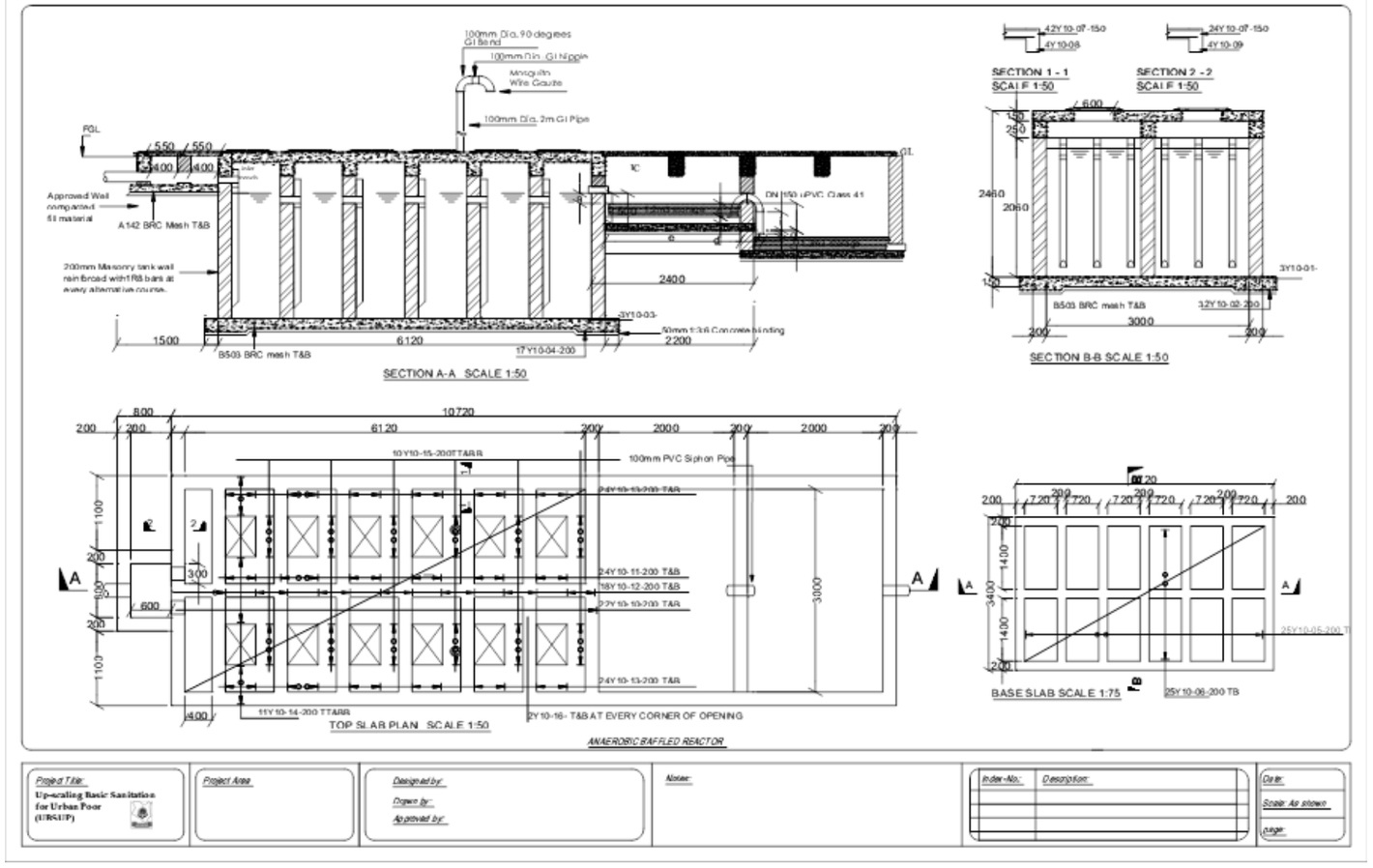
WATER SERVICES TRUST FUND

DECENTRALISED TREATMENT FACILITY (DTF)

CONSTRUCTION MANUAL



INSIDE

Structural Drawings

Bill of Quantities

Bar Bending Schedule

DO´s & DON´Ts

Health & Safety

Construction Monitoring

WATER SERVICES TRUST FUND

DECENTRALISED TREATMENT FACILITY (DTF)

CONSTRUCTION MANUAL

About this Manual

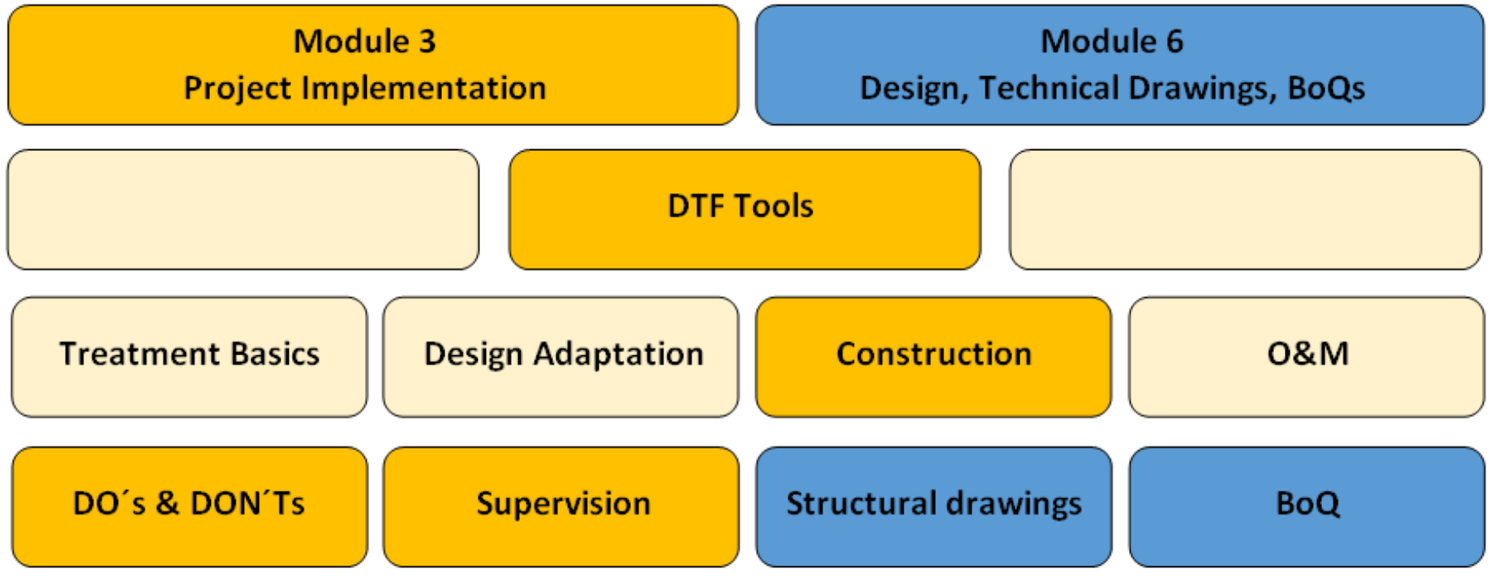
This manual is one from a series of three manuals, prepared by Water Services Trust Fund (WSTF), covering the following aspects of a DTF project cycle:

- DTF Design Adaptation
- **DTF Construction**
- DTF Operation & Maintenance (O&M)

This manual is supposed to support Water Service Providers (WSPs) with the implementation of DTF projects. The manual covers tools developed by WSTF for the successful implementation of DTF. These tools include:

- Structural drawings * and Bar Bending Schedule
- Bill of Quantities (BoQs)
- DO´s & DON´Ts during construction, and health and safety
- Tools for tendering and construction monitoring

The below figures shows where these tools are embedded within the SafiSan Toolkit:



*) This DTF Construction Manual presents structural drawings of all DTF modules and auxiliary modules. Architectural drawings are presented in the DTF Design Adaptation Manual and show how the final DTF looks like.

If you have any questions, observations or suggestions, please do not hesitate to contact:

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WATER SERVICES TRUST FUND

DECENTRALISED TREATMENT FACILITY (DTF)

CONSTRUCTION MANUAL

How to use this Manual

This manual is an “easy to handle and use” construction guide and serves:

- As source of detailed structural drawings to be used for tendering, construction (by Contractors) and construction supervision (by water companies)
- As source of detailed Bill of Quantities (BoQs) to be used for tendering and project monitoring
- As guide during the construction of DTFs to avoid construction errors
- As a collection of templates to be used during tendering and construction monitoring

The Manual is divided into colour-coded sections for ease of reference. The sections are:

- Structural Drawings
- Bar Bending Schedules
- Bill of Quantities (BoQ)
- Construction DO´s & DON´Ts
- Health & Safety
- Tendering & Construction Monitoring

In the following the content and purpose of these sections is explained:

Structural Drawings

The structural drawings are used to get the construction right. They show detailed information to be used during tendering and construction supervision. Architectural drawings are included in the “Design Adaptation Manual”.

The drawings provide technical details for all treatment and auxiliary modules that are part of the generic DTF. An electronic version is provided in AutoCAD attached to this manual. The softcopy is supposed to be used for future projects as well as to prepare “as-built” drawings after completion of construction including approved variations.

Bar Bending Schedules

The Bar Bending Schedules complement the structural drawings. These clearly show the shape and lengths of the required reinforcements.

Bill of Quantities (BoQs)

This section provides an overview of the BoQ for the treatment and auxiliary modules.

Although a tailor-cut, final BoQ is prepared for a specific DTF during the “Design Adaptation” phase, an overview cost categories of the generic DTF is presented. The final BoQ shall be used by water companies during the tender phase. Contractors are requested to prepare their priced BoQ based on this template.

An electronic version of the BoQs is provided in MS-Excel format attached to this manual to be used for preparing the “as-built” BoQ that includes approved variations.

Construction DO´s & DON´Ts

This section provides practical instructions and recommendations related to the construction of DTF, incl. general directions, and module-by-module recommendations for all treatment and auxiliary modules.

This section shall be used by Contractors and water companies to avoid errors during construction.

Health & Safety during Construction

This section provides a basic overview of required measures to avoid or reduce any health and safety risks during the construction of a DTF.

Tendering & Construction Monitoring

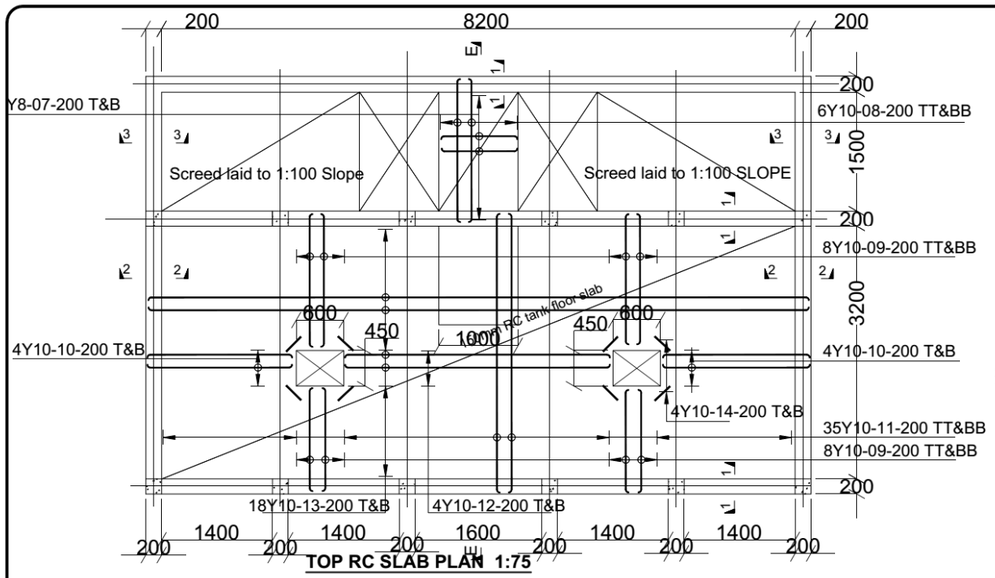
This section provides recommendations and templates to be used by water companies during the tender and construction phase as reference.

This includes recommendations for and templates of standard tender documents, contract templates, payment schedules, other templates for construction supervision and handover.

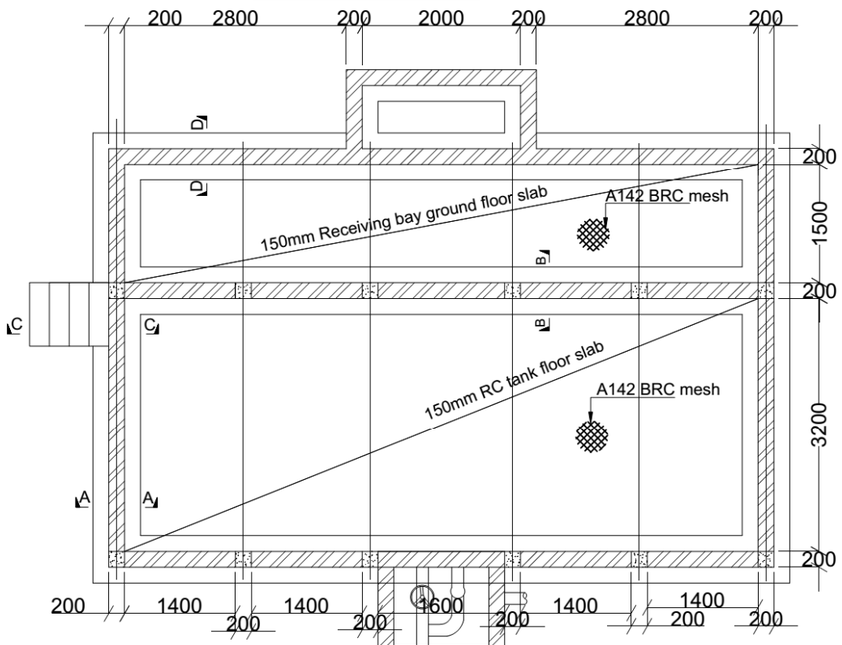
As this is a “living document” please inform WSTF
if you feel that any information is misleading, wrong or missing

STRUCTURAL DRAWINGS

TABLE OF CONTENTS



TOP RC SLAB PLAN 1:75



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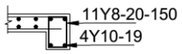

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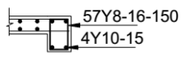

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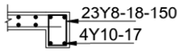

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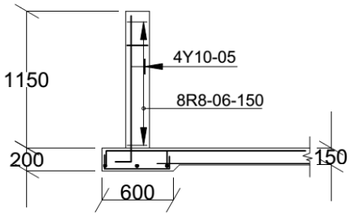

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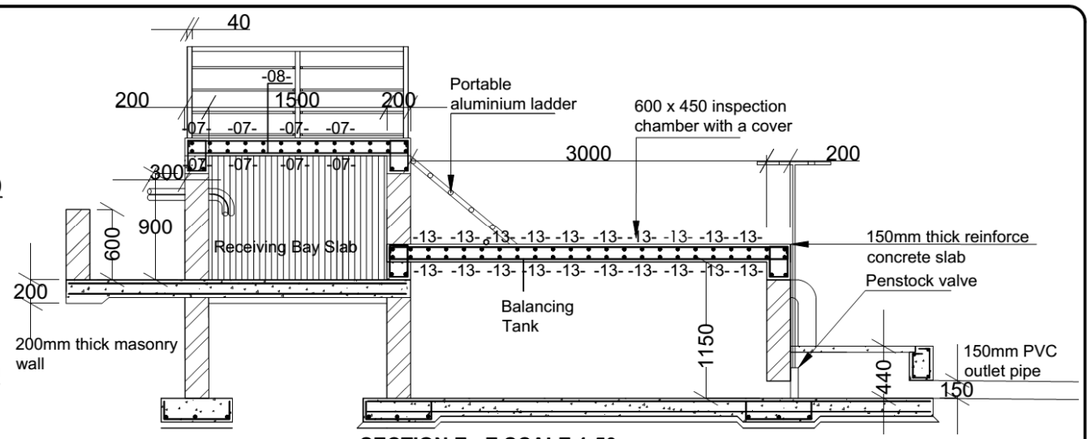

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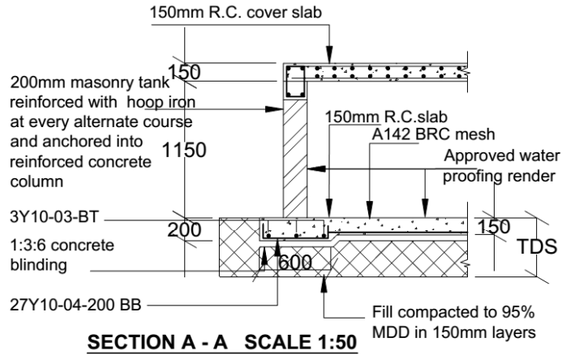

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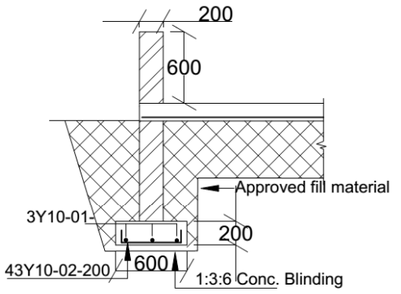

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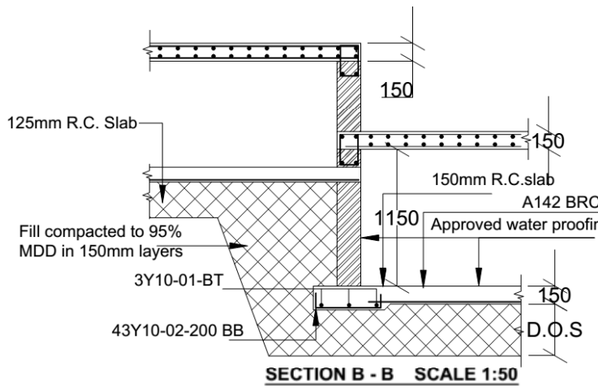

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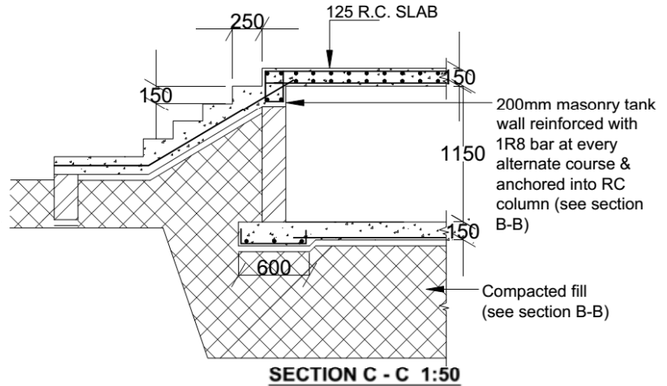
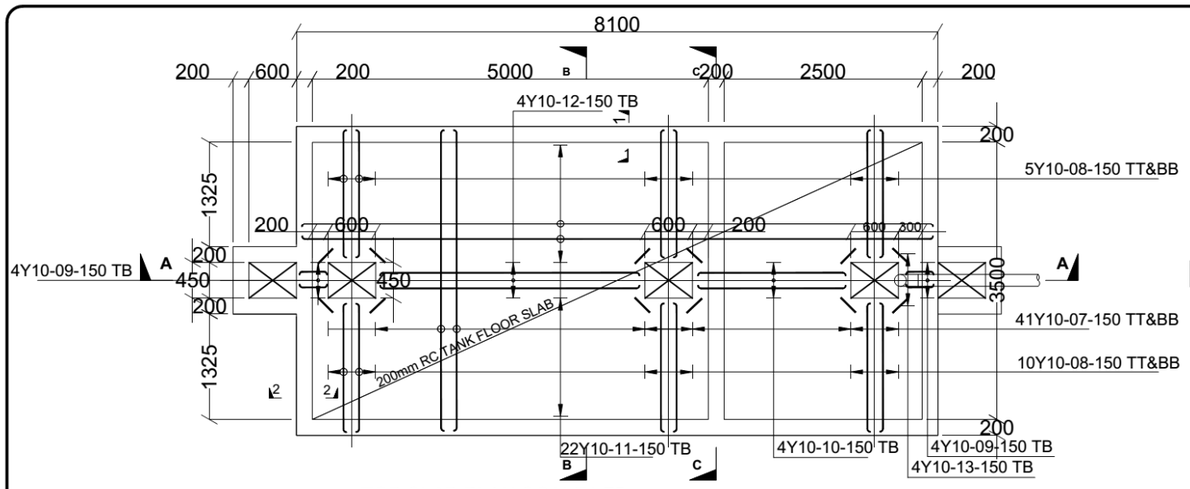


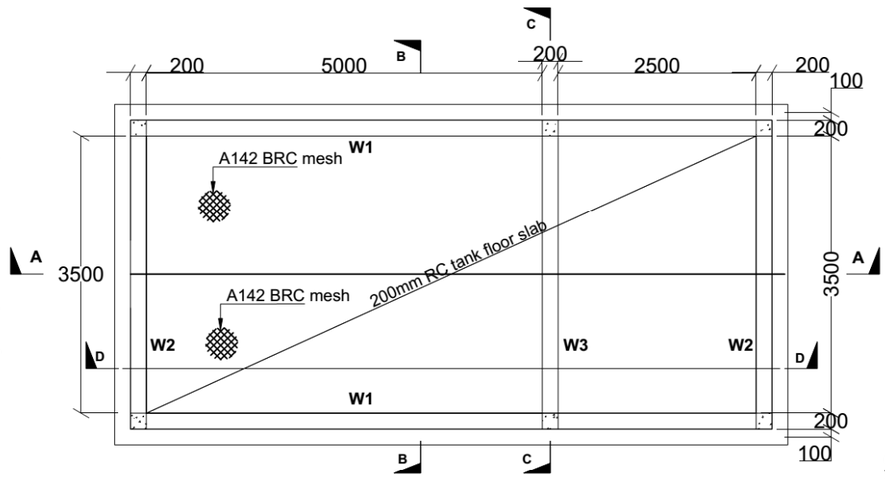
SECTION C - C 1:50

RECEIVING BAY AND BALANCING TANK

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** UBSUP technical team ***Checked by:*** Programme Manager Urban Investments ***Approved by:*** CEO WSTF	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



TOP SLAB PLAN SCALE1:75



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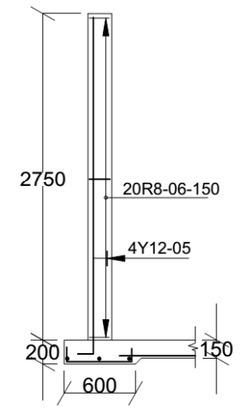

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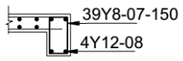

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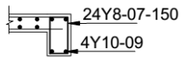

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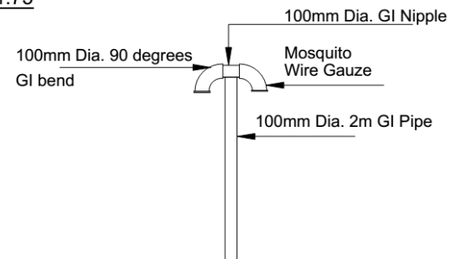

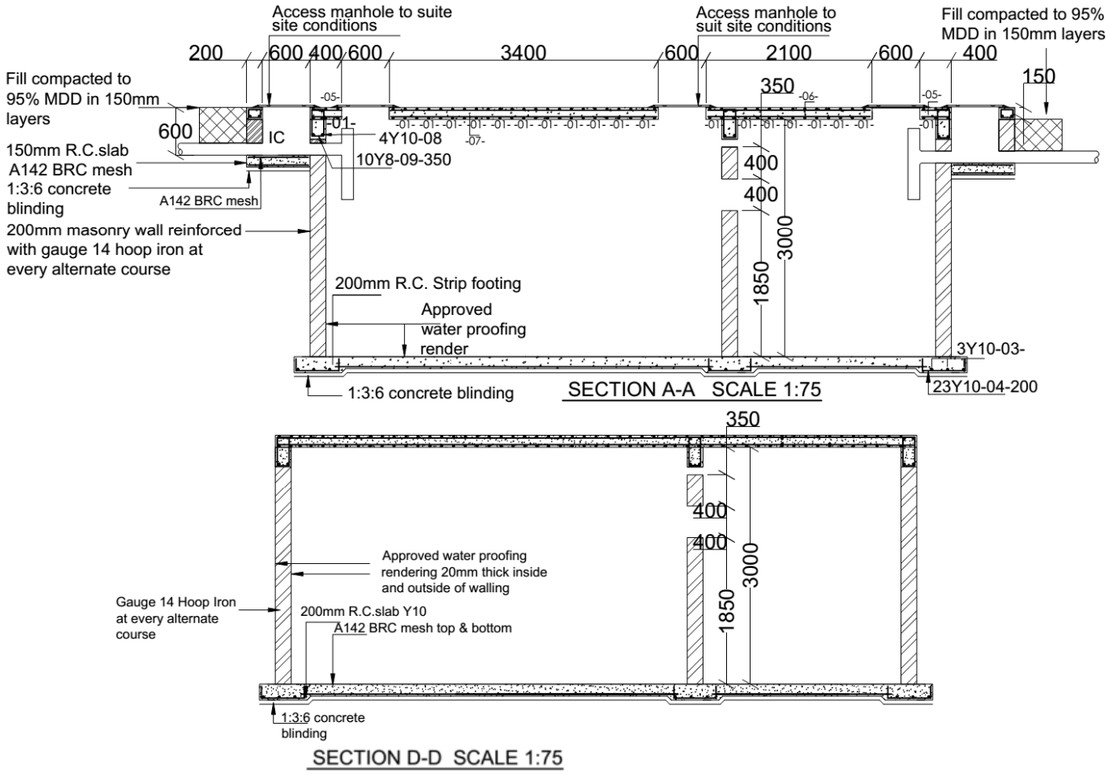

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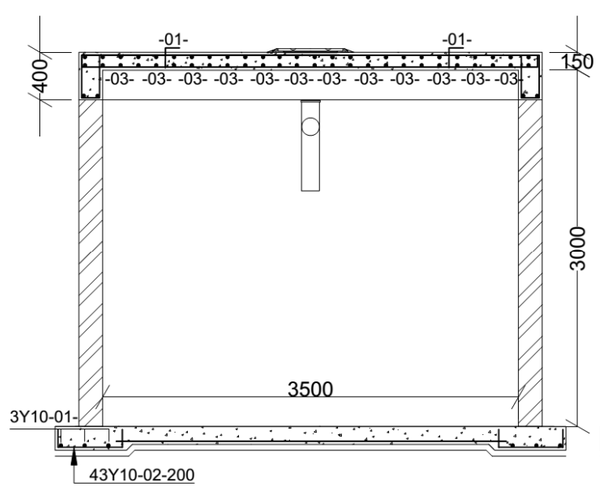

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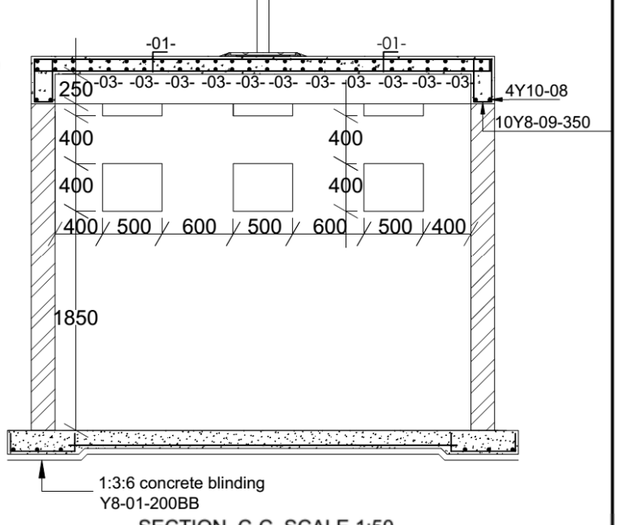

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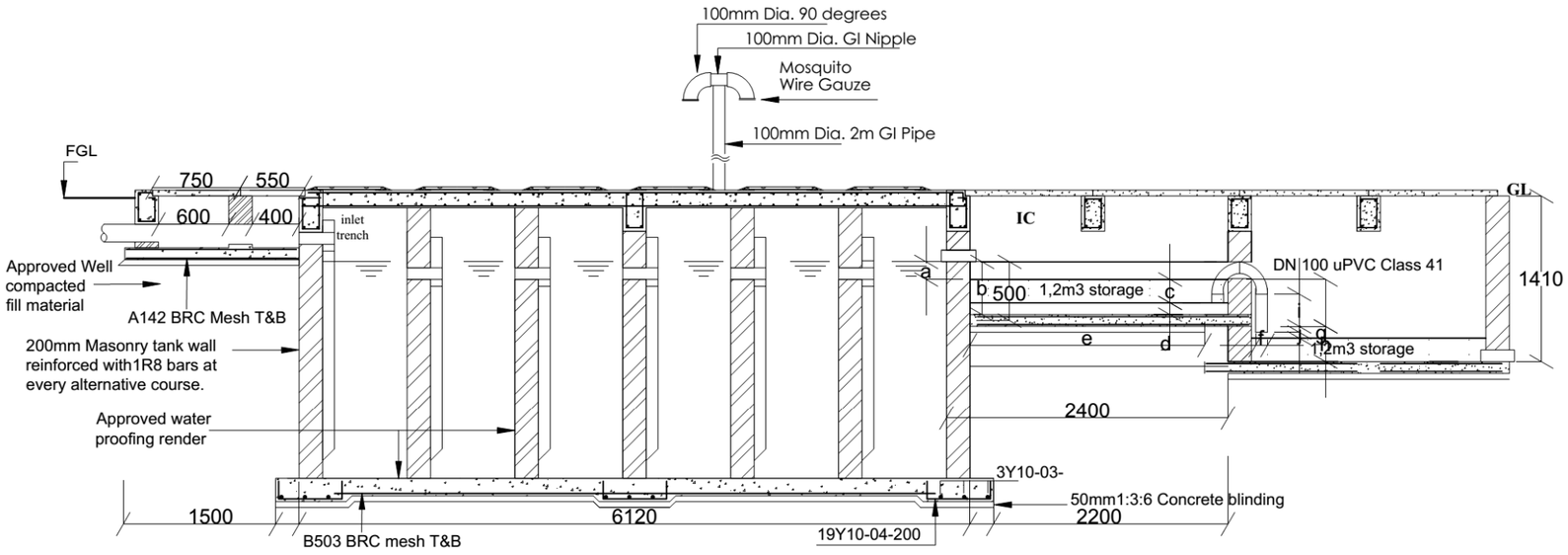
SETTLER TANK

