



HYDROGOLD PTY LTD
104 Second Ave
Mount Lawley
Perth, W.A.
Australia 6050

Web Site: www.hydrogold.com
Email: admin@hydrogold.com
Tel (+61 8) 6262 8127

HYDROGOLD'S WATER BALANCE STUDY MATHEMATICAL MODELLING SOFTWARE

**THE SIMPLE APPROACH
APPLICATIONS
UNDERSTANDING THE OUTPUT
METHODOLOGY OF THE MODEL**

HYDROGOLD PTY LTD
www.hydrogold.com

Date: 18 September 2009

CONTENTS

1	WATER BALANCE STUDY - THE SIMPLE APPROACH	1
2	APPLICATIONS	2
3	UNDERSTANDING THE GRAPHS	4
4	THE WATER BALANCE MODEL	12

1 WATER BALANCE STUDY - THE SIMPLE APPROACH

There is a quick, simple and cheap approach...

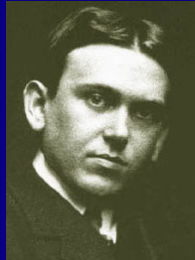
- 💧 We know the Peak Irrigation demand. An easy calculation.
- 💧 We have a look at the climate and decide we need 60 days of storage.
- 💧 This gives us the volume that we need to store.
- 💧 Set the maximum allowable drawdown on the lake
- 💧 This gives a required lake area.

Simple..

Description	Unit	Quantity	Comment
Peak Irrigation Demand	m ³ /day	2,500	Calculated based on Area of Coverage and Peak Application.
	US Gallons	661,376	
Required Days of Storage	No	60	Your guess is as good as mine.
Required Storage Volume	m ³	150,000	
	acre-feet	122	
Maximum Allowable Drawdown on Irrigation Lake	m	1.00	Typical desired Drawdown
	ft	3.28	
Required Lake Area	m ²	150,000	
	Ha	15.0	
	Acre	37.1	

Simple! Maybe a bit too simple?

- 💧 How do we determine the "Required Days of Storage?". This estimate is made based on gut feeling, not an objective calculated number.
- 💧 How do you know the lake will be full at the start of a dry period? In fact, it normally is not full. What happens if there are two dry periods a short time apart? What happens when there is rain but not much? What happens in a dry year?
- 💧 Drawdown on the lake (from the level when full) is a critical factor since it is (normally) so important to the aesthetics (look) of the golf course. A 1 m drawdown with a typical lake embankment (1 vertical to 4 horizontal) exposes 4 m of muddy embankment. So having a deep lake does not help with the storage volume if you are restricted on the maximum drawdown.
- 💧 The lake area determined by this method can only be taken as an indication. Is valuable real estate area being wasted on the lake? Will there be enough water to even fill the lake? Will there be enough water for the turf?
- 💧 What about lake evaporation, seepage via the lake floor, water collection via the drainage system, implementing a water conserving strategy, etc?

Henry Louis Mencken (1880-1956) - "The Sage of Baltimore"	
	For every complex problem, there is a solution that is simple, neat, and wrong.

A more thorough approach is needed to protect the investment in the golf course.

2 APPLICATIONS

The power of Hydrogold's mathematical modelling software combined with our wealth of experience (over 240 golf courses in 24 countries over 22 years) makes Hydrogold the ideal choice to carry out this important work. *The financial and environmental viability of many projects rests on a proper assessment of water balance issues.*

2.1 About the Model - ACTUAL APPLICATIONS

Hydrogold's mathematical modelling software has been used and tested since 1992 on many projects in many countries (refer to our web site www.hydrogold.com for details).

Our model combines daily (not monthly) climate data with mathematically precise software. The result is a model that accurately emulates the real-life, day-to-day operation of a golf course or resort. The software has been used for many purposes including:

- To determine the optimum lake (storage) size (to ensure sufficient storage but not unnecessarily taking up value real estate).
- Assessing the viability of a golf course in a fragile environment. Eg, Ensuring the sustainability of coastal aquifers.
- Assessing options. Eg. Cost of lining lakes versus cost of purchasing extra water. Or the cost of alternative water sources.
- Designing efficient lake storage and transfer pump systems over different watersheds (catchment areas) to reduce the cost of pumping.
- Balancing water demands between competing entities in a fair and reasonable outcome for all.
- Determining environmental flows in and out of the site.

2.2 DIFFERENT PATHS

With a Water Balance Study there are 2 paths to follow:

✓ A PROPER ANALYSIS

Our proposal provides analysis of different climate and water balance scenarios. Accurate analysis saves you the high cost of over-protection while giving you the satisfaction of knowing that sufficient provision has been made.

✗ TRIAL AND ERROR

The alternative is to take a risk or make excessive (and expensive) provisions to avoid it.

