Turfwise Consulting

Managing with less.....
Water management

Daryl Sellar M.Agr (Turf Mgt)

GCMA National Conference 2011

GLENELG GOLF CLUB

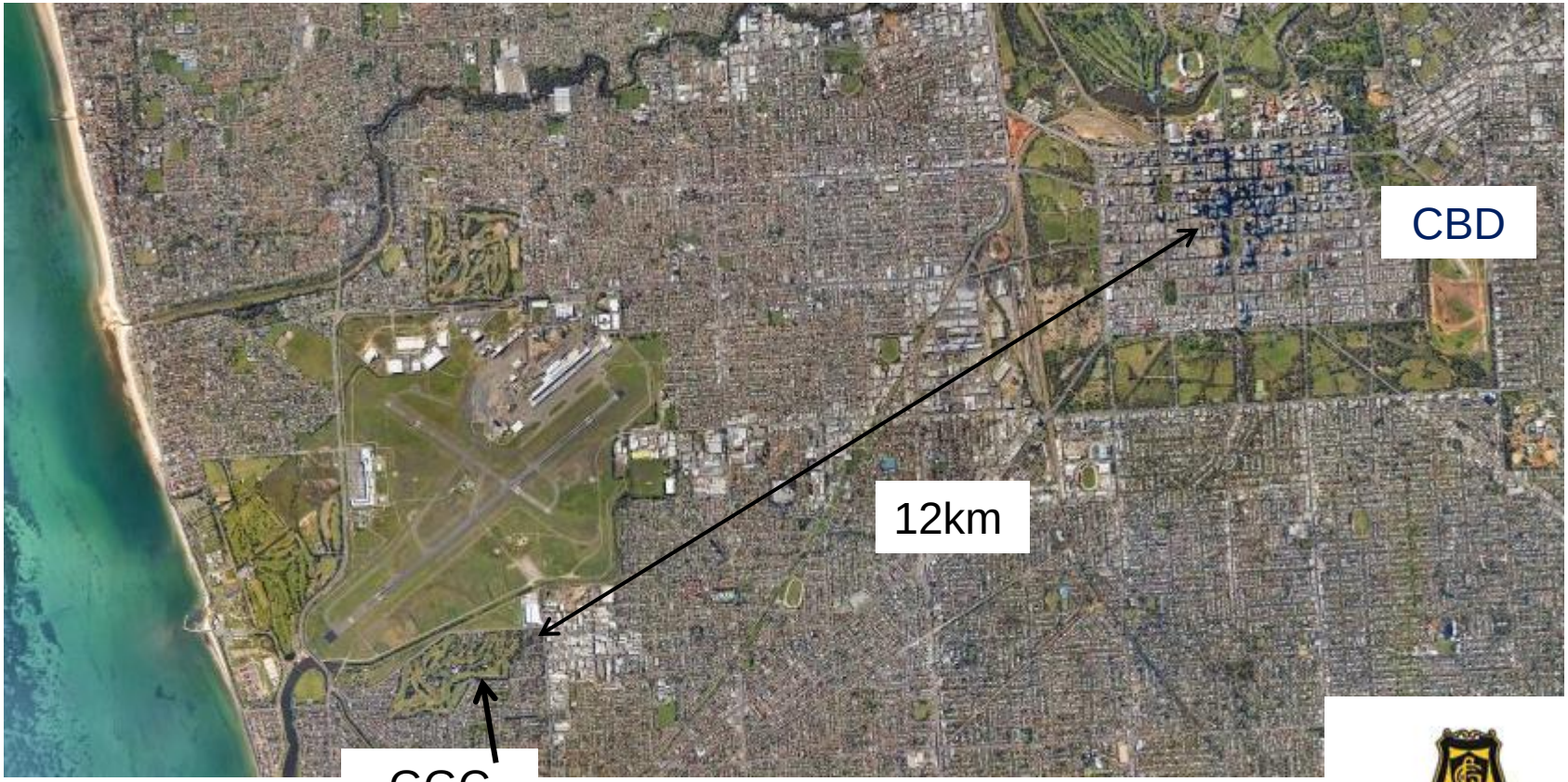
A bit about me.....

- Over 22 years in the golf course / turf industry
- Glenelg Golf Club
  - Superintendent May 2000 – April 2007
  - Consulting Superintendent April 2007 – present
    - 2006 AGCSA Excellence in Golf Course Management
    - 2006 Australian Golf Digest's Superintendent of the Year
- Turfwise Consulting
  - AGCSA HR and Best Practice Manager
  - Golf course management advice
  - Australian Football League
  - State and Local Government
  - Thoroughbred Racing
  - South Australian Cricket Association/SMA
  - Schools
- Also
  - SAGCSA past Vice President
  - AGCSA Education committee
  - AGCSA Environmental committee
  - SA LGT&ITG
  - Lecturing in Turf Management
  - Presentations to AGCSA, NSWGCSA, VGCSA, GMA

Where am I from?

- **Adelaide, South Australia**
  - **1.2 million people**
  - **Mediterranean climate**
  - **450mm rainfall (winter)**
  - **Temperature from 12ºC to 45ºC**

Where is Glenelg Golf Club?