Project Title: **Up-scaling Basic Sanitation for Urban Poor (UBSUP)**	***Project Area***	***Designed and drawn by:*** *UBSUP technical team* ***Checked by:*** *Programme Manager Urban Investments* ***Approved by:*** *CEO WSTF*	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



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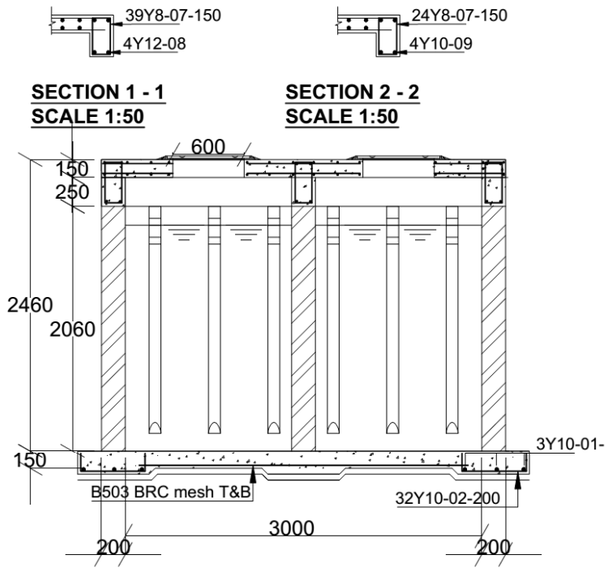

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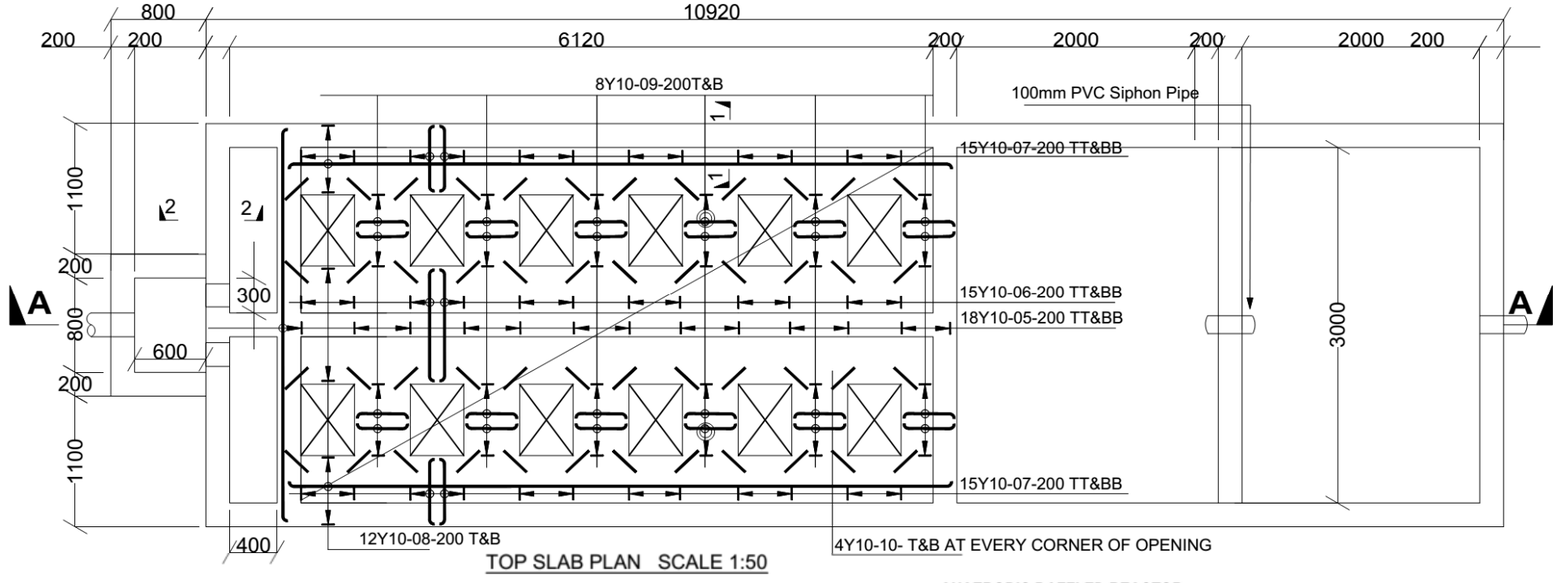
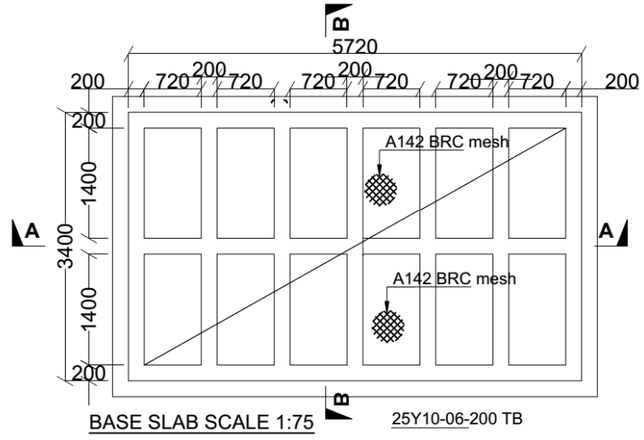


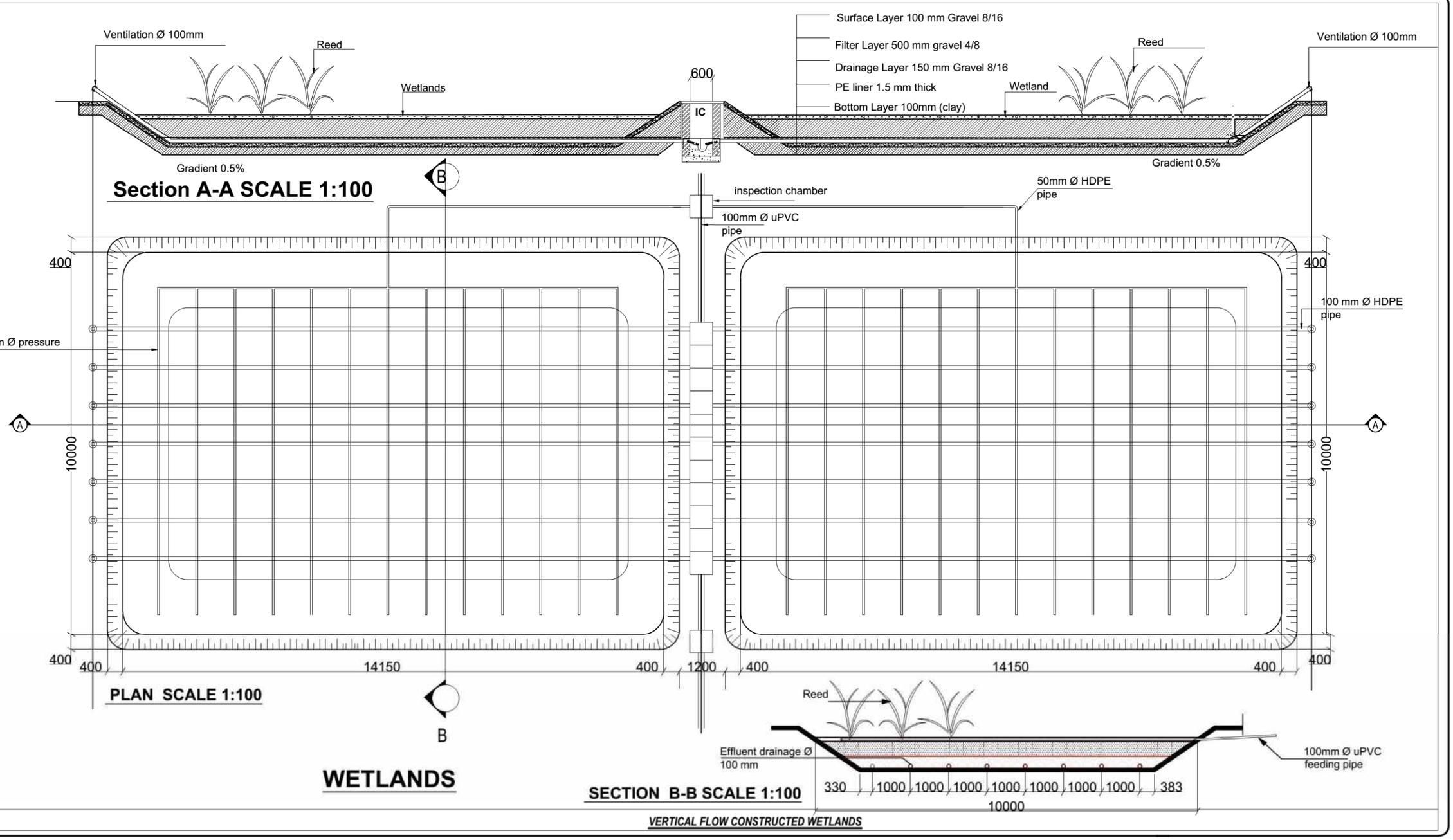
TOP SLAB PLAN SCALE 1:50



BASE SLAB SCALE 1:75

ANAEROBIC BAFFLED REACTOR

Project Title: **Up-scaling Basic Sanitation for Urban Poor (UBSUP)**	***Project Area***	***Designed and drawn by:*** *UBSUP technical team* ***Checked by:*** *Programme Manager Urban Investments* ***Approved by:*** *CEO WSTF*	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



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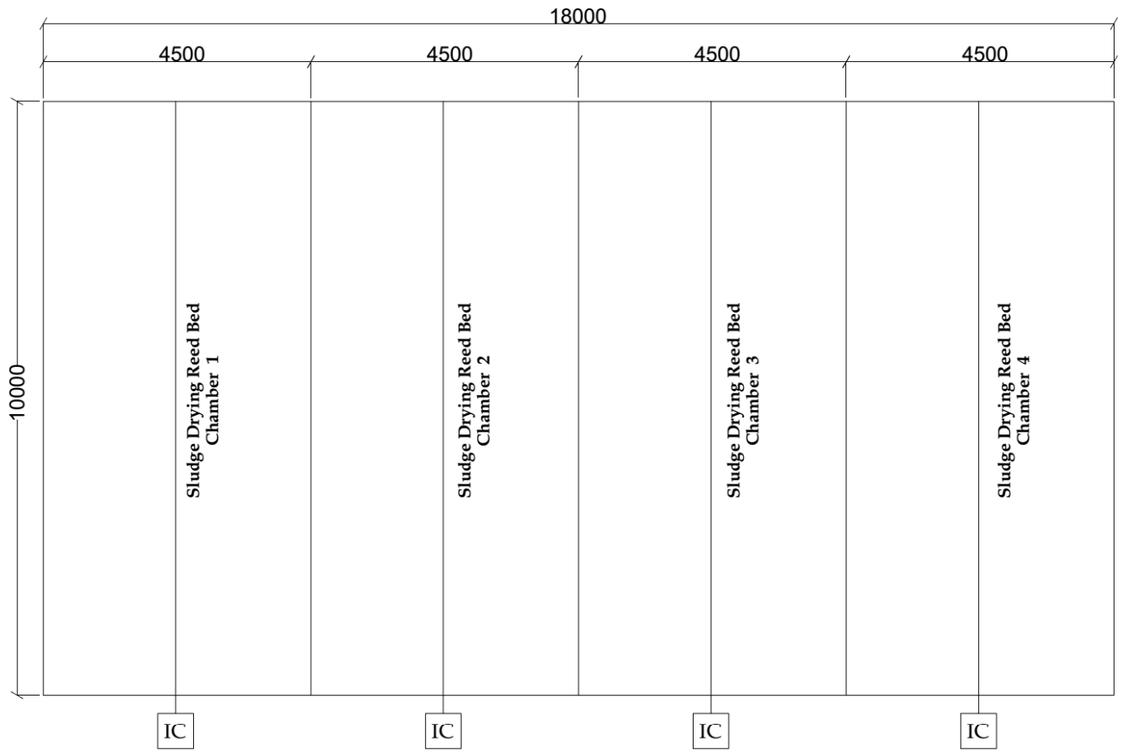
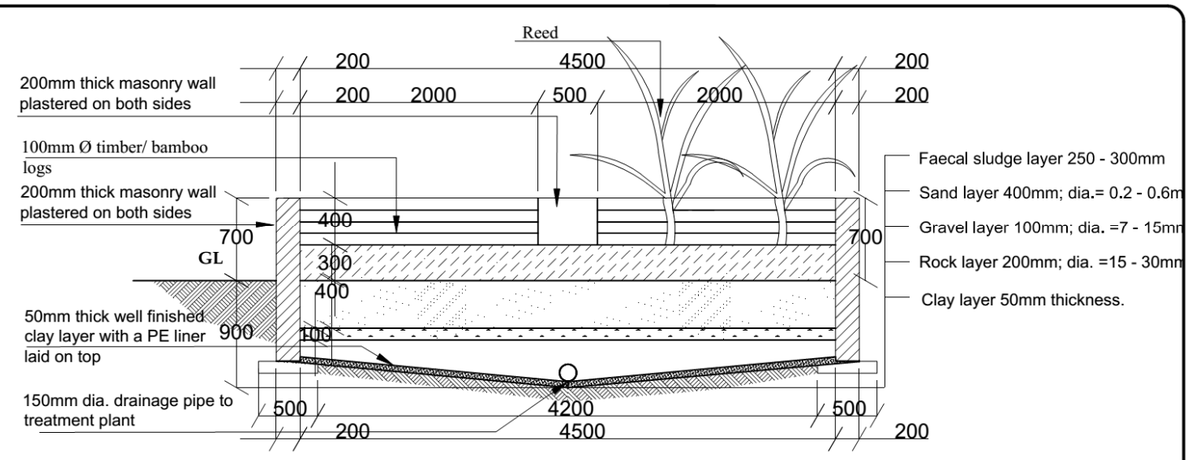


SDRB LAYOUT PLAN (FOUR UNITS) SCALE 1:100



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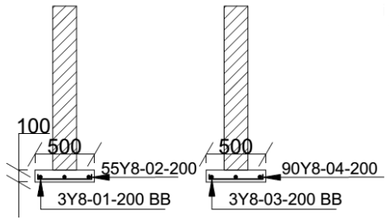
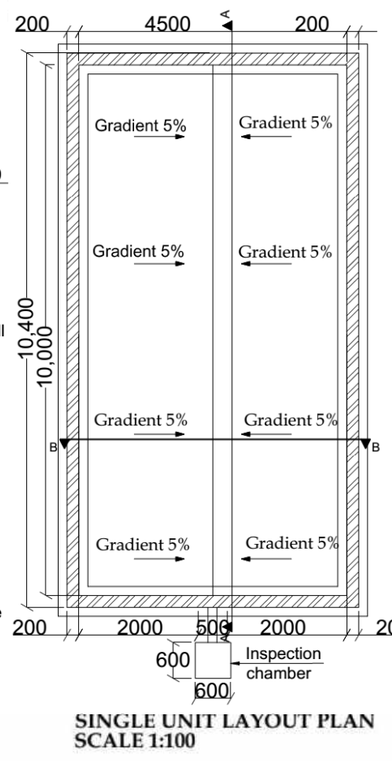
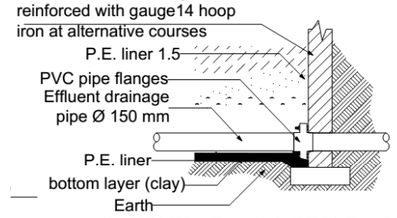
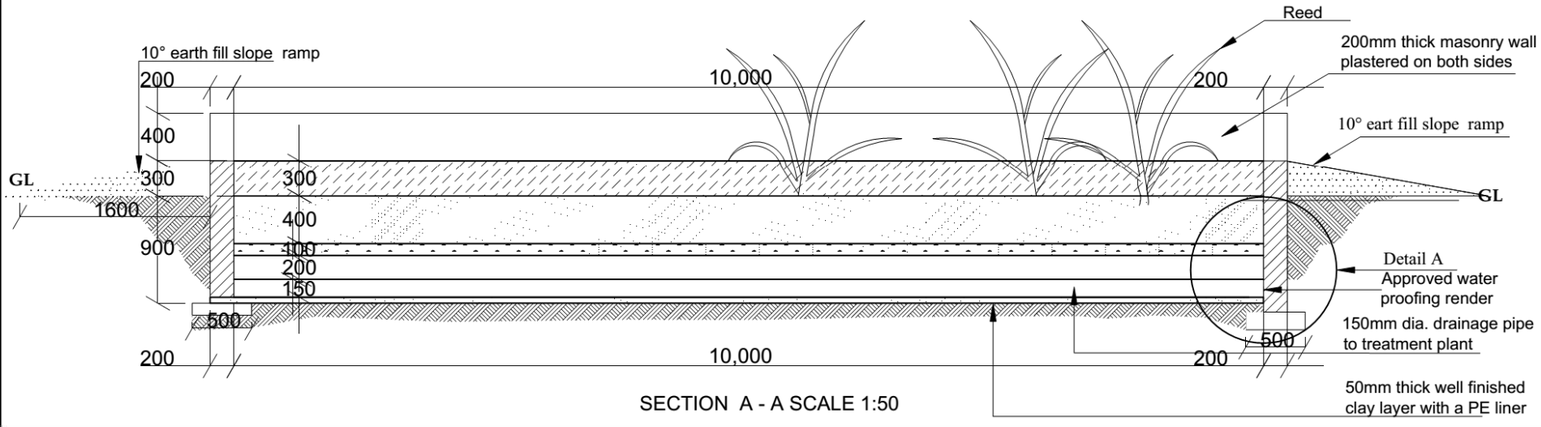


FOUNDATION Detail B SCALE 1:50





COUPLING Detail A SCALE 1:50



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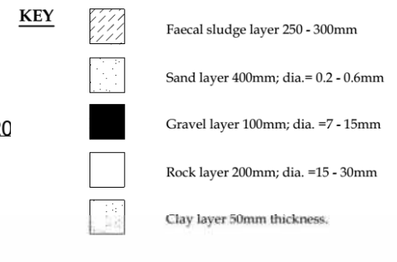
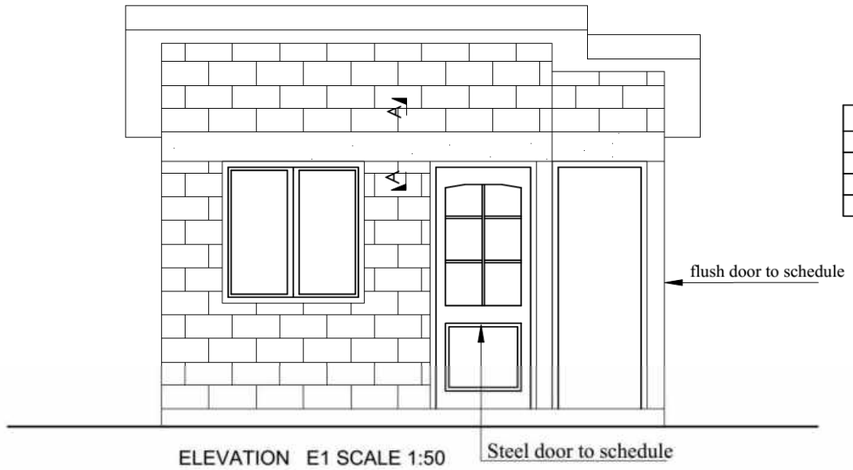


SINGLE UNIT LAYOUT PLAN SCALE 1:100

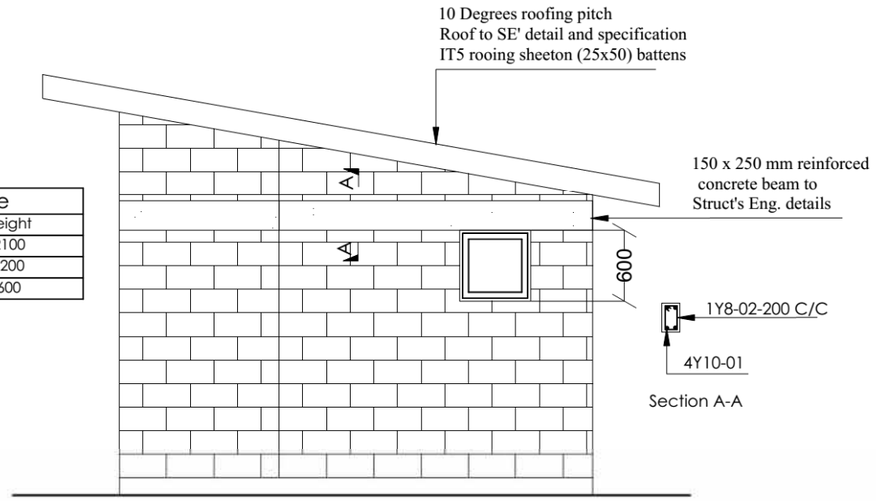
SLUDGE DRYING REED BED

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed by:*** UBSUP technical team ***Drawn by:*** Programme Manager Urban Investments ***Approved by:*** CEO WSTF	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



ELEVATION E1 SCALE 1:50

Doors and Windows Schedule		
Type	Width	Height
Door D1	900	2100
Window W1	1200	1200
Window W2	600	600



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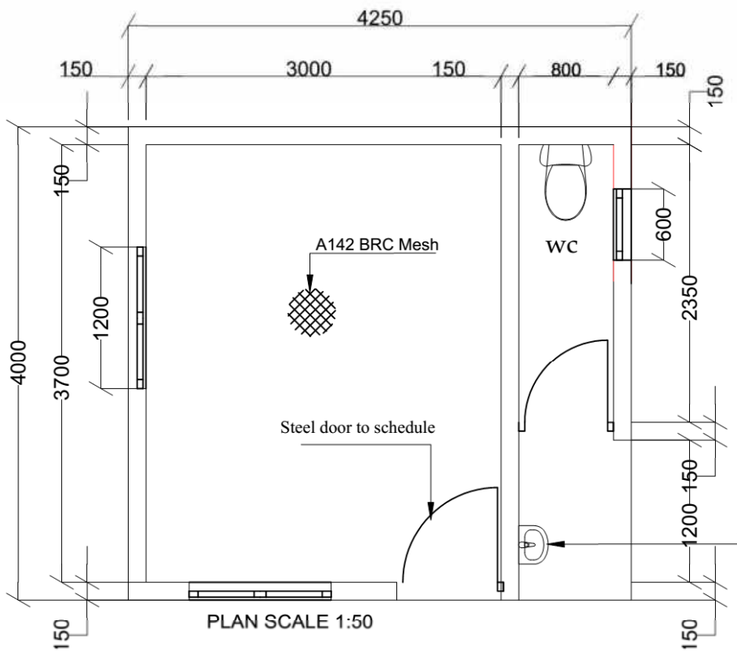
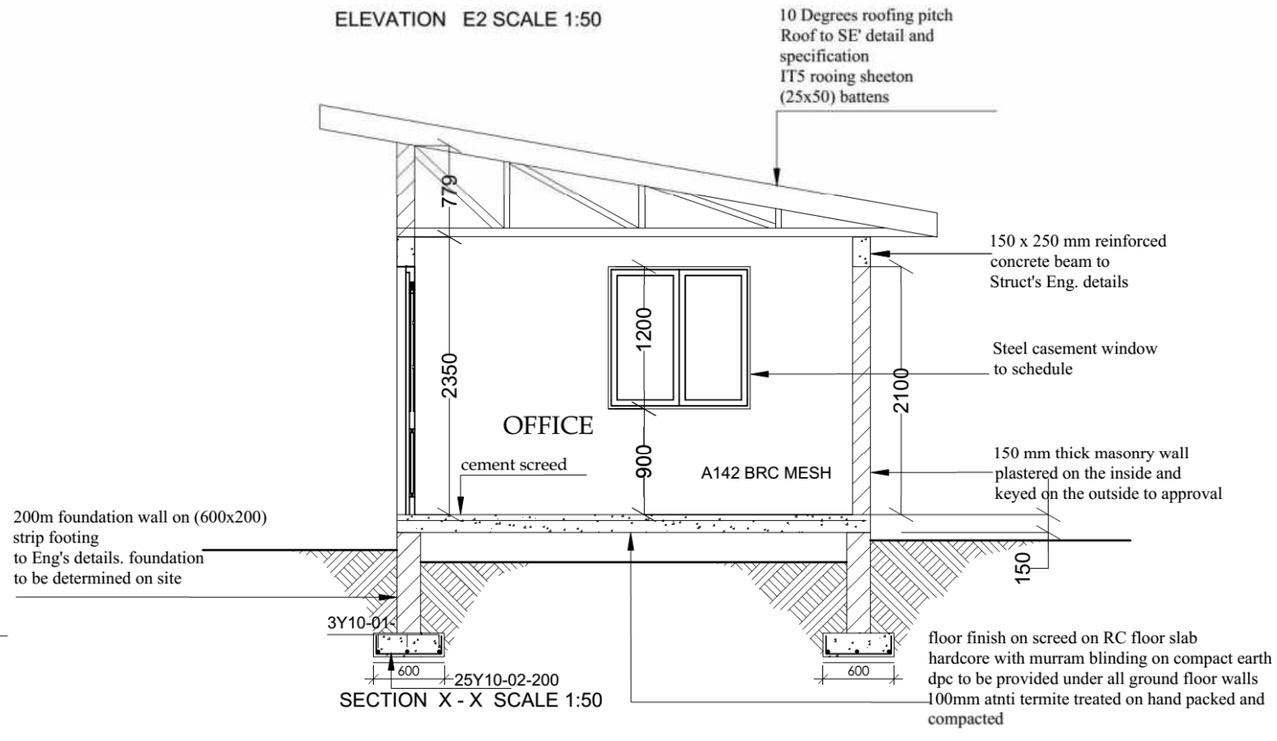
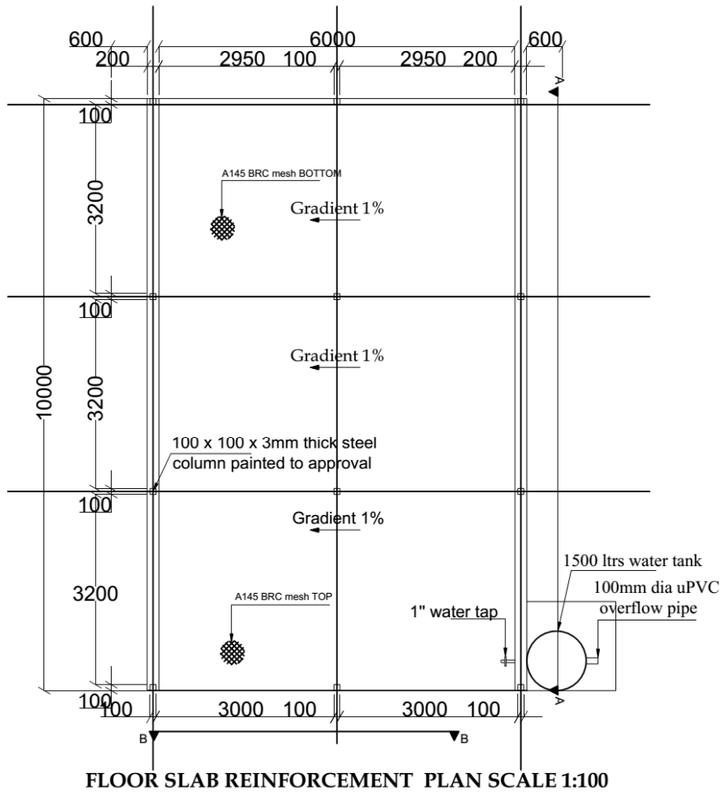


PLAN SCALE 1:50

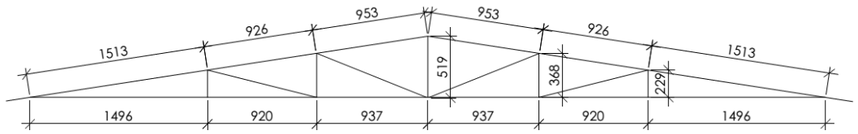


SECTION X - X SCALE 1:50

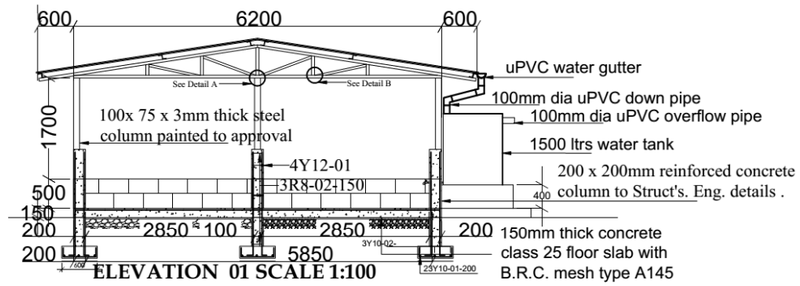
Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** UBSUP technical team ***Checked by:*** Programme Manager Urban Investments ***Approved by:*** CEO WSTF	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



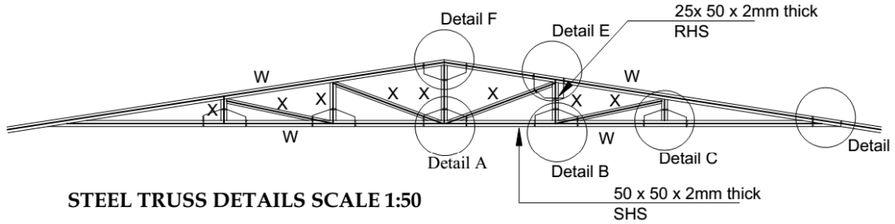
FLOOR SLAB REINFORCEMENT PLAN SCALE 1:100



