2-3-4-4 Consultant Supervision

(1) Consultancy Work

1) Detailed Design, Preparation of Tender Documents and Assistance for Tender

As part of the detailed design study, the consultant will conduct following site survey to verify the planned contents.

- Survey on the targeted boreholes by hearing from some area mechanics and site visit
- Trial rehabilitation work through the local contractor
- Decision of drilling sites and depth for substitute and additional boreholes by electric survey and agreement with the community
- Cost estimation for tender including collection of quotations

After these surveys, the consultant will prepare the tender documents and will assist the MoAIWD to select a Japanese contractor for Sub-Project (2).

2) Consultant Supervision on Construction and Procurement

① Outline

The consultant will conduct the construction supervision as described below.

a) Checking and approval of the contents of the work plan and other documents submitted by the contractor
b) Checking and approval of the conformity of the equipment procured by the contractor with predetermined specifications
c) Instruction of drilling site, targeted depth and direction of drainage to the contractor in the presence of the representative of community. Explanation of the hydro-geological characteristics and other relevant matters for the planned borehole drilling sites with geo-electric survey result.
d) Acceptance of reports from the contractor on the progress of the work and problems encountered and examination of and discussions and instructions on viable measures to deal with such problems to ensure the completion of the work as planned

e) Implementation of suitable measures upon the reporting from the contractor whenever drilling is unsuccessful
f) Inspection and approval of the quality control work conducted by the contractor during the construction work
g) Interim and final inspection of the facilities and defect inspection one year later

The consultant will also conduct the procurement supervision for the equipment at the pre-shipment inspection in Japan and the handover inspection in Malawi.

② Work Execution System and General Guidelines to Unsuccessful Borehole

It is assumed that the planned borehole rehabilitation/construction work will be conducted in the form of a lump-sum contract awarded to a Japanese contractor. As such, the said contractor will conduct the rehabilitation of the existing boreholes and the construction of new water supply facilities at the designated sites on its own responsibility.

The selection of the drilling locations will be conducted through geo-electric survey and consent with the community during the detailed design survey work. The contractor shall drill the borehole at the point instructed by the consultant. In case the borehole is not successful, the contractor can select the alternate drilling sites as long as the locations are within the boundary of each community involved while referring to the results of the electric prospecting conducted by the consultant.

The consultant will supervise the contractor according to the general guidelines described above.

(2) Project Implementation System

The required personnel and their respective roles to execute the consultancy services are described below.

1) Detailed Design

① Chief Consultant	:	Overall supervision of the detailed design, tender.
② Hydro-geologist	:	Detailed design for construction of borehole through geo-electric survey and agreement with community
③ Cost estimator	:	Estimation of the prospective bidding prices of the construction work
④ Tender coordinator	:	Pre-qualification, preparation of the construction agreement and assistance for the tender work

Above Chief Consultant, Cost estimator and Tender coordinator have posts concurrently for Sub-project (1)

2) Construction Supervision

As the on-site supervision involves a swift and precise response to unsuccessful drilling and other critical issues in order to ensure the smooth progress of the work as planned, a Japanese engineer will be assigned to the site on a full-time basis. Given the diversity of the required work, ranging from the witnessing of various types of work at scattered sites to progress control and the preparation of various documents, this engineer will be assisted by one local (civil) engineer and one office boy (concurrent with Sub-project (1)).

3) Soft Component

A specialist is dispatched three times at the beginning, ending of detailed design stage and the end of construction stage to supervise the soft component for technical assistance.

The personnel required for detailed design and construction supervision through the entire Project including Sub-project (1) are shown in Table 2-3-11.

Table 2-3-11 Staff Planning for Consulting Services

Staff	Work	in Malawi	in Japan
Detailed Design Stage			
<Detailed Design Work>			
Chief Consultant (concurrent*)	・ Overall supervision of detailed design ・ Contract out field survey work to local companies ・ Supervision of trial rehabilitation work ・ Over viewing targeted borehole for rehabilitation	○	○
Hydrogeologist	・ Site selection for borehole construction through geo-electric survey ・ Assistance to supervision of trial rehabilitation work	○	―
Water supply facility designer (for Sub-Project (1))	・ Detailed design for water supply facilities ・ Supervision of foundation survey work	○	○
Plumbing designer (for Sub-Project (1))	・ Site confirmation for land acquisition, obstacles etc. ・ Detailed plumbing design	○	○
Cost estimator (concurrent*)	・ Estimation of construction cost including data collection	○	○
<Tendering stage>			
Chief Consultant (concurrent*)	・ Preparation of tender document, approval from the client ・ Assistance to tender, tender evaluation, assistance to conclusion of contract	○	○
Tender coordinator (concurrent*)	・ Preparation of tender document, approval from the client ・ Assistance to tender, tender evaluation, assistance to conclusion of contract	○	○
Construction Supervision / Procurement supervision			
Chief Consultant (concurrent*)	・ Overall supervision of the work for construction supervision and procurement supervision ・ Final Inspection	○	―
Resident engineer – 1 (for Sub-Project (1))	・ Supervision of construction for Sub-project (1)	○	―
Resident engineer - 2	・ Supervision of construction for Sub-project (1) ・ Supervision of procurement (Acceptance, hand over)	○	―
Inspector for completion (concurrent*)	・ Final inspection for construction	○	―

* Concurrent with Sub-Project (1)

Underlined staff will take charge of Sub-Project (2)

2-3-4-5 Quality Control Plan

In regard to the borehole rehabilitation work, the consultant will direct the contractor to conduct the inspection, etc. outlined in Table 2-3-12 and will ensure that the quality control reflects the results of these inspections, etc.

Table 2-3-12 Confirmation for Quality Control (Borehole Rehabilitation)

Work item	Test Item and purpose	Frequency	Remarks (records to be checked)
Dismantle of handpump	Record of observation before rehabilitation Confirmation of disposal	1/BH	List of dismantled item (disposal or keeping by community) Photograph for all of removed pump parts
Dredging	Record of work method - Depth of BH, - Duration of dredging	1/BH	Measurement of depth of bottom (before and after the dredging) Duration of air lifting : not less than 4 hours Duration of dredging with bailer : not less than 8 hours
Pumping Test	Comparison of discharge before and after dredging by step drawdown test	2 times /BH	Only for BHs to be rehabilitated by procured equipment
Installation of Pump	Confirmation of installation With WPC's agreement	1 /BH	Certificate of completion issued by WPC, with list of pump parts installed

In regard to the borehole and ancillary facility construction work, the consultant will direct the contractor to conduct the analyses and tests outlined in Table 2-3-13 and Table 2-3-14 and will ensure that the quality control reflects the results of these analyses and tests.

Table 2-3-13 Testing and confirmation for Quality Control (Borehole Drilling)

Work item / material	Test / purpose	Frequency	Remarks
1. Selection of alternate drilling site in case of unsuccessful drilling	Decision of drilling point Geo-electric survey result, Agreement with community	Each borehole after an unsuccessful borehole	Refer to the electric survey results and agreement from representative of the community. Produce a sketch of ancillary structure with ground inclination and direction for approval. Against an unsuccessful borehole, same process will be taken for selection of alternate site.
2. Drilling of Borehole	Position of aquifer - Record of blow yield	3 m pitch	For casing programming
	Judging success of borehole - Pumping test	1 / BH	－Step draw down test : 1.5 hrs/step, not less than 4 steps For determination of discharge of continuous test and fsir yield －Continuous test : 24hours －Recovery test : 4 hours
	Judging success of borehole - Pumping test	Each BH	Refer to MS 733 : 2005 Parameters :Microbial (E-Coli or Faecal streptococci), pH, SS, EC, TDS, Carbonate, Bicarbonate, Chloride, Sulphate, Nitraye, Fluoride, Sodium, Potassium, Calcium, Magnesium, Total Iron, Manganese and Total Hardness)
3. Packing Gravel	- Grain size analysis	1 / carrier truck	Testing Standard : MS or BS Grain size :2mm to 5mm Observation of hardness, homogeneity, weathering grade etc.