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Glenelg Golf Club

- Formed 1927
- 3 major course construction projects
- Various stages of land loss and “acquisition”
  - Now 49ha

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Glenelg Golf Club

- 2000 members
- >60,000 rounds / yr
- Corporate days / events
- Receptions / conferences

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Redevelopment Planning

Background Factors Influencing Decisions

- **Water Restrictions**
  - mains restrictions, bore metering, increased use of effluent.
- **Environmental Issues**
  - tighter EPA regulations
  - groundwater quality monitoring / Irrigation Management Plan
  - influence on wider community being scrutinized (Patawolonga)
- **Health and Safety**
  - committed to reducing exposure of staff and members to chemicals
- **Cost**
  - striving towards more efficient maintenance through redirection of funds
- **Turf Quality**
  - striving to continually improve turf quality for year round playability
- **Sustainability**
  - need for a course that is sustainable with the above factors in mind

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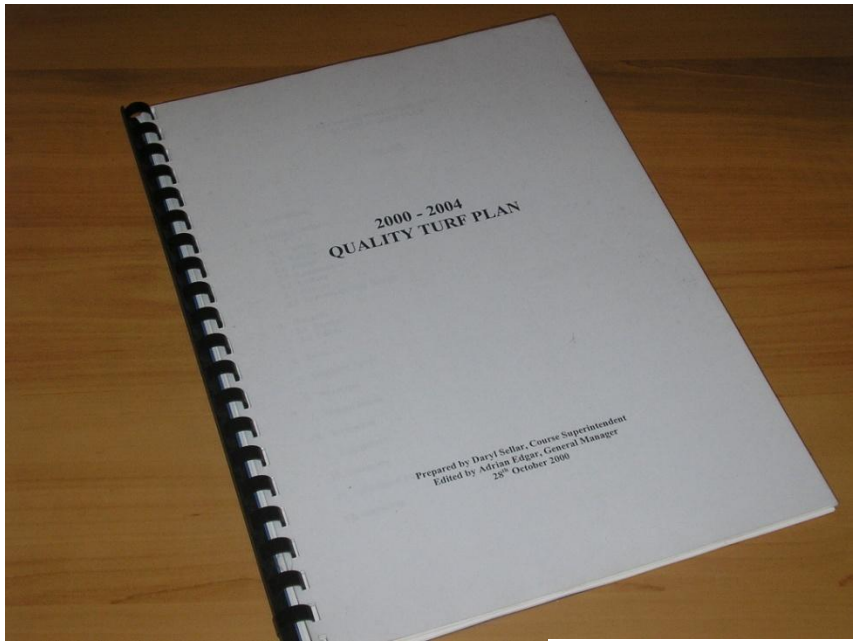
Redevelopment Planning

Documentation & Communication

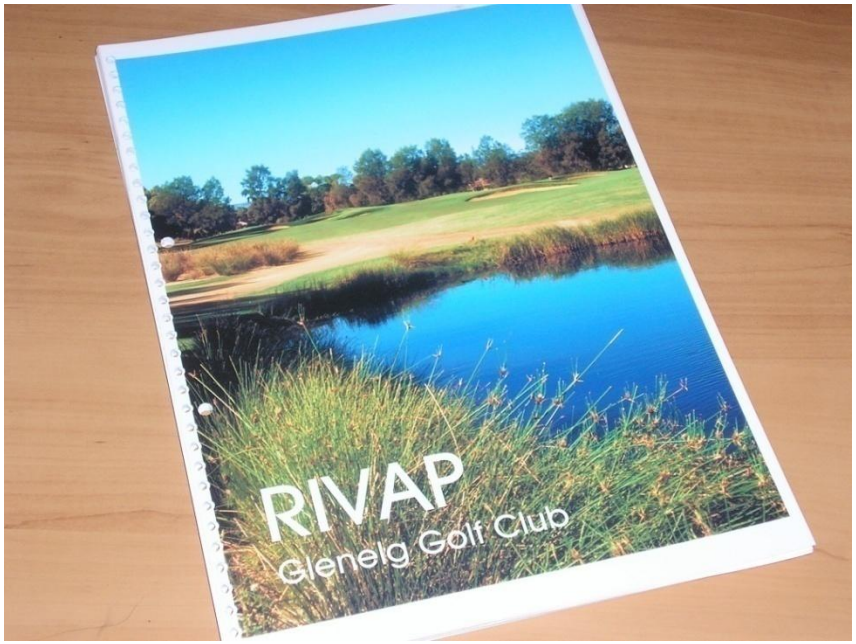
- **QUALITY TURF PLAN**
  - **2000 – 2004 (05 – 10, 11-15)**
  - **An all encompassing document**
  - **Aimed at producing sustainable, quality playing surfaces**
  - **Has driven policy development**
  - **Now part of Committee induction package**
  - **Justify the work being proposed**
  - **Consistency in the inconsistent world of committees**



Turf Management

- Conversion of species through Course Redevelopment
- Fertility management
- Soil conditioning
- Renovation practices

Environmental Management



- **Remnant Indigenous Vegetation Action Plan (RIVAP)**
  - **Policy for revegetation**
  - **Local species only, grown on site (exc. *Pinus spp*.)**
  - **Implemented at commencement of redevelopment**
  - **Integral to the success of entire project**
  - **Time to "convince" members**
  - **Component of Landscape Masterplan**
  - **Now a marketing tool**
    - **"Friends of the Course"**

