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The R-G WAREA Project for Australia

(A National Water & Energy Infrastructure & System)

Memorandum of Information

(for General Release)

Prepared by Richard Thorp on 13 March 2014

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For General Release

Foreword

From even the most elementary study of some basic human concepts, including of physics and chemistry, anatomy and biology, astronomy and cosmology, history of mankind and civilisation – there is one undeniable and fundamental realisation:

The inextricable-link of Water and Energy is the basis for all life and living on this planet – not just for the creation of all life, but for the continued existence and sustainability of all life – past, present, and future.

From now, and into the foreseeable future, the human race – as de facto custodians of the planet – will need to judiciously harness and utilise whatever water and energy resources are available and accessible in a manner which is both viable, sustainable, and of mutual benefit for all life and living on this planet.

Background

Up until the present day, mankind has relied on a variety of systems/methodologies to separately capture, store, process, and distribute various sources of Water and Energy for a variety of essential purposes. Many of these systems/methodologies are increasingly found to be fraught with deficiencies and/or problems – primarily, their inability to properly address and sustainably meet a wide variety of current and projected needs for life (and living) on this planet. In Australia, these deficiencies and problems include:

- **A perpetual (and increasing) inability to properly harness and manage Water** – not only to provide adequate supplies of quality water (and at a fair and just price) whenever, and to wherever, it is reasonably required in Australia but, also, to satisfactorily address and mitigate against significant detrimental effects (economically, socially, and environmentally) from the seemingly inevitable recurrence of the following:
  - **either, a lack of ("too little") Water**, as and when required, which is a major contributor to:
    - **drought** – which, while usually associated with a lack of rain (either 'none', or 'too little', or 'too late'), the real issue of drought is simply the lack of a reliable quantity and quality of water 'as, and when, required';
    - **the unnecessary spread, and consequential damage, of bushfires** – which, because time is critical, any delay in the access to (and the application of) crucial water supplies from whatever sources are locally available, is often a case of 'too little, too late'; and,
    - a variety of other undesirable consequences, including rising charges for restricted water supplies (especially for private/personal purposes); unnecessary environmental damage.
  - **or, an excess of ("too much") Water,** which contributes to:
    - **the flow of excess Water**, which can lead to **floods; and,**
    - **the stagnation of excess Water**, which can prolong the disruption to human lives and living, and to the natural environment; and, increase the incidence of various types of debilitating (and potentially lethal) water-related diseases, including malaria, dengue fever, etc.
- **An inability to not only properly control and manage the extraction and subsequent use of existing sources and supplies of Energy** – primarily non-renewable energy (various carbon-based/fossil fuels (oil, coal, various gases, etc.), and nuclear energy – **but to fully and properly access alternative forms, sources, and supplies of cheaper, cleaner, and more-sustainable, renewable Energy** (especially solar) to effectively reduce the mounting economic, social, and environmental costs related to maintaining the status quo.

From an international perspective, most (if not all) countries experience variations of the same deficiencies and problems as experienced in Australia. However, in many countries – especially those which are undeveloped or under-developed (which also tend to be over-populated, and have sub-standard living conditions) – the impact of these events can be much greater, and the consequences more severe (refer Appendix 1). Other than the unpredictable but, nonetheless, the seemingly regular recurrent nature of these traumatic events (and of the consequences therefrom), Australia is currently in a parlous state – economically, socially, and environmentally. Unfortunately, the likelihood of this situation deteriorating further is possible, and to continue for some time.

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Despite the rhetoric of our leaders – primarily (but not exclusively) of our politicians (and of all persuasions!), because they are at the vanguard of our society's leadership – there is an urgent need for a fundamental re-think and decisive action to review and re-discover this nation's 'narrative' for the future
To achieve this, it will be necessary to re-focus and re-define an overall objective (on behalf of all of the citizens of this nation), and to determine real strategies AND real and effective, non-partisan policies, to appropriately redress this situation. This narrative must be for the foreseeable future – not just to suit the short-term (election-oriented) cycles, and the self-interests of a privileged few, but to shape and deliver strategies and policies which will be in the national interest of (and for) all Australians into the future.
One strategy which must be front and centre – The No.1 Priority – is a National Water & Energy Infrastructure & System. If such a real Water & Energy Infrastructure & System strategy was expediently developed, including of appropriate policies to implement, then much of what needs to be fixed in this country would be fixed, including the reversal of the cynicism (even contempt) which much of the silent majority of this country's citizens have (think and feel) towards this country's contemporary leadership.
The purpose of this document is to present a National Water & Energy Infrastructure & System Strategy for Australia – ***The R-G WAREA Project*** – which is 'technically valid', 'pragmatically feasible', and commercially viable'.

Description of The Project

The R-G WAREA Project ("The Project") is a proposed National Water & Energy Infrastructure & System Strategy for Australia to transform this nation (economically, socially, and environmentally) through its progressive construction (over a period of 25 years), and almost simultaneous commencement of operations, commencing by 1 January 2016. The resultant stimulus to real growth in this country's will be immediate and at an unprecedented rate in the history of this country. This growth will be in all facets of our society, and will be sustainable into the foreseeable future – for the remainder of this century, and for well beyond.