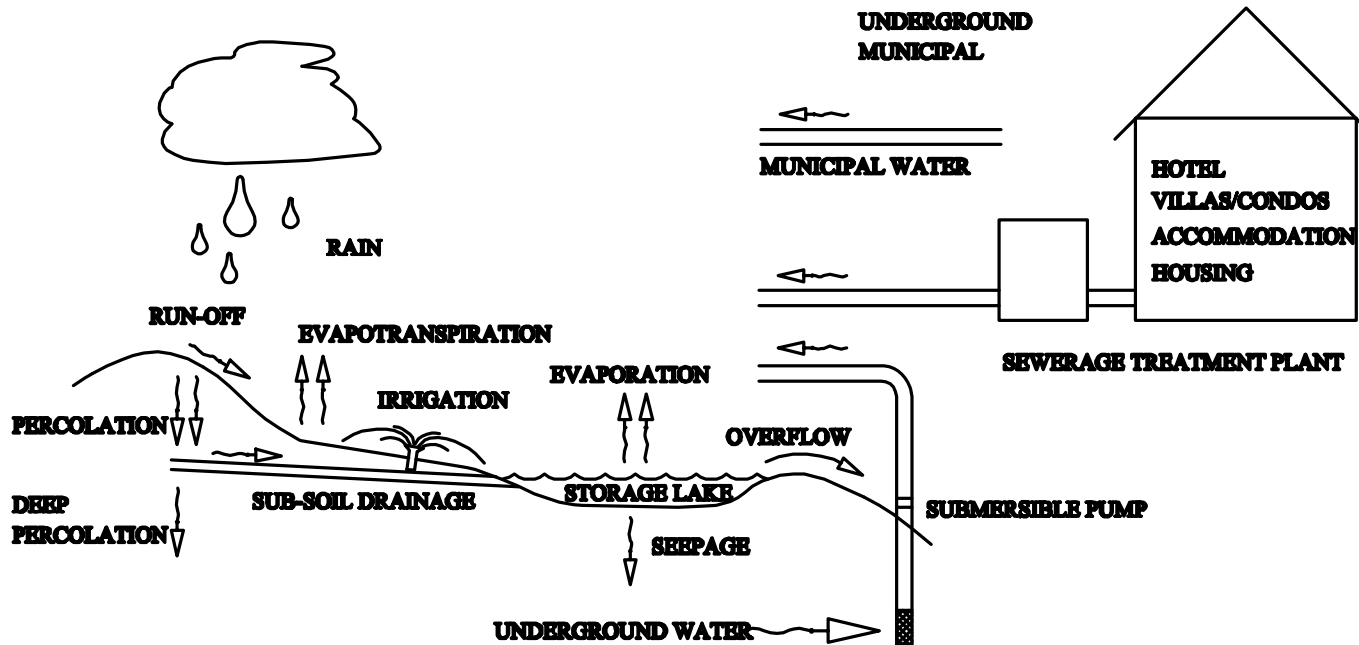
Hydrogold's software allows us to test many scenarios using a mathematical model. It is quicker and cheaper to test mathematical models than to run real life experiments on your projects.

The cost of the study could be saved (perhaps many times over) in the excavation of 1 lake or the sale or 1 more block of real estate. Have the comfort of mind knowing that you have made the correct provisions for water storage and supply.

2.3 A diagram of our model follows:

THE WATER BALANCE EQUATION

Δ STORAGE -	INFLOW -	OUTFLOW
LAKES	RAINFALL	PERCOLATION
TANKS	S.S. DRAINAGE	EVAPORATION
	TRANSFER PUMPS	SEEPAGE
	MAIN DRAINS	EVAPOTRANSPIRATION
	CREEK/RIVERS	IRRIGATION
	EFFLUENT	OVERFLOW
	UNDERGROUND	
	MUNICIPAL	



WWW.HYDROGOLD.COM

COPYRIGHT (C) 2008
HYDROGOLD PTY LTD

NOT TO SCALE

FILE: SK_MISC

DRAWING No 441-A4

WATER BALANCE MODEL:
THE EQUATION

3 UNDERSTANDING THE GRAPHS

There are 2 basic graphs output. They reflect the most important parameters during the design or master planning stage:

- The levels of the lakes
- The condition of the plant material.

