Chapter 8

SYSTEMS

The environmental stage.

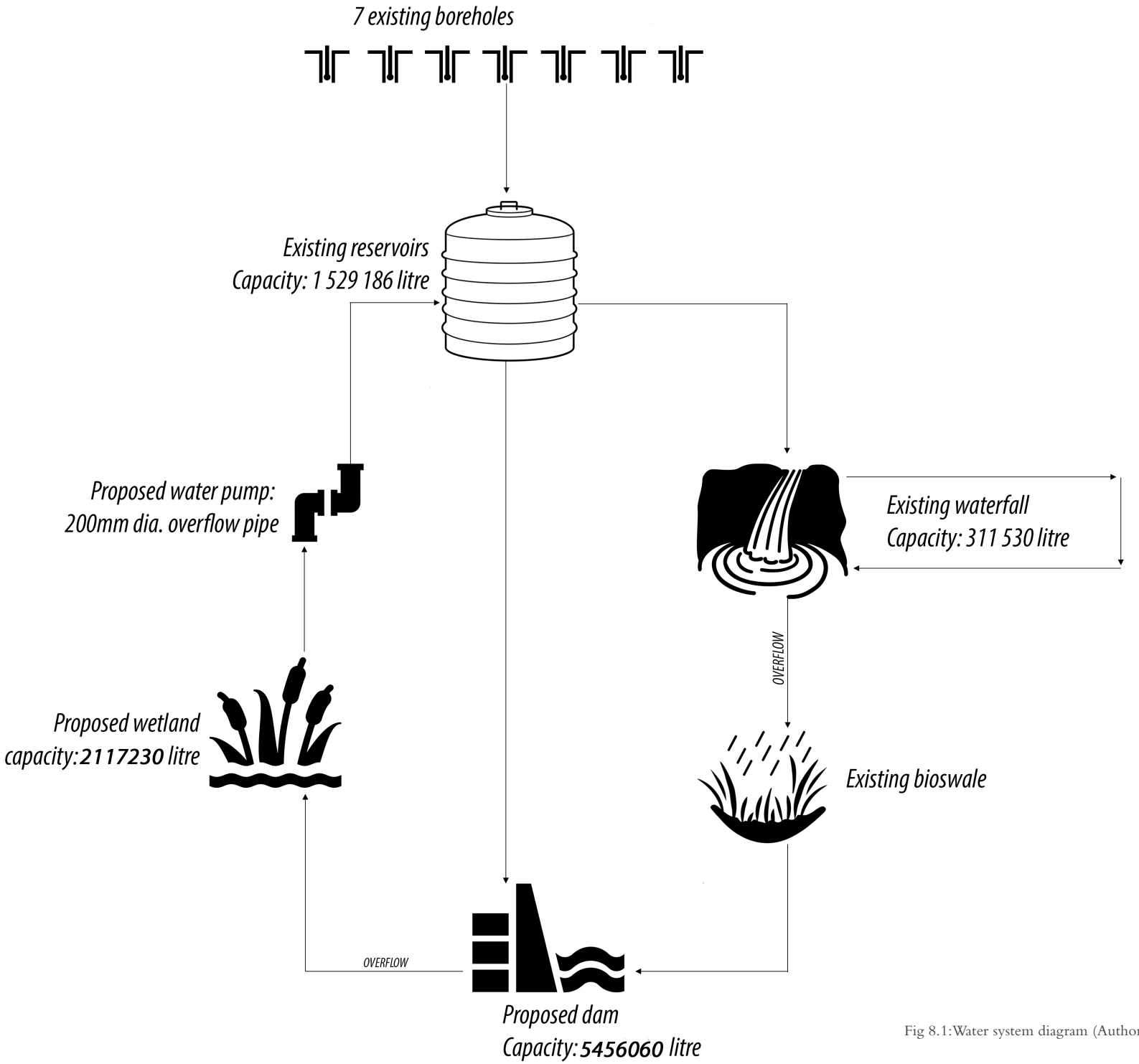

Fig 8.1:Water system diagram (Author 2015)

8.1 Water systems:

The Pretoria NBG has an existing water system that pumps water out of seven boreholes. This is used to keep the waterfall running, irrigation as well as domestic use. My aim in the design is to catch all the water runoff coming from the site and to utilise this for water demand on site. According to the calculations that follows it shows that this is in fact possible, however, the dam and wetland created will be kept full with water coming from the borehole. The reason for this is that water in a botanical garden play a big role within the creation of habitats and influencing microclimate. The usage of the water from the boreholes will eventually get less as system stabilizes over the years.