Table 2-3-14 Analysis and Testing for Quality Control (Ancillary Facilities)

Work item / material	Test	Frequency	Remarks
1． Concrete			
(1) Trial mixing	Fine aggregate	1/ source	Sieve analysis
	Coarse aggregate	- Ditto -	Sieve analysis
	Chloride ion	- Ditto -	Simplified method
	Compression test	- Ditto -	7day and 28 day strength
(2) Cast-in-place	Slump test	1 test/ 5 sites	
	Chloride ion	1 test/ 5 sites	Simplified method
	Compression test	1 test/ 5 sites	7 day and 28 day strength
2． Re-bar Work	－	By purchase	Mill sheet

2-3-4-6 Procurement Plan

The main construction equipment and materials to be used for Sub-Project (2) are hand pumps (Afridev), cement, reinforcing bars and PVC pipes. The planned procurement methods for these items are outlined below, taking the required quality and ease or difficulty of their local procurement into consideration.

In addition, the following procurement plan is based on the local market situation from August, 2010 to May, 2011.

(1) Hand Pumps (Afridev)

Afridev pumps imported from India are available in Malawi. They will, therefore, be procured in principle in the local market. However, the import of some pumps through a local agent may be necessary depending on the quantity of local stock.

(2) Cement

As there is a cement factory in Malawi, cement can be procured in the local market. In addition, cement produced in Zambia and other neighbouring countries is available in Malawi. As the procurement of cement in the local market is not thought to be problematic in terms of quality and stable supply, cement will be procured in Malawi.

(3) Aggregates

Crushed stone and sand are sold throughout the Central Region and can be procured in the market near the target sites. As their sizes, quality and quantity do not pose any problems for their use in Sub-Project (2), aggregates will be procured in Malawi.

(4) Reinforcing Bars

Imported reinforcing bars are available in the local market. As their sizes, quality and quantity do not pose any problems for their use in Sub-Project (2), reinforcing bars will be procured in Malawi.

(5) PVC Pipes

As there is a PVC pipe factory in Malawi, PVC pipes can be procured in the local market. As their sizes, quality, screen processing technology applied and quality do not pose any problems for their use in Sub-Project (2), PVC pipes will be procured in Malawi.

(6) Packing Gravel

Packing gravel used for the finishing stage of borehole construction work is produced on Lake Malawi in good quantity and with good quality. Many local borehole drilling companies have their own gravel pit along Lake Malawi while the MoAIWD has designated a gravel pit for its exclusive use for government projects. As all of these sources can be used for the borehole construction work under Sub-Project (2), packing gravel will be procured in Malawi.

Table 2-3-15 Procurement of Construction Material

Construction Material	Malawi	Japan	Third Countries
Handpump	○		
Cement	○		
Aggregate	○		
Reinforced bar	○		
PVC pipe	○		
Packing gravel	○		

2-3-4-7 Initial Operational Guidance Plan

An engineer(s) of the contractor will provide guidance on the operation of the borehole rehabilitation equipment to be procured by the contractor for Sub-Project (2) after the handing over of the said

equipment to the MoAIWD. The actual guidance will be provided through the borehole rehabilitation work to be conducted by the MoAIWD (its borehole construction team).

2-3-4-8 Soft Component Plan

In regard to the O & M of boreholes by the local residents themselves, when the target boreholes of Sub-Project (2) were originally constructed, the CBM programme was in its infancy. The said programme was introduced to the communities in question for the purpose of demonstration and a WPC was established by local residents following training on the O & M of boreholes for WPC members in each area.

Since the original training under the CBM programme, hardly any communities have had the opportunity for refresher training designed to systematically enhance the O & M capability of the WPC in the 15 years up to the present. The technical capability acquired at the time of the construction of the existing borehole has, therefore, diminished while the WPC members selected from among local residents have been struggling to conduct the O & M of boreholes in a trial and error manner. In some communities, the WPC has become less active or has even disappeared altogether.

The number of local government staff members providing guidance on borehole maintenance and repairing serious pump breakdowns has been static and the existing personnel cannot provide effective support for communities as the number of boreholes in operation has dramatically increased over the years. In the Mchinji District, area mechanics have been trained and deployed to conduct periodic inspection and the necessary repairs in response to the increasing demand for pump repair. Their presence, however, is not well recognised by local communities. The social condition survey conducted this time revealed that many WPCs are uncertain about fund management (collection, saving, safe-keeping and use) and the technical aspects of borehole repair (repair of damaged riser pipe, use of an area mechanic and other aspects). In view of this reality, the implementation of resident support activities is judged to be necessary to strengthen the capacity of the existing WPCs (and some newly established WPCs) in view of the proper maintenance of the rehabilitated and newly constructed boreholes under Sub-Project (2).

While the MoAIWD has been implementing such activities under the CBM programme, technical assistance by Japanese Consultant for the following issues is judged to be necessary to make these activities effective under Sub-Project (2).

- Application of the existing CBM programme, which it is assumed is implemented at the time of borehole construction, to Sub-Project (2) (planning of efficient and effective activities corresponding to the scale and schedule of the proposed work under Sub-Project (2)

- Planning of a publicity campaign designed to facilitate the effective use of the area mechanics

- Educational activities corresponding to the diverse O & M capability of WPCs and training of the required trainers to conduct these activities

- Evaluation of the implementation situation of various CBM-related activities and improvement of these activities

- Collaboration with the Project for Enhancement of Operation and Maintenance for Rural Water Supply which is a technical cooperation project of the JICA and of which the target area overlaps with that of Sub-Project (2)

- Evaluation of the O & M capability of WPCs which have undergone the above-mentioned CBM-related activities

- Facilitation of anti-theft measures

2-3-4-9 Implementation Schedule

The following implementation schedule is based on the local market situation from August, 2010 to May, 2011.

(1) Implementation Schedule

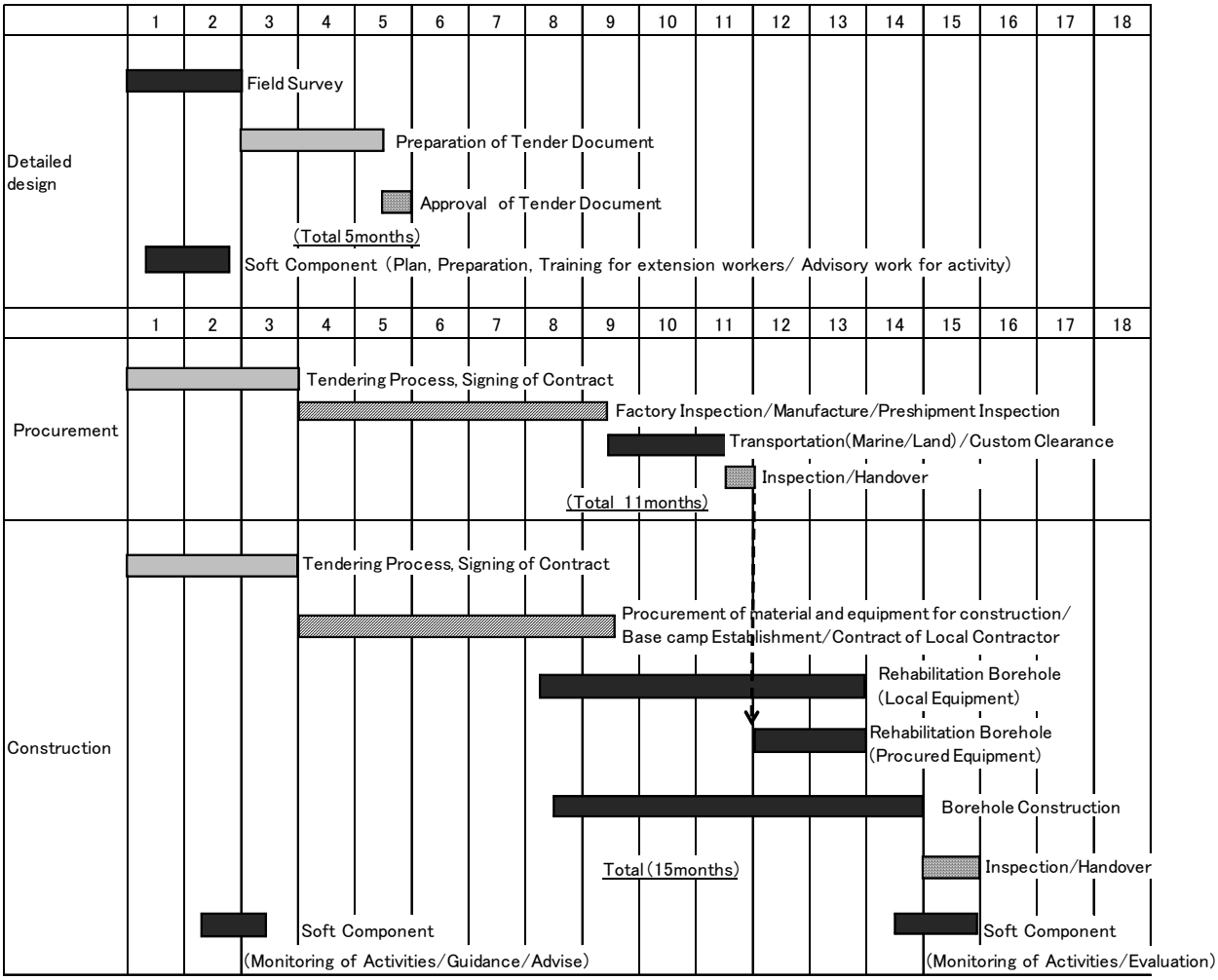
It will take a total of 20.0 months to complete Sub-Project (2) as described below, taking into consideration (i) the types and scales of the planned facilities, required period for the procurement and transportation of the construction equipment and materials and implications of the dry and rainy seasons for the construction work and (ii) requirements of the grant aid scheme of the Government of Japan into consideration.