LAKE LEVELS

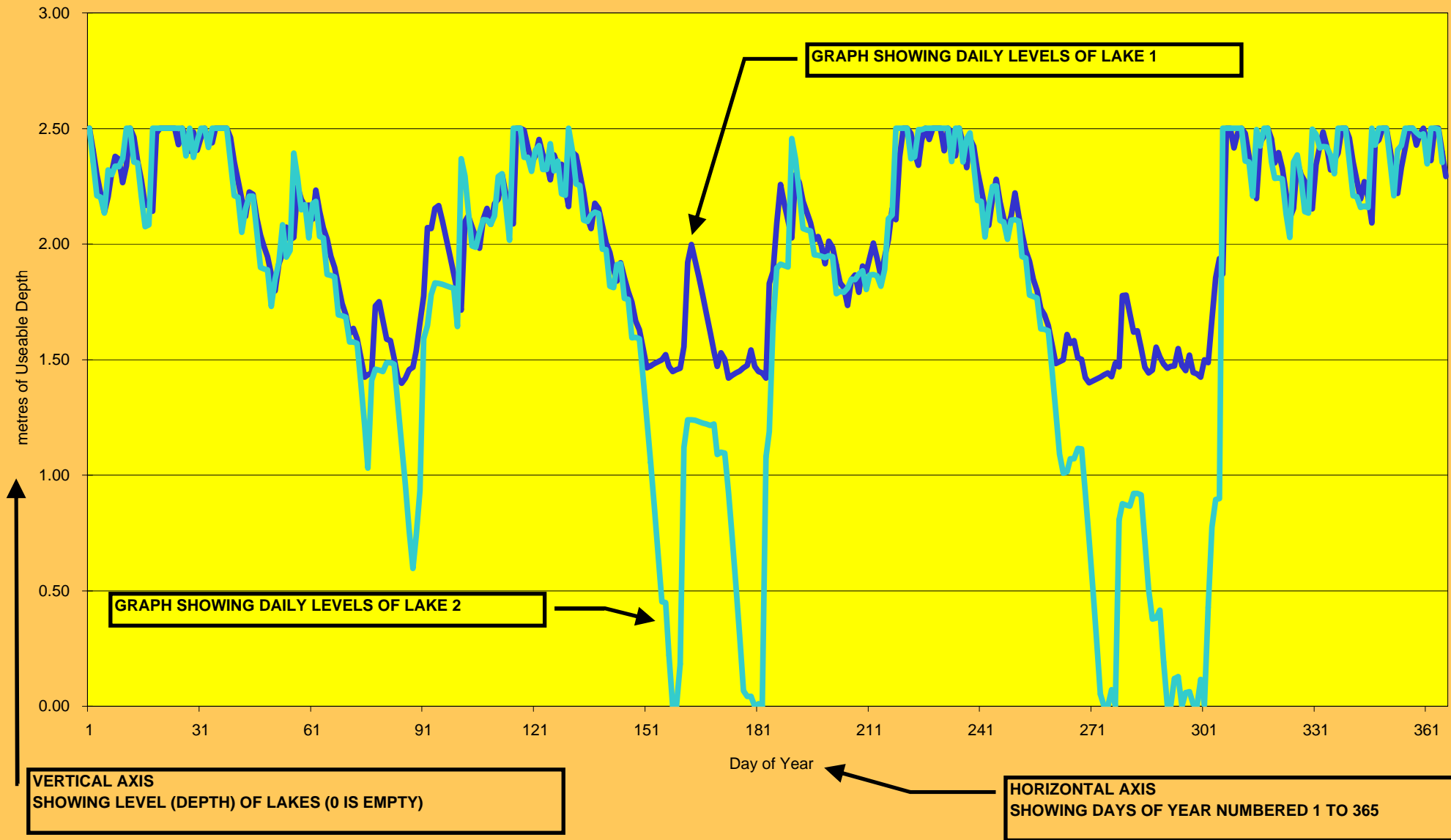
No 1 - TYPICAL YEAR

DESCRIPTION OF SCENARIO

SUPPLEMENTARY WATER = 224,000 cu m

ADDITIONAL WATER REQUIRED TO SUPPLEMENT RAINFALL

- Lake 1
- Lake 2



3.1 Graph of Lake Levels

This shows how each lake level varies in a yearly cycle, but on a daily basis. Observations here include:

3.1.1 The Amount of Drawdown

Drawdown is the distance from the high water level to the current water level. This is both aesthetic and functional:

- a) If there is a drawdown of 1 metre and the slope of the lake embankment is 1 in 4, then there will be approximately 4 metres of exposed bank. Depending on the location of the lake, this could be unsightly.
- b) If the useable depth of the lake falls to zero, then no water will be available for irrigation. This normally indicates a failure of the system.

3.1.2 The Ability of the Lakes to be Re-Charged:

- a) At some point during the yearly cycle (typically the wet season), the lakes should reach the maximum depth of water (zero drawdown).
- b) Failure to reach the maximum depth of water (zero drawdown) could be interpreted as there being insufficient water to meet demands or that the lake surface area is too large (eg, storage volume too large for the catchment area).
- c) If the maximum depth of water is maintained throughout long periods, then this may indicate an abundance of water or possibly insufficient lake area. Normally there will be also significant overflow from the lake.