Water yield into dam:

Area of (Per surface)	Area (m^2)	Run-off Coefficient
Roofing	4 766,80 m^2	0,9
l Landscaping	29 709,20 m^2	0,8
Landscaping :	36 236,75 m^2	0,45
Lawn	75 190,00 m^2	0,2
Grassland	18 062,00 m^2	0,35
e south slope	24 454,50 m^2	0,2
TOTAL:	**188 419,25 m^2**	14,81

8.2 Proposed dam calculations:

The dam will be filled up to start off with and will be kept full with the water coming from the reservoir. The overflow, which is necessary for the dam wall design to be effective, will be seasonal. The yield from site runoff will overflow into the wetland and cause fluctuating water levels in the wetland, however the dam levels will remain effectively full for aesthetical reasons.

MONTH	Precipitation Average Monthly (m)	Roofing **P(m) x A(m^2) x C**	Hard landscaping Yield **P(m) x A(m^2) x C**	Soft landscaping Yield **P(m) x A(m^2) x C**	Lawn Yield **P(m) x A(m^2) x C**	Grassland Yield **P(m) x A(m^2) x C**	Ridge south slope Yield **P(m) x A(m^2) x C**	Total yield
January	0,154	1020, 68 m^3	3660, 17 m^3	2511, 21 m^3	2315, 85 m^3	3704, 52 m^3	753, 2 m^3	264 240 m^3
February	0,102	456, 94 m^3	2424, 27 m^3	1663, 27 m^3	1533, 88 m^3	644, 81 m^3	498, 87 m^3	134 460 m^3
March	0,078	353, 98 m^3	1853, 85 m^3	1271, 91 m^3	1172, 96 m^3	493, 09 m^3	381, 49 m^3	102 920 m^3
April	0,055	255, 31 m^3	1307, 2 m^3	896, 86 m^3	827, 09 m^3	347, 69 m^3	269, m^3	72 680 m^3
May	0,013	75, 12 m^3	308, 98 m^3	211, 98 m^3	195, 49 m^3	82, 18 m^3	63, 58 m^3	17 480 m^3
June	0,007	49, 38 m^3	166, 37 m^3	114, 15 m^3	105, 27 m^3	44, 25 m^3	34, 24 m^3	9 580 m^3
July	0,003	32, 22 m^3	71, 3 m^3	48, 92 m^3	45, 11 m^3	18, 97 m^3	14, 67 m^3	4 340 m^3
August	0,006	45, 09 m^3	142, 6 m^3	97, 84 m^3	90, 23 m^3	37, 93 m^3	29, 35 m^3	8 280 m^3
September	0,022	113, 73 m^3	522, 88 m^3	358, 74 m^3	330, 84 m^3	139, 08 m^3	107, 6 m^3	29 300 m^3
October	0,073	332, 53 m^3	1735, 02 m^3	1190, 38 m^3	1097, 77 m^3	461, 48 m^3	357, 04 m^3	96 340 m^3
November	0,102	456, 94 m^3	2424, 27 m^3	1663, 27 m^3	1533, 88 m^3	644, 81 m^3	498, 87 m^3	134 460 m^3
December	0,125	555, 62 m^3	2970, 92 m^3	2038, 32 m^3	1879, 75 m^3	790, 21 m^3	611, 36 m^3	164 700 m^3
		3747, 54 m^3	**17587, 85 m^3**	**12066, 84 m^3**	**11128, 12 m^3**	**7409, 03 m^3**	**3619, 27 m^3**	**1038 780 m^3**