STEEL TRUSS DETAILS SCALE 1:50



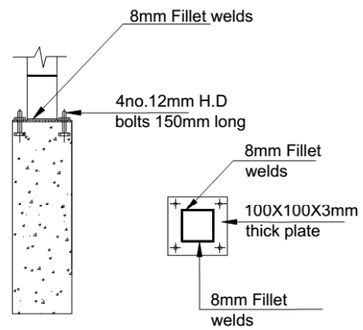
ELEVATION 01 SCALE 1:100



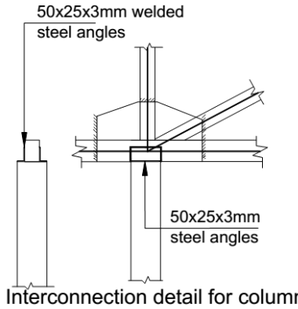
STEEL TRUSS DETAILS SCALE 1:50

ALL MEMBERS 'X' ARE 25x50x2.0

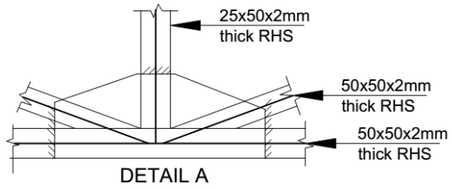
ALL MEMBERS 'W' ARE 50x50x2.0



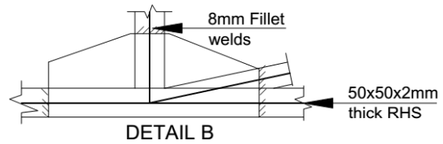
Steel column connection details
DETAIL A SCALE 1:20



Interconnection detail for column
and truss DETAIL B SCALE 1:20

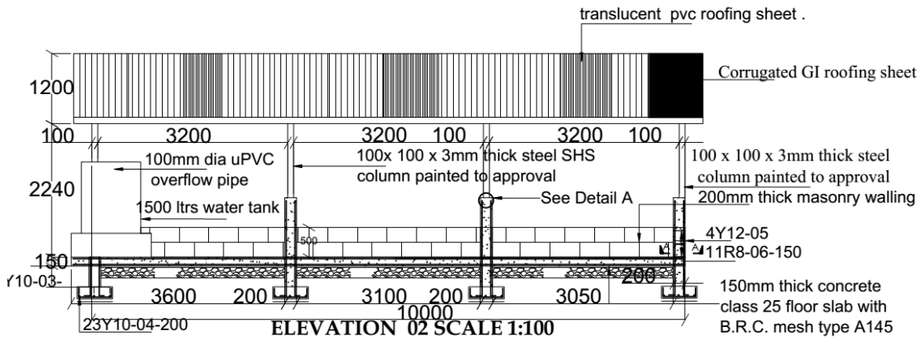


DETAIL A

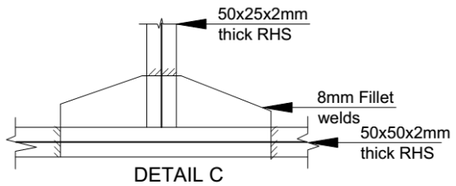


DETAIL B

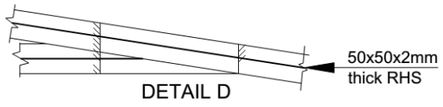
SCALE 1:10



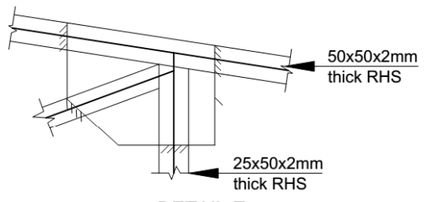
ELEVATION 02 SCALE 1:100



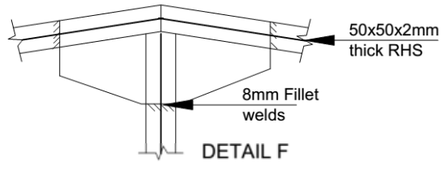
DETAIL C



DETAIL D

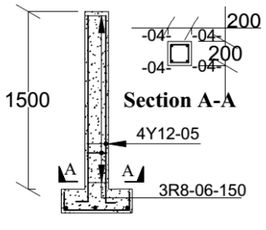


DETAIL E



DETAIL F

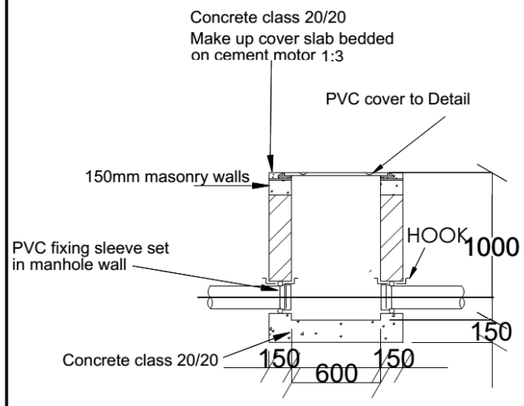
SCALE 1:10



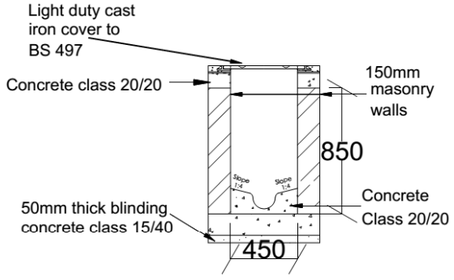
TYPICAL COLUMN
SCALE 1:50

COMPOSTING BED

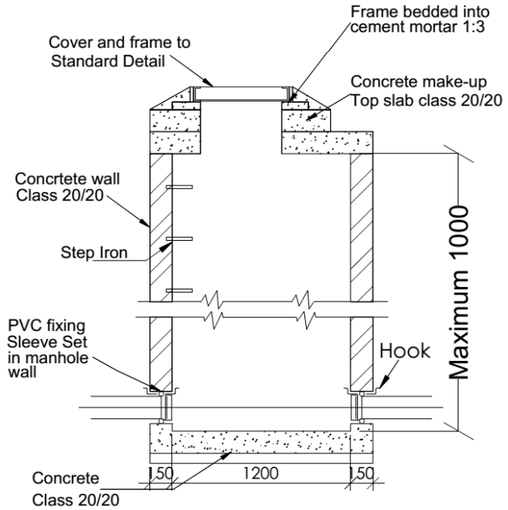
Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	**Project Area**	**Designed and drawn by:** UBSUP technical team **Checked by:** Programme Manager Urban Investments **Approved by:** CEO WSTF	**Notes:**	**Index-No.:** / **Description:**	**Date:** **Scale: As shown** **page:**



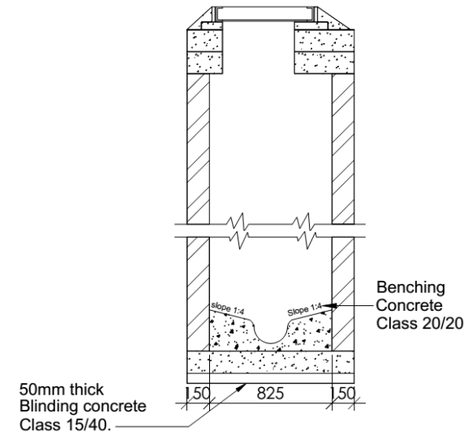
SECTION B-B
SCALE 1:40



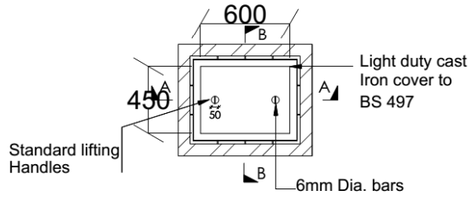
SECTION A-A
SCALE 1:40



SECTION B-B
SCALE 1:40



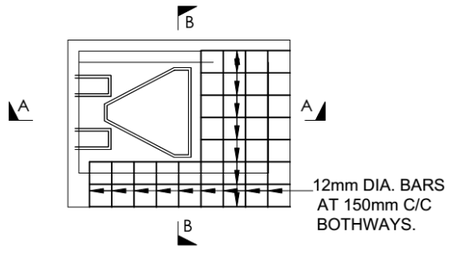
SECTION A-A
SCALE 1:40



PLAN SCALE 1:40

NOTES:

1. INSPECTION CHAMBER SHOULD BE SIZE 600x450mm UP TO DEPTH OF 1000mm
2. FOR CHAMBERS EXCEEDING DEPTH 1000mm SIZE SHOULD BE 850x1200mm
3. WALLS OF INSPECTION CHAMBER TO BE OF MASONRY
4. ALL CONCRETE TO BE CLASS 20/20 IN ACCORDANCE WITH THE SPECIFICATION



PLAN SCALE 1:40

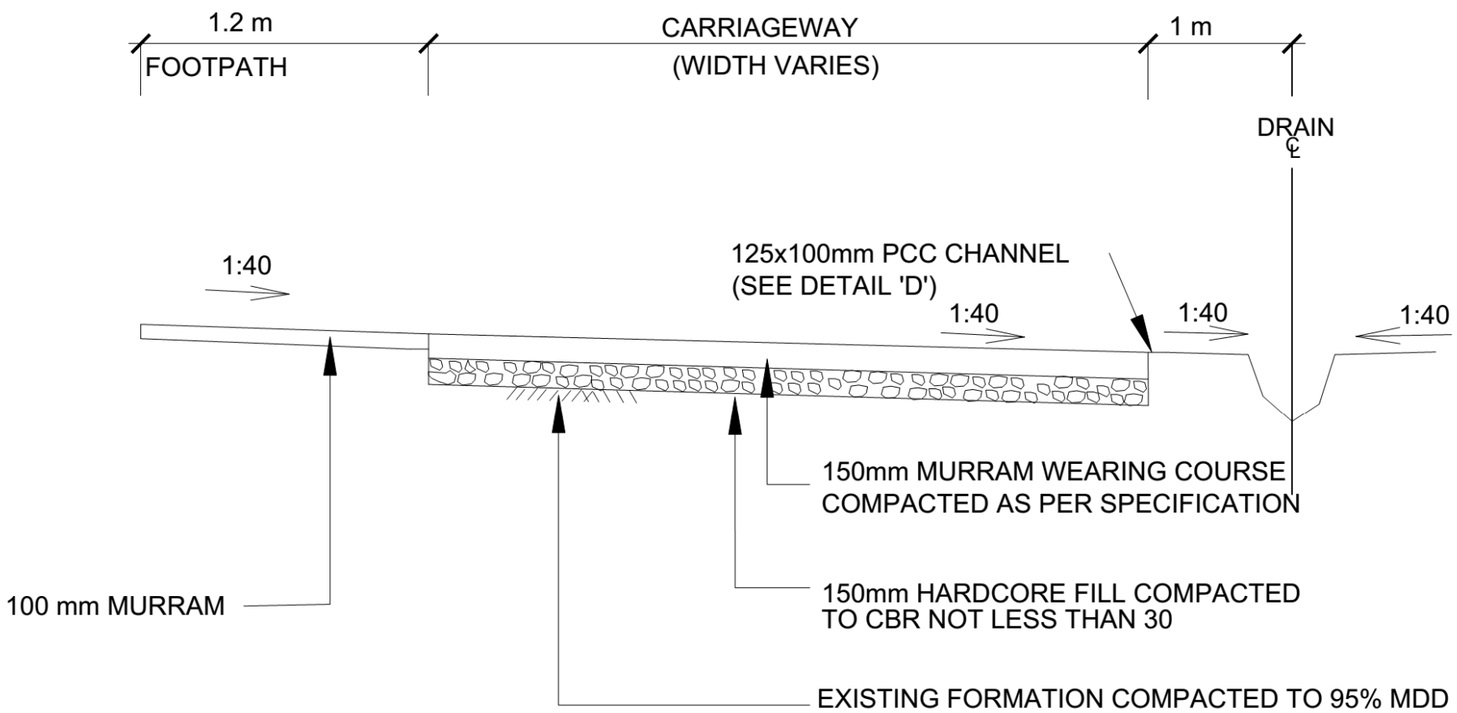
INSPECTION CHAMBER DETAILS

RECTANGULAR MANHOLE DETAILS

TYPICAL INSPECTION CHAMBER

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** UBSUP technical team ***Checked by:*** Programme Manager Urban Investments ***Approved by:*** CEO WSTF	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***

TYPICAL MURRAM ROAD DETAILS



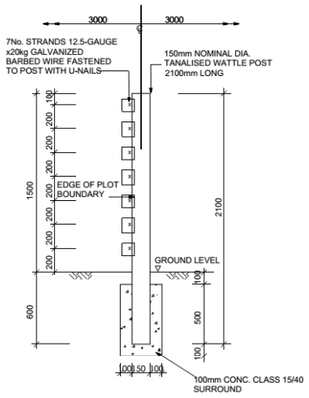
TYPICAL SECTION OF MURRAM ROAD

SCALE 1: 50

TYPICAL MURRUM ROAD

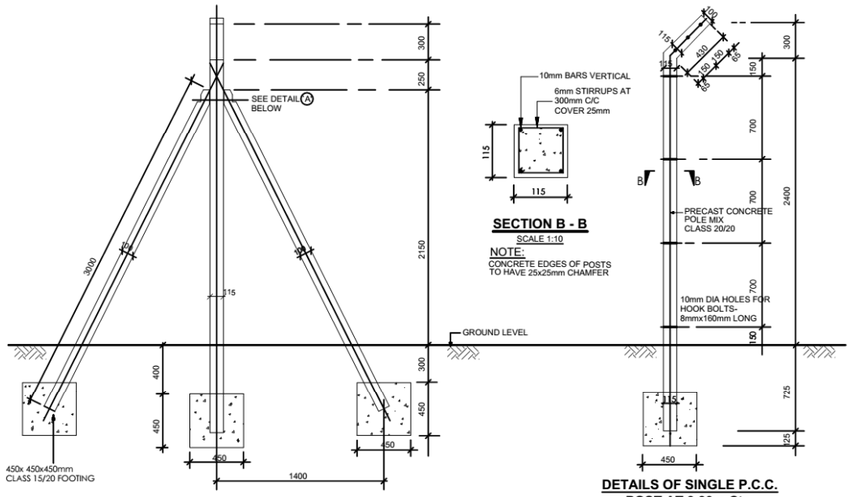
Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** *UBSUP technical team* ***Checked by:*** *Programme Manager Urban Investments* ***Approved by:*** *CEO WSTF*	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***

DETAILS OF WATTLE POSTS FOR BARBED WIRE FENCE



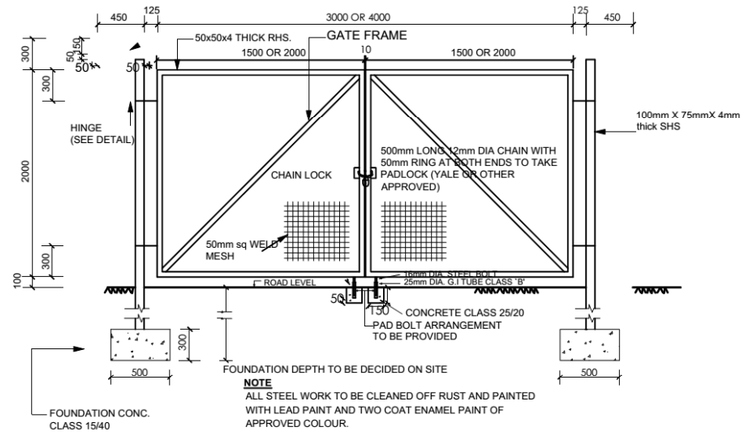
TYPICAL END ELEVATION - SINGLE POST (TO BE AT 3.0m CENTRES)
(NTS)

DETAILS OF PRECAST CONCRETE POSTS FOR CHAIN LINK FENCE



DETAILS OF STRAINING POST FOR CHAIN LINK FENCE AT 33.3m Cts.
SCALE 1:40

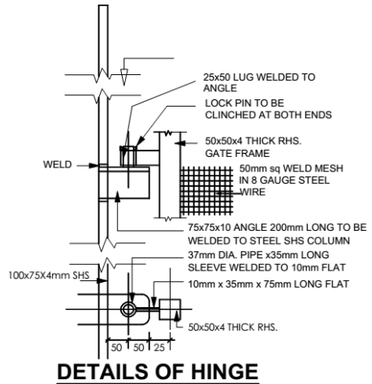
DETAILS OF SINGLE P.C.C. POST AT 3.30m Cts.
SCALE 1:40



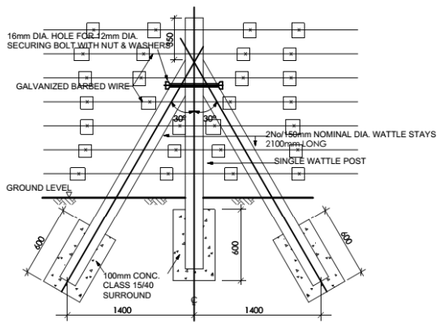
NOTE
ALL STEEL WORK TO BE CLEANED OFF RUST AND PAINTED WITH LEAD PAINT AND TWO COAT ENAMEL PAINT OF APPROVED COLOUR.

ELEVATION
SCALE 1:20

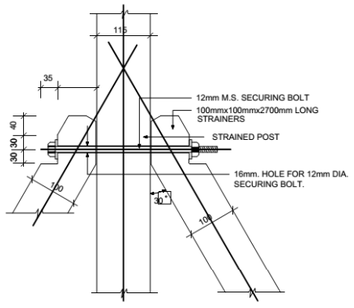
DETAILS OF 3m & 4m WIDE GATE



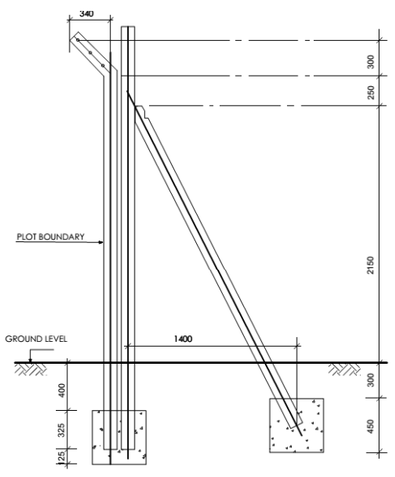
DETAILS OF HINGE (VIEW AT Y - Y)
SCALE 1:5



TYPICAL FRONT ELEVATION - STAYED POST (STAYS TO BE PROVIDED AT 30.0m c/c AND AT CORNERS
(NTS)



DETAIL A
SCALE 1:10

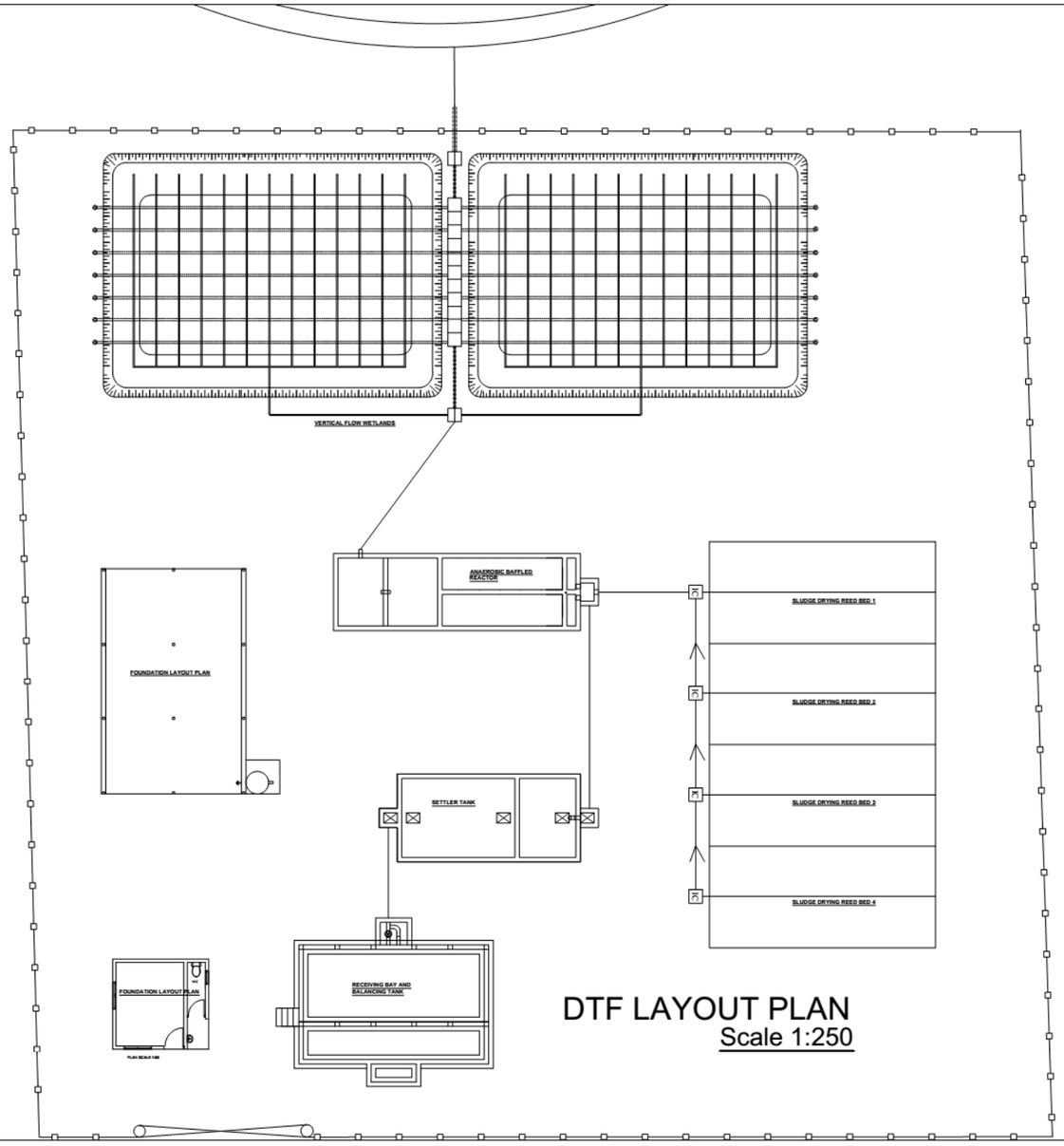


DETAILS OF CORNER POSTS
SCALE 1:40

TYPICAL CHAIN LINK FENCE

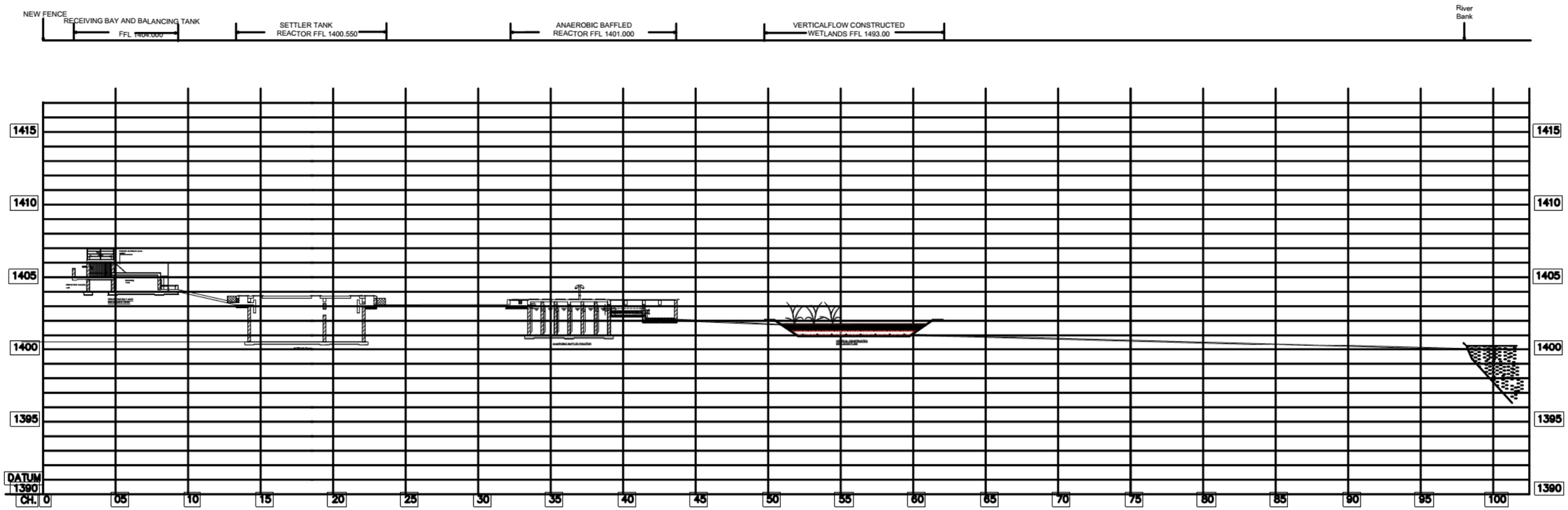
TYPICAL GATE

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed by:*** ***Drawn by:*** ***Approved by:***	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



TYPICAL CROSS SECTIONAL PROFILE

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** *UBSUP technical team* ***Checked by:*** *Programme Manager Urban Investments* ***Approved by:*** *CEO WSTF*	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***



DTF LONGITUDINAL PROFILE

Scale 1:350

TYPICAL CROSS SECTIONAL PROFILE

Project Title: Up-scaling Basic Sanitation for Urban Poor (UBSUP)	***Project Area***	***Designed and drawn by:*** *UBSUP technical team* ***Checked by:*** Programme Manager Urban Investments ***Approved by:*** *CEO WSTF*	***Notes:***	***Index-No.:*** / ***Description:***	***Date:*** ***Scale: As shown*** ***page:***

BAR BENDING SCHEDULES

Data Bar Receiving Bay / Balancing Tank

WSTF DTF BBS Bar schedule ref : 001 | 01 | Rev letter

Site ref : RB & BT Date prepared : 10-Jul-15

Job no : 1 Prepared by : D.C Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm
STRIP FOUNDATI	1	T	10	3	3	9	8500	20	8500				
	2	T	10	3	43	129	700	35	500				
	3	T	10	2	3	6	5600	20	5600				
	4	T	10	2	27	54	700	35	500				
COLUMN	5	T	10	12	4	48	1325	37	1200	150			
	6	T	8	12	8	96	700	79	120	120			
SUSPENDE D FLOORS	7	T	10	1	18	18	1150	35	950				
	8	T	10	1	12	12	1900	35	1700				
	9	T	10	1	32	32	1875	35	1670				
	10	T	10	1	16	16	2000	35	1800				
	11	T	10	1	70	70	3600	35	3400				
	12	T	10	1	8	8	3500	35	3300				
	13	T	10	1	36	36	8900	35	8700				
	14	T	10	1	8	8	800	20	800				
BEAM 1	15	T	10	4	4	16	8800	38	150	8550	150		
	16	T	8	4	57	228	900	61	250	150			
BEAM 2	17	T	10	2	4	8	3800	38	150	3550	150		
	18	T	8	2	23	46	900	61	250	150			
BEAM 3	19	T	10	2	4	8	2100	38	150	1850	150		
	20	T	8	2	11	22	900	61	250	150			

This schedule complies with BS 4466. UNREGISTERED COPY FOR EVALUATION Bar Schedule v3.21 for Excel 97

* Specified in multiples of 5mm. † Specified in multiples of 25mm.

Data Bar Settler / Balancing Tank

WSTF DTF BBS | Bar schedule ref : 001 | 02 | Rev letter

Site ref : ST BS | Date prepared : 10-Jul-15

Job no : 1 | Prepared by : D.C | Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm
STRIP FOUNDATI	1	T	10	3	3	9	8400	20	8400				
	2	T	10	3	43	129	700	35	500				
	3	T	10	2	3	6	4200	20	4200				
	4	T	10	2	23	46	700	35	500				
COLUMN	5	T	12	6	4	24	2925	37	2800	150			
	6	T	8	6	20	120	700	79	120	120			
SUSPENDED FLOOR	7	T	10	1	82	82	3900	35	3700				
	8	T	10	1	60	60	1825	35	1625				
	9	T	10	1	16	16	600	35	400				
	10	T	10	1	8	8	2100	35	1900				
	11	T	10	1	44	44	8200	35	8000				
	12	T	10	1	8	8	3500	35	3300				
	13	T	10	1	24	24	800	20	800				
BEAM 1	14	T	10	2	2	4	8350	38	200	8000	200		
	15	T	8	2	55	110	1100	61	350	150			
BEAM 2	16	T	10	3	3	9	3900	38	200	3550	200		
	17	T	8	3	26	78	1100	61	350	150			

This schedule complies with BS 4466. UNREGISTERED COPY FOR EVALUATION Bar Schedule v3.21 for Excel 97

* Specified in multiples of 5mm. † Specified in multiples of 25mm.

Data Bar Anaerobic Baffled Reactor

WSTF DTF BBS | Bar schedule ref : 001 | 03 | Rev letter

Site ref : ABR | Date prepared : 10-Jul-15

Job no : 1 | Prepared by : D.C | Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm
STRIP FOUNDATI	1	T	10	3	3	9	6025	20	6020				
	2	T	10	3	32	96	700	35	500				
	3	T	10	3	3	9	3550	20	3550				
	4	T	10	3	19	57	700	35	500				
SUSPENDED FLOOR	5	T	10	1	36	36	3500	35	3300				
	6	T	10	1	30	30	1150	35	950				
	7	T	10	1	60	60	750	35	550				
	8	T	10	1	24	24	5850	35	5650				
	9	T	10	1	96	96	625	35	420				
	10	T	10	1	96	96	800	20	800				
BEAM 1	11	T	10	3	4	12	6025	38	200	5670	200		
	12	T	8	3	39	117	1000	61	300	150			
BEAM 2	13	T	10	3	4	12	3600	38	150	3350	150		
	14	T	8	3	24	72	1000	61	300	150			

This schedule complies with BS 4466. UNREGISTERED COPY FOR EVALUATION Bar Schedule v3.21 for Excel 97

* Specified in multiples of 5mm. † Specified in multiples of 25mm.