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Environmental Management

No mow / maintenance zones

2000
~ 0.2ha

2006
~15ha

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Water Management

- Scheduling techniques
- System audit and upgrade
- Introduction dual heads around greens and adjustable arc sprinklers for playing corridors
- Soil moisture sensors

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IRRIGATION MANAGEMENT

2011 WATER BUDGET REPORT

Base Irrigation Requirement (B.I.R)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Data (Source - BoM Data - Average)													
Evaporation	276	237	202	129	81	57	62	86.8	114	170.5	216	254	1885.3
Rainfall	18	19	21	35	54	57	60	50	47	40	26	24	451
Effective rainfall (50%)	9	9.5	10.5	17.5	27	28.5	30	25	23.5	20	13	12	225.5
Net Evaporation (Epan)	267	227.5	191.5	111.5	54	28.5	32	61.8	90.5	150.5	203	242	1659.8
Species Crop Factor (Couch) (CF)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Evapotranspiration (Etc) - mm	160.2	136.5	114.9	66.9	32.4	17.1	19.2	37.1	54.3	90.3	121.8	145.2	995.9
Evapotranspiration (Etc) - ML@0.01ML per ha per mm	1.60	1.37	1.15	0.67	0.32	0.17	0.19	0.37	0.54	0.90	1.22	1.45	9.96
System Factor (SyF)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Site Factor (SiF)	1	1	1	1	1	1	1	1	1	1	1	1	1
TQVS (average)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Application Required (AR) - ML/ha	1.51	1.29	1.08	0.63	0.31	0.16	0.18	0.35	0.51	0.85	1.15	1.37	9.39
Total ha	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Total Consumption	49.69	42.34	35.64	20.75	10.05	5.30	5.96	11.50	16.84	28.01	37.78	45.04	308.92

Actual Irrigation Requirement (A.I.R.)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Actual Data (Source - BoM Data - Actuals)													
Evaporation	269	219.6	174.8	132.4	81.8	64.8	63.8	86.6	150.4				
Rainfall	16	38	75.4	17.75	43.5	32.5	63	64.75	34.5				
Effective rainfall (50%)	8.0	19.0	37.7	8.9	21.8	16.3	31.5	32.4	17.3	0.0	0.0	0.0	0.0
Net Evaporation (Epan)	261.0	200.6	137.1	123.5	60.1	48.6	32.3	54.2	133.2	0.0	0.0	0.0	0.0
Species Crop Factor (Couch) (CF)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Evapotranspiration (Etc) - mm	156.6	120.4	82.3	74.1	36.0	29.1	19.4	32.5	79.9	0.0	0.0	0.0	0.0
Evapotranspiration (Etc) - ML@0.01ML per ha per mm	1.57	1.20	0.82	0.74	0.36	0.29	0.19	0.33	0.80	0.00	0.00	0.00	0.00
System Factor (SF)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Site Factor (SiF)	1	1	1	1	1	1	1	1	1	1	1	1	1
TQVS (average)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Application Required (AR) - ML/ha	1.29	0.99	0.68	0.61	0.30	0.24	0.16	0.27	0.66	0.00	0.00	0.00	0.00
Total ha	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Total AIR	42.5	32.7	22.3	20.1	9.8	7.9	5.3	8.8	21.7	0.0	0.0	0.0	171.1
Scheduled Irrigation Consumption	38.5	26.5	20.6	12.4	6.2	2.7	0.61	1.1	1.8				110.41
Total Consumption	36.7	27.6	22	22	8.14	4.1	0.42	2.2	4.3				127.46
Estimated Actual Irrigation Consumption	36.7	27.6	22.0	22.0	8.1	4.1	0.4	2.2	4.3				127.5
Efficiency	0.86	0.84	0.99	1.09	0.83	0.52	0.08	0.25	0.20	#DIV/0!	#DIV/0!	#DIV/0!	0.75

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Weather Station
Bore
Probe (Right Click to select)
Saturated
...
..
.
Refill Point
.
Onset of Water Stress
..
...
Severe Water Stress

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Monday February 5th, 2007 – 9am