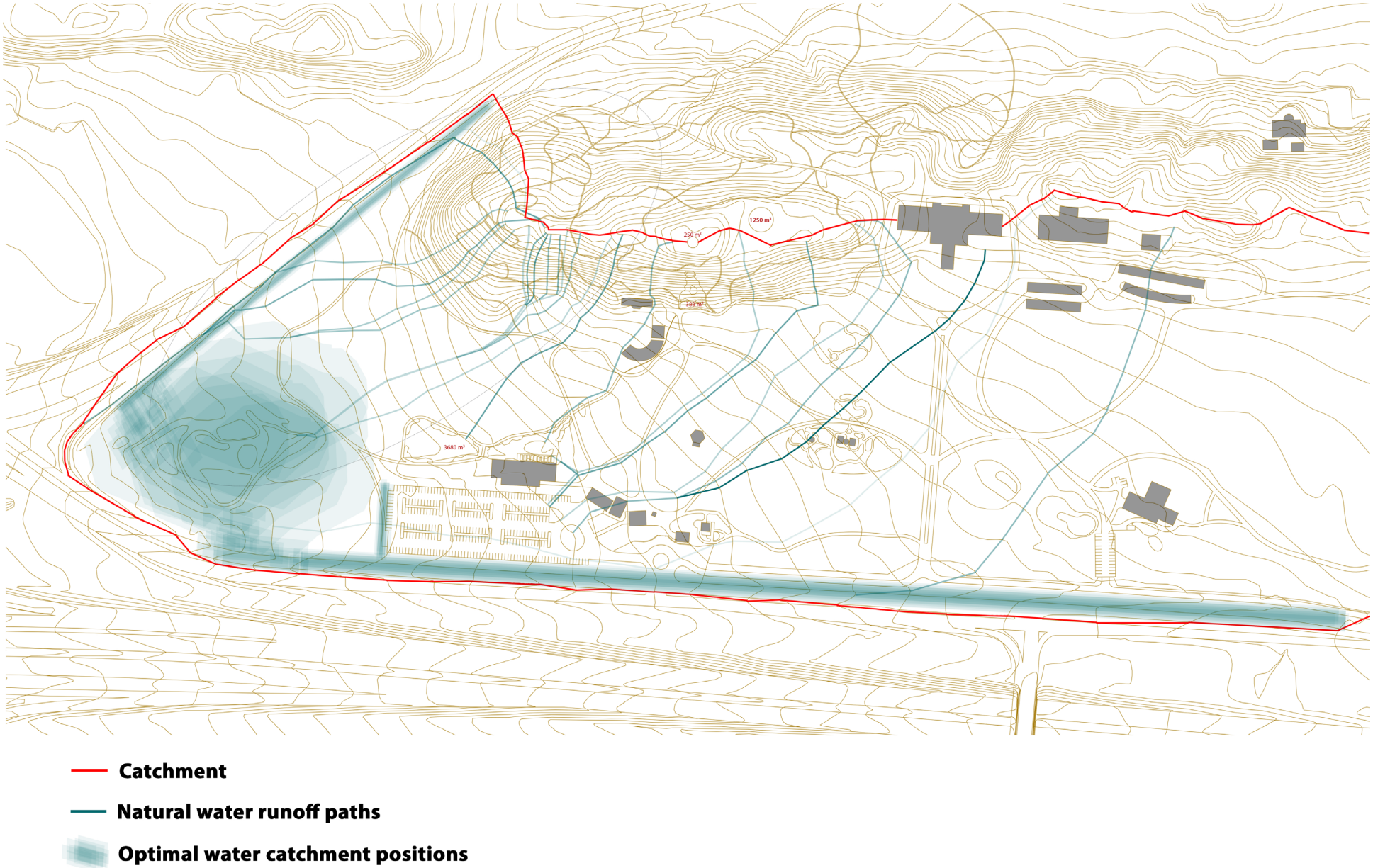

Fig 8.2: Water catchment on site (Author 2015)

Water budget:

MONTH	Dam volume - evaporation = Fluctuating water volume (l)	Volume required to fill up dam (l)	Full dam overflow (l) [YIELD FROM RAIN]	Liters left in resovoir after filling dam	Demand	Liters left after Demand	Evaporation Coefficient	Evaporation cubic meters	Evaporation in liters
January	4865180,00	590880,00	264240,00	938306,00	416,81	937889,19	0,16	590,88	590880,00
February	4939040,00	517020,00	134460,00	1012166,00	387,81	1011778,19	0,14	517,02	517020,00
March	5086760,00	369300,00	102920,00	1159886,00	416,81	1159469,19	0,10	369,30	369300,00
April	5160620,00	295440,00	72680,00	1233746,00	310,81	1233435,19	0,08	295,44	295440,00
May	5234480,00	221580,00	17480,00	1307606,00	217,81	1307388,19	0,06	221,58	221580,00
June	5308340,00	147720,00	9580,00	1381466,00	213,81	1381252,19	0,04	147,72	147720,00
July	5308340,00	147720,00	4340,00	1381466,00	213,81	1381252,19	0,04	147,72	147720,00
August	5160620,00	295440,00	8280,00	1233746,00	217,81	1233528,19	0,08	295,44	295440,00
September	5012900,00	443160,00	29300,00	1086026,00	310,81	1085715,19	0,12	443,16	443160,00
October	4939040,00	517020,00	96340,00	1012166,00	416,81	1011749,19	0,14	517,02	517020,00
November	4939040,00	517020,00	134460,00	1012166,00	406,81	1011759,19	0,14	517,02	517020,00
December	4865180,00	590880,00	164700,00	938306,00	416,81	937889,19	0,16	590,88	590880,00