①	Detailed design period	:	5.0 months
②	Construction period	:	15.0 months (including 3.0 months for the tender)
③	Procurement period	:	11.0 months running in parallel to ② above
	Total	:	20.0 months

(2) Sub-Project (2) Implementation Schedule

The implementation schedule for Sub-Project (2) with due consideration of the various conditions described above is shown in Table 2-3-16.

Table 2-3-16 Project Implementation Schedule (Sub-Project (2))



2-4 Obligations of the Recipient Country

2-4-1 Project for Water Supply Systems for Market Centres (Sub-Project (1))

For the implementation of Sub-Project (1), the Malawi side will be responsible for the following matters.

① Provision of a stock yard for the construction materials and equipment to construct the water supply facilities at Mkanda and Santhe Market Centres (2,500 m^2 x 2 = 5,000 m^2)

② Acquisition of land to construct the water supply facilities

Facility	Area	Notes
1. Intake Facility ・Mkanda Market Centre (2 sites) ・Santhe Market Centre (6 sites)	 $100m^2 \times 2$ sites ＝ $200m^2$ $100m^2 \times 6$ sites ＝ $600m^2$	 10m×10m (not yet acquired) - ditto -
2. Water Distribution Facility ・Elevated Tank (Control Building) ・Ground Tank (Control Building) ・Communal Tap (14 sites)	 $500m^2 \times 1$site ＝ $500m^2$ $600m^2 \times 1$site ＝ $600m^2$ $50m^2 \times 14$ sites ＝ $700m^2$	 20m×25m (not yet acquired) 20m×30m (- ditto -) 5m×10m (- ditto -)
3. Building ・Office Building (2 sites)	 $465m^2 \times 2$ sites ＝ $930m^2$	 15m×31m (not yet acquired)
4. Transmission and distribution Pipe	(parts upon requirement)	

③ Wiring electricity to the water supply facilities (intake wells, control buildings and office buildings

④ Preservation of the test boreholes constructed under the Preparatory Survey until the commencement of construction work for utilisation as productive boreholes (intake wells)

⑤ Taking required procedures related to environmental and social consideration for Sub-Project (1)

⑥ Formation of understandings in local community on introducing water supply system through briefing of project concept for public hearing

⑦ Payment of all expenses not included in Japan's grant aid but necessary for the implementation of Sub-Project (1), such as project management cost in MoAIWD and CRWB, Initial working capital for O & M of water supply facilities

⑧ Prompt customs clearance and tax exemption of all imported equipment and materials required for the implementation of Sub-Project (1) and their swift transportation in Malawi

⑨ Exemption of all equipment and materials procured for Sub-Project (1) and associated services provided by Japanese nationals in accordance with the relevant contracts from customs duties, domestic taxes and other levies imposed in Malawi

⑩ Granting of the relevant visas and permits to stay in Malawi to Japanese nationals working for Sub-Project (1) in accordance with the relevant contracts

⑪ Payment of the banking commission for the Authorisation to Pay (A/P) and other bank commissions payable to a Japanese bank based on the Banking Arrangement (B/A)

⑫ Prompt implementation of individual house connection services and proper operation and maintenance for effective use of the facilities to be constructed under Sub-Project (1)

2-4-2 Project for Rehabilitation of Boreholes in Mchinji (Sub-Project (2))

For the implementation of Sub-Project (2), the Malawi side will be responsible for the following matters.

① Provision of a temporary warehouse, temporary stock yard for cement, sand, gravel and a fuel tank as well as the provision of land for the secure overnight parking of work vehicles (on the Mchinji DWDO premises), all of which are essential for the implementation of the planned rehabilitation/construction work

② Preparation of the borehole construction sites (securing of consent for the detailed design study and selected site among local residents as well as ground preparation by local residents)

③ Implementation of CBM programme consists of sensitisation, education and training related to the self-reliant maintenance of the water supply facilities by local residents for the Mchinji Project.

④ Payment of the personnel cost of staff members of the MoAIWD participating in the initial operational guidance (OJT) on the equipment procured with Japanese grant aid

⑤ Payment of all expenses not included in Japan's grant aid but necessary for the implementation of Sub-Project (2)

- Management cost of Sub-Project (2) on the part of the MoAIWD
- Expenses associated with activities under the CBM programme
- Personnel cost of the MoAIWD's borehole construction team which will conduct the borehole rehabilitation work while receiving OJT on the newly procured equipment

Other matters are identical to ⑧ through ⑫ for Sub-Project (1)

2-5 Project Operation Plan

2-5-1 Project for Water Supply Systems for Market Centres (Sub-Project (1))

(1) Operation and Maintenance (O & M) System

In Malawi, a regional water board was established in the Northern, Central and Southern Regions in 2002 as the organisation responsible for the O & M of piped water supply facilities in local cities and these water boards have since been operated as independent accounting bodies in principle. While they are under the jurisdiction of the MoAIWD, each board has the authority to manage personnel matters, including recruitment except for the Chief Executive Officer who is appointed by the MoAIWD, illustrating its high level of independence.

The body to be responsible for the O & M of the water supply facilities to be constructed under Sub-Project (1) is the CRWB which has sufficient experience and know-how of O & M as well as the administrative aspects (such as collection of the water charge) of these facilities through the O & M and other activities of many similar water supply facilities in the Central Region. The organisation of the CRWB is shown in Fig. 2-5-1.

(2) O & M Method

The water supply system to be constructed at Mkanda Market Centre and Santhe Market Centre under Sub-Project (1) will be a small, simple water supply system with a design service population of approximately 7,000 and will use groundwater which is chlorinated using bleaching powder at both sites. Groundwater drawn from the boreholes will be conveyed to an elevated tank or reservoir for subsequent distribution to communal taps, etc. using the gravity method. Local residents will have access to water by a public tap or individual connection.

For water supply using communal taps, a tap manager appointed for each tap will sell the water using a bucketful of water as the unit. In the case of individual connections, each tap will be equipped with a water meter in view of collection of the water charge based on the actual consumption as same as other water supply system managed by CRWB. The CRWB will issue a bill based on the monthly meter reading and this bill will be paid by the user at the water charge payment counter in each market centre.