No 1 - TYPICAL YEAR

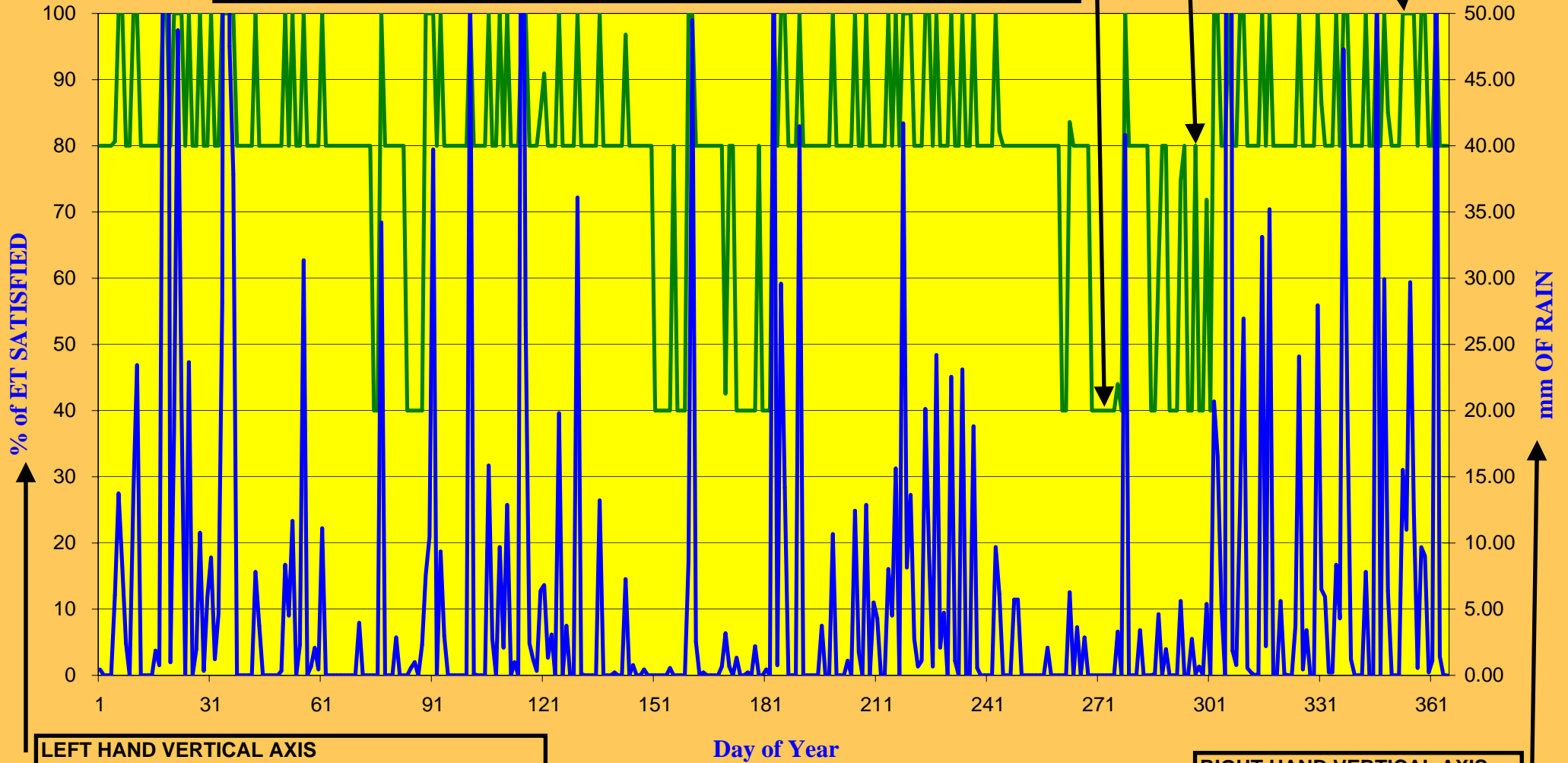
DESCRIPTION OF SCENARIO

NO IRRIGATION - 100% OF E.T. BEING MET BY RAINFALL - TURF IN GOOD CONDITION

NORMAL IRRIGATION - 80% OF E.T. BEING MET BY IRRIGATION - TURF IN GOOD CONDITION

WATER CONSERVING STRATEGY - 40% OF E.T. BEING MET BY IRRIGATION - TURF IN POOR CONDITION

— % E.T. Satisfied
— Rain Fall



LEFT HAND VERTICAL AXIS
SHOWING PERCENTAGE OF
EVAPOTRANSPIRATION SATISFIED

RIGHT HAND VERTICAL AXIS
SHOWING DAILY RAINFALL

3.2 GRAPH OF PLANT CONDITION AND RAINFALL

This graph reflects the condition of the plant material and correlates it with the natural rainfall. The "spikey" nature reflects the reality of daily rainfall variations.

3.2.1 Evapotranspiration (ET)

- a) Water is 'consumed' by evaporation (direct from the surface to the atmosphere) or transpiration (via the plant to the atmosphere). The combined effect is termed 'Evapotranspiration' (ET). There is a base ET that is then multiplied by a crop factor to give the ET for a particular type of plant.
- b) ET represents the water losses that should be replaced. ie. If there is an ET of 6 mm and no rainfall, then the irrigation system should (ideally) apply 6 mm of water over the irrigated area.
- c) Optimal growth is achieved by replacing 80% of ET.
- d) However, in times where there is restricted water availability, we may replace (for example) only 50% of ET.