Data Bar Sludge Drying Reed Bed

WSTF DTF BBS | Bar schedule ref : 001 | 05 | Rev letter

Site ref : SDRB BS | Date prepared : 10-Jul-15

Job no : 1 | Prepared by : D.C | Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm
STRIP FOOTING	1	T	10	5	3	15	10700	20	10700				
	2	T	10	5	55	275	600	35	400				
	3	T	10	2	6	12	9200	20	9200				
	4	T	10	2	90	180	600	35	400				

This schedule complies with BS 4466.
* Specified in multiples of 5mm.

Data Bar Operator Store

WSTF DTF BBS | Bar schedule ref : 001 | 06 | Rev letter

Site ref : OS | Date prepared : 10-Jul-15

Job no : 1 | Prepared by : D.C | Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm
STRIP FOUNDATI	1	T	10	2	3	6	4600	20	4600				
	2	T	10	2	25	50	700	35	500				
	3	T	10	2	3	6	4350	20	4350				
	4	T	10	2	23	46	700	35	500				
BEAM 1	5	T	12	2	2	4	4850	38	150	4600	150		
	6	T	8	2	32	64	700	61	200	100			
BEAM 2	7	T	12	2	2	4	4600	38	150	4350	150		
	8	T	8	2	30	60	700	61	200	100			
BEAM 1	14	T	10	2	2	4	8350	38	200	8000	200		
	15	T	8	2	55	110	1100	61	350	150			
BEAM 2	16	T	10	3	3	9	3900	38	200	3550	200		
	17	T	8	3	26	78	1100	61	350	150			

This schedule complies with BS 4466.
* Specified in multiples of 5mm.

Data Bar Co-composting Area

WSTF DTF BBS

Bar schedule ref : 001 04 Rev letter

Site ref : CB

Date prepared : 10-Jul-15

Job no : 1

Prepared by : D.C Checked by :

Member	Bar mark	Type and size		No. of mbrs	No. of bars in each	Total no.	Length of each bar † mm	Shape code	*A* * mm	*B* * mm	*C* * mm	*D* * mm	*E/R* * mm
STRIP FOUNDATI	1	T	10	3	3	9	10400	20	10400				
	2	T	10	3	53	159	700	35	500				
	3	T	10	4	3	12	6500	20	6500				
	4	T	10	4	34	136	700	35	500				
RC COLUMNS	5	T	12	12	4	48	1775	37	1600	200			
	6	T	8	12	11	132	850	79	150	150			

This schedule complies with BS 4466.

* Specified in multiples of 5mm.

† Specified in multiples of 25mm.

BILL OF QUANTITIES

Schedule of Materials / BoQs

WSTF
URBAN SANITATION UPSCALING PROGRAMM
1st Call

BILL 1 - RECEIVING WELL AND BALANCING TANK

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
2.30	Compaction				
				SUBTOTAL 2	
3.00	**SUBSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
3.30	Formwork				
3.40	Finishing				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Damp-proof course				
4.30	Plaster				
				SUBTOTAL 4	
5.00	**SUPERSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
5.10	Concrete				
5.20	Reinforcement				
5.30	Formwork				
				SUBTOTAL 5	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipes				
6.20	Fittings and Valves				
6.30	Pipe laying				
				SUBTOTAL 6	
7.00	**METAL WORKS**				
				SUBTOTAL 7	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

WSTF
URBAN SANITATION UPSCALING PROGRAMM
1st Call

BILL 2 - SETTLER TANK

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
2.30	Compaction				
				SUBTOTAL 2	
3.00	**SUBSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
3.30	Formwork				
3.40	Finishing				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Damp-proof course				
4.30	Plaster				
				SUBTOTAL 4	
5.00	**SUPERSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
5.10	Concrete				
5.20	Reinforcement				
5.30	Formwork				
				SUBTOTAL 5	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipework				
6.20	Fittings and Valves				
6.30	Pipe laying				
				SUBTOTAL 6	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

WSTF
URBAN SANITATION UPSCALING PROGRAMM
1st Call

BILL 3 - ANAEROBIC BAFFLED REACTOR

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
2.30	Compaction				
				SUBTOTAL 2	
3.00	**SUBSTRUCTURE: CONCRETE / REINFORCEMENT/ FOMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
3.30	Formwork				
3.40	Finishing				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Damp-proof course				
4.30	Plaster				
				SUBTOTAL 4	
5.00	**SUPERSTRUCTURE: CONCRETE / REINFORCEMENT/ FOMWORKS**				
5.10	Concrete				
5.20	Reinforcement				
5.30	Formwork				
				SUBTOTAL 5	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipes				
6.20	Fittings and Valves				
6.30	Pipe laying				
6.40	Siphon				
				SUBTOTAL 6	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

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BILL 4 - VERTICAL FLOW CONSTRUCTED WETLANDS

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
				SUBTOTAL 2	
3.00	**CONCRETE / REINFORCEMENT/ FORMWORKS**				
3.10	Drainage channel				
				SUBTOTAL 3	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipes				
6.20	Fittings and Valves				
6.30	Sealing				
6.40	Pipe laying				
				SUBTOTAL 6	
8.00	**FILTER MEDIA AND PLANTS**				
8.10	PE liner				
8.20	Filter media				
8.30	Plants				
				SUBTOTAL 8	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

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BILL 5 - SLUDGE DRYING REED BED

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
				SUBTOTAL 2	
3.00	**CONCRETE / REINFORCEMENT/ FOMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Plaster				
				SUBTOTAL 4	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	**Pipes**				
6.20	**Pipe laying**				
				SUBTOTAL 6	
8.00	**FILTER MEDIA AND PLANTS**				
8.10	PE liner				
8.20	Filter media				
8.30	Plants				
				SUBTOTAL 8	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

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BILL 6 - COMPOSTING FACILITY

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
2.30	Compaction				
				SUBTOTAL 2	
3.00	**CONCRETE / REINFORCEMENT/ FOMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
3.30	Formwork				
3.40	Finishing				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Damp-proof course				
4.30	Plaster				
				SUBTOTAL 4	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipes				
6.20	Fittings				
6.30	Supplementary parts				
				SUBTOTAL 6	
7.00	**METAL WORKS**				
7.10	Steelwork for columns				
7.20	Steel truss				
				SUBTOTAL 7	
9.00	**ROOFING**				
				SUBTOTAL 9	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

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BILL 7 - OPERATORS STORE

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
1.00	**DEMOLITION & SITE CLEARANCE**				
1.10	General Clearance				
1.20	Removal of trees and stumps				
				SUBTOTAL 1	
2.00	**EARTHWORKS**				
2.10	Top soil removal				
2.20	Excavation for foundation				
2.30	Compaction				
				SUBTOTAL 2	
3.00	**SUBSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
3.10	Concrete				
3.20	Reinforcement				
3.30	Formwork				
				SUBTOTAL 3	
4.00	**WALLING**				
4.10	Natural stone wall				
4.20	Damp-proof course				
4.30	Plaster				
				SUBTOTAL 4	
5.00	**SUPERSTRUCTURE: CONCRETE / REINFORCEMENT/ FORMWORKS**				
5.10	Concrete				
5.20	Reinforcement				
5.30	Formwork				
				SUBTOTAL 5	
6.00	**PIPEWORK - PIPES and FITTINGS**				
6.10	Pipes				
6.20	Supplementary parts				
				SUBTOTAL 6	
7.00	**METALWORK**				
7.10	Steel Doors				
7.20	Steel Casement Windows				
7.30	Glazing				
				SUBTOTAL 7	
9.00	**ROOF COVERINGS**				
9.10	Roofing sheets				
9.20	Carpentry and joining				
				SUBTOTAL 9	
10.00	**PAINTING AND DECORATING**				
10.10	Painting				
10.20	Tiling				
				SUBTOTAL 10	
11.00	**ELECTRICAL CONNECTION**				
				SUBTOTAL 11	
12.00	**WATER SUPPLY**				
				SUBTOTAL 12	
				TOTAL	
				ALLOW 5% CONTINGENCIES	
				TOTAL	

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

Schedule of Materials / BoQs

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BILL 8 AUXILIARY WORKS

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	RATE [KSh]	AMOUNT [KSh]
13.0	CHAMBERS				
				SUBTOTAL 13	
14.00	FENCING AND GATE				
				SUBTOTAL 14	
15.00	ROADS				
15.10	Excavation				
15.20	Compaction				
15.30	Overlay				
				SUBTOTAL 15	
16.00	TESTING OF SYSTEM				
				SUBTOTAL 16	
17.00	SITE DRAINAGE WORKS				
				SUBTOTAL 17	
18.00	PROTECTIVE WORKS				
				SUBTOTAL 18	
19.00	SIGN POST				
				SUBTOTAL 19	
	TOTAL				
	ALLOW 5% CONTINGENCIES				
	TOTAL				

NOTE: all prices include supply, handling, assembling, installation, deployment of machines, processing (i.e. welding), and all related labour work

CONSTRUCTION DO´s & DON´Ts

GENERAL DIRECTIONS

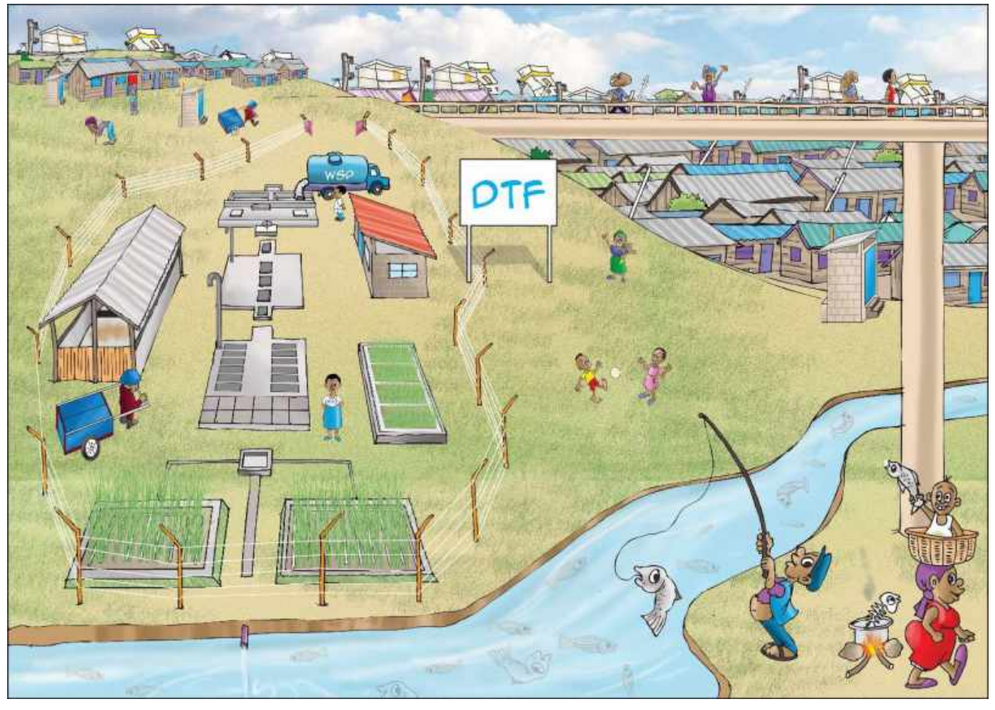
Construction quality is of utmost importance to ensure that

- The DTF treatment modules run as designed
- The DTF operates sustainably

It is therefore within the responsibility of the WSP as well as the Contractor that all necessary care is taken to ensure that all works are implemented...

- State-of-the-art
- Reliable
- According to the technical drawings
- According to the technical specifications outlined in the bid document
- According to the information provided in the BoQ

Issues presented in the following must be particularly taken care of.



GENERAL DIRECTIONS

Sequence of Works

To ensure good construction quality and to reduce logistical efforts and costs, works shall be implemented in a logical sequence, not by treatment module.

Works shall be implemented (**and approved**) in the following order:

1. Marking of total site and treatment modules with **cornerstones**
2. **Site clearance**, incl. removal of vegetation
3. Setting of a temporary **benchmark** (survey mark) for the entire project time
4. **Excavation** for all modules and required landscaping
5. Construction of **foundations** and **ground slabs** for all modules, incl. proper compacting and blending
6. Construction of **walls** for all modules (incl. inspection boxes)
7. Construction of all **piping** (inside modules, connecting, drainage, bypass)
8. Construction of **cover slabs** for all modules, incl. manholes
9. Water-tight **plastering** and proper **curing**
10. Filling of SDRB and VFCW with **filter materials** and **plantation**
11. Testing of system on **water tightness** and **operation**
12. **Fencing**, final **landscaping** and construction of **access roads, fence and gate**

Example: Construction of foundations

The construction of ground slabs requires a big amount of Reinforced Concrete Cement (RCC). The quality of the mortar is crucial for structural stability and water tightness. The Contractor is supposed to use a **concrete mixer** to ensure proper quality. In order to avoid bringing the concrete mixer to the construction site various times, it is recommended to construct all required ground slabs / foundations at once.

GENERAL DIRECTIONS

Access & Working Space

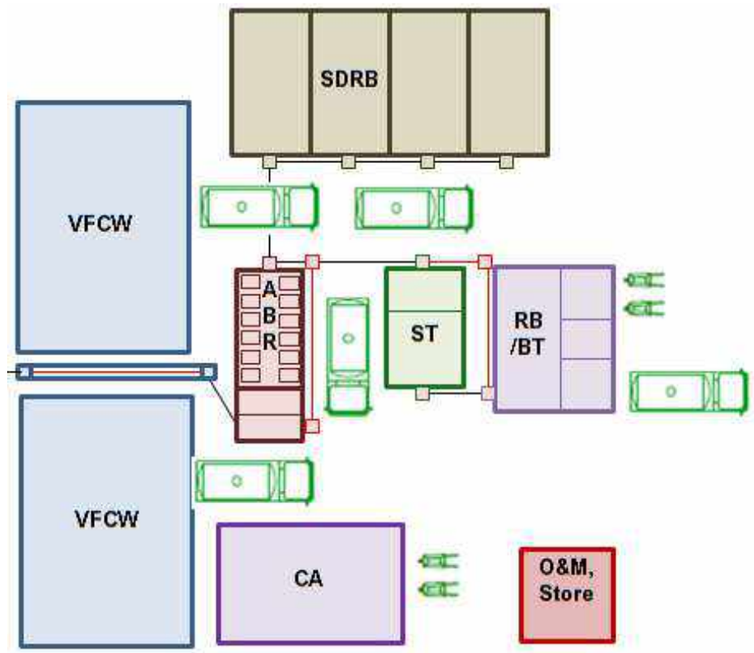
Apart from having the different work steps in mind, it is also important to consider **access** to the construction site as well as the possibility to move and **manoeuvre** within the construction site. This applies to:

- Trucks delivering bulk materials, such as (i) cement, sand and aggregate for mortar, (ii) metal bars for reinforcement, (iii) gravel for filling the wetland system and sludge drying bed, and (iv) raw water for testing on water tightness/operation, etc.
- Machinery, such as (i) concrete mixer, (ii) compactors, (iii) excavator, (iv) bulldozer, etc.

In order to ensure easy access to all treatment and auxiliary modules it is generally recommendable to start construction with modules that are located further away from the access point to the DTF construction site.

Both, the work sequence as well as access / space, must be considered when establishing the final detailed work programme.

Nevertheless, the fact that all modules should be accessible by i.e. exhauster trucks *(see figure)* during the operation and maintenance (O&M) phase presumes a general accessibility to the modules at any time, hence also during construction.



GENERAL DIRECTIONS

Storage of Materials

The Contractor, supervised by the water company, must ensure that materials required for construction are stored adequately so that materials do not get damaged or destroyed before installation.

In the following some examples are presented:

- Store cement in an elevated and roofed shed to **protect from rain and flooding** (risk of hardening)
- Store metal bars and mesh (used for reinforcement) in an elevated and roofed shed to protect from rain and flooding (risk of corrosion)
- Store metal pipes (vent pipes, hand rails for receiving bay) in an elevated shed to protect from rain and flowing (risk of corrosion)
- Store metal pipes (vent pipes, hand rails for receiving bay) on a **horizontal surface** and use **timber wedge** in between pipes (risk of deforming and scratching)
- Store bituminous felt damp-proof course and damp-proof membrane (both to ensure water tightness) as well as PE liner (for bottom sealing of the wetland system) in a roofed shed to **protect from sunlight** (UV radiation destroys structure of plastics)
- Store uPVC and HDPE pipes in a roofed shed to protect from sunlight (UV radiation destroys structure of plastics)
- Store uPVC pipes on a horizontal surface and use timber wedge in between pipes (risk of deforming and scratching)

It is within the responsibility of the Contractor to ensure proper storage of materials, which also includes **security** and **measures against theft**.

The Supervisor of the water company is responsible to ensure that the Contractor fulfils its responsibilities.

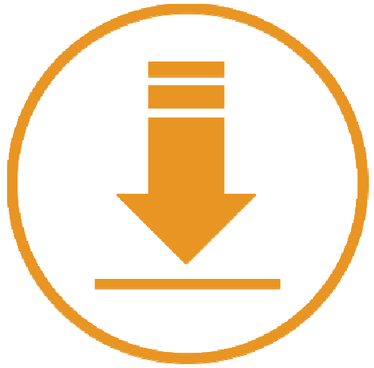
GENERAL DIRECTIONS

Benchmark for construction

Careful consideration of levels is crucial for the functionality of a DTF as the system usually runs on gravity. Even smallest variations in levels can lead to non-performance of the entire system.

It is therefore essential to select a main benchmark that follows the following requirements:

- A fixed reference point which **does not change** during the entire project duration in height or location. This reference point shall be **protected** against obstruction, damage and unintended / accidental relocation
- Should be **visible from all points** of the construction side (if not possible it must be temporarily transferred during work)
- All existing and future level points have to be calculated in reference to this reference point



If a benchmark already exists at site which meets above mentioned requirements, it can be reused for the DTF project. In that case the location should be **clearly and permanently marked**. Otherwise a new benchmark must be built, e.g. as shown at above pictures.

GENERAL DIRECTIONS

Excavation & Backfilling & Compacting

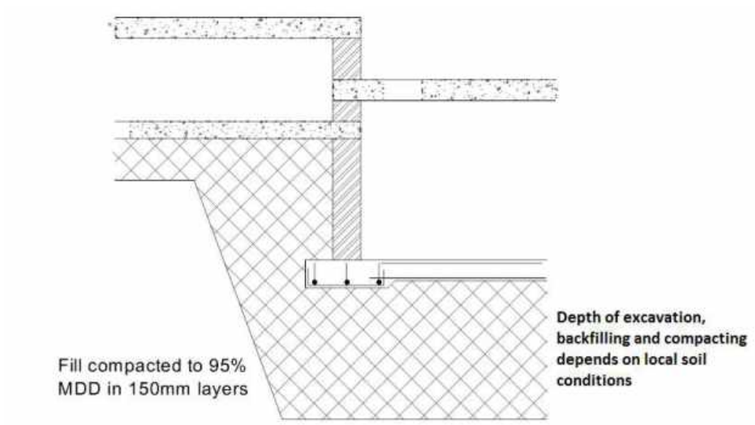
Before construction of foundations, excavation and proper compacting of the underground is essential.

The purpose of compaction is:

- Reduce subsequent settlement under working loads
- Increase the shear strength of the soil
- Reduce voids, making it more difficult for water to pass the soil

As indicated in the technical drawings and BoQ, the following work steps are required for excavation and compaction:

- **Excavation** to an appropriate depth depending on local soil conditions (e.g. removal of black cotton soil until a hard bed is reached). In case of underground modules (i.e. settler and ABR) it is likely that hard bed is reached with the depth of the modules. In case of structures on ground level further excavation might be required for proper anchoring
- **Backfilling** with an approved fill material (either excavated soil or imported filler) in layers of 150mm and compacting until a Maximum Dry Density (MDD) of 95% is reached (compaction test) – if required as per local site / soil conditions
- **Backfilling** a layer of 200mm of approved hardcore, followed by a blinding with final material of 25mm thickness
- **Final compacting** of top layer



GENERAL DIRECTIONS

Quality of Mortar

A proper concrete mixture is essential to ensure structural stability and water tightness. The following must be kept in mind:

- Ensure that **sufficient amount of cement** is used. If not mentioned otherwise on the structural drawings and/ or BoQ, a mixture of C15 (1:3:6) is used for blinding and C20 (1:1.5:3) for all other concrete works including ground slabs and roof slabs
- Ensure the concrete mix is workable, which allows correct placement and consolidation. Use a **concrete mixer** to ensure perfect blending
- Ensure the optimum desired **quality** of the hardened concrete is met to improve water tightness, wear resistance, and strength
- Avoid too much **water**; the quality of concrete mainly depends on the water to cement ratio; the mix should be a **stiff** as possible
- Use the **largest aggregate** practicable; use the optimum **ratio** of fine to coarse aggregate
- Ensure proper **compacting** of blinding and concrete ground / roof slabs to ensure water tightness and structural stability. By default, a compacting machine must be used (a porker vibrator is adequate for this type of works)

GENERAL DIRECTIONS

Foundations

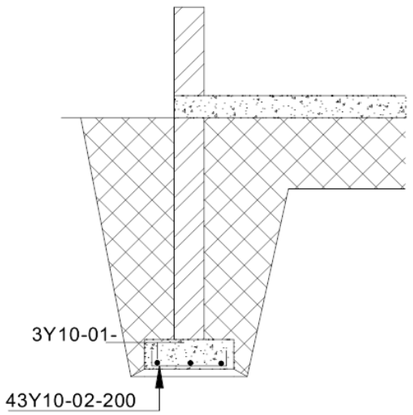
As indicated in the technical drawings and BoQ, foundations are required for all modules, except the constructed wetland and sludge drying beds.

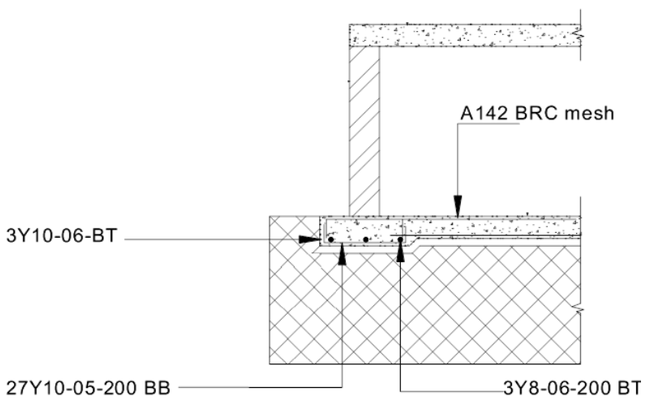
Foundations are required to support the civil structures to avoid that modules sink into the underlying soil under working loads. Sinking would result in cracks and compromise the water tightness of the modules.

The foundations include proper **blinding** (see section backfilling & compacting) and **strip footing** running below the outer walls of the treatment modules.

Additionally strip footing is required under the separation wall of the settler. No strip footing is required below the separation walls of the anaerobic baffle reactor, as indicated in the structural drawings.

The strip footing is built in concrete grade C20 (1:1.5:3) and includes deformed high yield steel Y10 bars as **reinforcement**.





GENERAL DIRECTIONS

Reinforcement & Water Proofing

Reinforcement is crucial to support the structural stability of ground and roof slabs as well as of walls. The water company and well as the Contractor must take special care that reinforcement is done according to structural drawings and BoQ.

Improper reinforcement, e.g. to save material, is not acceptable and the Supervisor as well as the Contractor must be held responsible for any variations from the technical specifications.

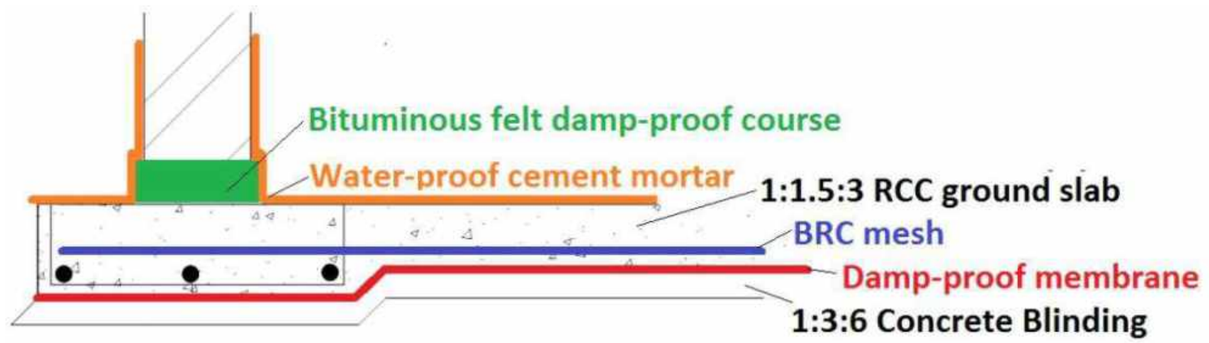
For reinforcement the following materials are to be used:

- Metal bars for the (i) strip footing of the ground slab (below walls) and (ii) reinforcement of the cover slab
- BRC mesh for the (i) ground slab and (ii) cover slab

Water tightness of all modules is of great concern, irrespective whether they are constructed above ground or underground. Leakage leads to environmental pollution and groundwater contamination.

The design includes various construction elements that ensure water tightness, summarized under damp-proof course in the schedule of materials:

- Bituminous felt damp-proof course laid under the strip footing
- Damp-proof membrane (Gauge 500) laid under the entire ground slab
- Internal and external plastering with <u>water proof cement</u> mortar

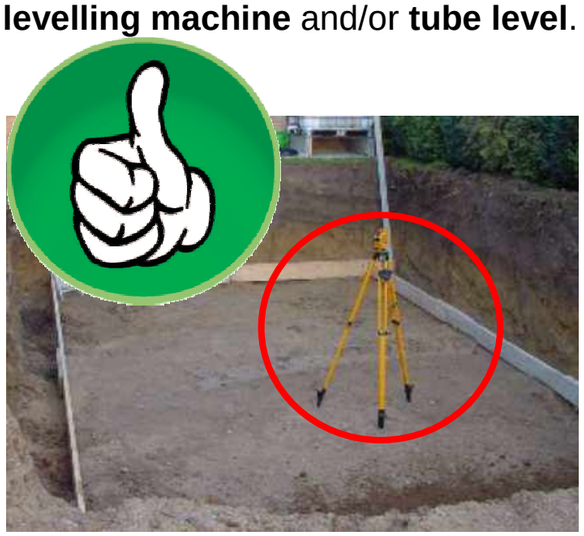


GENERAL DIRECTIONS

Horizontal construction

It must be ensured that ground slabs of all modules are built horizontally to guarantee an equal distribution of (i) loads and (ii) of settled sludge.

This can be ensured during construction of the ground slab by using a **levelling machine** and/or **tube level**.



Curing

Proper curing is essential after concreting; particularly due to the hot climate conditions and extensive sunlight exposition. A minimum of **7 days** is required. Only after 21 days the maximum strength will be derived.

Freshly cast concrete must be protected against sunlight, drying and evaporation. Frequent watering may be required to keep the concrete moist.

Backfilling of outer Walls

During backfilling of soil around the treatment modules (after plastering and curing) a risk exists that the soil pressure damages / destroys walls (cracks).

In order to avoid cracks it is recommended **to fill tanks with water** during backfilling to compensate soil pressure from outside with water pressure from inside. Hence water should be filled gradually into the tanks while the excavation is backfilled with soil.

GENERAL DIRECTIONS

Check on Water Tightness

It is crucial towards the end of the construction phase that all treatment modules are checked on water tightness to avoid pollution of the surroundings (i.e. the receiving bay / balancing tank) and groundwater (i.e. in case of the settler and ABR).

It is within the responsibility of the Contractor and Construction Supervisor to ensure that all modules are water tight. Water-tightness should be the case if all technical specifications were followed (see section: *“Water Proofing”*).

In order to test the system on water tightness the entire system must be **filled with raw water** (e.g. from a borehole or river). In case of the settler and ABR all chambers must be filled simultaneously to avoid unbalanced pressure forces that might result in damage or collapse of separation walls.

The following quantities are approximately required:

- Receiving Bay & Balancing Tank: 35 m^3
- Settler: 70 m^3
- Anaerobic Baffle Reactor with Balancing Tank (outlet plugged): 25 m^3
- Wetland (before filling with gravel, outlets plugged): 225 m^3
- Sludge Drying Reed (before filling with gravel, outlets plugged): 220 m^3

Testing of water-tightness of the wetland is explained further in the respective section of this manual. **Water can be re-used** for testing various modules (e.g. pumped from the wetland to the drying bed). For the co-composting area testing on water tightness is not required.

During the test, the maximum water level must be marked (e.g. with a chalk) in all modules. After 8 hours the water level must be re-checked. If the water level decreased, the Contractor is required to **ensure water-tightness by roughening and re-plastering the walls with water-tight mortar**.

Testing on water tightness must be done during the acceptance of works. **Without being water-tight no completion certificate** shall be given to the Contractor.

GENERAL DIRECTIONS

General Piping

The entire DTF consists of various pipe systems, as follows:

- Piping within the treatment modules (drains, distribution, ventilation)
- Piping in between treatment modules
- Bypass pipes

There are three main issues related to piping that need to be taken care of during construction: (i) quality of pipes, (ii) required slopes, and (iii) installation of pipes.

Quality of pipes

As described in the structural drawings and BoQ, the following types of pipes are required for the different modules:

- DN 150 class 41 uPVC (pressure) pipe
- DN 100 class 41 uPVC (pressure) pipe
- DN 50 HDPE (pressure) pipe

It must be ensured by the Contractor and the Company Supervisor that pipes with adequate diameter; material and thickness are purchased and used as outlined in the structural drawings and schedule of materials.

PVC pipes are vulnerable to UV light and should not be exposed to sunlight. Hence, HDPE pipes must be used for the distribution system of the wetlands.