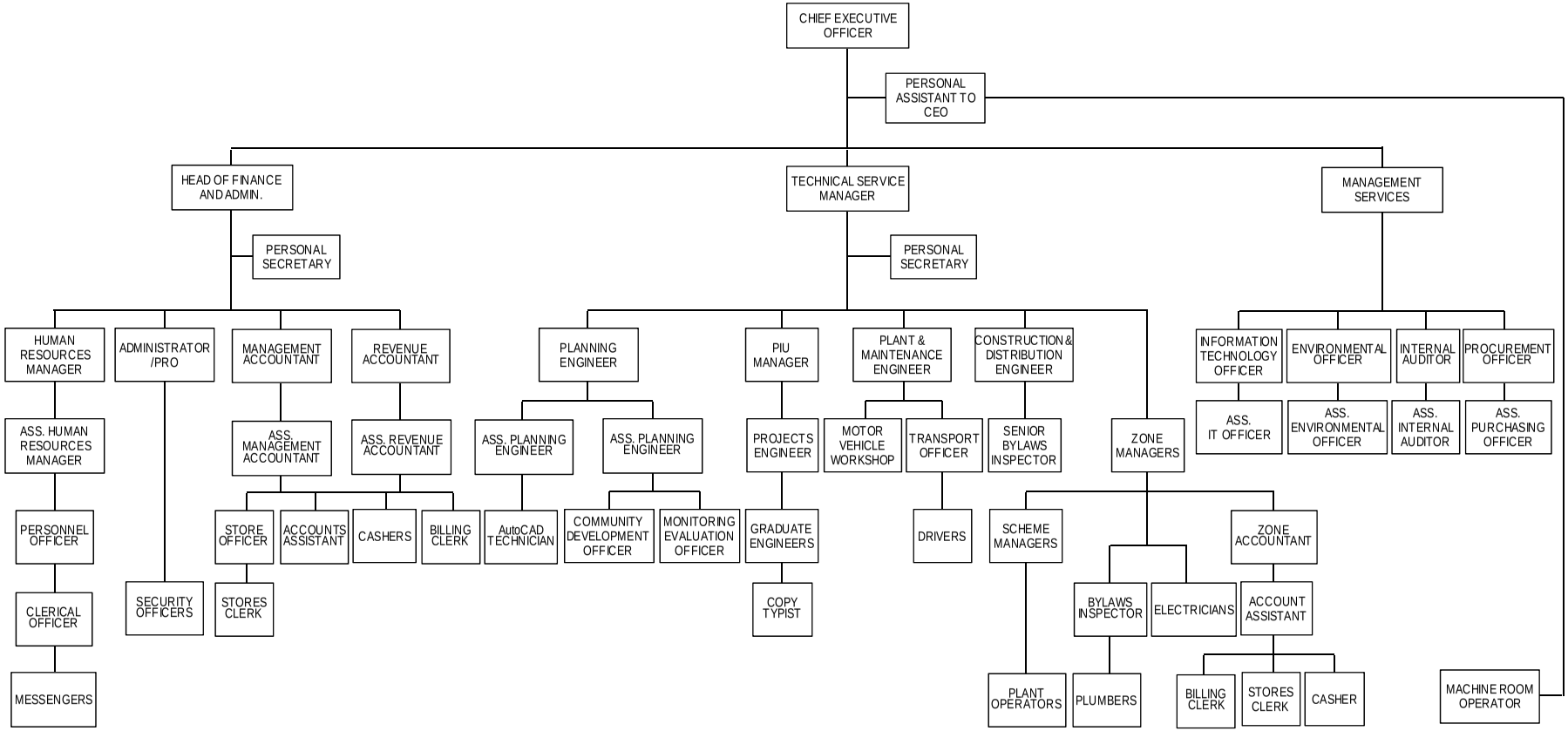


Fig.2-5-1 Organisation Chart of Central Region Water Board

The O & M of the water supply facilities to be constructed at Mkanda and Santhe Market Centres will be conducted by staff members dispatched by the CRWB. The duties of the technical staff conducting the O & M of the water supply facilities and the administrative staff conducting the management of the water supply service are briefly described below.

1) Scheme Manager

The scheme manager controls the O & M of the entire water supply facilities and the operation of the water supply service in the service area. In addition to the issue of instructions and guidance for staff members in connection with the daily work, the scheme manager compiles facility operation records (status of tap connections, volume of water supply, consumption of chemicals and electricity and state of maintenance), operational expenses (personnel cost, O & M cost and others), collected amount of the water charge and other information on a monthly basis and reports them to the zone manager of the CRWB. The scheme manager should try to quickly solve any problems encountered through consultation with the Head Office of the CRWB.

2) Administrator

In addition to the handling of personnel issues within the O & M body, legal issues (including the issue of reminders for non-payment and suspension of the water supply) and the procurement and control of chemicals and materials required for the operation of facilities, the administrator is responsible for publicising the water supply service to local residents, handling complaints and requests made by local residents and improving the water supply service.

3) Billing Clerk and Cashier

While the biller clerk issues bills for the water supply service, the cashier accepts payments for the water charge. The process of issuing a bill involves calculation of the actual charge using the tariff based on the user register and monthly meter reading by the meter reader. Based on this bill, each user pays the water charge at the nearby payment centre of the CRWD office. The cashier records each payment and issues a receipt.

4) Maintenance Personnel

Maintenance personnel are responsible for (i) control of such materials as piping, valves, spare parts and tools, (ii) maintenance of electrical and mechanical equipment, such as submersible pumps and chlorination devices, and (iii) maintenance of water supply facilities, including the repair of leakages. They also conduct the work to connect service pipes at the request of users (including preparation of an estimate for the connection work) and to remove water meters from non-paying users.

5) Operator

In addition to the operation of the borehole pump, the operator is responsible for the disinfection of the groundwater using a chlorination device. As part of the pumping operation, the operator monitors the water level of the elevated tank or reservoir and also controls the number of boreholes to be operated as well as their switching operation. The operator records the operating hours of each pump, amount of bleaching powder used and readings of the flow meter and watt hour meter in the daily operation book.

6) Meter Reader

The meter reader reads the water meter installed at each individual connection every month. The meter readings are then forwarded to the billing clerk as basic data for the water charge calculation. The meter reader also distributes the bills issued by the billing clerk for the previous month to each household with a water meter.

7) Tap Leader

Water supply from a communal tap and collection of the water charge are entrusted to a tap leader who is a local resident appointed by the CRWB. The tap leader sells water in units of bucketfuls (20 litres). The CRWB collects the water charge from each tap leader based on the reading of the water meter installed at each communal tap. The different between this amount and the amount collected by the tap leader from users is the income for the tap leader.

The CRWB guides tap leaders regarding an adequate price of water and publicises it to local residents. In addition to the sale of water, tap leaders clean the communal tap and its surrounding area to ensure the supply of water in a clean environment at all times.

(3) Organisation of the O & M System for Water Supply Facilities at Mkanda and Santhe Market Centres

In view of the scale of the planned water supply facilities and present conditions of water supply facilities in other areas managed by the CRWB, the organisation and staff strength required for the O & M of the new water supply facilities in Mkanda and Santhe Market Centres are as shown in Fig. 2-5-2.