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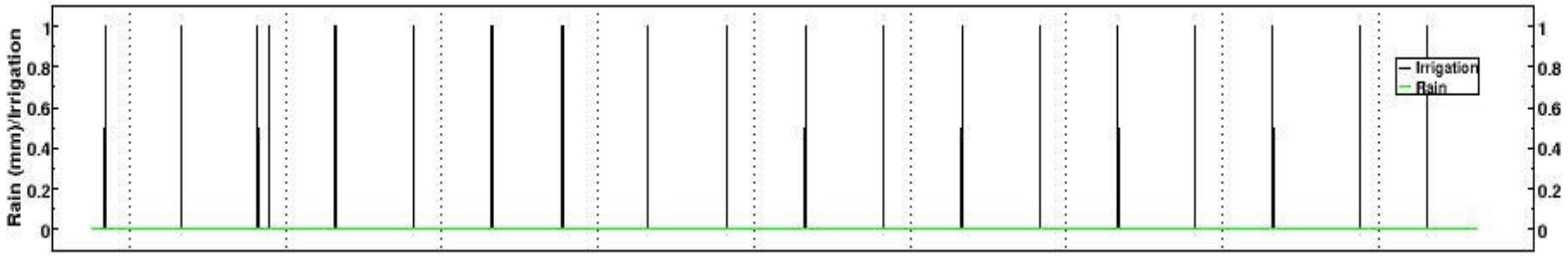
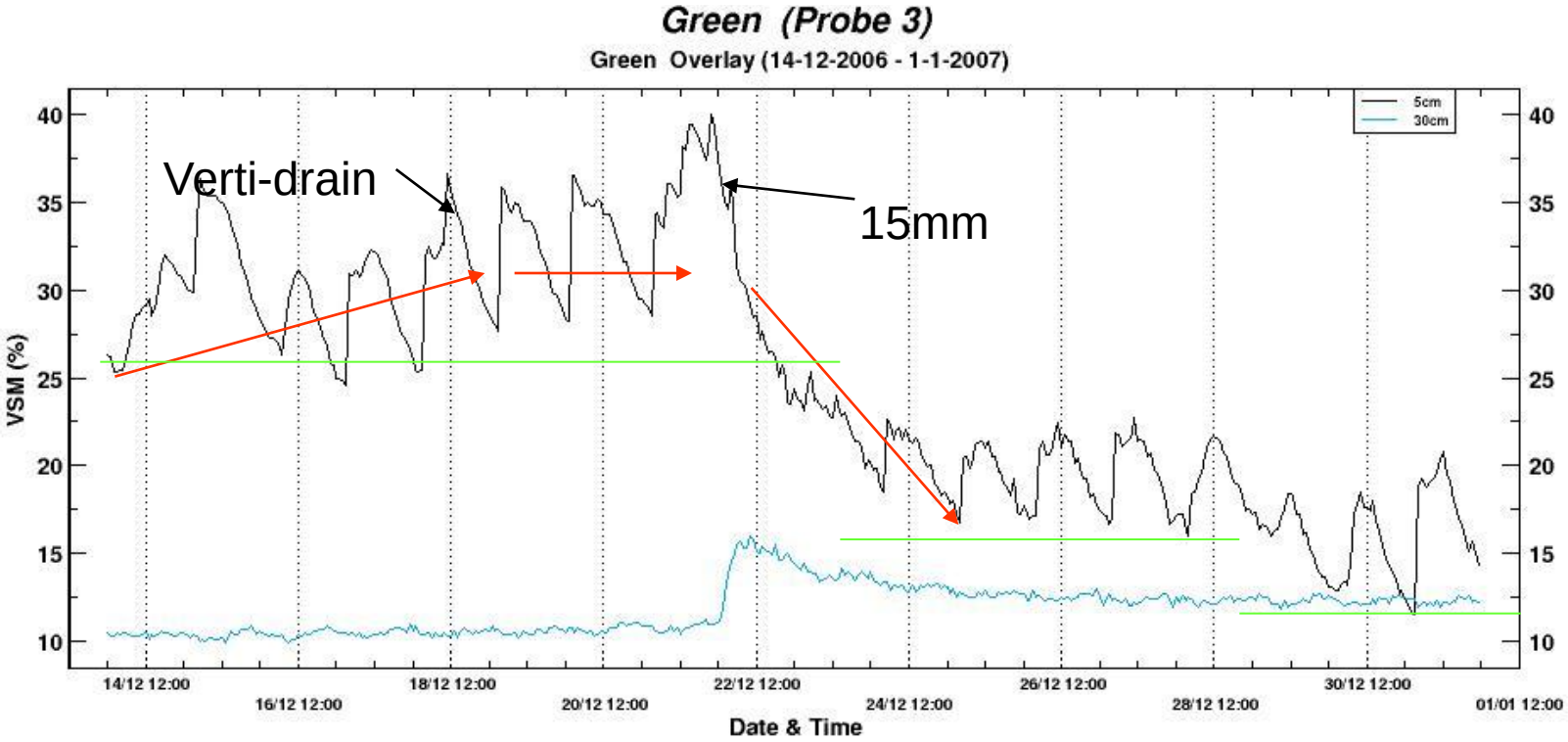
8G Rainfall V Renovation





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Water Management

- **Moisture Sensors - their future?**
  - **Improved efficiency (IPM)**
  - **Quantifying and illustrating water use**
    - » **Irrigation Management Plan data**
    - » **Environmental Management Plan data**
  - **Documentation of management**
    - » **Tighter regulation of water resources**
    - » **Community education**

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Water Management

- **Irrigation**
  - **Water supply (pre July 2005)**
    - » **Bores (x2)**
      - 40% of consumption
      - 1000-1200ppm
      - High sodium, bicarbonates
      - Bore water quality deteriorating
    - » **Class B effluent**
      - 60% of consumption
      - 1100-1200ppm
      - High sodium, bicarbonates, nutrient loading
      - Restricted hours of use (10pm – 6am)
      - Irrigation Management Plan required
      - Pricing reviews (400% - 1500% increases)

Water Management

- **Irrigation**
  - **Water supply**
    - » **Storm water harvesting and utilization of proposed wetlands with a view to Aquifer Storage and Recovery (ASR) was suggested in original QTP in light of quality issues with bore and effluent**
    - » **Potable water not a sustainable option**
    - » **Pricing proposals of effluent led to more detailed investigation for cost comparison**
    - » **Partnership with Patawolonga Catchment Water Management Board (2003)**

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Aquifer Storage and Recovery