Conditions on a DTF do not allow the use of steel pipes and should be avoided. Only for the air-vents and overflows of the Balancing Tank DN100 galvanised iron pipes (GI) should be used.

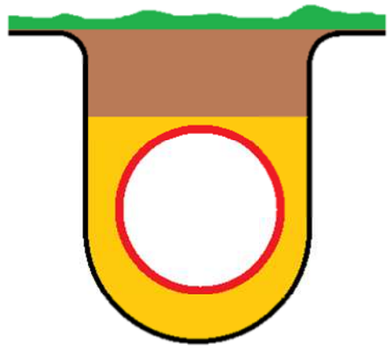
Required slopes within pipe network

As the DTF usually runs purely on gravity it is essential to ensure the required minimum slopes (at least 1%) during lying of pipes. The required slope between two points (e.g. outlet of ST and inlet of ABR) is determined by:

- Measure the horizontal distance between both points (fix as per design) with a measuring tape and calculate the available level difference, and
- Measure the vertical level difference with a tube level / levelling machine

GENERAL DIRECTIONS

Installation of pipes

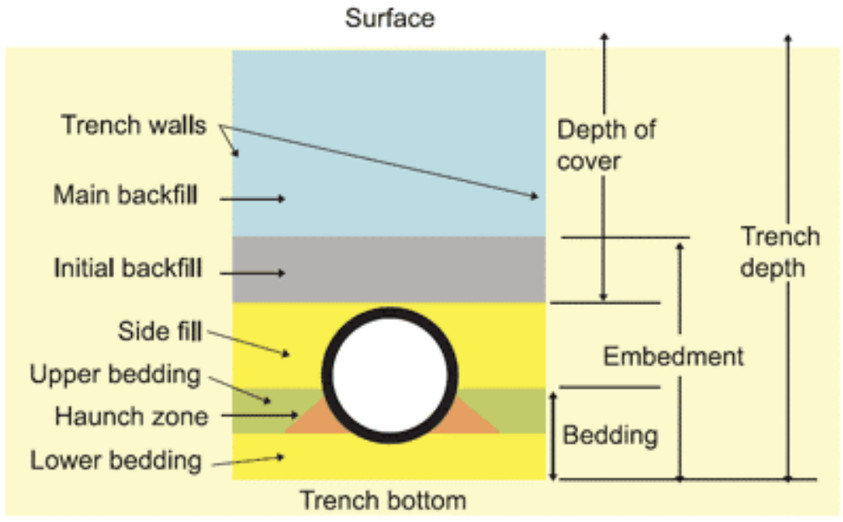


Pipes that are constructed below ground level are either pipes connecting the different treatment modules or bypass pipes.

Pipes that are installed underground must be able to withstand certain loads, i.e. if exhauster trucks pass above.

In order to prevent breaking, the Contractor needs to assure to place pipes on proper **sand or gravel bedding**. Used gravel should have a grain size of not more than 5mm.

The following figure illustrates the principal arrangement of a **trench** for buried pipes, incl. bedding and backfill.



Apart from appropriate bedding, it must be ensured that the pipes are **joined tightly**. Special glue for PVC pipes is to be used.

Fitting includes the following work steps: (1.) measure and cut, (2.) prime, (3.) dry fit, (4.) glue, and (5.) push and twist. The glue must be applied on both pipes that are to be joined.

When connecting the pipes, a lever rod and a timber wedge shall be used to **avoid that pipes get damaged**.

GENERAL DIRECTIONS

Levels of Treatment Modules

The DTF is supposed to run entirely on **gravity**. For this reason a construction site was selected that features a suitable topography. A decisive criteria for site selection was sufficient natural slope between the location where the faecal sludge enters the treatment system (the receiving bay) and the receiving water body (even the flooding level was considered).

Therefore the following must be considered during construction:

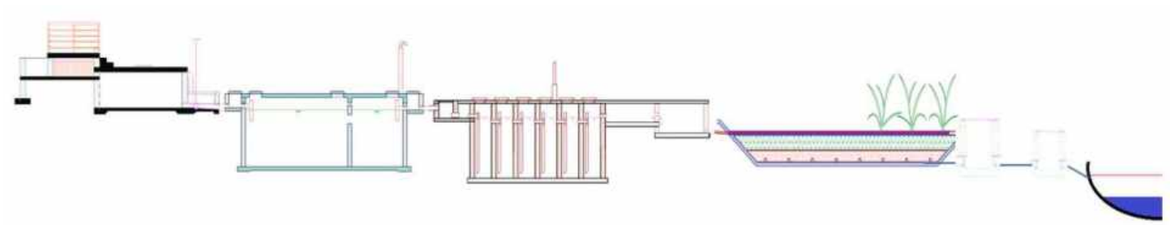
- **Ensure required levels** of slabs and pipes, as indicated in the cross-section technical drawing
- **Avoid any deviation** in the levels of the treatment modules from the final design, as even small variations can lead to clogging and overflowing

The Contractor and the Construction Supervisor need to take special care that all required levels are maintained. This refers to

- **Absolute levels** of the treatment modules, particularly of the outlet pipes
- Required **level differences** within the treatment modules

In order to ensure correct levels, the levels of the modules must be **checked regularly** during:

- Excavation
- Construction of ground slabs (receiving bay, settler, ABR) and ground bottoms (wetland and drying bed)
- Installation of pipes (i.e. outlet pipes of treatment modules)



RECEIVING BAY & BALANCING TANK

For the combined Receiving Bay and Balancing Tank (RB/BT) a couple of issues must be particularly considered during construction:

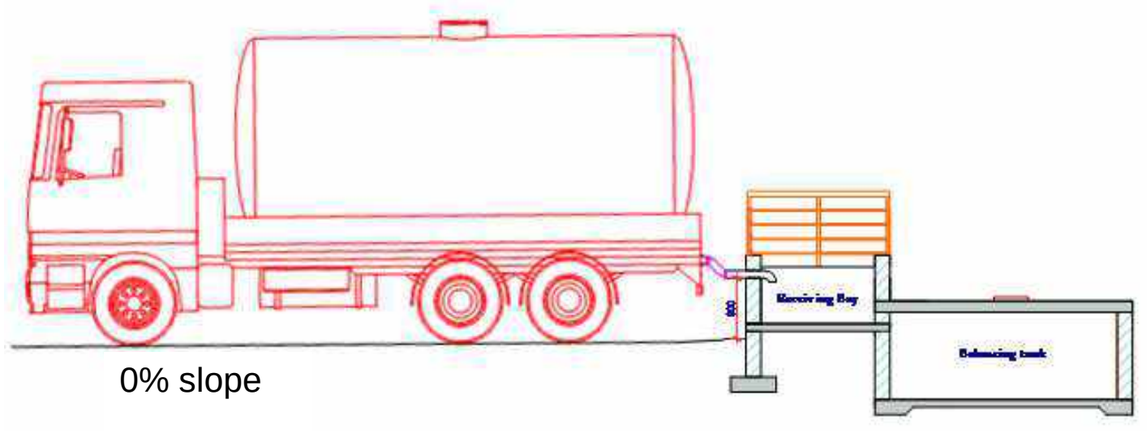
- Ensure by proper **landscaping** that exhauster trucks can connect easily to the inlet pipes, ensuring that the exhauster can be emptied by gravity
- Ensure that the **screens** and **cleaning channels** in the RB are constructed according to the technical specifications to avoid clogging
- Ensure that the BT is properly **plastered** inside and outside to make it water tight

Access

The level of the RB/BT depends on the levels of the subsequent modules, particularly the Settler, to ensure a pipe slope of minimum 1%.

Depending on the existing ground level it might be necessary to either **excavate** in front of the RB or to **backfill** respectively. It must be ensured that the vertical distance between the ground level and the DN 100 inlet pipes is at least 80 cm to ensure that the sludge can flow through the outlet of the exhauster into the RB by gravity (connected by a hose).

Furthermore it must be ensured that the parking area for the exhauster trucks is **exactly horizontal** to ensure that exhauster trucks can be emptied by gravity entirely. A slope would either result in incomplete emptying of the trucks or problems with drainage of surface waters during rain events.



RECEIVING BAY & BALANCING TANK

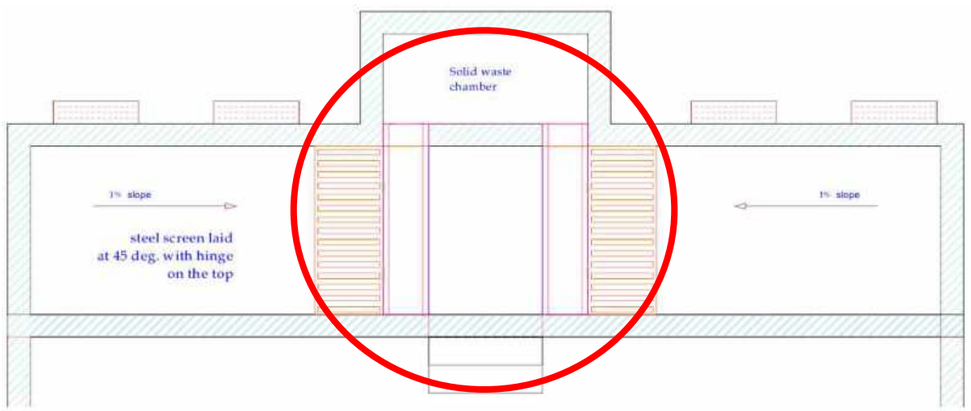
Screens and cleaning channels

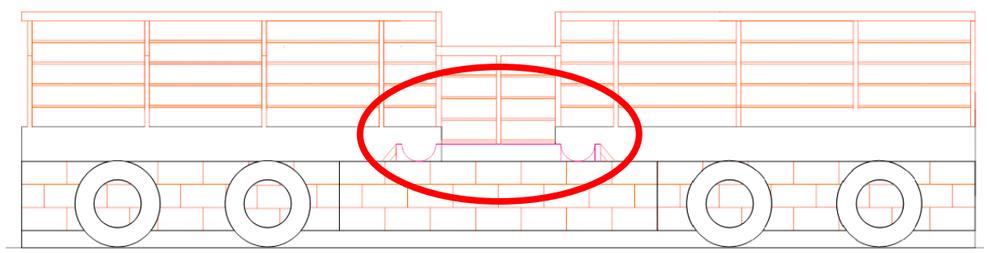
Ensure that the screens are exactly built and installed according to the specifications laid out in the BoQ and technical drawings to (i) avoid clogging during operations and (ii) **facilitate cleaning**:

- Coarse Screen fabricated using GMS bars with diameter of 20 mm
- spacing between screen bars of 40 mm
- Hinge on top to swing open for easier cleaning

Ensure that the **concrete U-shape** cleaning / drainage channels are built according to the technical specifications:

- 300 mm wide to avoid clogging
- Leading to the solid waste chamber to allow for removal of collected solid waste with a shovel or rake





RECEIVING BAY & BALANCING TANK

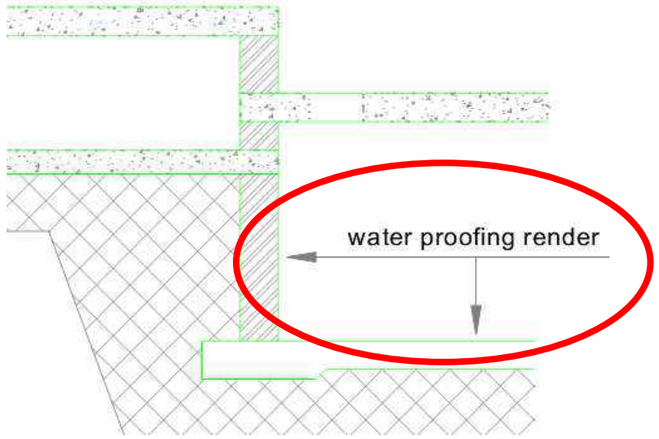
Water tightness

It must be ensured that the walls of the RB/BT are properly plastered with a **water proof cement mortar** (incl. **plastic additive**) to ensure that the tanks are absolutely water tight (see also "*General Directions*" above).

A **damp-proof membrane** must be inserted under the ground slab.

Due to the fact that the RB/BT is constructed above ground level, a leaking tank would result in pollution of the surroundings. This in turn would result in smell, attraction of flies and other carriers of diseases and would finally pose a health risk to operators.

Apart from that, a leaking tank could result in groundwater pollution.



4,00	**WALLING**	
	Natural Stone Block Walling, Medium Chisel Dressed, Reinforced with 20 swg Hoop Iron at every third course, and Bedded, Jointed and bonded in Cement Mortar (1:5) :-	
4,10	200 mm Walling	m^2
4,20	Damp-proof course:	
4,21	Bituminous felt damp-proof course	m
4,22	Damp-proof membrane	m^2
4,30	Plaster internally and externally with water proof cement mortar 1:4	m^2

SETTLER

The Settler (ST) is the first treatment step. It receives the untreated faecal sludge and poses a high risk of environmental pollution and health hazards. A couple of things must be particularly taken care of:

Water tightness

Due to the fact that the ST receives the untreated sludge, which contains the full load of pollutants and pathogens, it must be ensured that no water is leaking from the tank into the surrounding soil to avoid groundwater pollution.

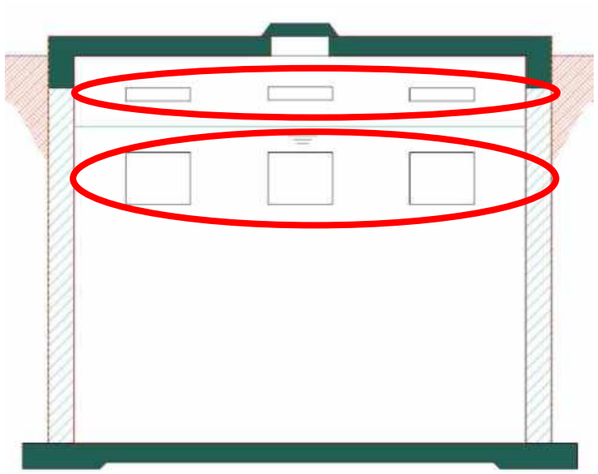
It is therefore crucial to provide a damp-proof course consisting of **felt damp-proof course** laid under the strip footing**, damp-proof membrane** (Gauge 50) laid under the entire ground slab, as well as **internal and external plastering with water proof cement mortar** (incl. plastic additive).

Apart from that **proper curing** is required, as it is for all modules.

Connections between both chambers

Ensure that the first and second chamber are connected properly:

- **Allow water flow** from the first into the second chamber through three openings that are located **<u>below</u>** the water level
- Allow for **gas exchange** through openings located **<u>above</u>** the water level. Forgetting might result in cracks or even bursting as only one ventilation pipe exists



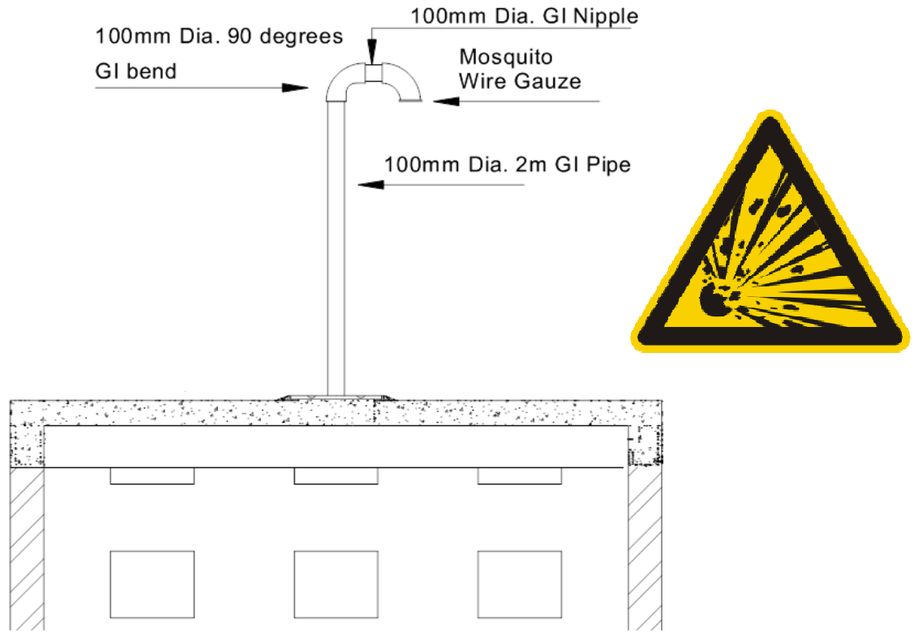
SETTLER

Ventilation

Methane gas is generated inside the settler due to anaerobic processes. This biogas needs to be released to avoid an increase in gas pressure inside the tanks that could result in cracks or even bursts.

For this reason a ventilation pipe is required. As mentioned before, both chambers must be interconnected to allow gas exchange between the chambers.

It is crucial that the GI vent pipe ends **at least 2 metres above the surface** of the cover slab as the escaping gas may not get in contact with operators or persons visiting the DTF due to toxicity and risk of explosion (i.e. if somebody is smoking).



The pipe shall be built in **anti-corrosive GI metal** (galvanized iron) and should be covered with a **90 degrees GI bend** to avoid rainwater coming into the system. **Mosquito wire gauze** prevents insects getting into the system to breed.

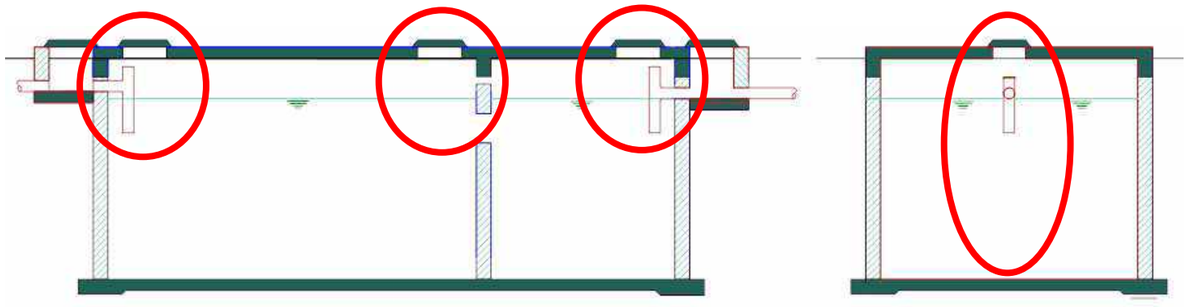
SETTLER

Manholes

The Settler is fed with untreated faecal sludge. A lot of sludge settles at its bottom. Therefore the settler needs to be de-sludged frequently. Exhauster trucks remove the sludge from the two chambers through manholes. Two manholes are located in the first chamber, one in the second chamber.

It must be ensured that the manholes are **located as per technical drawings**, meaning one above the inlet pipe, one above the outlet of the first chamber, and one above the outlet pipe of the second chamber.

It must be ensured that the manholes are located **centrally** on the cover slab to allow access to the inlet and outlet pipes for the operator. Access to the pipes from outside is important to clean the pipes in case of clogging.



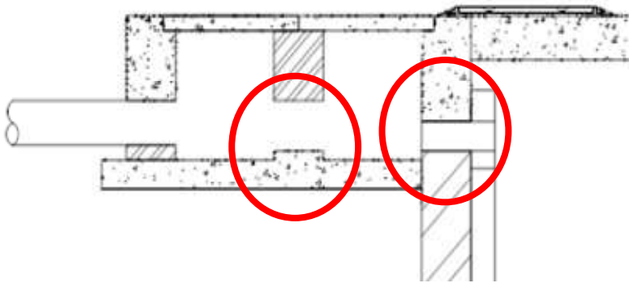
Apart from the location it is required to construct the manholes as per technical specifications. It must be ensured that the manhole covers **can be lifted easily by one person** (the DTF operator), particularly as de-sludging is required on a frequent basis. Manholes should therefore be constructed as follows:

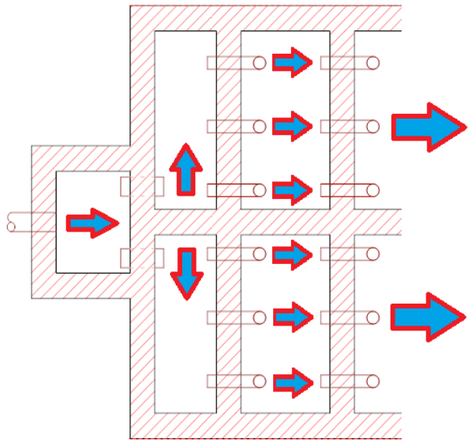
- 600mm x 450mm air-tight plastic manhole covers
- Placed into a plastic frame

ANAEROBIC BAFFLE REACTOR

Distribution channel and inlet pipes

An equal distribution of water into the ABR is crucial, particularly as the ABR is constructed in two <u>separated</u> parallel treatment lines that should treat the same quantity. To ensure water distribution over the entire width of the ABR a distribution channel is needed.

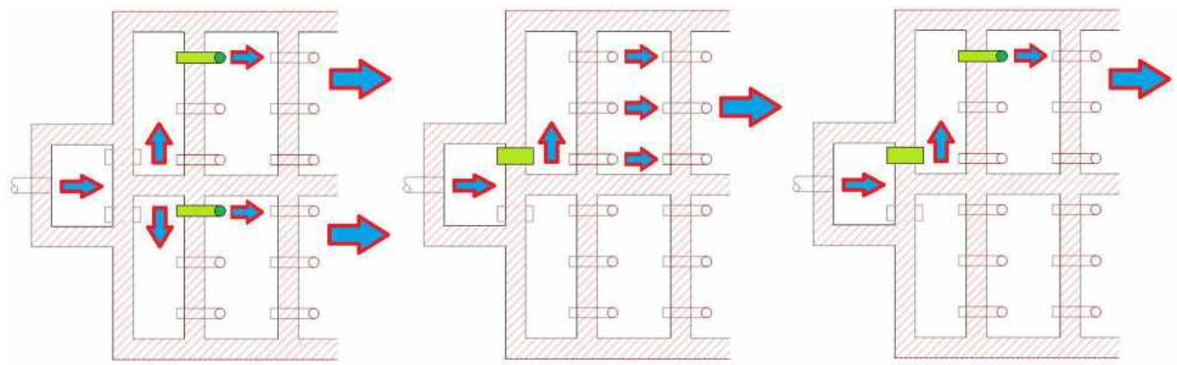




Within the **distribution channel**, that follows an inspection box equipped with two outlet pipes, the water is distributed over the entire width as the outlet pipes are slightly elevated above the ground slab of the channel *(see above)*.

During construction it is crucial to make sure that **all outlet pipes are exactly at the same level**; otherwise the water would only flow through the lowest pipe, leading to an unequal flow distribution within the ABR.

In the following three examples are given that show how imprecise work during installation of the outlet pipes leads to unequal flow distribution:



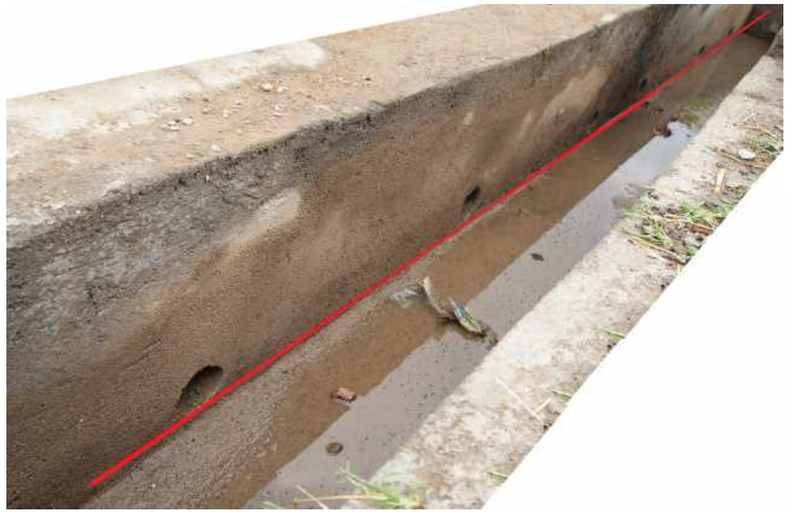
(The green pipes indicate exemplary those ones that are laid lower than the other pipes, resulting in an unequal flow distribution of the liquid)

ANAEROBIC BAFFLE REACTOR

As shown in the example drawings, an entire treatment line consisting of 6 subsequent chambers will be useless (empty) if one of the outlet pipes of the inlet box is lower than the other *(indicated in green in the previous example drawings)*. It is therefore crucial that both pipes are laid **exactly at the same level**.

Same applies principally if an outlet pipe of the distribution channel is laid lower than others. In that case the water will only flow through the lowest pipe. This also leads to an unequal flow distribution within the concerned treatment line of the ABR (which is however less dramatic compared to the outlet pipe of the inlet chamber).

In order to ensure that all pipes are constructed exactly at the same level, the exact location (bottom of pipe) must be **marked before installing the pipes**. A levelling machine or at least a level tube must be used for marking the right level.

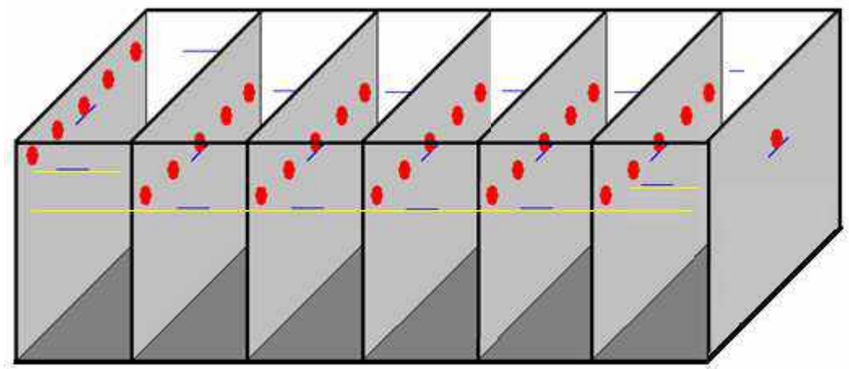


Ensuring the correct level of the inlet pipes into the ABR is one of the most important DO´s during the construction of a DTF as already small variations due to impreciseness lead to significant malfunctions.

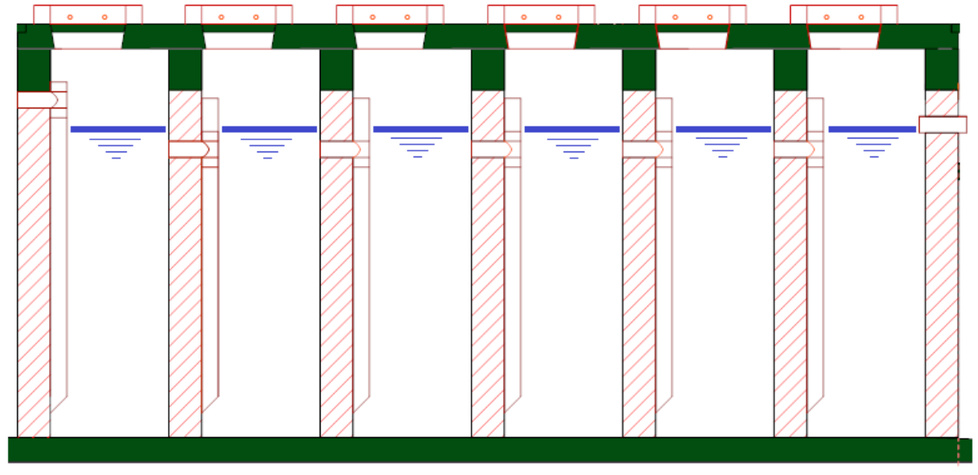
ANAEROBIC BAFFLE REACTOR

Distribution pipes inside the ABR

Besides inlet pipes, also the DN100 uPVC pipes within the treatment chambers must be installed with care. The exact level of the pipes must be **marked at walls before the pipes are installed**. Instead of measuring the distance from the ground slab (which might not be constructed entirely horizontal), the level of the pipes shall be determined by using a levelling machine or a tube level.



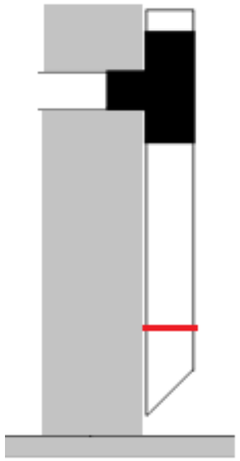
The water level is determined by the level of the ABR outlet pipe (bottom of pipe). As indicated in the technical drawings, the water level is at **1,850mm above the ground slab**. The inlet pipe is installed **150mm higher than the outlet pipe** to ensure a hydraulic gradient. The inner connection pipes are constructed **150mm below the outlet pipe**; hence below water level.



ANAEROBIC BAFFLE REACTOR

As shown in the technical drawings, a total of six DN100 uPVC inlet pipes are to be installed per line; hence 36 pipes in total. The inlet pipes reach to the bottom of each chamber to a distance of **150mm above the ground slab**.

It must be ensured that the down-flow pipes are not cut too short to ensure that the incoming wastewater is getting mixed with the sludge that is accumulating at the bottom of each chamber.



The pipes should however not be too long to avoid clogging. The pipes should be **fixed to the walls with clamps** to avoid moving and breaking.

The inlet pipes must be cut at the lower end in an **angle of 45 degree**. It must be ensured that the outlet of the pipes is **facing the chamber**, not the wall.

As indicated on the sketch, each set of pipes connecting two chambers consists of 4 parts. All pipes must **protrude the water level**. During cutting it must be considered that pipes are to be joined inside the T-pipes, which reduces the length of the pipes after installation.

ANAEROBIC BAFFLE REACTOR

Water tightness

To avoid groundwater pollution a **damp-proof course** consisting of (i) felt damp-proof course laid under the strip footing, (ii) damp-proof membrane laid under the ground slab, as well as (iii) internal and external plastering with water proof cement mortar (incl. plastic additive) is required.

Curing of the walls over the next seven days is essential to ensure a water tight plastering.