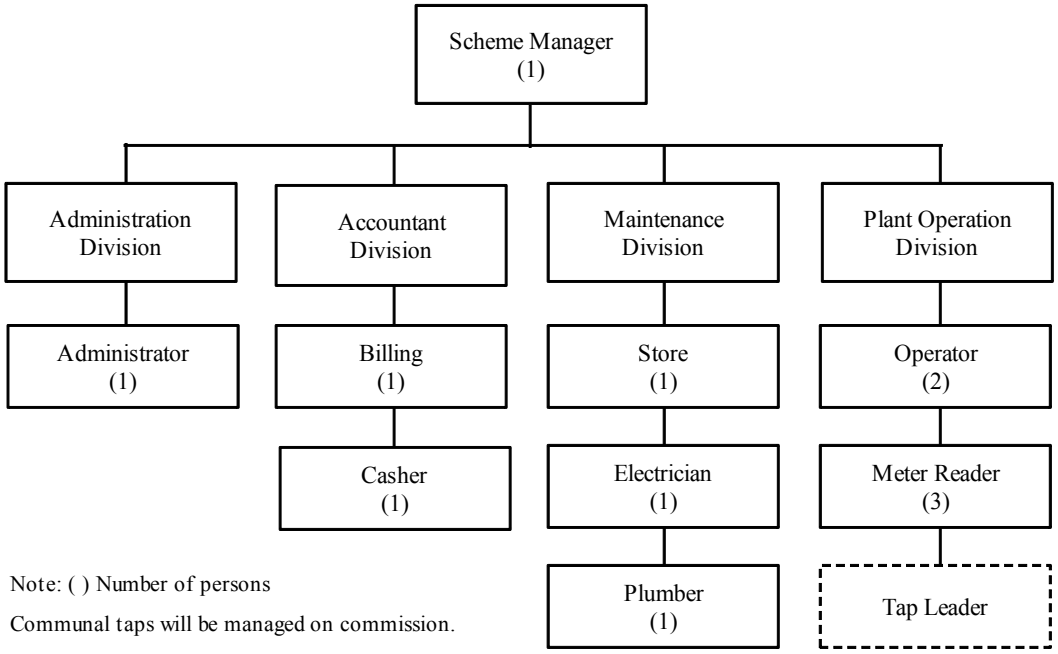


Fig. 2-5-2 Organisation of Water Supply Systems for Market Centres in Mkanda and Santhe

2-5-2 Project for Rehabilitation of Boreholes in Mchinji (Sub-Project (2))

(1) O & M of Boreholes

Because of the urgency to commence the use of each borehole to be either rehabilitated or newly constructed without awaiting the completion of Sub-Project (2), a proper O & M system must be prepared prior to and parallel with the actual rehabilitation/construction work.

[O & M by VHWCs and WPCs]

The bodies of local residents listed below will be organised or re-organised under the CBM programme to facilitate the local understanding that the O & M of the rehabilitated or constructed boreholes is fully the responsibility of such bodies. In the case of the WPCs responsible for individual newly constructed boreholes, technical training on pump maintenance will be provided for the pump caretakers.

Village level : Village Health Water Committee (VHWC)
Representatives of individual WPCs shall be involved as members of the VHWC.

Borehole level : Water Point Committee (WPC)

Committee members: chairman, deputy chairman, secretary, deputy secretary and four ordinary members of which three are pump caretakers; at least half of the WPC members should be women.

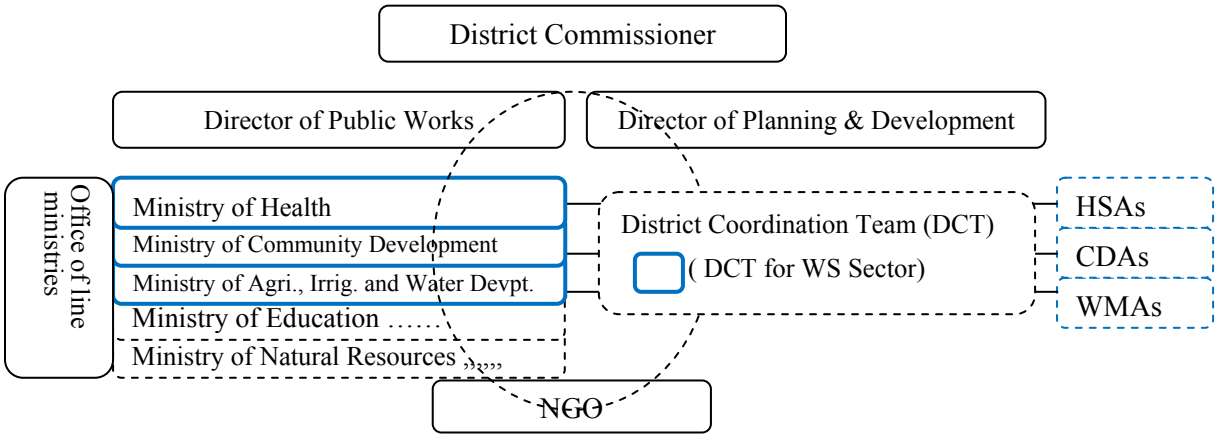
These educational activities will take the following points into careful consideration.

- When the construction of a new borehole means that there will be more than one borehole in the same village, the scope of users must be specified at the time of organising the individual WPCs. At the same time, a VHWC should be organised to coordinate and liaise with the O & M of the boreholes within the village.
- The area mechanic for the area should be introduced to the members of the WPC and advice provided to develop a good relationship.

[O & M by Local Administration]

With the on-going process of decentralisation, there is a mechanism for the planning and coordination of district-level water supply and sanitation activities under the leadership of the district coordination team (DCT). As shown in Fig. 2-2-2, members of this DCT are assigned from various central ministries and representatives of major NGOs also join the DCT in some cases.

In the Mchinji District, 19 area mechanics were appointed by the MoAIWD in 2007. Since 2008, each area mechanic has been assigned a responsible area and water points under the leadership of a NGO and their activities have been monitored. These area mechanics have also been the subject of capacity building. Because there are only two watering monitoring assistants (WMAs) in the district despite the huge size of the district and number of water points (1,333), efforts are being made to develop a maintenance system which effectively and efficiently utilises the existing area mechanics.



WMA: （Water Monitoring Assistant）

CDA: （Community Development Assistant）

HSA: （Health Surveillance Assistant）

Fig. 2-5-3 Project Implementation for O & M in District Level

Table 2-5-1Number of extension Workers in Mchinji and Surroundings

	Water Monitoring Assistant (WMA)	Community Development Assistant (CDA)	Health Surveillance Assistant (HSA)
Mchinji District	3	13	Approx. 300
Kasungu District	7	9	Approx. 590
Lilongwe District	3	21	Approx. 300

For the proper O & M of boreholes, guidance as well as monitoring will be required for the hygienic use of water and appropriate collection, management and spending of the maintenance charge. Under Sub-Project (2), assistance will be provided to ensure the smooth maintenance of the water supply facilities by each WPC with the cooperation of the DCT.

(2) O & M of Procured Equipment

The newly procured equipment will be used for the borehole rehabilitation work, such as dredging and pumping test, under Sub-Project (2). The borehole drilling team members mobilised by the MoAIWD for this work will learn how to operate and maintain the said equipment through OJT. After the completion of Sub-Project (2), the equipment will be operated by staff members of the MoAIWD engaged in borehole drilling (five teams plus mechanics: total of 50 persons) and will be managed by the Chief Driller as in the case of drilling rigs, support vehicles, pumping test vehicle and other equipment.

From the viewpoint of the central government budget, the cost of borehole rehabilitation work is included in the borehole construction cost. Based on past experience, some 200 ~ 400 boreholes are either rehabilitated or constructed each year and the equipment maintenance and repair cost is included in the construction budget.

2-6 Project Cost Estimation

2-6-1 Initial Cost Estimation

(1) Malawi Side Portion of Project Cost

Approximate MK. 51.1 million (= JPYen 28.6million)

① Project management cost
- Detailed design stage (explanation to local resident, etc.) : MK. 1.0 million
- Construction Stage (witness and inspection, local management) : MK. 1.0 million

② Personnel Cost for Attending to OJT for operation of rehabilitation equipment:: MK. 1.0 million
③ Land acquisition for water supply facilities in Market Centres : MK. 0.7 million
④ Cost for wiring electricity to the water supply facilities in Market Centres : MK. 10.4 million
⑤ Initial working capital for O & M of water supply facilities in Market Centres : MK. 2.0 million
⑥ Implementation cost for soft component (CBM activities) : MK.35.0 million

Note: US$1.0 = JPYen 83.53, MK 1.0 = JPYen 0.5594 (as of June, 2011)

2-6-2 Operation and Maintenance Cost

2-6-2-1 Project for Water Supply Systems for Market Centres (Sub-Project (1))

The O & M cost in the target year of 2020 of Sub-Project (1) is estimated for both Mkanda Market Centre and Santhe Market Centre to verify the commercial viability of Sub-Project (1). This estimation is based on the water tariff adopted by the CRWB, electricity charge, wage level of the CRWB staff members and other data at the time of the field survey. The estimated revenue is based on the actual consumption of water which does not include the volume of leaked water.