3.2.2 Plant Health

As the amount of water replacement falls below 80% of ET, the plant condition deteriorates:

- a) The plant loses turgidity (rigidity). As the amount of water held in its cells reduces, cell walls begin to collapse. This leads to the unhealthy appearance of the plant wilting.
- b) The plant loses its colour (becomes dull). The greens become yellows.
- c) The ability of the plant to regenerate diminishes. Plant growth is directly related to transpiration. Eg. Turf in high wear areas (such as golf tees, high traffic areas) will take longer to repair.
- d) Ultimately the plant dies.

3.2.3 Rainfall

The rainfall is (by nature) a 'spikey' graph. The graph is provided to correlate the rainfall with plant condition and also the lake levels.

3.3 Numerical Output

The statistical output from the software can be varied to suit requirements. A sample follows:

DESCRIPTION	UNITS	HU0	SITE TOTAL	HU1	HU2	HU3
PROJECT		WARREN GOLF & COUNTRY CLUB				
SCENARIO		No 1 - TYPICAL YEAR				
COMMENT		SUPPLEMENTARY WATER = 224,000 cu m				
DATE & TIME		17-Nov-06 16:15:02				

INFLOWS

=====

Type of Year		TYPICAL				
Rainfall	mm/yr	2,571				
CATCHMENT						
Area	sq m	463,268	291,779	134,682	36,807	
	Ha	46.3	29.2	13.5	3.7	
	acres	18.8	11.8	5.5	1.5	
	%	100%	63%	29%	8%	
SUBSURFACE DRAINAGE						
Area	sq m	150,000	102,628	47,372	0	
	Ha	15.0	10.3	4.7	0.0	
	acres	6.1	4.2	1.9	0.0	
Coefficient	ratio		0.30	0.30	0.30	
EFFLUENT						
Discharge	cu m/day	0	0	0	0	
	US Gal/day	0	0	0	0	
SUPPLEMENTARY WATER						
Inflow	cu m/day	1,000	1,000	0	0	
	US Gal/day	264,550	264,550	0	0	
Drawdown to Activate	m		0.3	0.6	0.9	
	ft		1.0	2.0	3.0	
OVERFLOW INTO HU						
From HU	No	1	3			
From HU	No	2				
From HU	No					
From HU	No					
From HU	No					
From HU	No					
From HU	No					
From HU	No					
From HU	No					
STREAMS INTO HU						
Flow	cu m/day	0	0	0	0	
	US Gal/day	0	0	0	0	
TRANSFER IN						
From HU	No		2	0	0	
Desired Drawdown	m		1.0	0.0	0.0	
	ft		3.3	0.0	0.0	
Volume	cu m/day		750	0	0	
	US Gal/day		198,413	0	0	

DESCRIPTION	UNITS	HU0	SITE TOTAL	HU1	HU2	HU3
PROJECT						
SCENARIO						
COMMENT						
DATE & TIME						

WARREN GOLF & COUNTRY CLUB
No 1 - TYPICAL YEAR
SUPPLEMENTARY WATER = 224,000 cu m
17-Nov-06 16:15:02

OUTFLOWS

=====

PERCOLATION

Coefficient	ratio			0.50	0.50	0.10
-------------	-------	--	--	------	------	------

EVAPORATION

Rate	mm/day			4.50	4.50	4.50
	in/day			0.18	0.18	0.18

SEEPAGE

Darcy's Permeability Coefficient	cm/sec			1.16E-06	1.16E-06	1.16E-06
Seepage/day with 1m water	mm/day			3.00	3.00	3.00
	in/day			0.118	0.118	0.118
Liner Thickness	mm			500	500	500
	in			19.69	19.69	19.69

TRANSFER OUT

To HU	No			0	1	0
-------	----	--	--	---	---	---

IRRIGATION - AREA 1

Normal Application (80% of ET)	mm/day			6.00	6.00	6.00
	in/day			0.24	0.24	0.24
Normal Volume	cu m/day	2,844		2,844	0	0
	US Gal	752249		752,249	0	0
Minimum Application	mm/day			3.00	3.00	3.00
	in/day			0.12	0.12	0.12
Minimum Volume	cu m/day	1,422		1,422	0	0
	US Gal	376124		376,124	0	0

IRRIGATION - AREA 2

Normal Application (80% of ET)	mm/day			6.00	6.00	6.00
	in/day			0.24	0.24	0.24
Normal Volume	cu m/day	0		0	0	0
	US Gal	0		0	0	0
Minimum Application	mm/day			3.00	3.00	3.00
	in/day			0.12	0.12	0.12
Minimum Volume	cu m/day	0		0	0	0
	US Gal	0		0	0	0

IRRIGATION TOTALS

Normal Volume	cu m/day	2,844		2,844	0	0
	US Gal/Day	752,249		752,249	0	0
Minimum Volume	cu m/day	1,422		1,422	0	0
	US Gal/Day	376,124		376,124	0	0
Drawdown for Min Applic.	m			1.0	1.0	1.0
	ft			3.3	3.3	3.3