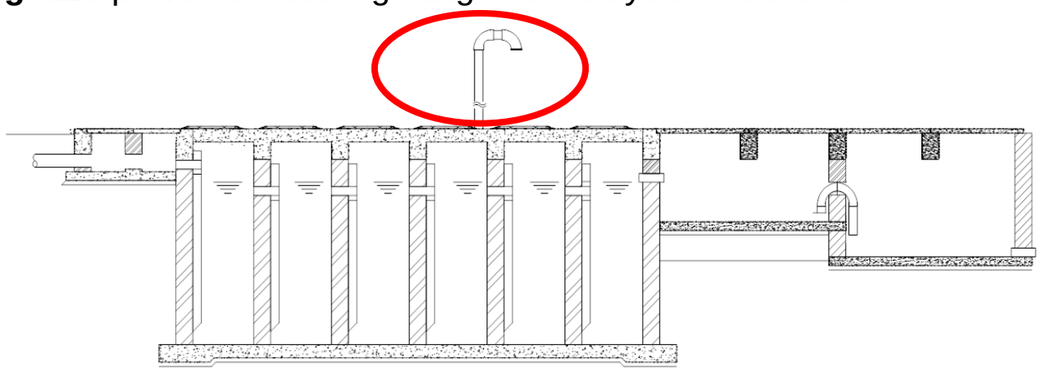
Ventilation

Due to anaerobic processes methane gas is generated inside the ABR which needs to be released through a ventilation pipe to avoid cracks or bursts.

As only **one vent pipe** is foreseen to minimize construction cost, all 12 chambers (2 parallel treatment lines of 6 chambers each) need to be **interconnected to allow gas exchange** between the individual chambers.

It is crucial that the vent pipe ends at least **2 metres above the cover slab** as the escaping gas may not get in contact with operators or visitors.

The pipe shall be built in **anti-corrosive GI pipe** and should be covered with a **90 degrees GI bend** to avoid rainwater coming into the system. **Mosquito wire gauze** prevents insects getting into the system to breed.

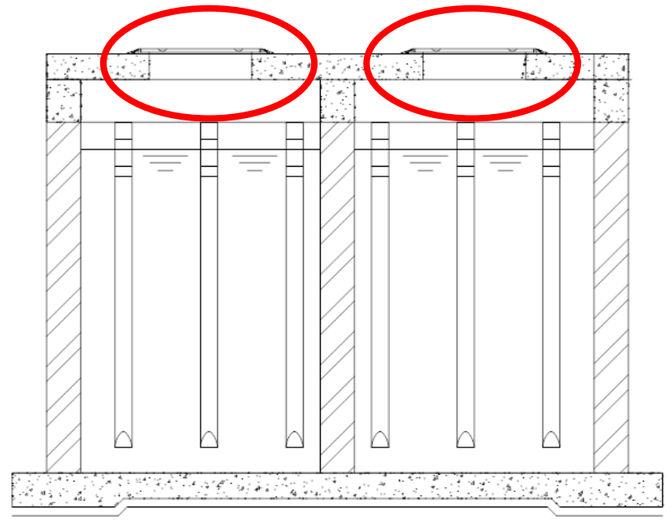


ANAEROBIC BAFFLE REACTOR

Manholes

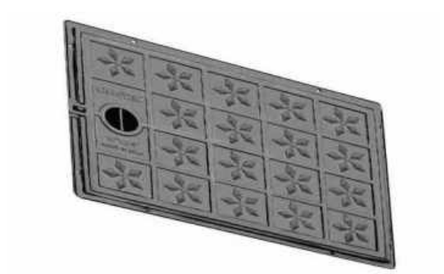
The ABR needs to be de-sludged with exhausters frequently. Manholes must be placed in the cover slab **on top of each of the 12 chambers**.

It must be ensured that the pipes are **located centrally** on the cover slab to allow access to the inlet pipes for the operator. Access to the pipes from outside is important to clean the pipes in case of clogging.



Apart from the location it is required to construct the manholes as per technical specifications. It must be ensured that the manhole covers can be **lifted easily by the DTF operator**. Manholes should be constructed as follows:

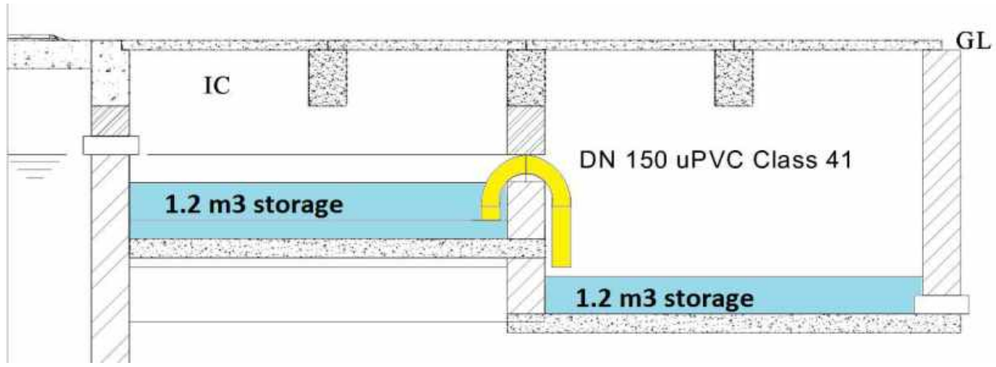
- 600mm x 450mm air-tight plastic manhole covers with metal ring
- Placed into a plastic frame.



ANAEROBIC BAFFLE REACTOR

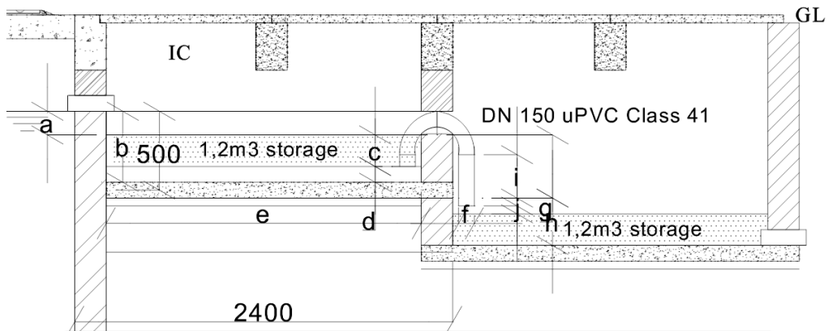
Siphon

The siphon is intended to load the subsequent wetland intermittently. Proper functioning of the siphon is crucial for the performance of the entire system.



The siphon works purely hydraulically. Its **dimensions** as well as its **exact location** determine the discharge interval, volume, time, flow velocity, etc.

It is therefore crucial to **follow the technical specifications** laid out in the structural drawings very carefully. Below figure and table indicate the exact dimensions and distances that must be followed strictly.



Name	Distance	Unit	Remarks
a	150	mm	-
b	450	mm	-
c	200	mm	-
d	100	mm	-
e	2000	mm	-
f	150	mm	-
g	500	mm	-
h	300	mm	-
i	200	mm	-
j	100	mm	-
k	3000	mm	width of tank

ANAEROBIC BAFFLE REACTOR

Testing of Siphon

Before works are approved by the Construction Supervisor and an approval for the completion of the ABR is given, the siphon should be **tested on its full functionality**.

For practical reasons, this shall be preferably done **during testing the entire DTF on water tightness** as a significant quantity of clear water is required for testing the siphon on its functionality.

When loading the ABR with clear water (remember: all chambers should be filled at the same time to avoid damage of separation walls), the following should be confirmed:

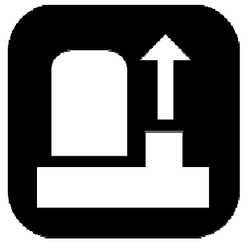
- The water level in the first chamber of the Balancing Tank rises to about **350mm** before the siphon starts draining water from the first tank to the second tank
- The drainage process will stop automatically after approximately **4 minutes**
- The water level in the first chamber will reduce during the drainage interval to approx. **100mm**

During operations it should be tested how many drainage intervals occur per day. As per design this should be between **15 and 18 per day** if the system is operated with about 22m^3 per day.

Kindly inform the DTF Technical Team of Waster Services Trust Fund about the number of discharge intervals per day.

ANAEROBIC BAFFLE REACTOR

Wiring



Installation of electrical wires is only required if the siphon needs to be replaced by a submerged pump. In that case also the balancing tank needs to be adapted as only one chamber (pump sump) would be required. Nevertheless, the decision whether a pump is required or a siphon can be used (preferred) depends on the local topography and is considered during site selection and design adaptation.

The following is therefore only relevant if a pump is required:

The required **electrical wires must be installed in a cable channel underground**. During installation of the cable channel it must not be forgotten to lay a **pulling wire** into the cable channel. Later, during installation of the pump, the electrical cable can be pulled through the channel by means of the pulling wire.

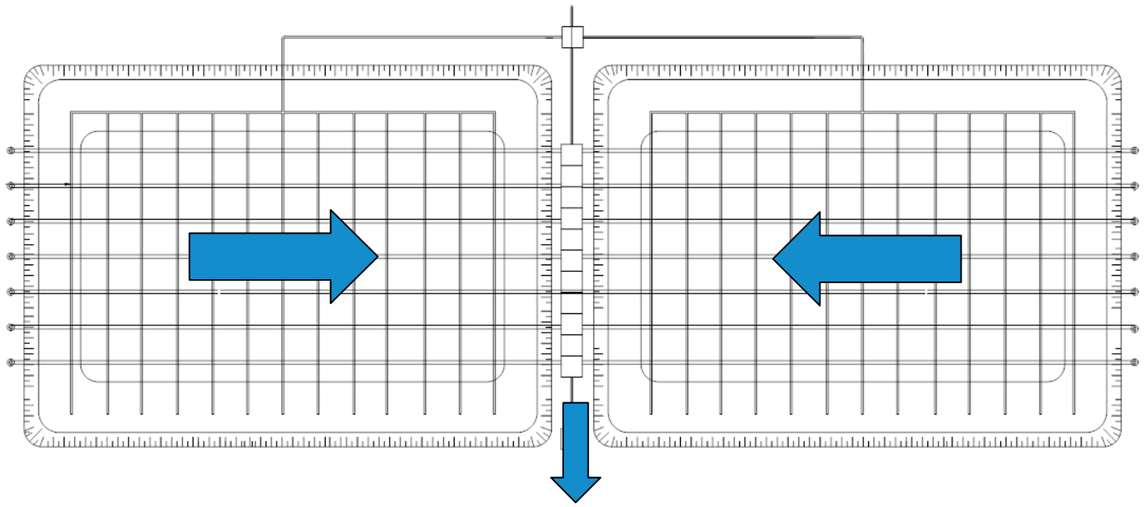
If the wire is forgotten during installation of the cable channel, the channel must be excavated at a later stage and re-installed.

The decision whether the use of a siphon (as part of the generic DTF design prepared by WSTF) is feasible or whether a pump is required due to the local topography is to be taken during the site selection and design adaptation process.
Neither the water company nor the Construction Contractor are allowed to take this decision without involving the WSTF in the decision making process as the usage of a pump has considerable implications on the design, construction as well as O&M of the DTF.

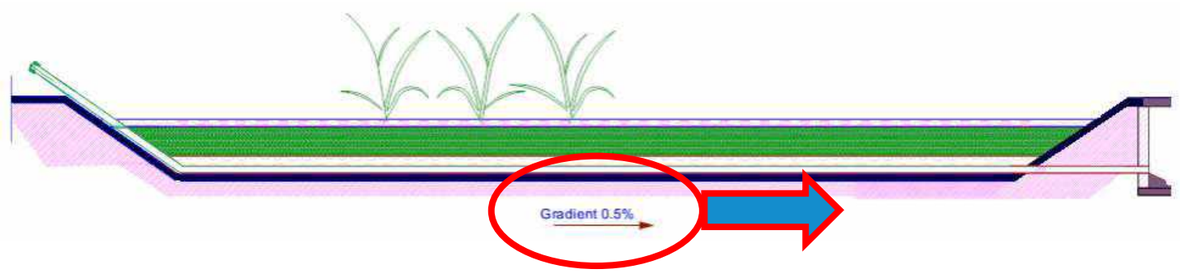
VERTICAL FLOW CONSTRUCTED WETLAND

Slope of ground bottom and drainage pipes

After trickling vertically through the filter media, the soakage is drained from the ground bottom of the filter beds towards a collection pipe that is running in between the two parallel filter beds.



To assure that the filtered water flows through the drainage pipes on gravity, the pipes must be laid in a **slope of 0.5%** towards the collection channel.



In order to ensure the required slope within the pipe network, the bottom of the filter beds shall be constructed with the same gradient. The gradient can be **created when constructing the clay laver** below the filter bed and the **PE liner**. The PVC drainage pipes will then be placed on top of the PE liner.

The Contractor and the Construction Supervisor need to **check the 0.5% slope of the bottom slab** before the drainage pipes are installed.

VERTICAL FLOW CONSTRUCTED WETLAND

Water-tight foundation of filter beds

Water tightness of the VFCW filter beds is crucial to

- Avoid groundwater pollution (the water is fit for discharge into a receiving water body but not intended to be infiltrated)
- Avoid water losses if the effluent water is used for any kind of irrigation (provided that effluent standards are met)

A water-tight bottom layer is particularly important due to the large surface area of the filter beds.

The bottom of the filter beds are therefore constructed as follows:

- **Compacted soil** (if required after backfilling with suitable soil)
- **Clay layer of 100mm thickness**
- **PE liner of 1.5mm thickness**

Picture source: Geosynthetics Ltd., UK

VERTICAL FLOW CONSTRUCTED WETLAND

Installation of PE liner

Special care is to be taken during the installation of the PE liner; otherwise the water will leak through the PE sheets. The following general working steps are required for **welding of PE liners**:

- Installation of PE sheets, overlapping by 5 to 10 cm
- Preparation and heating of weld contact area
- Joining of the sheets that are to be connected under welding pressure (either single or double welding seem)
- Controlled cooling of the welding seems under continued pressure
- Refinishing of the welding seems
- Inspection of the welding seems on water tightness (optically, with scribing iron, test with blowing, pressure or vacuum test)
- Correction of seems by repeated welding where required

Overlap welding

Before filling with gravel, the **filter beds shall be tested on tightness** by filling the basins with clear water and monitor the water level.

For laying and welding a **specialized Contractor** is required who possesses the **required experience** and know-how as well as a **electrical welding machine** for wedge / hot air welding of PE liners.

A suitable Contractor for the installation and welding of the PE liner might be found in companies which are specialised on the construction of fish/shrimp ponds, aquacultures and landfills.

VERTICAL FLOW CONSTRUCTED WETLAND

Water-tight installation of drainage pipes

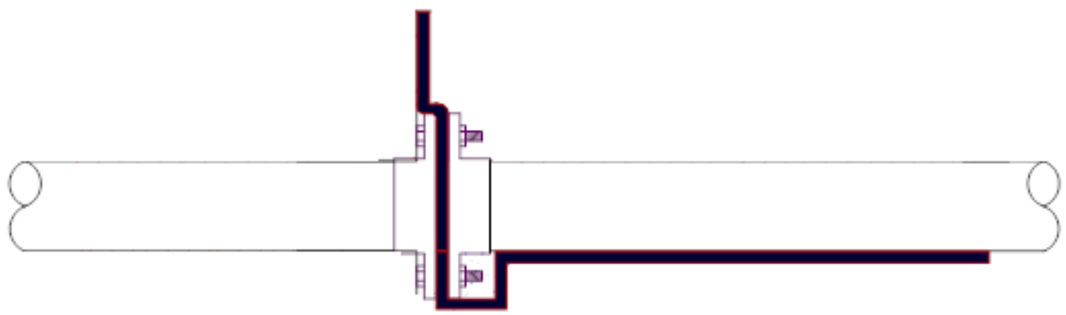
On the bottom of the VFCW filter beds a series of parallel DN100 uPVC drainage pipes are installed. The pipes are connected to a collection channel that is constructed in between both filter beds.

The drainage pipes need to pass the before mentioned PE liner before they connect with the collection channel. It has to be ensured that the points where the DN100 drainage pipes advance the PE liner are constructed **water-tight to prevent leakage.**

Generally two possibilities exist, out of which one is preferable and long-lasting, meanwhile the second option is rather improvisational.

The preferred option is to connect the inner part of the drainage pipe (running at the bottom of the filter bed) with the outer part of the pipe (connecting the drainage pipe with the collection channel) with a **pipe duct, also called pipe flange**. The flange can be either made of PVC or anti-corrosive metal. If a flange is used it might become necessary to use **adapters** to connect drainage pipes with either commercially available or customized flanges

If a pipe duct is used, the **PEL must be placed in between two flanges** that are screwed together in the following as shown below:



VERTICAL FLOW CONSTRUCTED WETLAND

Water-tight installation of drainage pipes

Another possibility to connect the drainage pipes with the PE liner is by **welding and use of brackets**. In that case a hole is to be cut into the PE liner where the pipe is supposed to pass the liner. The PE liner is then extended by welding additional sheets of PE to it. The extended PE liner is then put over the pipe and fixed with brackets, as demonstrated in the following picture.

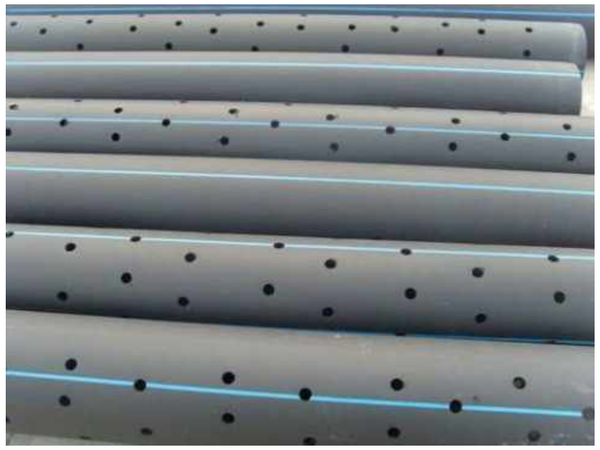
If neither pipe ducts nor the connection by welding and brackets are available or feasible for any reasons, the connections between the PVC pipes and the PE liner could be sealed using **bitumen** or **duct tape.** This solution is however less durable.

Finally the company and the contractor should decide which technology they want to use to connect the drainage pipes to the PE liner. It just must be assured that the connection is water tight.

VERTICAL FLOW CONSTRUCTED WETLAND

Shape of drainage pipes

For drainage a DN100 PVC pipe shall be used. The drainage pipe shall be a **commercially available perforated / slotted drain pipe**:



If ready-made pipes are not available, the Contractor might be allowed by the Construction Supervisor to produce drainage pipes by drilling holes into regular DN100 PVC pipes.

When choosing the drainage pipes it must be ensured that the **size of the drainage holes / slots is smaller than the diameter of the filter material** that is used in the drainage layer of the VFCW in order to avoid clogging.

In the **drainage layer 8/16 gravel** shall be used; hence the diameter of the gravel is between 8mm and 16mm. In order to avoid gravel entering the drainage pipes it must be ensured that the pipe holes / slots have a diameter (in case of holes) or width (in case of slots) of less than 8mm.

If grit (e.g. rubbed-off gravel parts) or other solids (e.g. accumulated bacteria, moss, dead roots) enter the drainage pipes despite appropriate perforation, the pipes can be cleaned by flushing water through the vent pipes into the drainage pipes. The solids are then flushed through the drainage pipes towards the collection channel. Mechanical cleaning is possible by using a brush tool.

VERTICAL FLOW CONSTRUCTED WETLAND

Mixture of filter materials

The following filter materials are to be used (from bottom to top):

- 150mm **drainage layer** of gravel (8mm – 16mm)
- 500mm **filter layer** of gravel (4mm – 8mm)
- 100mm **surface layer** of gravel (8mm – 16mm)

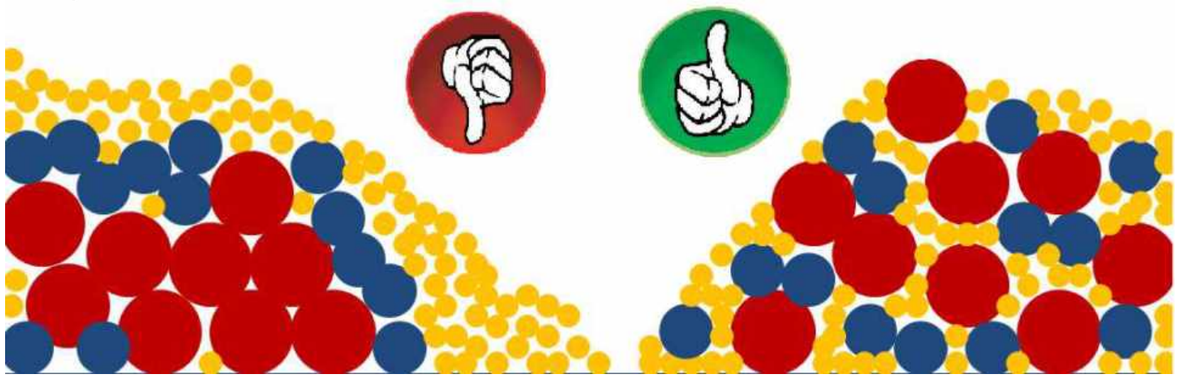
Hence, each layer is a mixture of gravel, either with a diameter of 4-8mm, or a diameter of 8-16mm. In order to avoid clogging as well as to provide an ideal surface area for the bacteria to attach, it must be ensured that the **mixtures are uniform**. In an ideal mixture, larger, medium and smaller pebbles are distributed equally within the volume.

During transport to the site (e.g. through vibration of the lorry) as well as during unloading (i.e. in case of tipper trucks) de-mixing can occur due to individual weights and forms of the different corn sizes (larger particles will lay on the bottom-centre of a heap).

The Contractor as well as the Construction Supervisor must assure that de-mixing is minimized by

- **Careful driving** with the lorry to minimize vibrations
- **Careful unloading**, preferably manually instead of tipping
- **Conscious loading of the filter beds** to guarantee a equal distribution

Re-mixing after transport and unloading might be required. The Construction Supervisor needs to confirm to the Contractor that the gravel is ready to be loaded into the filter beds.

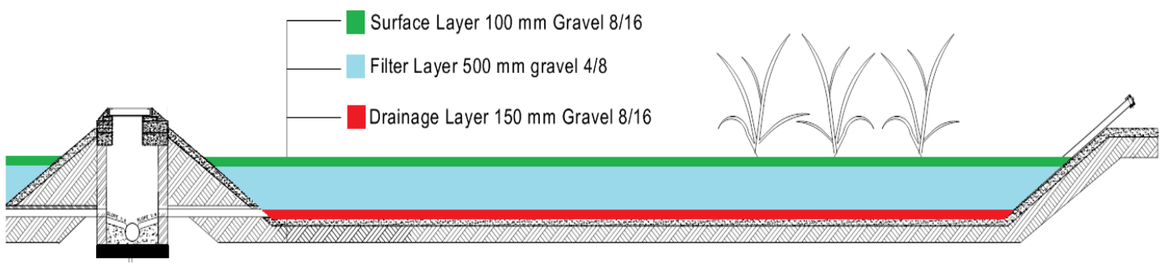


VERTICAL FLOW CONSTRUCTED WETLAND

Installation of filter materials

As mentioned before, the two filter beds are to be filled in three separate layers with different materials. The layers have specific functions:

- The drainage layer consists of coarse gravel (8mm – 16mm) to ensure a equal distribution of filtrate over the entire bottom area as well as to ensure that no small gravel enters the drainage pipes
- The filter layer consists of finer gravel (4mm – 8mm) to provide a large surface area for aerobic bacteria to attach as well as to act like a mechanical filter. Moreover the roots of the vegetation attach to the surface of the fine gravel
- The surface layer consists of coarse gravel (8mm – 16mm) to avoid clogging of the filter media by allowing the water to infiltrate quickly into the filter beds. The surface layer facilitates an equal distribution of the loaded wastewater over the entire surface area



It is crucial that the Contractor takes care of **arranging the different filter layers according to the technical drawings** as otherwise the treatment performance will deteriorate, as well as to avoid clogging.

The procured gravel is often dirty as dust and fine sand / abrasion is attached to the gravel. Also during unloading of the gravel from the lorry more dust and fine particles might occur.

Before filling of the filter beds with the different gravel layers, the **gravel shall be cleaned with water to flush off dust and sand.**

VERTICAL FLOW CONSTRUCTED WETLAND

Installation of filter materials (cont´d)

Furthermore it must be considered that sharp edged material can lead to damage of the PE foil sealing. It must be ensured that, especially for the drainage layer, **only round gravel (e.g. river pebbles)** is used; hence no quarry stones. Sharp-edged stones may destroy the PE liner and the system would not be water-tight anymore.

Furthermore, sharp-edged quarry stones may impede the development and growth of the vegetation.

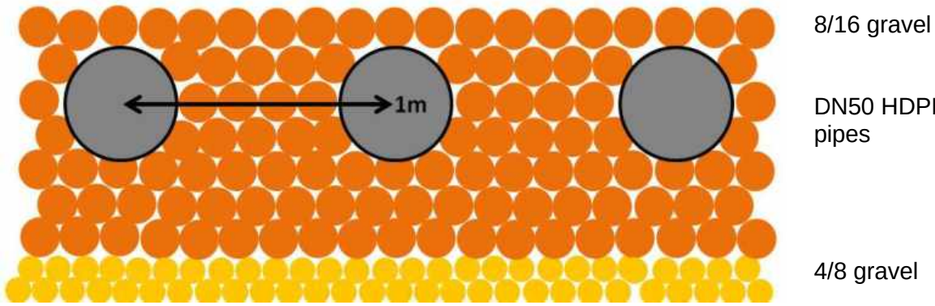
It must be ensured that the **filter material is not compacted during incorporation**; hence stepping on the filled material must be avoided to the extent possible. In order to avoid soil compaction the filling is to take place from **supporting planks**.

VERTICAL FLOW CONSTRUCTED WETLAND

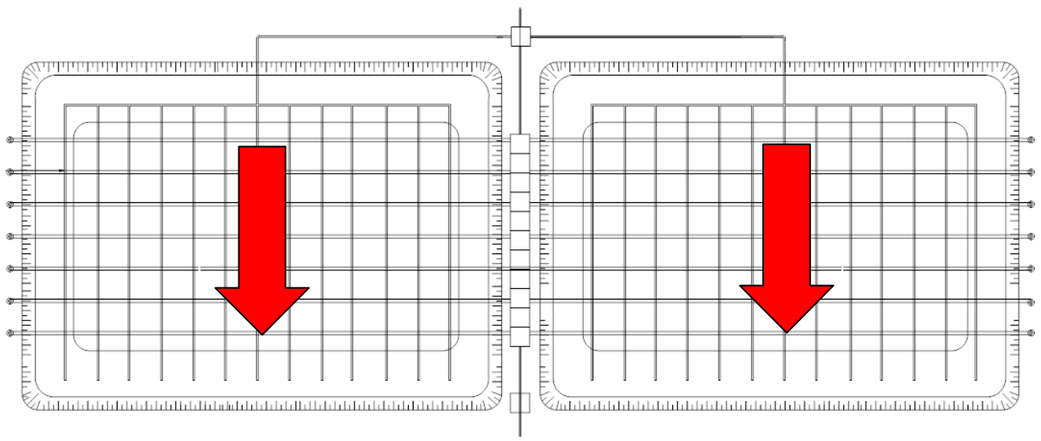
Distribution pipes

DN50 HDPE perforated pipes are to be used as distribution pipes. The pipes are laid in parallel (in 1m distance) within the surface layer of the filter beds and shall be slightly covered by the 8/16 gravel to avoid / reduce:

- Smell
- Mosquito breeding
- Exposition to sunlight
- Risk of being destroyed or damaged during operation and maintenance of the filter beds.



It must be ensured that the pipes are l**aid in a slight slope of 0.5%** towards the end of the filter beds to ensure that the water is distributed over the entire surface. The slope can be ensured during placement of the pipes on top of the gravel layer



The pipes must be **perforated with holes of 10mm diameter**. The holes shall be **placed every 1 running meter**.

VERTICAL FLOW CONSTRUCTED WETLAND

Planting

Common reed (phragmites) is the most common plant used for plantation of filter beds. Iris, reed mace (typha), bulrush (juncus) and others can also be employed if common reed is not available.

The following information can be given for the planting of reed:

- Reed can be planted as **clumps**, individual **rhizomes** or as **seedlings**
- Reed clumps can basically be planted all year round, preferably during the rainy season; **2 clumps per m^2** are sufficient.
- The planting of rhizomes is most successful if the rhizomes have one or two 10 - 60 cm shoots; **4 – 6 rhizomes per m^2** are sufficient
- Reed seedlings are developed from seed in greenhouses and it is advised that they be planted if they already show the start of rhizomes. Seedlings are easier to plant than pieces of rhizome and grow lushly in the first season; **3 - 5 seedlings per m^2** are sufficient.

To **avoid soil compaction,** planting is to take place from supporting planks.

Plant beds are to be provided immediately following construction with a **freeboard of 20 -30 cm** (distance from the bed surface to the upper edge of the sealing). The **edge of the sealing (PE liner) shall be fixed** with large stones to avoid destruction / removal of the PE liner and for visual reasons.

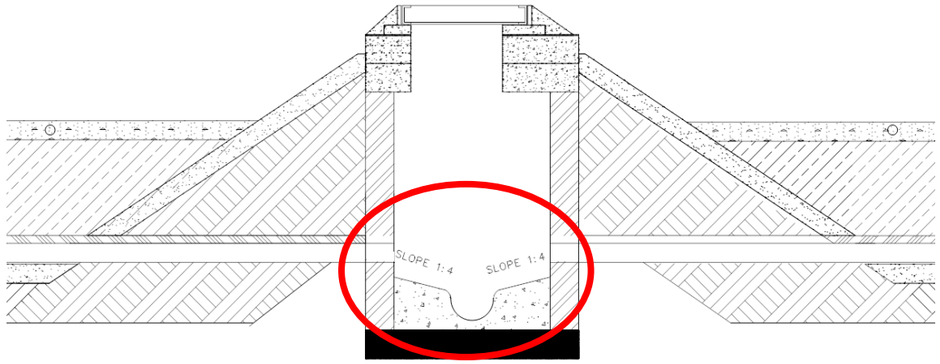
During construction, commissioning and first months of operation the plants may need to be watered until they have reached a height of some 50cm.