Government of South Australia

Adelaide and Mount Lofty Ranges Natural Resources Management Board

ECOLOGICAL ENGINEERING

AGT

fmg CONSULTING

KOUKOURROU ENGINEERS

Hydro Tasmania Consulting

Taylor Cullity Lethlean

ASR – The Concept

- **120 km² catchment area**

Gulf St Vincent

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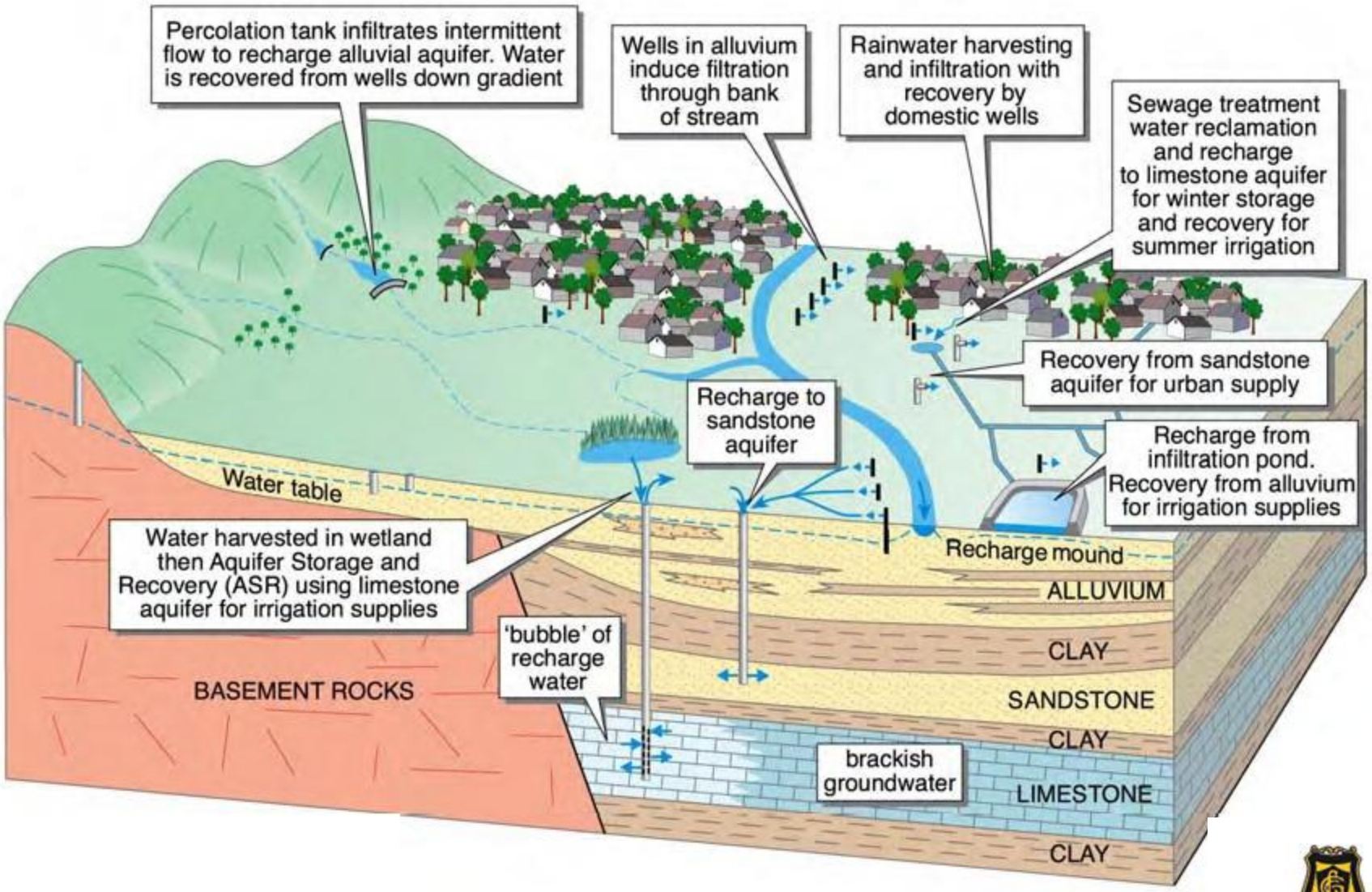

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ASR – The Concept

- **Joint venture with the State and Federal Governments**
  - **Royal Adelaide and The Grange.**

- **The scheme designed to**
  - **assist with stormwater management in the region, which has become problematic with urban development and subsequent localised flooding**
  - **reduce the outfall of urban runoff entering the Gulf of St Vincent**
  - **replenish and reduce demand on the Adelaide Plains Aquifer**
  - **provide a sustainable use for urban stormwater**
  - **provide a secure, superior quality of irrigation water for the golf club**

ASR Design

- **ASR investigations**
  - » **Supply 300ML per year**
  - » **Harvesting options**
  - » **Volume / area requirement for wetlands**
  - » **Modeling of aquifer flows and projected draw downs**
  - » **Water quality and quantity projections**
- **Successful submission to National Water Initiative through Australian Government Water Fund**
  - » **Federal Government $750,000**
  - » **PCWMB $400,000**
  - » **GGC $400,000**


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Sedimentation pond litter nets
Sedimentation pond
Weir at RL 2.0m AHD
Brown Hill Creek
flow
Proposed diversion route
Proposed wetland site
Sediment upstream of weir