DESCRIPTION	UNITS	HU0	SITE TOTAL	HU1	HU2	HU3
PROJECT						
SCENARIO						
COMMENT						
DATE & TIME						

WARREN GOLF & COUNTRY CLUB
No 1 - TYPICAL YEAR
SUPPLEMENTARY WATER = 224,000 cu m
17-Nov-06 16:15:02

STORAGE

=====						
Surface area	sq m		34,637	29,147	5,490	0
	Ha		3.5	2.9	0.5	0.0
	acres		1.4	1.2	0.2	0.0
	%		100%	84%	16%	0%
Perimeter	m		0	1,842	342	0
	ft			6,043	1,122	0
Useable Depth	m			2.5	2.5	2.5
	ft			8.2	8.2	8.2
Slope 1:	ratio			3.0	3.0	3.0
Initial Drawdown	m			0.0	0.0	0.0
	ft			0.0	0.0	0.0
Maximum Volume	cu m		66,559	55,746	10,666	147
	US Gal		17,608,277	14,747,622	2,821,696	38,958
Catchment/Lake Area	ratio		13.4	10.0	24.5	N/A

SUMMARY FOR THE YEAR

=====						
Storage at Year Begin.			66,559	55,746	10,666	147
INFLOWS (Totals)	cu m		1,667,934	1,208,689	364,611	94,635
CATCHMENT	cu m		1,191,113	750,196	346,282	94,635
SUBSURFACE DRAINAGE	cu m		58,056	39,727	18,329	0
EFFLUENT	cu m		0	0	0	0
SUPPLEMENTARY WATER	cu m		224,000	224,000	0	0
OVERFLOW INTO HU	cu m	271,710	85,171	85,171	0	0
STREAMS INTO HU	cu m		0	0	0	0
TRANSFER IN	cu m		109,594	109,594	0	0
OUTFLOWS (Totals)	cu m		1,674,785	1,214,624	365,526	94,635
PERCOLATION	cu m		516,595	340,148	166,983	9,463
EVAPORATION	cu m		51,346	43,605	7,742	0
SEEPAGE	cu m		11,457	9,730	1,727	0
TRANSFER OUT	cu m		110,344	0	110,344	0
IRRIGATION - AREA 1	cu m		628,162	628,162	0	0
IRRIGATION - AREA 2	cu m		0	0	0	0
OVERFLOW FROM HU	cu m		356,881	192,980	78,730	85,171
Net Loss/Gain	cu m		(6,850)	(5,935)	(915)	0
Storage at Year End	cu m		59,824	49,811	9,866	147

%ET SATISFIED ANALYSIS

=====			
IRRIGATION - AREA 1			
<40% - No Irrigation or Rain	days/yr		0
40% - Conserving	days/yr		46
80% - Irrigation	days/yr		232
>80% - Rain	days/yr		87
IRRIGATION - AREA 2			
<40% - No Irrigation or Rain	days/yr		365
40% - Conserving	days/yr		0
80% - Irrigation	days/yr		0
>80% - Rain	days/yr		0

4 THE WATER BALANCE MODEL

Hydrogold's water balance model mathematically simulates the water flows and storage on a site. This is calculated on a daily basis for accuracy. The result is:

- Realistic graphs of water level and plant health over a year long cycle reflecting the real-life day to day variations.
- Access to a variety of water related statistics including:
 - Water Used For Irrigation
 - Overflow Of Water From The Site
 - Water Losses Through Lake Seepage

4.1 Organization of the Model

The model represents a closed system consisting of at least 2 hydrologic units

4.1.1 Hydrologic Units (HUs)

- a) A geographic area representing part or all of a surface drainage basin or distinct hydrologic feature.
- b) Water may flow into, out of or be stored within the HU.

4.1.2 Inflow And Outflow

Since our model is a closed system:

- a) The inflow into a zone is a result of an equal outflow from another HU.
- b) The net flow between all HUs is zero.
- c) The inflow into a zone is a result of an equal outflow from another HU.
- d) Inflows and outflows are relative to the HU being considered.