VERTICAL FLOW CONSTRUCTED WETLAND

Drainage / bypass channel and effluent pipe

The soakage of the filter beds is routed into a drainage channel running in between the two filter beds via drainage pipes that are placed on the bottom of the filter beds.

This drainage channel is running in between both filter beds. To avoid clogging, the channel must be constructed with a **slope of 1%.**



The same channel is also used as **bypass channel** if both filter beds (that are usually used intermittently) are to be closed down for any reason.

The **channel shall be covered** by precast concrete covers with Y10 lifting handle rings to avoid easy access for cleaning. It must be ensured that the dimensions do not exceed 600mm x 600mm x 50mm for weight reasons.

At the end of the drainage channel an **inspection chamber** shall be placed. From this chamber the effluent shall be routed through a DN100 uPVC pipe towards the receiving water body (i.e. a river or trench). The following must be ensured:

- The pipe shall be laid with **at least 0.5% slope** (1% if topography allows)

Inspection chambers must be placed every 25 meters to allow access to the pipe system for cleaning in case of any clogging. Standard inspection chambers with the dimension of 1200mm x 825mm covered with 600mm x 450mm x 50mm PVC covers shall be used.

SLUDGE DRYING REED BED

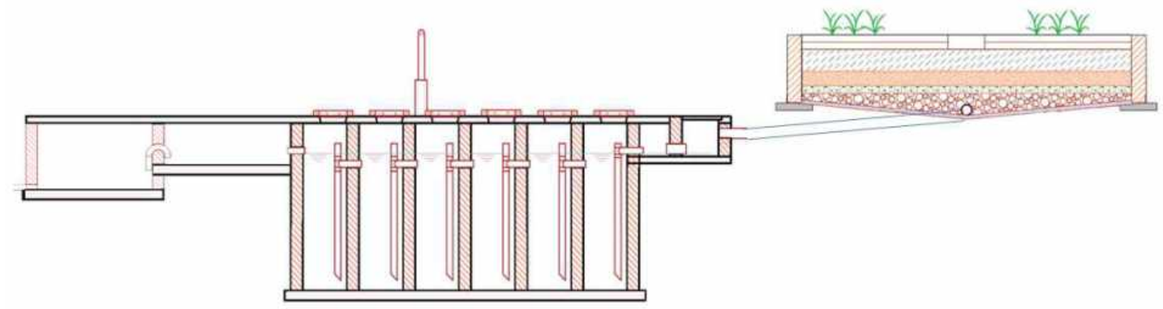
Level of the Sludge Drying Reed Bed

Already during the design phase the location and the level of the different treatment modules were considered.

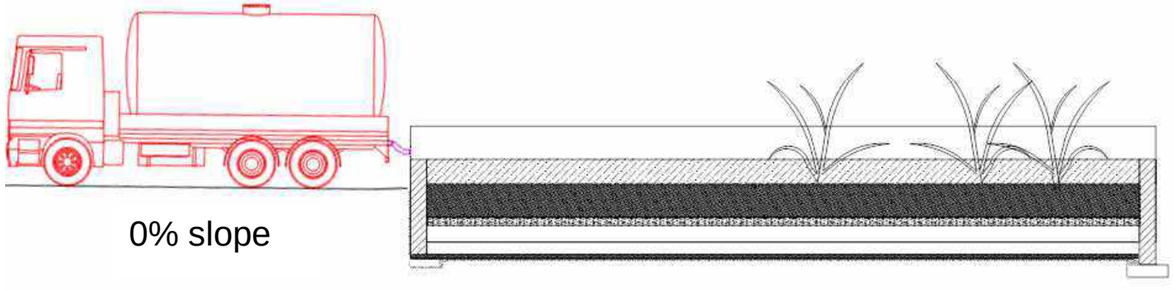
For the drying beds a location and a level was chosen that allows gravity-based discharge of the drained soakage to a nearby treatment module.

It has to be ensured, that the pipe that is collecting the soakage from all drying beds is located higher than the following treatment modules to allow for gravity-based drainage. A **slope of at least 0.5% in the pipe** is required.

The Contractor and the Construction Supervisor need to assure that the sludge drying bed is **built sufficiently elevated** to allow for gravity-based drainage.



The sludge drying bed is to be constructed at an elevated level. It must be ensured that the parking area for the exhauster trucks is **exactly horizontal** to ensure that exhauster trucks can be emptied by gravity <u>entirely</u> (compare to details about a ramp described under “Access to the Receiving Bay”).

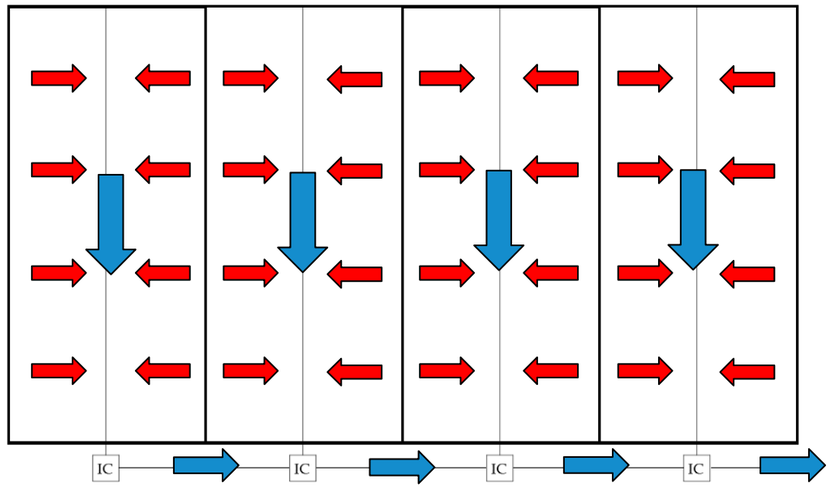


SLUDGE DRYING REED BED

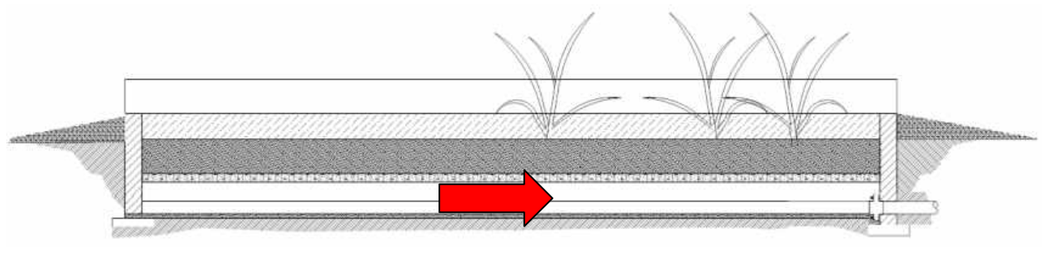
Slope of ground bottom and drainage pipes

After trickling vertically through the filter media, the soakage is drained from the ground bottom of the drying beds towards a collection pipe that is running along the four drying beds. This **drainage pipes** (indicated with blue arrows on below figure) shall run with at least **0.5% slope** to allow for gravity flow.

Apart from that, the **ground** of the individual drying chambers (indicated with red arrows) must be built with a **slope of 5%** towards the drainage pipe to allow easy collection of the soakage.



The required gradient (5% for the ground bottom of the drying beds) can be created during excavation and construction of the clay laver.



The Contractor and the Construction Supervisor need to check the slope of the bottom slab before the PE liner and drainage pipes are installed.

SLUDGE DRYING REED BED

Installation of PE liner and drainage pipes

Similarly to the vertical flow constructed wetland the ground bottom of the drying beds need to be **sealed water-tight**. Also here this is done by 1) compacting soil, 2) constructing a 100mm thick clay layer, and 3) installing a 1.5mm PE liner.

As for the vertical flow constructed wetlands, the **PE liner needs to be installed as follows**: 1) overlapping installation of PE sheets, 2) preparation and joining of sheets by overlap welding, 3) cooling and refinishing of welding seems, 4) inspection on water-tightness, and 5) corrections as required.

Again, an **experienced Contractor** possessing an **electrical welding machine** for wedge / hot air welding of PE liners is required. It is therefore recommended to install the PE liner of the sludge drying beds at the same time as for the wetland system to avoid that the specialised Contractor needs to be mobilised twice.

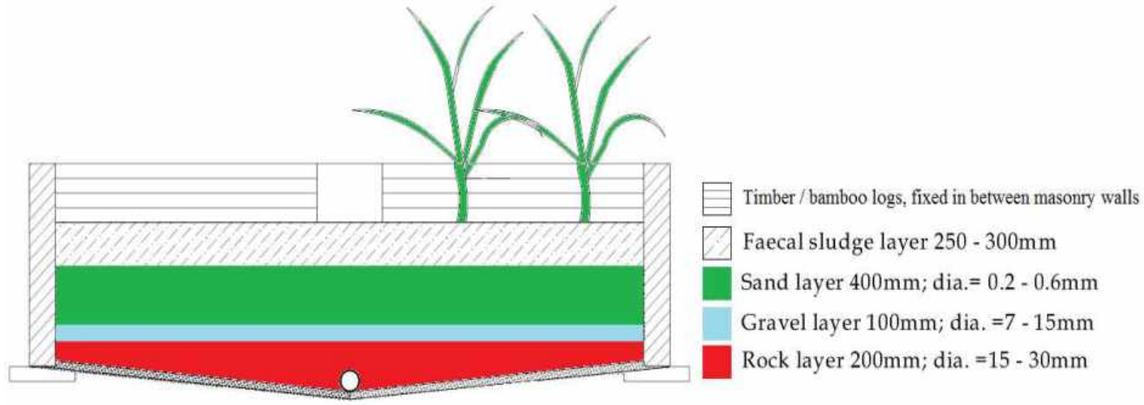
The DN150 uPVC drainage pipe that is running inside the drying beds has to penetrate the PE liner towards the main drainage pipe connecting the drying beds to a receiving treatment module. Hence for each filter bed one passage is required. As for the wetland, this **passage must be water-tight**. Again potential options include (i) the use of **pipe ducts**, (ii) welding and fixing with brackets, (iii) or sealing with bitumen of duct tape.

SLUDGE DRYING REED BED

Mixture and installation of filter materials

Also for the filling of the drying beds the **mixtures must be uniform**. The Contractor needs to avoid de-mixing during transport, unloading of lorries and loading of beds. If necessary, re-mixing is required. The Construction Supervisor needs to assure proper handling of the filter materials.

The drying beds are filled with **filling materials of different sizes**:



It is crucial that the Contractor takes care of **arranging the different filter layers** according to the technical drawings to avoid clogging and to ensure proper treatment of the soakage.

Furthermore it must be ensured that **round gravel** (e.g. river pebbles) is used; for the drainage / rock layer to avoid that the PE liner gets damaged by sharp edged stones.

The **filter material may not be compacted** during filling; hence stepping on the filled material must be avoided to the extent possible. In order to avoid soil compaction the filling is to take place from supporting planks.

Before filling of the drying beds with the different gravel layers, the gravel shall be cleaned with water to flush off dust and sand

Planting

Planting with common reed (or similar plants) works **similar to planning of the constructed wetland**.

CO-COMPOSTING AREA

Level of construction

The co-composting area is a stand-alone treatment module. Meanwhile in the previously mentioned treatment modules faecal sludge / wastewater is treated, the co-composting area is intended to further treat dried matter removed from dry toilets (UDDTs) as a separate waste stream

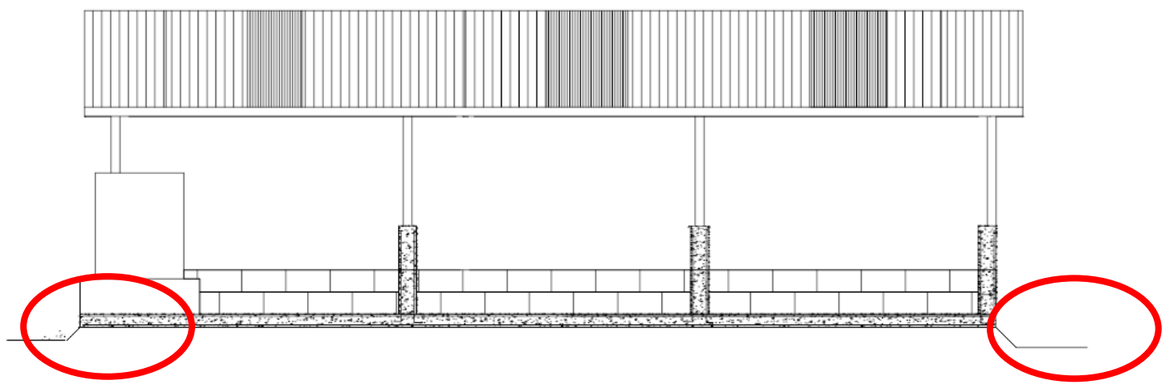
Therefore, the location and level of the co-composting shed is basically independent from the other treatment modules.

Nevertheless the following two facts need to be considered:

- The co-composting area must be **constructed slightly above ground level** to avoid that rainwater runoff flows into the shed during heavy rainfall. An **elevation of at least 30cm above the surrounding ground level** is recommended. The level can be ensured by means of adequate landscaping during construction. Construction of **drainage channels** around the shed can reduce the required elevation.
- If the drainage of the co-composting area shall be connected to a treatment module, sufficient **vertical level difference** between the drainage outlet and the inlet into the treatment module is required, considering a **slope in the connecting pipe of at least 1%.**

  If it is not intended to convey the leachate to a treatment module, it can be infiltrated into the ground through a properly constructed soak pit.

The Contractor and the Supervisor need to assure sufficient elevation.



CO-COMPOSTING AREA

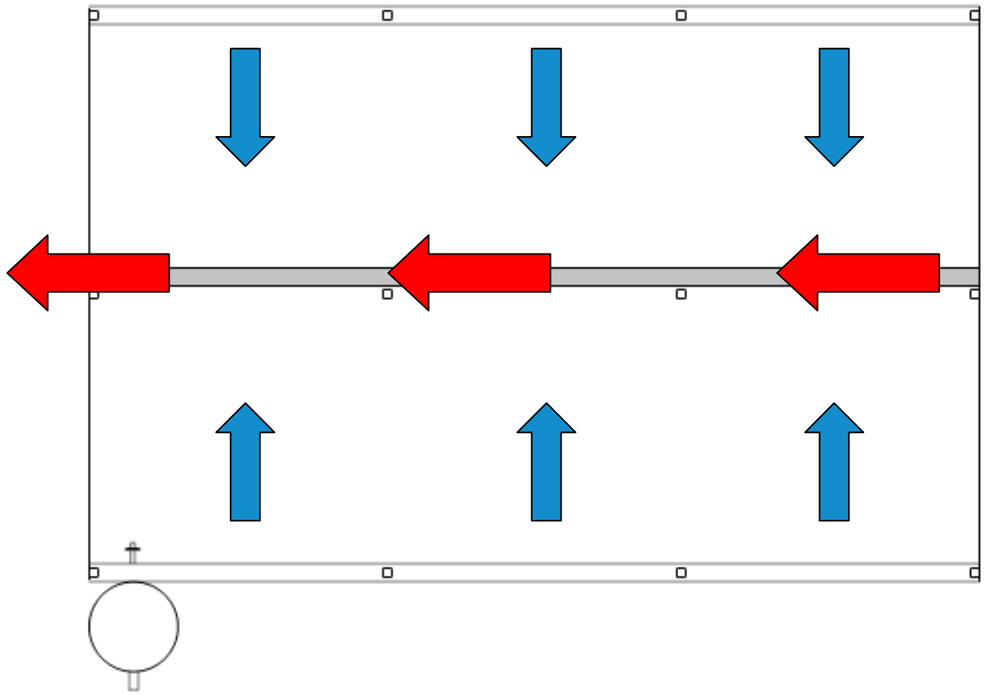
Drainage channels

During the composting process, water might collect at the bottom of the compost heaps (windrows). This leachate should be drained properly to avoid smell and other nuisances.

A longitudinal drainage channel is to be constructed therefore in the centre of the composting shed. The channel shall have a slope of 1% towards the intended drainage side.

The channel and its slope can be created during the plastering of the platform.

Additionally, the platform shall have a slope of 1% towards the drainage channel. Also this slope can be created during plastering of the ground slab.



As the leachate is a small quantity only (if there is leachate at all), it can be infiltrated into the ground by means of a small pit filled with gravel.

CO-COMPOSTING AREA

Supporting columns for roof

The roof of the co-composting shed has a considerable weight due to the steel truss and roofing sheets. It is therefore important to ensure good construction quality for the supporting columns. This includes:

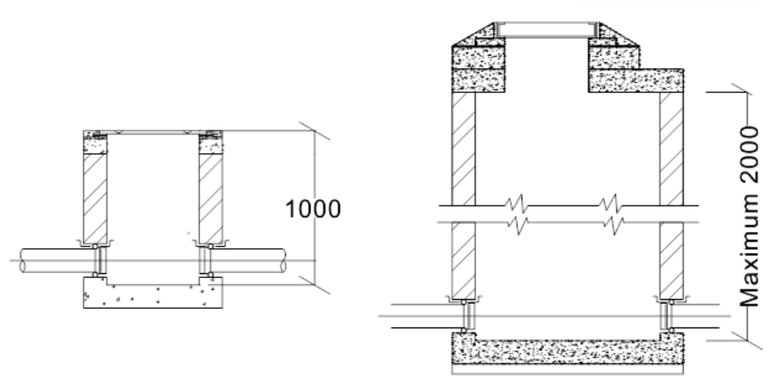
- Proper **quality** of square hollow section (SHS) columns, metal plates and bolts (anti-corrosive)
- Proper **cement mixture** (C20) for concrete pillars
- Proper use of **formworks** during construction
- Proper **installation of the bolts** into the concrete pillars to allow for easy installation of the metal plate
- Proper fixing of the **screw nuts on the bolts**, avoiding any kind of friction that could result in damaging the concrete pillars.

Good construction quality is crucial to ensure that the roof resists rough weather conditions such as heavy rain or storms.

INSPECTION CHAMBERS

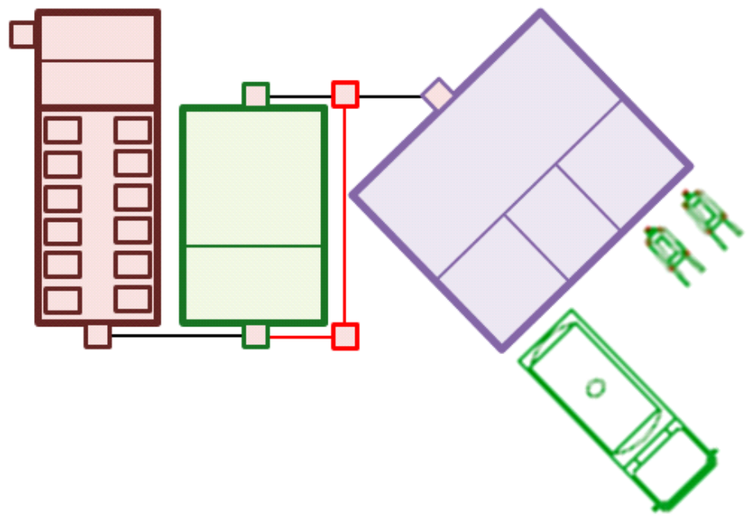
Types and location of inspection chambers

Principally two kinds of inspection chambers are foreseen for the construction of a DTF, depending on the depth of the connected pipes: one **standard chamber** to a depth of 1m below ground level and one for more than 1 meter.



Inspection chambers are generally located:

- **Every 25 meters** to provide access to buried pipes
- Where the **flow direction of pipes changes**, i.e. in case of bypasses

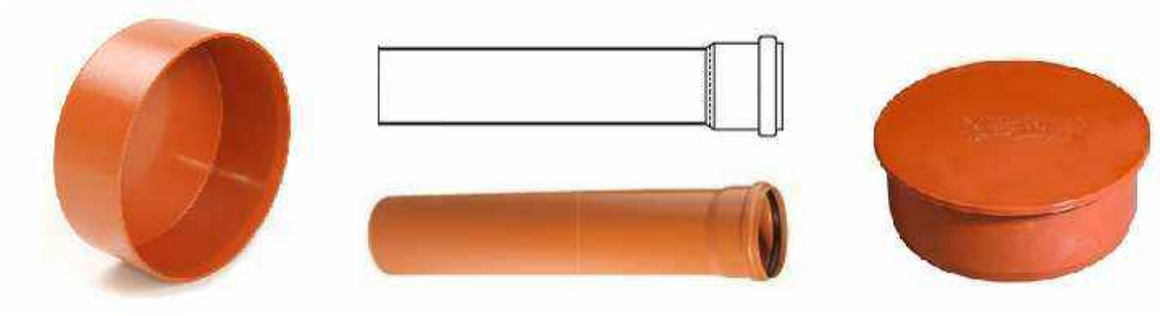


INSPECTION CHAMBERS / INLET BOXES

Plugging of pipes

Pipes, particularly bypasses, need to be plugged. Only for opening bypasses, the plugs need to be removed and used to close the main pipe.

Regular plastic plugs / end caps can be used for plugging the PVC pipes. Generally two kinds of plugs exist: an end cap that is pressed outside the normal end of a pipe, or a plug that is pressed inside the socket (muffle).



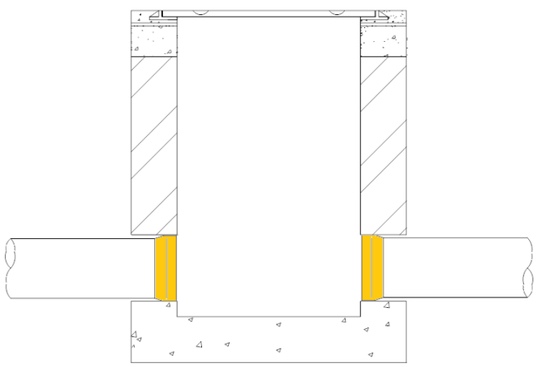
Generally it is recommendable to close pipes with a **plug that is placed inside the socket** as the socket it equipped with a **rubber sealing**. By using a plug, a pipe can be closed temporarily water-tight.

These plugs need to be **permanently fixed to the inspection box** with a rustproof, stainless steel chain to avoid theft.

In order being able to close pipes with plugs, the Contractor and Supervisor need to assure that pipes are placed in a way that the sockets of pipes are connected to inspection boxes, as demonstrated in below figure. Only if the **pipe socket is accessible**, a pipe can be plugged from inside.

Additionally, the Contractor must ensure that the pipe end finishes with the plastering of the inspection box. It is **not required to build any kind of channel**.

Again, it is required to use the pipe socket inside an inspection chamber as an end cap cannot be placed outside the pipe.



CHAMBERS FOR FLOW REGULATION

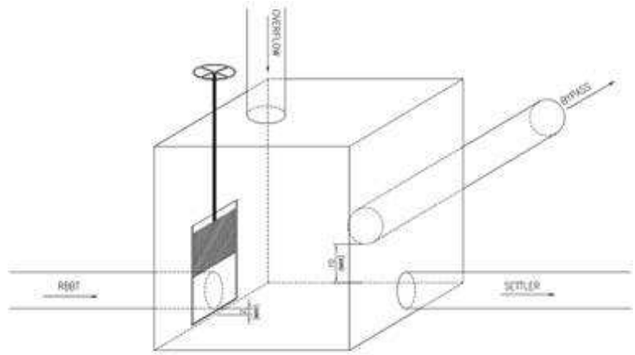
Within the DTF a regulated and controlled flow is required to ensure required flow velocities and hydraulic retention times.

It is therefore crucial that flow regulating devices are precisely constructed as per technical specifications, as laid out in the technical drawings and schedule of materials and as indicated in the following:

Outlet box of Receiving Bay

Here the main flow into the system is regulated to ensure a steady flow and to avoid peaks.

A penstock sliding valve (incl. an extension for the wheel) is placed at the outlet pipe of the Balancing Tank, located in an inspection chamber that also hosts outlets to the settler (bottom of chamber), a bypass (slightly elevated), as well as an overflow (on top of chamber).



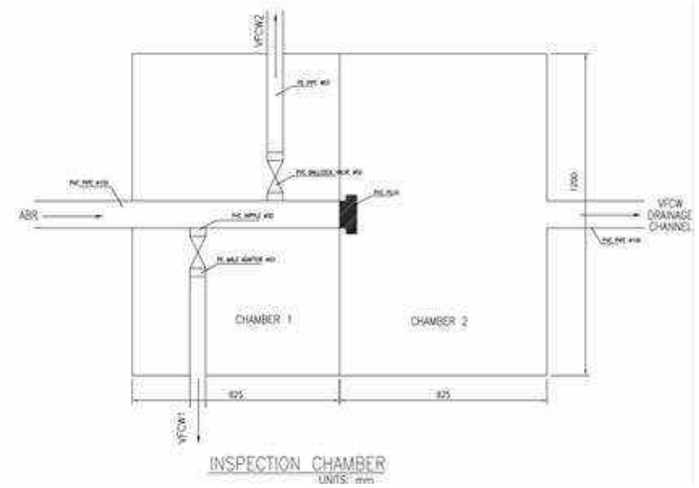
Respective penstock sliding valve are readily available in hardware stores and shall be selected according to the specifications laid out in the BoQ.

CHAMBERS FOR FLOW REGULATION

Inlet box of Constructed Wetland

Here the flow is diverted between the intermittently operating filter beds.

A volume-wise flow regulation is not required but opening and closing is sufficient, why PVC ballcock valves are used for the DN50 HDPE feeding pipes leading to the filter beds. The bypass pipe is plugged in an attached dry chamber.



Respective ballcock valves are readily available in hardware stores and shall be selected according to the specifications laid out in the BoQ.

CHANNELS / CHAMBERS / BALANCING TANKS / MODULES

Covers

Covers for inspection chambers, inlet/outlet boxes of treatment modules, on top of distribution channels, on top of balancing tanks, as well as on top of treatment modules must be constructed as per technical specifications.

It must be particularly ensured that the manhole covers **can be lifted easily by one person**: the DTF operator. Opening is required for the following purposes: (i) regularly changing the flow direction from one wetland filter bed to the other, (ii) regular de-sludging of treatment modules, (iii) occasionally open/plug bypass pipes, and (iv) occasionally clean channel, chambers and boxes.

Different covers are foreseen as per technical drawings / BoQ, as follows:

- Receiving bay balancing tank: 600mm x 450mm x 50mm PVC covers fitted with a handle *(2 pieces)*
- Settler: 600mm x 450mm x 50mm PVC covers fitted with a handle *(1 piece in inlet box, 3 pieces in settler cover slab, 1 piece in outlet box)*
- Inlet box of ABR: 1000mm x700mm x 50mm precast concrete cover with Y10 lifting handle ring *(1 piece)*
- Distribution channel of ABR: 15000mm x550mm x 50mm precast concrete cover with Y10 lifting handle rings *(2 pieces)*
- ABR: 600mm x 450mm x 50mm PVC covers fitted with a handle *(12 pieces)*
- ABR balancing tank: 2100mm x 550mm x 50mm precast concrete cover with Y10 lifting handle rings *(12 pieces)*
- Wetland drainage channel: 600mm x 600mm x 50mm precast concrete drainage channel cover with Y10 lifting handle rings *(11 pieces)*
- Inspection chambers (both sizes): 600mm x 450mm x 50mm PVC access cover fitted with a handle *(number depending on layout)*

PVC covers must be **permanently fixed to the inspection box** with a rustproof, stainless steel chain to avoid theft. All covers shall be equipped with a **moveable ring handle** that avoids risk of stumbling.

The Contractor as well as the Supervisor need to ensure that the covers a built as per specifications to ensure proper operation and maintenance of the DTF.

OPERATOR / STORAGE BUILDING

Location

The building serves as storage of O&M tools (e.g. wheelbarrow, shovel, rake, gloves, buckets, brooms, sampling devices). In order to **reduce walking distances** the location should be chosen close to the treatment modules.

As the building also serves as recreation room for the operator / watchman, the house should be located **close to the entrance gate**.

Finally the building shall be connected to fresh water, electricity and drainage. An adequate location for easy connection shall be identified.

Water supply

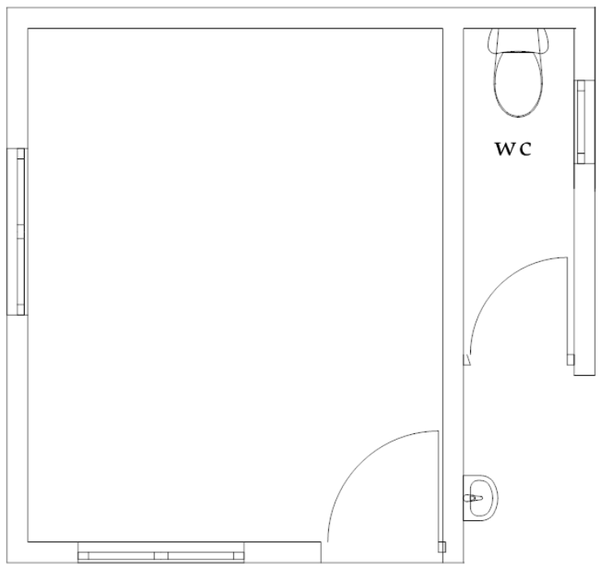
The building shall be connected to water supply for **O&M purposes** (cleaning of equipment) and **personal hygiene** (water flush toilet, hand washing).

A water tap is to be installed outside the building for cleaning boots, tools, etc. before entering the building.

Fresh water can be either supplied by piped network, rainwater harvesting, a borehole or a well, or a cistern filled occasionally by lorries.

Electricity supply

If possible by any means, the building shall also be supplied with electricity (e.g. for **lighting**, **O&M**). This can be done by connecting the building to a nearby power grid or by equipping it with a solar system.



Drainage

As the building is equipped with a **wash basin** and a **toilet**, it is required to connect it to a sewer system. It is recommended to connect the building by gravity to a DTF treatment module, i.e. the receiving bay, settler or ABR.