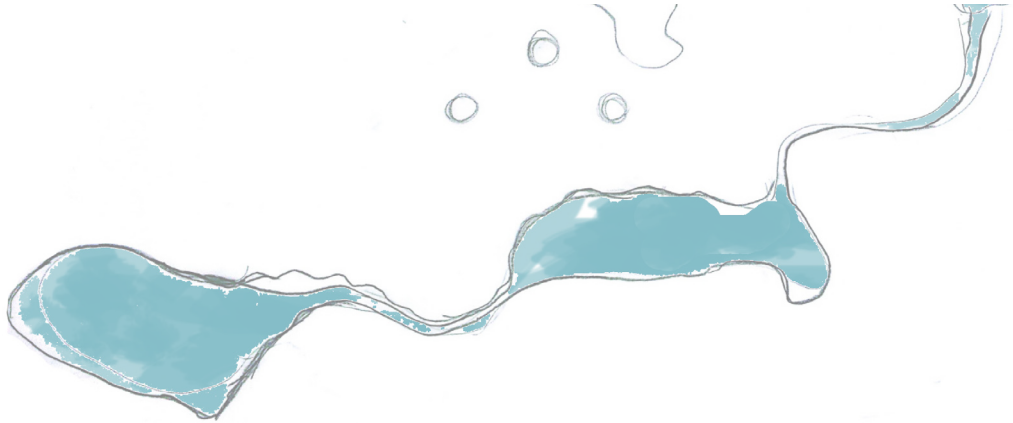

Fig 8.3: Water on site (Author 2015)

Water yield for wetland:

Area of Catchment: (Per surface)	Area (m^2)	Run-off Coefficient
Roofing	4 766,80 m^2	0,9
Hard Landscaping	29 709,20 m^2	0,8
Soft Landscaping :	38 200,25 m^2	0,45
Lawn	37 595,00 m^2	0,2
Grassland	49 960,80 m^2	0,35
Ridge south slope	24 454,50 m^2	0,2
TOTAL:	**184 686,55 m^2**	15,76

Wetland calculations:

Water overflows from the dam into the wetland. The wetland consists of two parts: a constructed wetland and a natural wetland. Since this is a closed system, the capacity for the wetland is taken as one volume. The constructed wetland will be kept full together with the dam, for aesthetical reasons, thus all the yield from rainwater on site will cause fluctuations in the water level of the wetland. This ensures a natural wetland process occurrence, supporting plant growth as well.

MONTH	Precipitation Average Monthly (m)	Roofing Yield P(m) x A(m^2) x C	Hard landscaping Yield P(m) x A(m^2) x C	Soft landscaping Yield P(m) x A(m^2) x C	Lawn Yield P(m) x A(m^2) x C	Grassland Yield P(m) x A(m^2) x C	Rige south slope Yield P(m) x A(m^2) x C	Total yield
January	0,154	1020, 68 m^3	3660, 17 m^3	2647, 28 m^3	1157, 93 m^3	10246, 96 m^3	753, 2 m^3	91160, m^3
February	0,102	456, 94 m^3	2424, 27 m^3	1753, 39 m^3	766, 94 m^3	1783, 6 m^3	498, 87 m^3	60380, m^3
March	0,078	353, 98 m^3	1853, 85 m^3	1340, 83 m^3	586, 48 m^3	1363, 93 m^3	381, 49 m^3	46180, m^3
April	0,055	255, 31 m^3	1307, 2 m^3	945, 46 m^3	413, 55 m^3	961, 75 m^3	269, m^3	32560, m^3
May	0,013	75, 12 m^3	308, 98 m^3	223, 47 m^3	97, 75 m^3	227, 32 m^3	63, 58 m^3	7700, m^3
June	0,007	49, 38 m^3	166, 37 m^3	120, 33 m^3	52, 63 m^3	122, 4 m^3	34, 24 m^3	4140, m^3
July	0,003	32, 22 m^3	71, 3 m^3	51, 57 m^3	22, 56 m^3	52, 46 m^3	14, 67 m^3	1780, m^3
August	0,006	45, 09 m^3	142, 6 m^3	103, 14 m^3	45, 11 m^3	104, 92 m^3	29, 35 m^3	3560, m^3
September	0,022	113, 73 m^3	522, 88 m^3	378, 18 m^3	165, 42 m^3	384, 7 m^3	107, 6 m^3	13020, m^3
October	0,073	332, 53 m^3	1735, 02 m^3	1254, 88 m^3	548, 89 m^3	1276, 5 m^3	357, 04 m^3	43220, m^3
November	0,102	456, 94 m^3	2424, 27 m^3	1753, 39 m^3	766, 94 m^3	1783, 6 m^3	498, 87 m^3	60380, m^3
December	0,125	555, 62 m^3	2970, 92 m^3	2148, 76 m^3	939, 88 m^3	2185, 79 m^3	611, 36 m^3	74000, m^3
PER ANNUM		**3747, 54 m^3**	**17587, 85 m^3**	**12720, 68 m^3**	**5564, 06 m^3**	**20493, 92 m^3**	**3619, 27 m^3**	**438080, m^3**