4.1.3 Storage

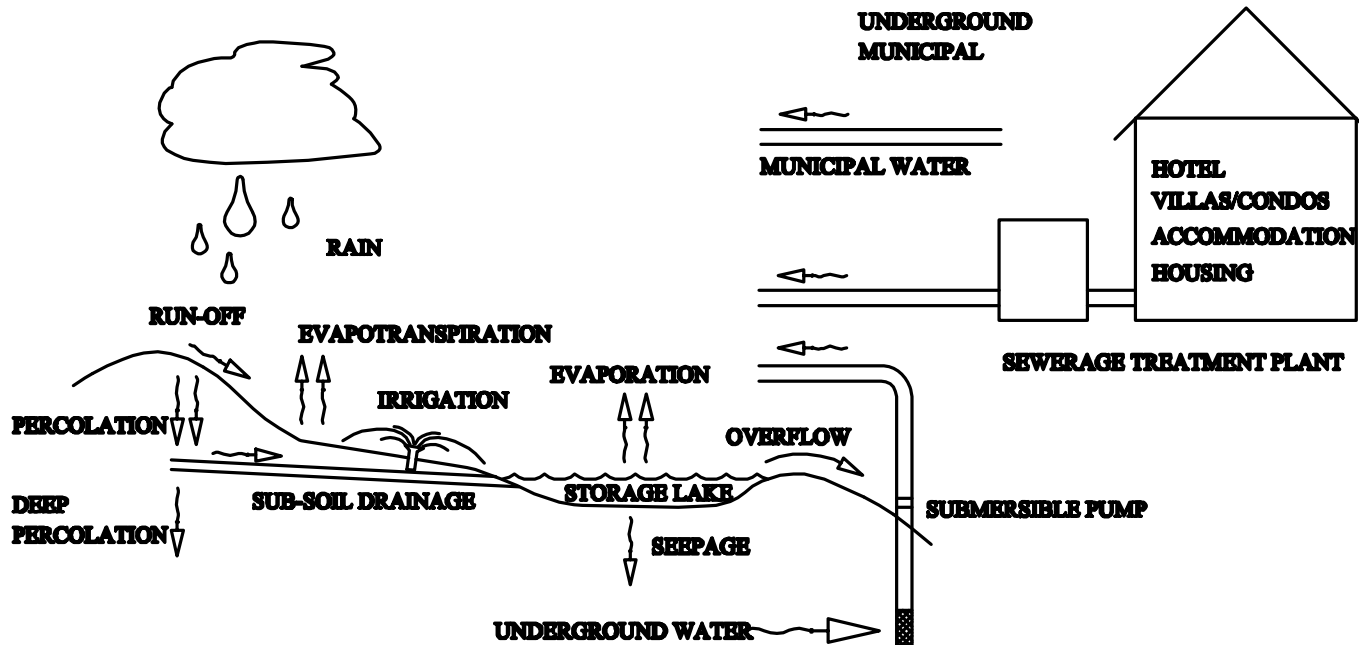
Storage is the accumulated excess of inflow over outflow.

4.1.4 Defining HUs

- a) There must be at least 2 HUs defined otherwise there can be no inflows and outflows. That is, the problem is trivial. For example, defining the world as a HU would not allow any analysis of what is happening within. The analysis only traces the movement of water between HUs.
- b) Though a HU can be arbitrary, judicious selection of boundaries will simplify the analysis.
 - ◆ There is only one storage device (typically a lake)
 - ◆ The boundaries are either natural catchment areas or site boundaries.

THE WATER BALANCE EQUATION

Δ STORAGE -	INFLOW -	OUTFLOW
LAKES	RAINFALL	PERCOLATION
TANKS	S.S. DRAINAGE	EVAPORATION
	TRANSFER PUMPS	SEEPAGE
	MAIN DRAINS	EVAPO-TRANSPIRATION
	CREEK/RIVERS	IRRIGATION
	EFFLUENT	OVERFLOW
	UNDERGROUND	
	MUNICIPAL	



4.2 Inflows

4.2.1 Catchment

Catchment is 100% of the rainfall that falls on the HU. The following parameters apply:

a) Rainfall

We normally consider a dry, typical and wet year. The rainfall is distributed in a typical daily rainfall pattern over the year long cycle.

b) Area

Each HU is defined by boundaries (normally within the property boundaries) that define the catchment area.

Note: The catchment is balanced by percolation that is an outflow from the system.

4.2.2 SubSurface Drainage (SSD)

This is the rainfall that has percolated into the ground (an outflow) and now has been captured by the sub-surface drainage system. Without a SSD system, this water would be lost to the system. The following parameters apply:

a) Area

This is the surface area covered by the SSD system.

b) Coefficient

This is related to the ability (efficiency) of the SSD to capture water that has percolated into the ground. This depends on the type of soil, spacing of the perforated pipes, size of pipes and gradients.

4.2.3 Effluent Water

This water comes from water treatment plants. These are often treating water from the clubhouse, hotels or residences on or adjacent to the site. This is a valuable source of water since it is normally available during the dry season. It is also an environmentally correct method of effluent disposal. The following parameters apply:

a) Discharge

This is the volume of effluent that will be supplied on a daily basis.

4.2.4 Supplementary Water

This is a generic water source that will be drawn from when the lake levels drop below a trigger level. Typically this is ground, recycled or municipal water.

Underground water is drawn from aquifers, springs or underground streams. The location and assessment of the quality and quantity of these water sources is a time consuming and expensive process that is not included in the scope of this report. However, this report will either incorporate any such data or assess the quantity of water required to supplement alternate sources.

Recycled water can come from water treatment plants for accommodation or industry. The quality must be checked regularly.

The use of municipal water is normally expensive and often socially and environmentally objectionable. Its use should be reserved to temporary or emergency situations.

The following parameters apply:

a) Inflow

This is the volume of water that will inflow each day.

b) Drawdown to Activate

When the drawdown exceeds this level, then the set inflow will be added to the HU storage. Otherwise there is no inflow.