FINAL LANDSCAPING

Levels & Landscaping & Freeboards

Most treatment modules are located underground, at least partly. Only the cover slabs are often located at the final ground level. Therefore a general risk of flooding exists during rain events in the following modules:

- Outlet box of the receiving bay – balancing tank (through manholes)
- Settler (through manholes)
- ABR (through manholes)
- Vertical flow constructed wetland (flowing into filter beds from surrounding ground level)
- Sludge drying reed bed (flowing into drying beds from surrounding ground level)
- Co-composting area (flowing into shed from surrounding ground level)
- Inspection chambers (through manholes)

Flooding of the system would result in dilution of the wastewater as well as reduce the treatment performance in terms of quantity.

It must be ensured that all modules are not prone to flooding during rain (surface runoffs).

In case of the co-composting area this can be done by constructing the shed above the existing / or final ground level.

The levels of the other treatment modules are nevertheless determined by the level of the receiving water body (based on the required slope in the pipe network as well as required level differences in the treatment modules).

Avoiding rainwater runoffs getting into the system must therefore be provided by **final landscaping**, including **construction of proper drainage**.

The cover slab of the settler, ABR, inspection chambers shall extent at least 20cm above final ground level (**freeboard**).

The barriers of the wetland system and sludge drying beds shall extent at least 30cm above final ground level.

Flattening

To allow for **access of all modules for trucks** (i.e. exhauster trucks for O&M) the terrain must be flattened. Apart from that the Co-composting area must be **easily accessible** for SaniGo.

FENCE & GATE

Fence

The location of the fence is already be considered and fixed during the design phase.

Nevertheless, during construction the Contractor as well as the Supervisor needs to take care to locate the fence appropriately, considering:

- **Ensure sufficient distance** between treatment modules and the fence. This shall also include that trucks can access between the modules and the fence for regular or on-demand O&M
- **Avoid access** to the site for unauthorised persons to avoid damages, theft and personal injuries. Particularly children shall not be able to enter the site
- Ensure that the fence is not installed outside the assigned lands to **avoid legal problems**
- Ensure that the fence is located at solid grounds, or ensure proper foundation, in order to **ensure structural stability**
- Follow the **technical specifications** (chain-link fence with concrete posts every 3m, straining posts at every 10th post, and additional posts at corners) to ensure structural stability

Gate

The location of the gate is determined during the final design. Nevertheless, the Contractor and the Supervisor need to ensure during construction that the gate is constructed – as per technical specifications – in a way that guarantees:

- Easy access of exhauster trucks to the receiving bay, having in mind required manoeuvring
- Easy access of exhauster trucks and SaniGo to the gate from outer roads.

Health & Safety

BASIC RULES FOR SAFETY

Tidy construction site

- Keep **passages clear** all time to avoid stumbling, stepping into nails
- **Pile materials safely**; stacks should not be too high
- Beware of **floor openings** and ensure that they are covered
- Remove **waste** as soon as possible

Safety measures

- Before you operate a machine, ensure that the dangerous part of the machine has been installed with a **guard**
- Keep vigilant all the time and watch out for **moving equipment**
- Before you use any electrical tool, check the condition of its **cables**
- Avoid dragging **electric cables** on the ground or allowing the cables to come into contact with water

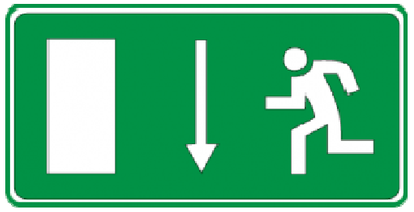
Personal safety

- Wear **protective equipment**
- Do not **drink** or take **drugs** while working
- Pay attention to **personal hygiene**
- Do not **play** in the workplace
- **Report** to your supervisor immediately if you notice any unsafe condition

EMERGENCY RESPONSE

The Contractor must have a good understanding of their working environment and the instructions given by the supervisor. When **evacuation** is required in an emergency, you should keep calm and find out :

- What dangerous situation the alarm refers to
- The routes for evacuation
- The safe place that you should go to as designated by the company



If an **accident** happen despite safety precautions it is important to:

- Keep calm
- Seek help immediately
- Accompany the injured person
- Assist in the immediate rescue work as far as possible
- Do not try to move the injured person unless it is really necessary

When a **fire** breaks out, you should remember:

- Put out the fire with a fire extinguisher if it is a small fire
- If the blaze is out of control, do not try to extinguish the fire on your own; call the Fire Services Department, or the police (999) right away

HEALTH & SAFETY EXAMPLES

Excavations

- Use safe access for ingress and egress
- Do not pile soil or any other materials at the edge of an excavation
- Make sure that a trench is securely shored before working in it

Gas welding & flame cutting (i.e. for roof of composing area)

- Wear personal protective equipment (i.e. safety glasses)
- Keep the workplace clean
- Place fire extinguishers within reach
- Keep gas cylinders upright and secure it against overturning
- If gas leakage is detected, report it to your supervisor immediately

Fire risk

- Always keep the workplace clean and tidy
- Handle machinery and tools that may generate sparks or heat carefully
- Do not smoke or use naked flames in any area where flammable and explosive substances are stored
- Know where fire extinguishers are located and how they are used
- Know the place of assembly for fire evacuation

HEALTH & SAFETY EXAMPLES

Public safety

It should be prevented that the public has access to the construction site, i.e. children. Nevertheless, pay attention to public safety:

- Members of the public are often unaware of or do not understand the work carried out on construction sites and the risks involved
- Take great care to prevent the fall of materials from height
- Do not stack materials on floor edges or on scaffolds

Waste disposal

- Dispose of all wastes and unwanted materials at a designated place
- Notify your supervisor of the requirement for the separate disposal of chemical or inflammable wastes
- Do not leave planks with nails on passageways

Eye protection

- A small fragment entering an eye may cause serious consequences
- When there is a risk of eye injury, such as in concrete breaking, wear suitable eye protectors
- Take proper care of the eye protectors provided to you; replace damaged eye protectors immediately

Noise

- Wear ear protectors in areas with high noise levels
- Do not reuse disposable ear plugs
- Clean ear protectors regularly

HEALTH & SAFETY EXAMPLES

Personal Protective Equipment

- Wear gloves when handling or contacting chemicals
- Wear a mask when working in a dusty environment
- Wear eye and ear protectors whenever necessary
- Wear safety shoes to prevent foot injury
- Wear a safety helmet on a construction site
- Keep the harness of the helmet clean and make sure that it fits well
- Do not drill any holes on the helmet or use it for pounding

First Aid

- Ensure that a first aid kit is available at the construction site
- Identify in advance a colleague who is trained in first aid procedures (if available)

Manual handling

- Avoid manual handling operations as far as possible
- Lift an object with a correct posture (e.g. straight back)
- Put on gloves as far as possible to protect your hands from cuts, scratch or puncture; wear safety boots or shoes to prevent injury to toes by heavy falling objects
- Seek assistance from someone in lifting a load if necessary

Alcohol and drugs

- Do not drink alcohol, or take drugs, while at work
- If you need to take drugs due to illness, report it to your supervisor

CONSTRUCTION MONITORING

GENERAL DIRECTIONS

Introduction

Construction Monitoring is crucial to ensure that during the entire period of construction no shortfall will frustrate the project and in the worst case will lead to a stop of the Works due to

- Poor time management
- Lack of various capacities at the site
- financial and technical disputes
- poor quality of works

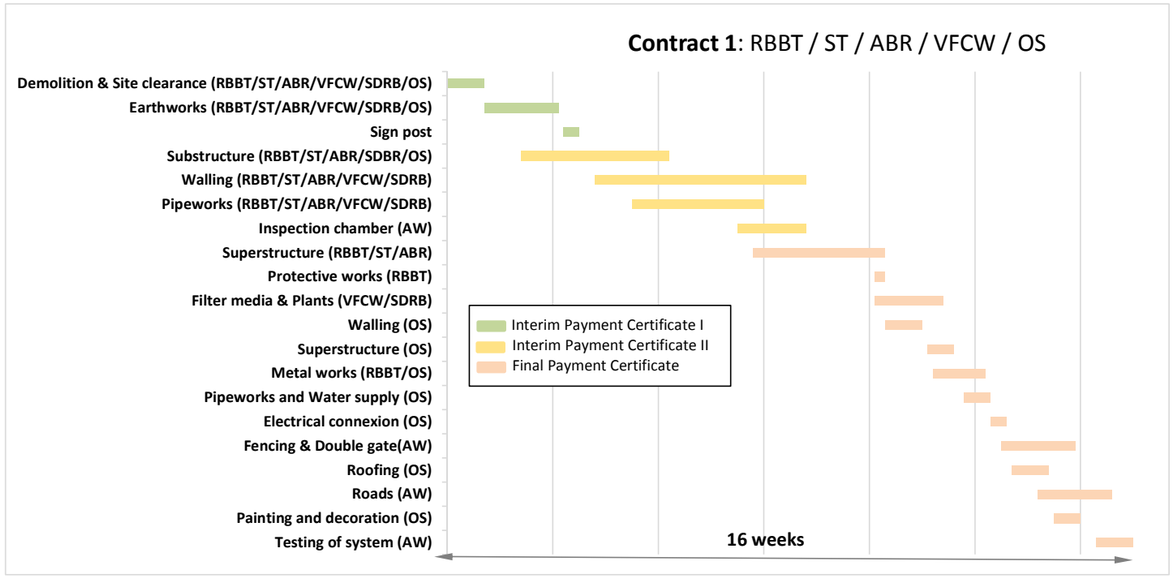
This chapter deals mainly with

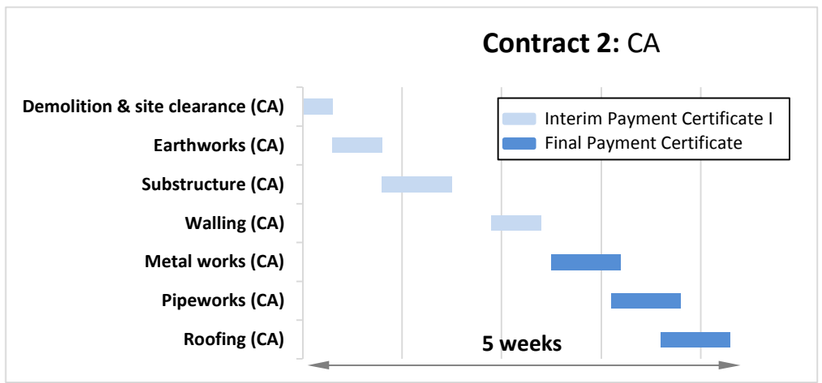
- Principal work plan
- Cost overview per item & payment breakdown
- Work and finance related processes
- Daily Report Diary
- Meetings
- Engineer´s Instruction Form
- Joint Work Measurement,
- Material Approval Request Form
- Concrete Approval
- Variation Order
- Payment Certificates
- Certificate of Completion

For smooth monitoring Supervisors are supposed to know the key clauses of the Tender document and signed contract.

Principal work plan

The **work plan** for DTF is part of the contract and mandatory for the entire project. Based on the principal work plan the Contractor is supposed to present within 30 days a detailed **work programme** to the Project Manager.





Cost overview per item & payment breakdown

The Project Manager is supposed to be familiar with the **cost overview and payment breakdown** as shown below to avoid any delays of works or payments to the contractor.

WSTF URBAN SANITATION UPSCALING PROGRAMM 1st Call									
COST OVERVIEW PER ITEM		SUB-PROJECT No. I (RBBT,ST,ABR,OS, Auxiliary)							SUB-PROJECT NO. II
ITEM	ITEM DESCRIPTION	Bill 1 RBBT	Bill 2 ST	Bill 3 ABR	Bill 4 VFCW	Bill 5 SDBR	Bill 7 OS	Bill 8 Auxiliary	Bill 6 CA
1.00	DEMOLITION & SITE CLEARANCE	40%	40%	40%	40%	40%	40%		60%
2.00	EARTHWORKS	40%	40%	40%	40%	40%	40%		60%
3.00	SUBSTRUCTURE: CONCRETE / REINFORCEMENT/ FOMWORKS	40%	40%	40%	40%	40%	40%		60%
4.00	WALLING	30%	30%	30%		30%	30%		60%
5.00	SUPERSTRUCTURE: CONCRETE / REINFORCEMENT/ FOMWORKS	30%	30%	30%			30%		
6.00	PIPEWORK - PIPES and FITTINGS	30%	30%	30%	30%	30%	30%		40%
7.00	METAL WORKS	30%					30%		40%
8.00	FILTER MEDIA & PLANTS				30%	30%			
9.00	ROOFING						30%		40%
10.00	PAINTING AND DECORATION						30%		
11.00	ELECTRICAL CONNEXION						30%		
12.00	WATER SUPPLY						30%		
13.00	CHAMBERS							30%	
14.00	FENCING & GATE							30%	
15.00	ROADS							30%	
16.00	TESTING OF SYSTEM							30%	
17.00	SITE DRAINAGE WORKS							30%	
18.00	PROTECTIVE WORKS							30%	
19.00	SIGN POST							40%	

CONTRACT No. 1

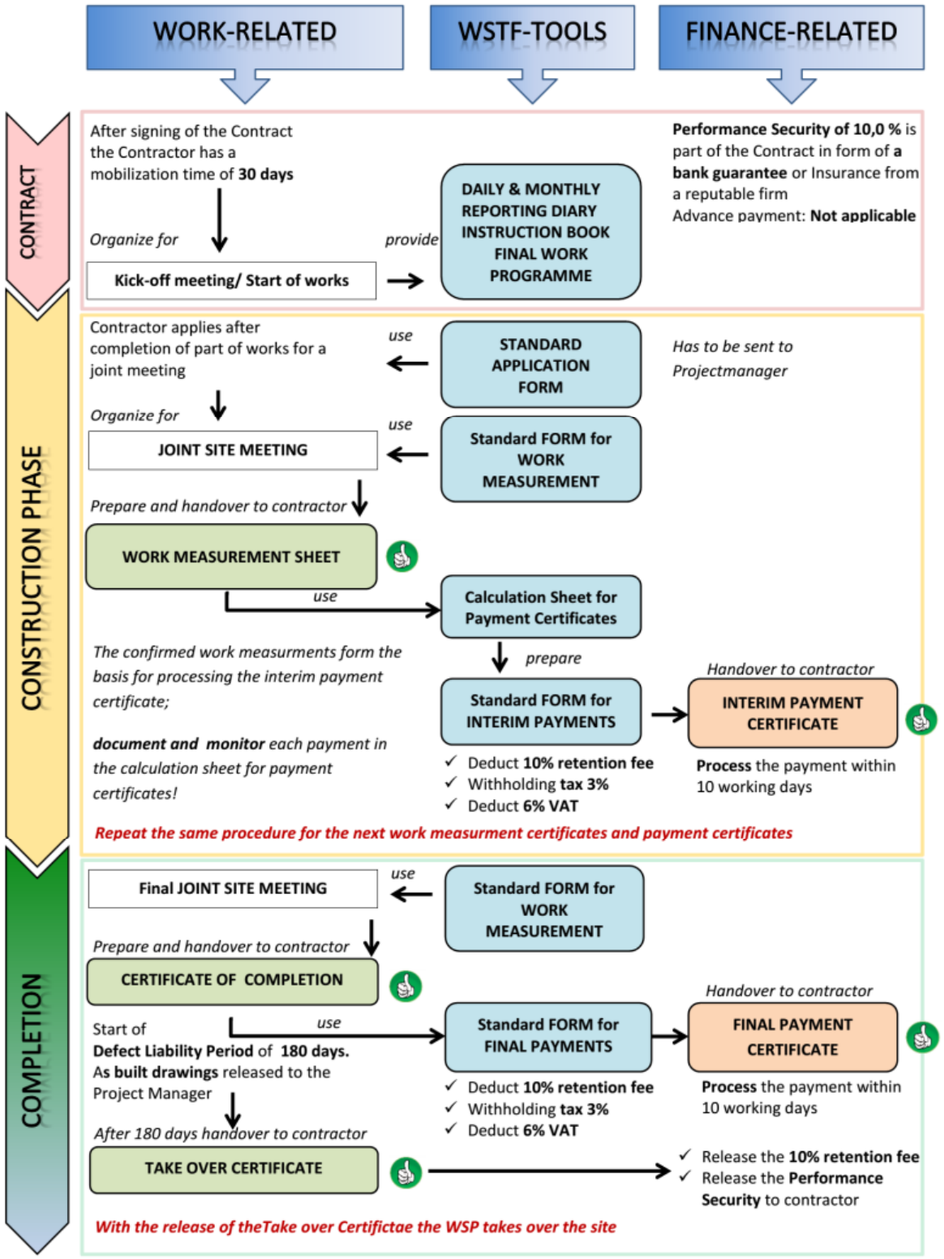
Interim payment certificate I	**40%**
Interim payment certificate II	**30%**
Final payment certificate	**30%**

CONTRACT No. 2

Iterim payment certificate I	**60%**
Final payment certificate	**40%**

Work and finance-related processes

As shown below the Project Manager is responsible for **work and finance related processes** during the entire construction period and should use the standard WSTF-Forms for monitoring the project.



Daily Report Diary

The WSTF standard **Daily Report Diary** is the formal document of "first record", in which the clerk of works (contractor's employee) records any progress and occurrences on site which may have affected the progress and quality of the finished works.

The daily report diary has to be available to any given time at the site.

This document includes:

- The date and weather conditions
- The number of workers in various trades if applicable
- Materials delivered to the site, the quantity, used and retained
- Items of plant on site, working or idling, including reasons for being idle
- Any concreting activity, the location and quantity of the mixes poured
- A brief description of the works completed with the approximate amount used
- Instructions received from the Project Manager with reference to the instruction book

In the site diary the clerk of work is also supposed to record contact details and other items specifically related to the given project for quick referencing.

It is essential that the Site Diary MUST be filled out DAILY and any given time as an important incidence occurs which might affect the progress of works

The **Daily Report Diary** has numbered pages (white) with a serial number and self-carbon duplicates in blue and yellow.

Meetings

The Project Manager has to provide suitable locations (e.g. a board room) for the necessary meetings.

Throughout the project period, site meetings are supposed to be held every week to discuss the progress of the work, methods of construction, procurement, transportation, labours, etc. These meetings can be called at any other time intervals at the request of the Contractor or as directed by the Project Manager.

For documentation a Monthly Report has to be produced by WSP technical team (Technical Service Manager) based on the daily reports provided by the contractor.

DAILY REPORT DIARY

CONSTRUCTION OF DECENTRALISED TREATMENT FACILITY

WSTF - URBAN SANITATION UPSCALING PROGRAMM

Site: *Embu* **Weather:**

Report *1*

Date: *10/21/2015* **A.M** *cold* **Site Conditions** *Rainy & Muddy*

P.M *Hot*

SUPERVISORY STAFF

S/No.	Description	Qty
1	Site Agent	
2	Deputy Site Agent	
3	Administrator	
4	Foreman	
5	Surveyors	
6	Technicians	
7	Plant Manager	
8	Mechanics	
9	Electricians	
10	Storekeeper	
11	Others	
12		
13		
14		
15		
16		
17		
18		
19		
20		

LABOUR

S/No.	Description	Qty
1	Headman	
2	Skilled - Masons	
3	Skilled - Steelfixers	
4	Skilled - Carpenters	
5	Skilled - Plumbers	
6	Skilled - Pipe Tester	
7	Skilled	
8	Unskilled Labourers	
9	Drivers	
10	Operators	
11	Security	
12	Chainmen	
13	Others	
14		
15		
16		
17		
18		
19		
20		

MAIN PLANT & EQUIPMENT

S/No.	Description	Capacity	Qty
1	Dozers		
2	Compactors		
3	Concrete Batch Plant		
4	Concrete Mixers		
5	Lorries		
6	Tippers		
7	Pick-ups		
8	Tractor Trailers		
9	Water Bowsers		
10	Excavators		
11	Compressors		
12	Dumpers		
13	Saloon Vehicle		
14	Survey Equipment (set)		
15	Poker Vibrator		
16	Generator		
17	Water Pumps		
18			
19			
20			

Summary of Works Executed

1. Steel fixing of the roof slab of the anaerobic baffled reactor
2. Casting of the floor slab of settler tank
3. Masonry walling of the strip wall of the balancing tank
4. Plastering and waterproofing of internal walls of receiving bay

Materials Delivered to Site

Material	Qty	Delivery Note	Remarks
Sand	1 tonne		river sand delivered has a lot of fines
Ballast	1 tonne		
Cement	1 tonne		ordinary portland strength 32.5 in good condition

Safety and Security

All personell are in safety gear and security tapes are placed around excavated foundations

	Name	Date	Signature
For and on behalf of contractor:			
For and on behalf of WSP:			

Original: Contractor
Copy: WSP

Engineer's Instruction Form

The WSTF standard **Engineer's Instruction Form** is the formal document for the Project Manager to record any instruction which was given at the site. The instruction Form can be used as the formal basis for variations.

WSTF - URBAN SANITATION UPSCALING PROGRAMM
ENGINEER'S INSTRUCTION FORM

THE CONTRACTOR IS INSTRUCTED TO ACT ON OR CARRY OUT WORKS IN ACCORDANCE WITH THE UNDER NOTED INSTRUCTION

INSTRUCTION:

Signed By:	**Received By:**
Name:	Name:
WSP representative	Contractor's Representative
Date:	Date:

This instruction does/does not constitute variation of the works

Name of WSP.....

in association with the Water Services Trust Fund

JOINT WORK MEASUREMENT SHEET

Contract Title: Contract Number: Contract Start Date:		Employers Name and	
Contractor's Name and Address:		Project Implementation Name and	

Modules: RBBT/ ST/ABR/ VFCW/ SDRB/ CA/ OS:

For Interim/Final Payment Certificate No.: _____; date: _____

Bill Item No.	Description	Unit	Quantity used

Comments (if required attach documentation):

Prepared and checked by Supervisor (WSP)	WSP Approval by (TSM)):	Accepted by Contractor	Accepted by WSTF
Name:	Sign:	Sign:	Sign:
Sign:	Date:	Date:	Date:

Joint Work Measurement

After completion of a specific scope of works – as indicated in the work programme – the Contractor has to apply for a joint work measurement meeting.

During this site meeting the standard **joint work measurement sheet** from WSTF has to be filled jointly and signed by the WSP Supervisor and Project Manager as well as the Contractor.

Material Approval Request Form (MAR)

The contractor is supposed to use the **Material Approval Request Form** for any major concrete works.

CONSTRUCTION OF DECENTRALISED TREATMENT FACILITY FOR WASTE WATER

WSTF - URBAN SANITATION UPSCALING PROGRAMM

APPROVAL FOR COMMENCEMENT OF CONCRETE PLACING

STRUCTURE: .. Anaerobic Baffled Reactor

ELEMENT: .. Top slab

REF. DRAWINGS: Civil Drg: .....

Reinforcement ABR dwg and BBS 003

CONCRETE CLASS: CONCRETE VOLUME 2,9 m³

CHECK ITEMS		Contractor Check	Contractor Date	Inspector / Engineer Check	Inspector / Engineer Date	Remarks
Foundation Preparation	No loose material	√	10/12/2015	√	10/12/2015	
	Clean Surface					
Formwork	Well supported					
	Correct internal dimensions	√		√	10/12/2015	correct dimension 5700mm x 3400mm
	Correct position (Surveyed)					
	Clean and Oiled					
	Joints mortar tight					
Reinforcement	Assembly (No. and spacing)					
	Diameter and Type (Y/R/T)					
	Cover to reinforcement (mm)	√	10/12/2015	√	10/12/2015	spacer blocks of right dimension 25mm
	Cleanliness, no formwork oil					
	Binding and fixtures					
Surface Finish	Control for finished levels					
	Floating equipment on site					
Embedded Item	Correctly positioned					
	Correct number					
	Fixed securely					
Waterproofing	Yes / No					
	Description					
Concrete Placing	Vibrators on site	√	10/12/2015	√	10/12/2015	Present in a working condition
	Placing equipment available					
Concrete Curing	Curing Material Availability					
Any Other Item						

Inspection Request: (Contractor) Signature:_____ Date:_____ Time:_____

Inspection Done: (Inspector) Signature:_____ Date:_____ Time:_____

Follow up Inspection Request: (Contractor) Signature:_____ Date:_____ Time:_____

Follow up Inspection Done: (Inspector) Signature:_____ Date:_____ Time:_____

FINAL APPROVAL: (WSP's Representative) **Signature:**_____ **Date:**_____ **Time:**_____

MATERIAL APPROVAL REQUEST (MAR) FORM

WSTF - URBAN SANITATION UPSCALING PROGRAMM

CONTRACT:

MAR No. 4

To: (Name) WSP Representative;

(Organisation) WSP's Name

Material Description:	Galvanised Iron pipes				
Specification Ref:	SRN 341				
BOQ No. & Item No.:	Bill 3 item no 5,14				
Project Component:	ABR				
Manufacturer/ Supplier	ASP				
Catalogue/ Ref. No.					
Size/ Capacity/ Duty	100mm dia. 2000mm long				
National/international Standard reference	BS.....				
Finish/ Colour	Silver				
Drawing No.	ABR dwg				
ENCLOSURES: (Tick)	Literature ☐	Drawing ☐	Sample ☐	Others ☐	(Sample Ref. No.
	Manufacturing & Delivery Schedules ☐			Testing/Test Certificates ☐	
	Inspection of Manufacturer's Facilities ☐			Witness Testing ☐	
Additional Information/ Notice of Cost Variation if any					

Signed: .....Duncan..... Date: ..... (Authorised Signatory - For Contractor)

APPROVED BY	COMMENTS
For: WSP:	
Signed: .....Date:	

STATUS (Tick):	Approved ☐	Approved as noted ☐	Not approved ☐

Authority	COO	Revised Date	11/5/2010	Revision	1	Page 1 of 1

Concrete Approval

The commencement of Concrete placing has to be approved by the Project Manager or the his respective Supervisor at the site

Variation Order

A variation order form needs to be filled in case there is an alteration from the original design or scope of works in a construction contract. The form is filled by the WSP Technical Service Manager and approved by the WSP Managing Director and the WSTF Engineer.

Name of Contractor: .....

in association with the Water Services Trust Fund

VARIATION ORDER FORM **No**

Contract Title: **Contract Number:** **Contract Start Date:**	
Employers Name and Address:	
Contractor's Name and Address:	
Project Implementation Unit of WSTF **Name and Address:**	

Basis for the confirmation of the variation

Variation Application form fully filled: ☐

Supporting documents attached: ☐ *(e.g. copy of instruction at the site from instruction book)*

Quotation for additional material attached : ☐

Contractor informed Employer in time of the variation: ☐ *(see also Clause 35 "Early warning")*

Breakdown of Works confirmed as a variation to the contract

Description	Unit	Quantity	Rate in Kes	Subtotal in Kes
			Subtotal	
			VAT (16%)	
			Total	

Prepared and checked by TSM	**WSP Approval by Managing Director**	**WSTF Approval by WSTF Engineer**
Sign:	Sign:	Sign:
Date:	Date:	Date:

Notes:

1. The variation order Form has to be prepared by the Technical Services Manager, approved by the Managing Director and respective WSTF Engineer

2. No approval shall be given without a fully filled variation application form and supporting documents. If the variation is based on an instruction given at the site by the responsible supervisor from the WSP, the contractor is supposed to attach a copy of this instruction to the application form.

Payment Certificate

In order to receive the instalment, a payment certificate must be filled by the WSP technical Service Manager to indicate that the agreed specific scope of work has been completed. The certificate is then approved for payment by the WSP Managing Director and the WSTF Engineer.

Name of WSP……			
in association with the Water Services Trust Fund			
INTERIM PAYMENT CERTIFICATE		**No.**	
Contract Title: **Contract Number:** **Contract Start Date**			
Employers **Name and Address:**			
Name and Address:			
Contractor's **Name and Address:**			
Project Implementation Unit of WSTF **Name and Address:**			
Percentage of Payment for this certificate:		**%**	
AMOUNT in KSH			
Total Value of Contract:			
Paid to Date:			
Remaining Contract Balance:			
Percentage of Payment for this certificate:			
Work Executed for this certificate (describe works):			
Other Claims *(must have supporting documents)*:			
Sub-total			
Deduct 10% Retention fee			
Withholding Tax 3%			
Deduct 6% VAT			
NET AMOUNT DUE			
I Certify that the sum of KSH (Kenya Shillings)			
……			
only is due to			
……			
and payable on demand and according to terms of Contract			
Prepared and checked by TSM	**WSP Approval by Managing Director**	**WSTF Approval by WSTF Engineer**	
Sign:	Sign:	Sign:	
Date:	Date:	Date:	

Certificate of Completion

The certificate of completion is used by the contractor to certify that the construction project has been substantially finished and that the required work has been completed. The certificate will be approved by the WSP Project Manager, the Chief Executive Officer County and the Water Service Board. A liability period of 3 months follows the aforementioned approval.

Name of WSP……			
in association with the Water Services Trust Fund			
CERTIFICATE OF COMPLETION OF WORKS			
Contract Title: **Contract Number:** **Contract Start Date:** **Contract Price:**			
Contractor's Name and Address:	*P.O.Box……*		
	……,00……		
	Kenya		
Employers Name and Address:	*……(WSP name)*		
	P.O.Box……		
	……,00……		
	Kenya		
Project Implementation Unit Name and Address:	*……WSP on behalf of the*		
	……Water Services Board		
	P.O. Box ……		
	Nairobi, 00100		
	Kenya		
In accordance with Clause 58.1 of the Conditions of Contract, the Works were inspected and are			
Certified as being Complete on ……			
The Defects Liability Period ends on ……			
Notes:			
1. Final Payment Certificate to be processed immediately.			
2. The Employer takes over the Site as from ……			
3. The contractor is supposed to hand over the as built drawings within the Defects Liability Period			
……	……	……	
Date of Issue:	Name of Project Manager	Chief Executive Officer County	
	Authorised Representative		
	of WSP	……	
	(Project Manager for the Contract)	Water Services Board/ County	