NEW PINE TREES
OPEN WATER
GRASS COVER
SHALLOW VEGETATED WATER
SANDTRAP
GRASS COVER
CONNECTING PIPE
FLOW
CELL 2
ALLOCASUARINA
TREES TO BE RETAINED
SALT MARSH AREA - RETAIN
AND PROTECT
OPEN WATER
SANDTRAP
FAIRWAY
GREEN
FLOW
FLOW
ACCESS TR
BRI
PINE TREES TO BE RETAINED
SHALLOW VEGETATED WATER
GRASS COVER
CONNECTING P
OPEN WA
FLOW
CELL 3
ASR
CONNECTION TO
ASR SYSTEM
WQ
CELL 1
FLOW
UM TREES TO BE RETAINED
NATIVE GRASS AREA
OUTLET PIT
DIV
FRO
HILL
OVERFLOW INTO
EXISTING CULVERT
WETLAND VEGETATION
UNDERSTOREY / GROUND COVER VEGETATION


50 year projection of freshwater “bubbles”
500,000L irrigation storage
Injection & production
Injection & production
Direction of aquifer flow
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Plants

Common Name	Species Name	Form Height (m) Spread(diam.)	Comments	Photo
1. Golden Wattle	**Acacia pycnantha**	F: open shrub H: 4 S: 3	Recorded as native to GCG by DNK.	
2. Umbrella bush	**Acacia ligulata**	F: rounded shrub H: 2 S: 3	Recorded as native to GCG by DNK. Hardy and fast.	
3. Drooping sheoak	**Allocasuarina verticillata**	F: Drooping tree H: 6 S: 6	Native to coastal sand dunes in SA. Preferably planted in clumps (as seen on site).	
4. Silver Banksia	**Banksia marginata**	F: Bush H: 3+ S: 3 +	Recorded as native to GCG by DNK.	
5. Bare twig rush	**Baumea juncea**	F: Clumps H: 0.9 S: 1 - 2	Recorded as native to GCG by DNK. Rush like.	
6. Southern Cypess pine	**Callitris preissii Syn Callitris gracilis**	F: H: 5+ S: 4+	Recorded as native to GCG by DNK.	
7. Salt Grass	**Distichlis distichophylla**	F: ground cover H: >0.1 S:Ground cover	Grass (Poaceae) native to coastal sand dunes in SA.Extensively established at GGC. Opportunity to salvage from within footprint of proposedwetland	

Common Name	Species Name	Form Height (m) Spread(diam.)	Comments	Photo
8. Red parrot pea	**Dillwynia hispida**	F: small shrub H: 0.5 S: 0.5	Recorded as native to GCG by DNK. Open loose form.	
9. River red gum	Eucalyptus camaldulensis	F: Spreading tree H: 15 S: 15	Native to river side areas in SA (and elsewhere). Preferably planted as individual tree. Avoid areas frequented by members.	
10.Club-rush	**Isolepis cernua**	F: Clumps H: 0.8 S: 1	Recorded as native to GCG by DNK.	
11.Knobby club rush	**Isolepis nodosa**	F: Clumps H: 1 S: 1	Recorded as native to GCG by DNK. Extensively established at GGC. Opportunity to salvage from within footprint of proposed wetland.	
12.	**Kennedia prostrata**	F: Creeping H: >0.1 S: 1-2	Recorded as native to GCG by DNK.	
13.Wooly tea tree	Leptospermum lanigerum	F: bushy H: 3 + S: 4	Native to coastal sand dunes in SA. Preferably planted in clumps.	
14.Mat-rush	**Lomandra leucocphala ssp. robusta**	F: clumps H: 0.4 S: 0.5	Recorded as native to GCG by DNK.	
15.Coastal Paperbark	Melaleua halmaturorum	F: tall shrub H: 4 + S: 3 +	Native to coastal estuary waterways in SA Preferably planted in clumps.	
16.Dryland tea tree	**Melaleuca lanceolota ssp. lanceolata**	F: sm tree H: 6 S: 5	Recorded as native to GCG by DNK. Bird / butterfly habitat.	
17.Climbing lignum	**Muehlen beckia adpressa**	Ground Cover - spreading	Recorded as native to GCG by DNK.	
18.Boobialla	**Myoporum insulare**	F: rounded shrub H: 4 S: 4	Native to coastal sand dunes in SA. Preferably planted in clumps	

Common Name	Species Name	Form Height (m) Spread(diam.)	Comments	Photo
19.	Myoporum parvifolium	F: ground cover H: .0.2 S: 1 -2	Native to coastal sand dunes in SA. Preferably planted in clumps	
20.	**Oleria ramulosa**	F: ground cover H: 0.15 S: 1.5	Recorded as native to GCG by DNK.	
21.	**Pelargonium australe**	F: Climps H: 1+ S: 1	Recorded as native to GCG by DNK.	
22.Coast tussock grass	**Poa poiformis**	F: Climps H: 1+ S: 1	Recorded as native to GCG by DNK.	
23.Variable groundsel	**Senecio lautus**	F: Low bush H: 0.4 S: 1	Recorded as native to GCG by DNK.	
24. Supple Spear grass	**Austrostip mollis**	F: Clumps H: 0.6 S: 1	Recorded as native to GCG by DNK. Grass like herb.	
25. Seaberry saltbush	**Rhagodia candolleana**	F: rounded shrub H: 1 S: 1	Recorded as native to GCG by DNK.	
26.	**Santalum acuminatum**	F: Tree H: 5 S: 5	Recorded as native to GCG by DNK. Difficult to establish.	
27.	**Pinus pinaster**	F: Domed Tree H: 20 S: 10	Non-native treeCharacter / feature of GCG. Suited to dry sandy soils.	