(1) Water Tariff

The water tariff imposed by the CRWB for piped water supply systems in the Central Region is shown in Table 2-6-1 (revised in August, 2010). This tariff is applied uniformly throughout the Central Region rather than for individual systems.

Table 2-6-1 Water Tariff (per unit water amount)

Usage	Range	Charge (MK)
Domestic	Consumption: less than 4m^3 (Minimum Charge)	356.13
	From 4m^3 to 30m^3 (per m^3)	84.57
	More than 30m^3 (per m^3)	91.70
Public	Consumption: less than 4m^3(Minimum Charge)	1,250.40
	From 4m^3 to 30m^3 (per m^3)	147.56
	More than 30m^3 (per m^3)	175.03
Commercial	Consumption: less than 4m^3 (Minimum Charge)	1,250.40
	From 4m^3 to 30m^3 (per m^3)	147.56
	More than 30m^3 (per m^3)	175.03
Communal Water Point		51.36

Table 2-6-2 Water Tariff (Basic Monthly Charge per tap)

Usage	Classification of dwellings	Charge (MK)
Domestic	Traditional and high density	66.78
	Medium density area	178.06
	Low density area	178.06
Public Institutions		625.20
Commercial Use		625.20

(2) Served Population and Number of Connections

The number of water supply connections is estimated (Table 5-2-3) based on the population size by type of housing density in the target year of 2020 and served population per tap (20 persons/yard tap; 6 persons/individual connection).

Table 2-6-3 Categorised Population in Target Year and Number of Individual Connection

Area Classification	Mkanda Market Centre		Santhe Market Centre	
	Service Population (person)	Number of Connection (taps)	Service Population (person)	Number of Connection (taps)
Traditional dwelling area	4,795 (68%)	Communal Taps	2,246 (30%)	Communal Taps
High density area	1,128 (16%)	56（YT）	3,218 (43%)	161（YT）
Medium density area	987 (14%)	165（FP）	1,497 (20%)	250（FP）
Low density area	141 (2%)	24（FP）	524 (7%)	87（FP）
Total	7,051 (100%)	245	7,485 (100%)	498

Note: See Table 2-2-4 for proportion of classification of dwelling, and Table 2-2-3 for population per tap respectively
Water supply to the area of traditional dwelling is through communal water points (tap)
YT: Yard Tap, FP: Full Plumbing (Connection to YT and FP will be conducted by Malawi side)

Accurate estimation of the number of water supply connections for public facilities (schools, hospitals, government offices, commercial facilities and others) is difficult. For the purpose of estimating the overall O & M cost, the number of these connections is assumed to be 10% of the number of household connections at both Mkanda Market Centre and Santhe Market Centre (resulting in 25 connections at Mkanda Market Centre and 50 connections at Santhe Market Centre).

(3) Water Supply Volume

Table 2-6-4 shows the calculated water supply volume for target year at Mkanda Market Centre and Santhe Market Centre based on the served population by type of housing density and unit water supply volume.

Table 2-6-4 Water supply amount in target year per dwelling classification

Classification of Area	Unit Consumption (lcd)	Mkanda Market Centre		Santhe Market Centre	
		Population (person)	Amount (m^3/day)	Population (person)	Amount (m^3/day)
Traditional dwelling area	36	4,795	173	2,246	81
High density area	50	1,128	56	3,218	161
Medium density area	80	987	79	1,497	120
Low density area	125	141	18	524	65
Sub-total		7,051	326	7,485	427
Public Institutions	Sub-total x 25%	–	82	–	107
TOTAL			408		534

Note: See Table 2-2-3 for unit consumption rate by area of dwelling classification

The water supply volume in the above table represents the average annual volume (consumption) and can be used as the basic value for estimation of the revenue based on the tariff table in Table 5-2-1. Meanwhile, a water intake volume from intake facilities (boreholes) of 453 m^3/day for Mkanda Market Centre and 593 m^3/day for Santhe Market Centre is required as the amount of leakage (10%) must be added.

(4) Costs

Using the basic figures required for estimation of the O & M cost described earlier, the monthly expenditure for the water supply facilities at Mkanda and Santhe Market Centres is estimated next.

1) Chemical Cost

Based on the actual figure for other water supply facilities managed by the CRWB, the injection rate of chlorine for disinfection is set at 2 mg/litre. Assuming a unit price of bleaching powder (high purity bleaching powder with an effective chlorine concentration of 60%) of MK.600/kg, the estimated chemical cost for each centre is given below.

・Mkanda Market Centre: 453m^3/day x 2mg/l x (100/60)÷1,000 x 30 days x MK.600/kg = MK27,180
・Santhe Market Centre: 593m^3/day x 2mg/l x (100/60)÷1,000 x 30 days x MK.600/kg= MK35,580

2) Electricity Charge

Tariff Code ET8/EC30 of the ESCOM (Electricity Supply Corporation of Malawi Ltd.) sets the basic charge at MK. 1,000/month and a unit price of MK. 11.7016/kWh. The likely electricity charge shown below is estimated based on this tariff and the expected operating hours based on the proportion of the mean water supply volume to the rated water supply capacity of the intake pumps (544 m^3/day for Mkanda Market Centre and 712 m^3/day for Santhe Market Centre).

・Mkanda Market Centre

Basic Charge	: 2 buildings x MK1,000/month	= MK. 2,000
Monthly Charge	: 453/544 x 24 x 5.5kW x 30days x MK.11.7016	= MK. 38,587
	TOTAL	MK. 40,587

・Santhe Market Centre

Basic Charge	: 6 buildings x MK.1,000/month	= MK. 6,000
Monthly Charge	: 593/712 x 24 x 15.7kW x 30days x MK.11.7016	= MK.110,167
	TOTAL	MK.116,167

3) Inspection Cost

The inspection cost consists of the fuel cost and maintenance cost for a patrol vehicle which travels through the water supply area to check the functioning of the water supply system. At both market centres, this cost is a total of the fuel cost based on a daily consumption of 10 litres of fuel (300 litres/month) and a monthly maintenance cost of MK.100,000.

・Mkanda Market Centre 300 litre x MK260/L + MK100,000 = MK. 178,000
・Santhe Market Centre 300 litre x MK260/L + MK100,000 =MK. 178,000

4) Personnel Cost

The personnel cost is estimated as shown below based on the organisation of the water supply service (Fig. 2-5-2) and the current wages of staff members of the CRWB.

・Mkanda Market Centre

Manager	: 1person x MK. 100,000＝	MK. 100,000
Administrator	: 1 person x MK. 85,000＝	MK. 85,000
Accountant	: 2 persons x MK. 85,000＝	MK. 170,000
Maintenance Staff	: 3 persons x MK. 35,000＝	MK. 105,000
Operation Staff	: 5 persons x MK. 30,000＝	MK. 150,000
	TOTAL	MK. 610,000

・Santhe Market Centre

Manager	: 1 person x MK. 100,000＝	MK. 100,000
Administrator	: 1 person x MK. 85,000＝	MK. 85,000
Accountant	: 2 persons x MK. 85,000＝	MK. 170,000
Maintenance Staff	: 3 persons x MK. 35,000＝	MK. 105,000
Operation Staff	: 5 persons x MK. 30,000＝	MK. 150,000
	TOTAL	MK. 610,000

5) Other

10% of the personnel cost is also included in the overall cost to account for various office expenses.