Water Budget:

MONTH	Dam volume - evaporation = Fluctuating water volume (l)	Volume required to fill up dam (l)	Reservoir liters left after fillig big damn and using demand	Water left in reservoir after filling small dam	RAIN YIELD [FOR SMALL DAMN]	Total water from overflow from big damn	Total water saved from using YIELD WATER	Water fluctuation over small damn (FULL WETLAND) from YIELD
January	1778473,20	338756,80	937889,19	599132,39	91160,00	264240,00	355400,00	0,07
February	1820817,80	296412,20	1011778,19	715365,99	60380,00	134460,00	194840,00	0,04
March	1905507,00	211723,00	1159469,19	947746,19	46180,00	102920,00	149100,00	0,03
April	1947851,60	169378,40	1233435,19	1064056,79	32560,00	72680,00	105240,00	0,02
May	1990196,20	127033,80	1307388,19	1180354,39	7700,00	17480,00	25180,00	0,01
June	2032540,80	84689,20	1381252,19	1296562,99	4140,00	9580,00	13720,00	0,00
July	2032540,80	84689,20	1381252,19	1296562,99	1780,00	4340,00	6120,00	0,00
August	1947851,60	169378,40	1233528,19	1064149,79	3560,00	8280,00	11840,00	0,00
September	1863162,40	254067,60	1085715,19	831647,59	13020,00	29300,00	42320,00	0,01
October	1820817,80	296412,20	1011749,19	715336,99	43220,00	96340,00	139560,00	0,03
November	1820817,80	296412,20	1011759,19	715346,99	60380,00	134460,00	194840,00	0,04
December	1778473,20	338756,80	937889,19	599132,39	74000,00	164700,00	238700,00	0,05

EVAPORATION		
Evaporation constant	Evaporation (square meters)	Evaporation (Liters)
0,16	338,76	338756,80
0,14	296,41	296412,20
0,10	211,72	211723,00
0,08	169,38	169378,40
0,06	127,03	127033,80
0,04	84,69	84689,20
0,04	84,69	84689,20
0,08	169,38	169378,40
0,12	254,07	254067,60
0,14	296,41	296412,20
0,14	296,41	296412,20
0,16	338,76	338756,80

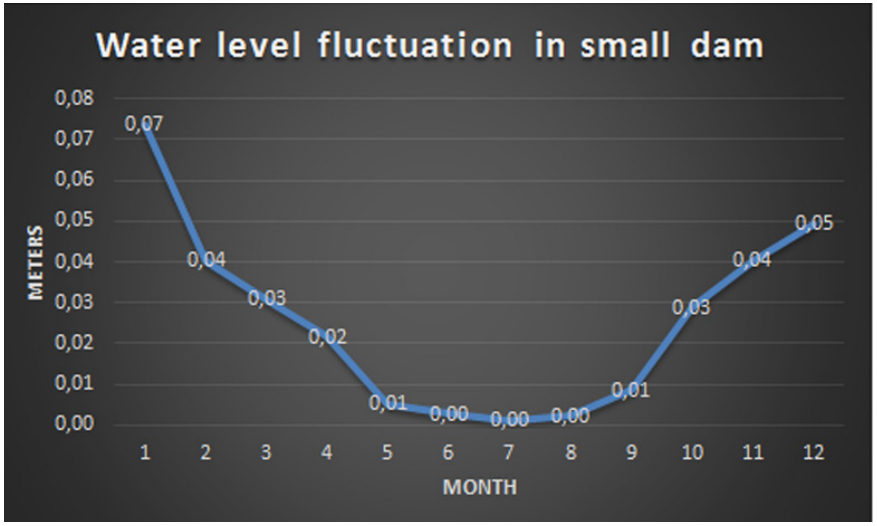

Fig 8.4: Water fluctuation graph(Author 2015)