Risk assessment

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Risk	Likelihood	Consequence	Risk management strategy
Insufficient flow in creek for supply	low	insufficient flow to meet irrigation demand	design contingency into diversion system, temporary storage in wetland and diversion rate
Authority approvals not gained	low	project is delayed or doesn't proceed	meet with authorities early in design process and consult on concerns
Leakage of wetland liner	low	plant die off, poor water quality, cease aquifer injection	Ensure wetland design provides for sufficient clay liner to retain water, provide continual construction supervision during clay liner construction
Insufficient clay to construct the liner	low/ medium	import clay or use artificial impervious liner	intensive network of geotech boreholes and testing to map available clay
Poor vegetation establishment	low/ medium	longer to establish wetland (for aquifer injection) additional planting required	carefully manage propagation and planting process, local species is design
Sediment clogging diversion structure	medium	clogging of off take pit, diversion pumps do not operate, no water into wetland	regularly inspect pit for first 2 years, maintain upstream sedimentation basin, remove sediment from pit when present
Poor water quality for aquifer injection	low	no injection to aquifer	maintain vegetation, monitor salinity of diverted water
Plant die off from herbicides	low	plant deaths reduce water quality treatment, no injection	design bunds and swales to collect fairway runoff and divert away from wetlands
Seawater intrusion into wetland via diversion structure	low	plant die off, poor water quality, cease aquifer injection	off-take from creek located above sea water intrusion level from Barloo inlet
Saline groundwater intrusion to wetland	low	plant die off, poor water quality, cease aquifer injection	extensive geotechnical investigations, additional thickness designed into liner, swale drains, underdrainage and bunds around wetland
Aquifer blockage from sediments	low/ medium	cease injection, blocked aquifer	provide robust investigation and design process to fully assess aquifer suitability, use scour lines and backflush routinely
Excess algal growth	low/ medium	algae smother vegetation, choking pipes, odours	ensure design provides for even water circulation, avoids stagnant areas, passes water through heavily vegetated areas (that provide shade for reduced growth and predation and competition by other aquatic organisms)
Bad odours from wetland	low	complaints	design wetland with good circulation and avoid stagnant areas
Introduced fish invade wetland	low	vegetation disturbance, increased turbidity, no injection	control public access, education and appropriate signage
Catchment contaminant spills enter wetland	low/medium	pollutants get into wetland, cease injection	design allows for cut off from diversion if pollution in Brown Hill Creek identified
Excess insect breeding around wetland	low	complains for public/ members/ health concerns	thorough wetland design, ensure that insect predators have access to all parts of the water body, provide refuge for predators, provide water level fluctuations with even drawdown, and prevent litter in the wetland
Aquatic weed invasion	low	desirable vegetation gets overtaken	provide signage and gross pollutant control to wetland, continuing maintenance to remove weeds and ensure desirable species establishment
Third party accidental fall into water body	low	drowning, people get wet - complaints	Fit for purpose design to manage the risk - including mild batters and shallow water where public access is possible, manage access elsewhere with vegetation design and landscape layout
Increased golf ball losses	medium	complaints about wet balls	wetland away from main hitting (landing) areas
Flooding of golf course	low	inconvenience of playing conditions	bunded wetland area in design, diversion based on wetland water levels, low diversion rate

Critical points

- **To occupy 1.4ha**
  - Course integration (15th, 16th, 17th holes)
  - 50,000 plants
- **Capacity of 14ML (14,000,000L)**
- **Water quality improvement**
  - 1200ppm to <500ppm
- **Construction May 2008 – January 2009**
- **Maintenance period until early 2011**
- **Hand over early 2011**