・Mkanda Market Centre	MK. 610,000×10%＝	MK. 61,000
・Santhe Market Centre	MK. 610,000×10%＝	MK. 61,000

(5) Revenue

The basic charge and metered charge based on the water supply volume (consumption volume) at Mkanda and Santhe Market Centres are shown below. For the purpose of simplified estimation, the unit price of water per 1 m^3 is set at MK. 50 for a communal tap, MK. 85 for an individual house connection and MK. 170 for public facilities (round unit prices assumed for possible consumptions based on the tariff which set up commodity charge stepped with consumption range; e.g. MK.86.4 will be charged for house connection at 10 m^3/householed per month, MK. 5,087 will be charged for public facility at 30 m^3/facility per month. The charge for communal tap is fixed as MK 51.36/m^3.)).

・Mkanda Market Centre

① Communal Tap	: Domestic Water:	173m^3/day x MK. 50 x 30 days	= MK. 259,500
② Individual Connection	: Domestic Water	153m^3/day x MK. 85 x 30 days	= MK. 390,150
	: Public Water	82m^3/day x MK. 170 x 30 days	= MK. 418,200
③Basic Charge	High Density	56 taps x MK. 66.78	= MK. 3,740
	Mid. Density	165taps x MK. 178.06	= MK. 29,380

	Low Density	24taps x MK. 178.06	= MK. 4,273
	Public Water	25taps x MK. 625.20	= MK. 15,630
	TOTAL		MK. 1,120,873

・Santhe Market Centre

①Communal Tap	: Domestic Water:	81m^3/day x MK. 50 x 30 days	= MK. 121,500
②Individual Connection	: Domestic Water	346m^3/day x MK. 85 x 30 days	= MK. 882,300
	: Public Water	107m^3/day x MK. 170 x 30 days	= MK. 545,700
③Basic Charge	High Density	161 taps x MK. 66.78	= MK. 3,740
	Mid. Density	250 taps x MK. 178.06	= MK. 29,380
	Low Density	87 taps x MK. 178.06	= MK. 4,273
	Public Water	50 taps x MK. 625.20	= MK. 15,630
	TOTAL		MK. 1,651,517

(6) Balance

The balance between the O & M cost and revenue estimated in (4) and (5) above for Mkanda and Santhe Market Centres is shown below.

Table 2-6-5 Operation and Maintenance Cost for Market Centres (per month)

Item		unit	Mkanda Market Centre	Santhe Market Centre
Supply Amount	1. Production Amount	m^3	13,590	17,790
	2.Accounted for water	m^3	12,240	16,020
	3.Ratio of unaccounted for water	%	10	10
① Expenditures	1.Chemical cost	MK	27,180	35,580
	2. Power rates	MK	40,587	116,167
	3. Maintenance cost	MK	178,000	178,000
	4. Personnel cost	MK	610,000	610,000
	5. Others	MK	61,000	61,000
	Total	MK	916,767	1,000,747
②Revenues for water charge			1,120,873	1,651,517
(②−①) Balance			204,106	650,770

The estimation results of the O & M cost for the new water supply facilities at Mkanda and Santhe Market Centres in the target year of 2020 show that the cost will represent some 80% and 60% of the expected revenue for Mkanda Market Centre and Santhe Market Centre respectively, suggesting the viability of the self-reliant finance of the new water supply facilities.

However, the served population in 2014 when the facilities are expected to commence operation is expected to be around 80 ~ 85% of the population in the target year of 2020 and the actual revenue will be proportionally smaller than that in 2020. In particular, water supply operation in the first few years after the commencement of operation may become loss-making. This makes it essential for the CRWB to adopt an approach to manage all water supply systems in a unified manner rather than as individual systems from the accounting point of view.

2-6-2-2 Project for Rehabilitation of Boreholes in Mchinji (Sub-Project (2))

Estimation of the O & M cost for Sub-Project (2) must deal with two aspects, i.e. O & M of boreholes and O & M of rehabilitation equipment.

(1) O & M Cost of Boreholes

[O & M Cost Borne by the Administration]

The annual O & M cost of water supply facilities to be borne by the MoAIWD means the cost of monitoring/follow-up of (i) WPCs which directly manage these facilities and (ii) boreholes. To be more precise, there are several cost items, such as the personnel cost, monitoring cost and motorcycle maintenance cost.

Assuming that monitoring is conducted at five facilities per day with 22 working days per month, one person can monitor 110 sites per month. The 334 boreholes (280 rehabilitated boreholes and 54 newly constructed boreholes) of Sub-Project (2) can be covered in one month provided that monitoring is conducted by three WMAs. However, as the total number of boreholes in the Mchinji District, including those of Sub-Project (2), is approximately 1,100, each borehole is likely to be checked every three or four months.

The annual cost of this monitoring is estimated to be approximately MK. 2,670,000 as shown below.

Personnel cost (3 WMAs)	: MK. 40,000 /month x 12 months x 3	= MK. 1,440,000
Fuel cost	: 5 litres/day x MK. 290 x 22 days x 12 months x 3	= MK. 1,148,400
Motorcycle maintenance cost: motorcycle price of MK. 540,000 x 5% x 3		= MK. 81,000
Annual total		= MK. 2,669,400

Though the cost of fuel and vehicle shall be allocated from the recurrent budget of Mchinji District, the current annual budget for them is less than the motorcycle maintenance cost in the above estimation. However the monitoring system utilising the area mechanics may reduce the activities of WMAs, increase of recurrent budget in the district is required to cover the cost of monitoring boreholes in the district.

[O & M Cost Borne by WPC]

The O & M cost to be borne by each WPC is estimated here. The likely cost items are replacement parts to ensure continual operation by preventing common breakdowns, cost of renewing the riser pipe, rod and other parts in approximately 15 years and saving of funds to cover the repair work by an outsider. Repair work is entrusted to an area mechanic. The field survey found that the method used to collect the repair cost varies from one area mechanic to another. Some area mechanics charge MK. 500 ~ MK. 1,200 per repair while others have a monthly contract (MK. 1,000) or annual contract (MK. 1,500 ~ MK. 2,000) to cover the repair work. For the present estimation, an annual contract of MK 2,000 is assumed.

The estimated annual O & M cost is MK. 17,230 (approximately JPYen 9,600) per borehole. Assuming the use of one borehole by 50 households, the monthly payment required by each household is approximately MK. 29 which is less than 1 % of the average of annual household income (MK 66,000/year: Social Condition Survey Result) and should be sufficiently low to achieve a high collection ratio.

Table 2-6-6 Maintenance Cost borne by Borehole Users

No.	Items	Way of Trial Calculation	Annual Cost（MK）	Monthly Cost for a household (50 hh/BH)
1	Spare Parts for Routine Maintenance	5% of cost for a unit of hand pump（MK. 117,150）	5,858	9.76
2	Commission for Repair	MK. 2,000 /year	2,000	3.3
3	Pump Parts for Renewal	120% of costs for a unit of hand pump, considering transportation and installation, for 15 years.	9,372	15.62
Total			17,230	28.68

(2) O & M Cost of Rehabilitation Equipment

The main cost items relating to rehabilitation equipment are the personnel cost, fuel cost and repair cost. As the equipment in question is used for rehabilitation work for the purpose of prolonging the service life of existing boreholes, it will be difficult to earn income through its operation unlike drilling rigs. Accordingly, these costs must be paid by the development budget of the MoAIWD.

Assuming an equipment operating ratio of 80% (17 boreholes/month for airlift dredging at all sites), the estimated annual O & M cost is MK. 8,059,000 (approximately JPYen4.48 million) as shown below. The cost except the personnel cost (MK 3,368,000) shall be additionally secured from the budget for development by the Government of Malawi. This amount is sufficiently low against the scale of annual

Table 2-6-7 Operation and Maintenance Cost for Borehole Rehabilitation Equipment

No.	Item	Description	Quantity M: months H: hours	Unit Rate （MK）	Amount (MK)	Remarks
1	Personnel Cost	Drilling Manager	12 M	136,866	1,642,392	
		Drilling Eng.	12 M	78,947	947,364	
		Driller	12 M	64,420	773,040	
2	Fuel & Lubricant*1	Truck with Crane	612 H	3,120	1,909,440	17days x 12M x 3hours
		Pick-up Truck	612 H	2,184	1,336,608	17days x 12M x 3hours
		Air Compressor	204 sites	3,960	807,840	17days x 12M
3	Maintenance of Machinery*2	Truck with crane	204 days	2,473	504,492	17days x 12M
		Air compressor	204 days	555	113,220	17days x 12M
		Air Lifting Pipe	204 days	122	24,888	17days x 12M
				Total	8,059,284	

*1 The fuel cost is calculated by multiplying the expected fuel consumption per hour or day for each type of equipment by the operating hours.