4.2.5 Overflow Into HU

Water overflows from the storage in one HU into another. This is traced by the model. The following parameters apply:

a) The HU number from which this HU will receive overflow.

4.2.6 Streams into HU

Any streams flowing into the site can be incorporated. However, there are normally governmental regulations covering (restricting) the use of this water. The viability of streams can vary during seasons (they often do not flow during the dry season) and over time may become polluted. The following parameters apply:

a) Flow

The volume of water flowing into the HU per day

4.2.7 Transfers into HU

The model can simulate transfer mechanisms (gravity feeds or pumps) used to transfer water between HUs (lakes) on site. This is normally done to transfer water to the irrigation lake or to balance lake levels for aesthetic reasons.

This HU becomes the 'master HU'. ie. When the drawdown in the master HU drops below the slave HU, then water is transferred. This is to maintain an even drawdown between HUs. When the drawdown in the master HU drops exceeds the desired drawdown, water is drawn from the slave HU regardless of the relative drawdowns.

The following parameters apply:

a) From HU

This is the HU from which the water is drawn.

b) Volume

This is the volume per day that will be transferred.

4.3 Outflows

4.3.1 Percolation

When rain falls on the land, it either runs off or percolates into the ground. Factors affecting percolation include slope, surface depressions, vegetation and soil type.

The Percolation Coefficient defines the ratio between the amounts of:

a) Rainfall that percolates into the ground

b) Rainfall

A ratio of 0.6 means that 60% will percolate into the ground and 40% will run off into the storage devices.

4.3.2 Lake Evaporation

Factors affecting lake evaporation are temperature, humidity, wind and solar radiation. The following parameters apply:

a) Rate

This is the amount that will evaporate from the lake surface each day

b) Area

This is the area of the storage lakes that varies with the depth of the lakes.

4.3.3 Lake Seepage

Factors affecting the seepage rate are the type of soil, type and thickness of lining, water table and depth of water. The following parameters apply:

a) Permeability

This is the rate water moves through the liner. By setting this value to zero we can quickly assess the impact of using different lake lining materials (eg. Clay, HDPE).

b) Thickness

The thickness of the liner.

c) Area

This is the 'projected' area of the lakes. ie, the 2 dimensional area of the lake on the drawing. This varies with the depth of the lake.

4.3.4 Transfer Out of HU

This is the mirror of 'Transfer In'. Refer to 'Transfer In' in the 'Inflows' section. Parameters that apply:

a) To HU

Defines to which HU the transfer mechanism will deliver the water to.

4.3.5 Irrigation

This is the amount of water used for irrigation. The following parameters apply:

a) Normal Application

This is the application rate during a normal irrigation cycle plus an allowance for manual watering. The normal application will replace 80% of ET.

b) Normal Volume.

This is the volume of water associated with a normal application of irrigation.

c) Minimum Application

This is the application rate when a water conserving strategy is implemented. This will be implemented when the drawdown has exceeded a trigger value. The trigger value is set to maintain a desirable drawdown or stretch out the available water.

d) Minimum Volume

This is the volume of water associated with a minimum application of irrigation.

e) Drawdown for Minimum Application

When the drawdown exceeds this level, the minimum application (water conserving strategy) will be implemented.

4.4 Storage

This defines the volume of the storage for the HU.

The catchment area of the lake primarily determines the volume of water that flows into it. The size of the storage will determine how much water is retained and how much overflows. The storage volume determines how much water is available to survive dry periods.

The ratio of catchment area to lake area is critical. It varies depending on the rainfall, dry periods, irrigated areas, etc. A large catchment area with a small lake will result in high overflows from site and a low tolerance to dry periods. A small catchment area will not recharge a large lake. Generally the catchment to lake area ratio should be similar throughout the site but transfer mechanisms will correct mismatches.

The following parameters apply:

4.4.1 Surface Area

This is the surface area of the lake when full.

4.4.2 Perimeter

This is the perimeter of the lake when full.

4.4.3 Depth

This is the depth of the lake when full

4.4.4 Useable Depth

This is the useable depth of water that is available for irrigation. Normally this is 0.5 m (20 inches) less than the actual depth of the lake. It is dependent on the levels of the intake, balance pipes, transfer pipes etc.

4.4.5 Slope

This defines the slope (steepness) of the lake embankment. This is used to calculate the volume and surface area of the lake. Typical lake embankments are 1:4.

4.4.6 Initial Drawdown

This defines the drawdown at the start of the cycle.

NOTE Drawdown is the difference between the high water level and the actual water level. The minimum drawdown is zero (lake full) and the maximum drawdown is the useable depth. The desirable drawdown is normally set between 0.5 m (20 inches) and 1.0 m (40 inches), normally for aesthetic considerations.

4.4.7 Maximum Volume

This is the volume of water stored when the lake is full.

4.4.8 Catchment/Lake Area

This ratio gives an indication of how well lake areas are matched to the catchment areas.