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Construction

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Staged construction

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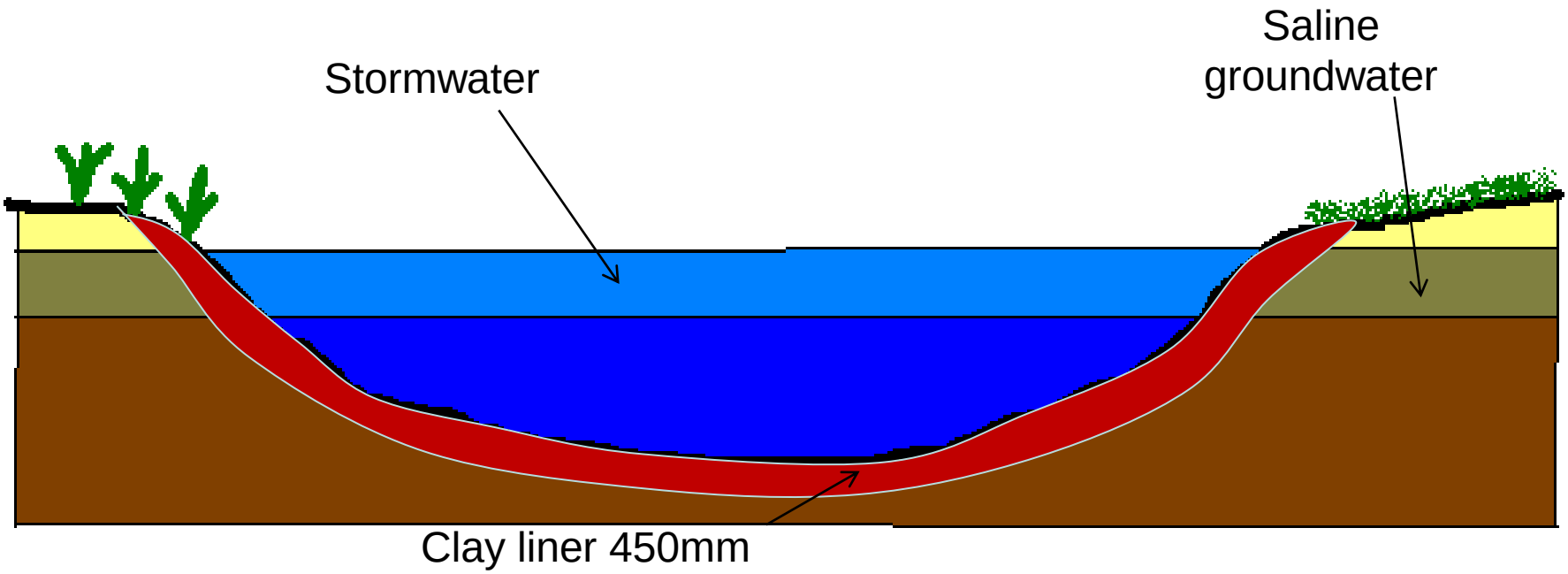
Protection of water quality



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Soil recycled

GLENELG GOLF CLUB

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Establishment

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50,000 plants

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GLENELG GOLF CLUB

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Operational

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2 years to mature

GLENELG GOLF CLUB

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Costs - Construction

- **Approx. $2.4M**
  - **GGC $800,000**
- **Original estimate $1.5M**
  - **GGC $400,000**

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Costs - Time

- >2000 GGC hours during and post construction
  - Continued refurbishment and revegetation work
  - Clearing of pump chamber
  - Circulation of water for algae control
- European carp infestation
- Maintenance requirements
  - Lack of plan for all three clubs

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Oops!

Costs – Water delivery

- ASR
  - Estimate 60c/KL ($600/ML)
    - » Power for pumping $70,000
    - » $1.00/KL with maintenance and management
- Recycled effluent (Class A)
  - $1.13/KL
    - » $1.61/KL with maintenance and management
- Previous bore water
  - 20c/KL
    - » 61c/KL with maintenance and management

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Training

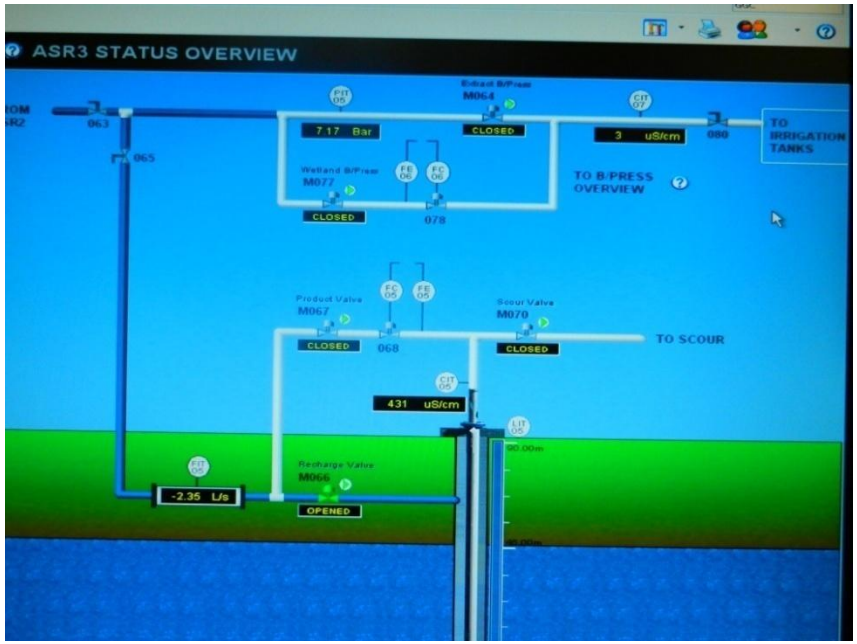
- Complex systems
  - Engineering and biologically
  - Constant attention to detail
- South Australian EPA Guidelines for Managed Aquifer Systems
- Estimate 15-20 hours per week to manage scheme

Operational issues

- Design
  - Access
  - Filtration
  - Circulation control
- Training, inductions
- Algae control
- Infestation of carp
- Bore instability

Lessons learned

- Be involved
- Local expertise if possible
- Detail of design and specifications
  - Consider risk assessment carefully
- Demand a management plan early
- Spread the water supply risk
- Adequate automation of monitoring
- Protection of water supply and quality



Summary

- **Commenced 2003**
- **100ML injected since June 20, 2011**
- **Great project**
  - Community and environmental benefit
  - Water quality / turf management benefit
- **More to be learned about "whole of life" costs**
- **Highlights the real costs associated with water use in our industry**
- **Worth it?.....**

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Absolutely.....

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Thank you

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