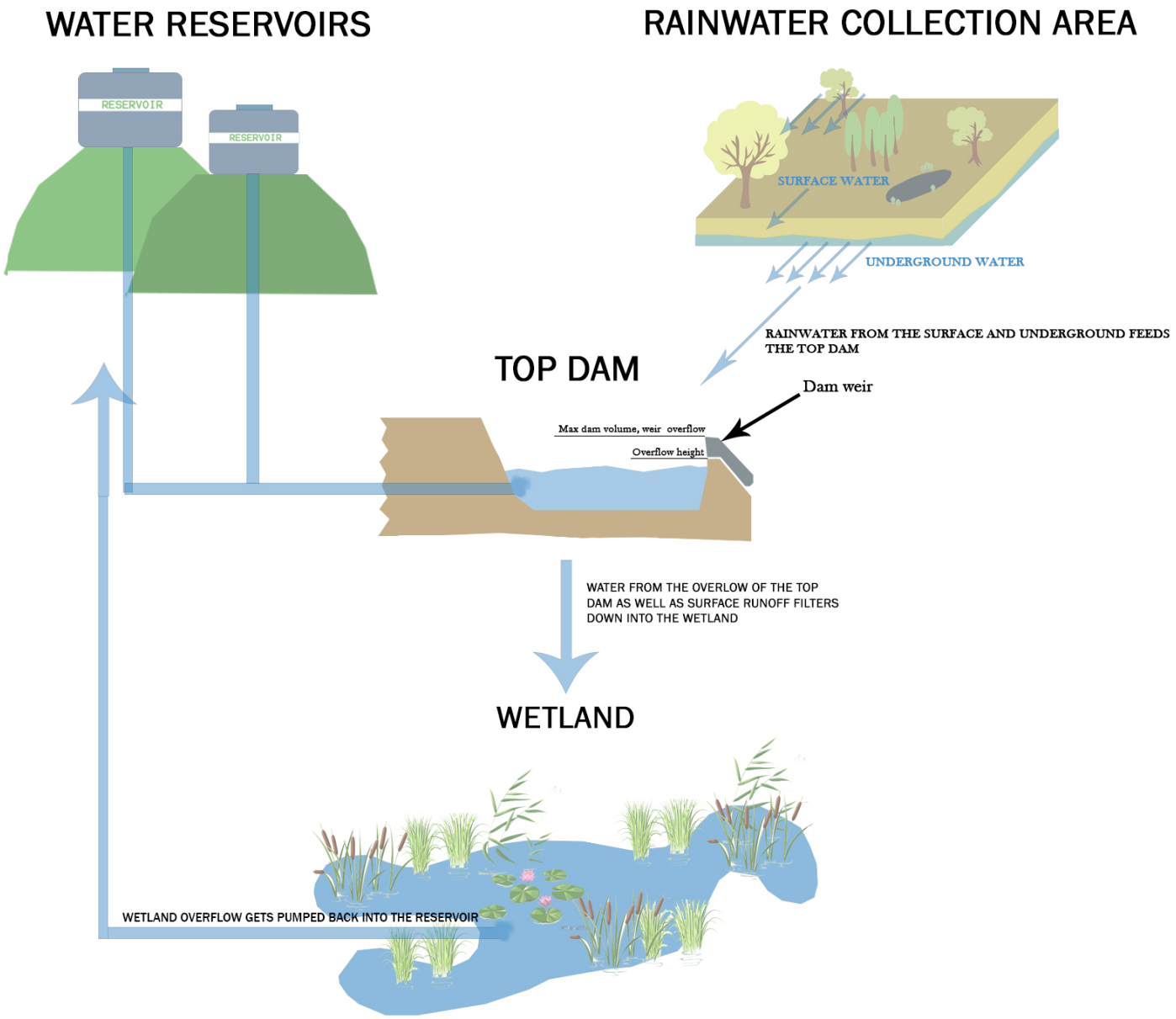

Fig 8.5: Water flow diagram (Author 2015)