*2 The unit repair cost of equipment is calculated using the following equation.
Equipment maintenance cost per day in use = original equipment price x O & M cost ratio ÷ days in use (standard service years x 360 days/year)

Chapter 3 Project Evaluation

3-1 Preconditions

The Project will be implemented on the assumption that the Government of Malawi bears the responsibilities and expenses (the items agreed in the Minutes of Discussions in Annex 4) required as the recipient country in the general grant aid scheme of the Government of Japan.

The Project will be predicated on implementation of the following points by the Government of Malawi.

Common Items

- Make the utmost effort to secure the fuel that is required for Project implementation.

Project for Water Supply Systems for Market Centres

- Secure construction sites for water supply facilities.
- Provide temporary installation space for storing the materials required for construction.
- Extend the public power grid to the construction sites by the start of the construction works.
- Preserve the boreholes excavated during the preparatory survey so that they can be used as production boreholes.
- Implement the necessary procedures pertaining to social and environmental consideration.

Project for Rehabilitation of Boreholes in Mchinji

- Implement a CBM programme geared to enlightening, educating and training the residents who will use the rehabilitated or constructed boreholes.
- Assign staff who will receive initial operation guidance for the borehole rehabilitation equipment to be newly procured and have them receive training (OJT) via participation in the rehabilitation works. Also, bear the necessary expenses for those staff members.

3-2 Necessary Inputs by Recipient Country

The items that need to be implemented by the Malawi side in order to realize and maintain the Project effects are as follows.

Project for Water Supply Systems for Market Centres

- The Central Region Water Board (CRWB) will assign facilities operation and maintenance staff and conduct training as required.

- It will bind door-to-door water faucet contracts, implement connection works and commence water supply services immediately following the end of the grant aid works.
- It will appoint managers and tariff collectors for each communal faucet and promptly commence water supply and tariff collections.

Project for Rehabilitation of Boreholes in Mchinji

- It will inform the communities targeted for rehabilitation and construction of the start of works, establish water management committees (WPCs) and gauge the needs for re-training. The findings will then be reflected in the action plan of the CBM programme implemented by the Malawi side in the Project.
- It will reinforce the maintenance setup for boreholes in collaboration with the technical cooperation project (Project for Enhancement of Operation and Maintenance for Rural Water Supply).

3-3 Important Assumption

In order to manifest and sustain the Project effects, the following external conditions will be needed.

- The Government of Malawi's policy of placing emphasis on rural water supply will be continued.
- The fuel and power required to construct, manage, operate and maintain facilities will be supplied.
- Physical distribution that allows construction materials and operation and maintenance materials to be easily acquired will be sustained.
- A system of tariffs that are affordable for the majority of residents who use the water supply facilities will be maintained.

3-4 Project Evaluation

3-4-1 Relevance

(1) Project for Water Supply Systems for Market Centres

Water supply facilities at the rural economic centres (market centres) that are emphasized by the Government of Malawi in its infrastructure development, still mainly comprise deep boreholes and shallow boreholes as in the rural communities, and some centres are even forced to use river water. At both Mkanda (population of 4,666 as of 2008) and Santhe (5,437 as of 2008) Market Centres, there are 21 deep boreholes deemed to be safe water sources. The estimated supply population of these boreholes is 5,250, which represents approximately 52% of the present population (10,100 in 2008) and is lower than the safe rural supply rate (72%) that is prescribed for rural areas of Malawi. The Project, which will enable water to be supplied to these two districts (design supply population 14,536 in 2020), has a high degree of urgency for improving civic stability and resident lifestyles from the viewpoint of BHN, and it is compatible with the state's rural economic promotion and development policy.

(2) Project for Rehabilitation of Boreholes in Mchinji

The non-operating rate of boreholes in Mchinji is estimated to be 24%. In particular, the non-operating rate is high among 300 boreholes that were installed more than 16 years ago under grant aid. Out of the 1,100 boreholes in this district, these boreholes have also been in the longest service following the installation of hand pumps too.

Although the recognition is steadily spreading that routine maintenance of hand pumps and replacement of expendable parts are the responsibility of user residents, there is no choice but to use unsanitary water from sources such as hand-dug shallow wells and rivers and it is also necessary to transport water over long distances in cases where boreholes cannot be repaired by the user resident organizations or cases where breakdowns frequently occur and there is a long time to wait for repairs. Accordingly, concerning the hand pumps that have already gone beyond their service life, it is urgently necessary to upgrade to higher durability specifications and to improve the operating conditions with a view to improving the basic living conditions of the residents who use the boreholes.

The Project aims to increase service population and extend the service life of boreholes in the rural communities of Mchinji District through carrying out borehole rehabilitation and construction of substitute and additional boreholes. In doing so, it will reduce the users' cost for maintenance. The Government of Malawi aims to reduce the ratio of non-functioning boreholes from the current 30% to 25% nationwide by 2015, and since implementation of the Project will improve the functionality of borehole in Mchinji District, it will contribute to the achievement of the goals in the Government of Malawi's development plans. As the Project also aims to implement enlightenment and education of the resident organizations that use the boreholes in tandem with the repair work, it will help foster a sense of ownership geared to the autonomous operation and maintenance of boreholes. Therefore, the Project is also compatible with the Government of Japan's assistance policy that aims to enhance operation and maintenance capacity on the village level.

The implementation of above two projects will also contribute to the achievement of the goals in MGDS which is aiming at improvement of coverage of safe water and making accessing to safe water point not more than 500 m.

Furthermore, these two projects will be the measures against the risks of interruption to safe water use caused by drought or flood which may be occurred by climate changes. The Malawi government also recognised this relevance.

3-4-2 Effectiveness

(1) Quantitative Effects

The Project intends to build water supply facilities with capacity of 544 m^3/day and 712 m^3/day respectively in two market centre districts (Mkanda and Santhe) and to rehabilitate at least 280 boreholes and construct a maximum of 54 boreholes in Mchinji District.

The only safe water supply facilities in the market centres are 21 boreholes, however, by the Project target year of 2020, it will be possible to supply safe water via conduit facilities to all the residents (design population 14,536) in the target area. Out of 300 boreholes that were previously constructed in Mchinji District under grant aid, only 209 are currently operating, however, since 334 boreholes will become operable following repair, substitution and additional construction in the Project, the service population will increase to 31,250 (assuming the standard value for Malawi of 250 users per borehole).

Table 3-4-1 Quantitative Effects of the Project

Indicator	Project	Reference Figure (2010)	Target Figure (2015)
Population receiving safe water supply (persons)	Construction of piped water supply system in each of Mkanda and Santhe Market Centres	5,250 (water supply from boreholes)	14,536 *
	Rehabilitation and construction of boreholes in Mchinji District	52,250	83,500

*: This population is adjusted to year 2020 complying with design year.

(2) Qualitative Effects

① Thanks to the supply of safe and stable water, it is expected that sanitary conditions will be improved and water-borne diseases will be reduced.

② As water drawing labour will be mitigated, it is expected that children will have more opportunities to obtain education and there will be more work opportunities for women, thus making it easier to participate in productive and economic activities.

③ Due to the renewal of hand pumps that have been used beyond their service life and are breaking down frequently, the frequency of breakdowns will decline and borehole operating conditions will be improved over the long term.

④ The operation and maintenance system of boreholes in Mchinji District is expected to be improved through the implementation of the soft component of the Project.

Based on the evaluations above, it is judged that the Project is expected to be highly relevant and effective.