The overall objective of The Project is:

1 **to progressively (and optimally) harness/capture:**
   - ***Water*; and,**
   - ***Solar Energy***

   from a variety of areas/locations across the landmass continent (and nation) of Australia; and,

2 **to separately process and manage the captured Water & Solar Energy for distribution and utilisation whenever, and to wherever, it is reasonably required within Australia.**

On a continental landmass basis, Australia has an abundance of both Water (from precipitation and, if necessary, from a variety of other sources), and Solar Energy – even though the availability of each resource is completely separate, and is totally variable, due to the forces of nature – from a multitude of locations and areas right across the continent.
More specifically, **The Project is an integrated National Water & Energy Infrastructure and System**:

- **to harness/capture Water throughout Australia** – primarily, but not exclusively, to capture water which falls as precipitation (whether as rain, and/or of snow/ice which subsequently melts) and commences to 'run off' over adjacent land/ground in any environment (from a heavily-populated human environment, to all types of natural environments) throughout Australia;
- **to securely store the captured Water in strategically-designated and located areas throughout Australia** – where, as deemed necessary, the stored water can initially be analysed, and then subsequently processed (and maintained) to produce a supply of water of a standard/grade for a variety of human endeavours and activities – whether for personal human consumption, or for any other type of reasonable economic, social, and environmental purpose;
- **to distribute the captured, securely-stored, tested, and processed Water whenever, and to wherever, it is reasonably required within Australia;**
- **to harness/capture Solar Energy** (and, where viable, other sources of renewable energy) **within Australia; and,**
- **to distribute supplies of Electricity (from the converted Solar Energy Captured) whenever, and to wherever, it is reasonably required within Australia.**

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The System of The Project

The System of The Project comprises two principal infrastructures, and their related operating systems:

- **"The Water System"; and,**
- **"The Energy System".**

Note: It is intended that there will be at least one other 'System' (a **"Security System")** which will be both essential (and integral) to The Project. The Security System will need to provide the highest possible level of security (both during the building of the infrastructure of The Project, and in the subsequent period of operation) which is befitting the need to secure and protect what will be the nation's most precious and vital resources (after its citizens) as represented in a National Water & Energy Infrastructure and System.

The Innovative Basis of The Project – The WS&SECU

The basis of **The System of The Project**, is an innovatively-designed unit which will integrate the separate functions of:

1 **securely-storing captured Water** – in a **Water Storage Unit ("WSU")**; and,
2 **capturing Solar Energy** – in a **Solar Energy Capture Unit ("SECU").**

This fundamental unit is referred to as:

The Water Storage & Solar Energy Capture Unit ("The WS&SECU").

Features of The WS&SECU

The principal feature of **The WS&SECU** is its innovative design (refer Appendix 2) which is based on a geometrical form or shape – **the hexagon** – which is a proven form in the sciences of mathematics, physics, and chemistry (refer Appendix 3); and in its practical application in the natural world, of which the honeycomb of the beehive is probably the most-renowned (refer Appendix 4).

It is this form which, when applied to the specific purposes of Secure Water Storage, and Solar Energy Capture – as in the innovative design of The WS&SECU in The System of The Project – offers a variety of desirable capabilities which cannot be matched by any alternative systems/methodologies (existing and, possibly, prospective). In respect of secure water storage, analysis/testing, and treatment; and, of solar energy capture, the innovative design of The WS&SECU provides significant and strategic advantages of versatility, capacity, and cost/benefits including of how, where, and by whom, the components of The WS&SECU can be made/produced; transported to a location where The WS&SECU is to be built, then operated, maintained, and, utilised. In addition, other advantages include:

- how much time is required to build/construct and commission The WS&SECU and, therefore, how long it will take for The WS&SECU to become functional and operational for the purpose of Securely Storing Water, and Capturing Solar Energy;
- how long the The WS&SECU will last; and,
- how much The WS&SECU will cost, compared to what will be its benefits.

The WS&SECU (as the fundamental component of The System, and of The Project) will be capable of being widely-utilised in a multitude of applications – primarily for the public interest (as a National Water and Energy Infrastructure & System) but, also, for a wide range of private purposes (commercial and personal) – possibly, with an inter-connection for mutual advantage.

The WS&SECU will be able to be built and used in almost any location on land/ground which is reasonably accessible by man – whether that location is in any type of human environment, or in a variety of remote natural environments, including in mountains, jungles, deserts, even of floodplains (as part of a levee system). The WS&SECU(s) can be located in areas, which:

- are in **relatively-close proximity to strategically-located sources of water**;
- have **minimal value/use for any known purpose** (including economic, social, environmental, cultural, etc.), and are considered to be relatively risk-free from a variety of natural events, e.g. earthquakes, volcanic activity, tsunamis;
- have **strategic importance, including for regional and national security, and/or for sustainable economic (and social) development.**

The components of The WS&SECU will be capable of being manufactured by mass production (including by pre-fabrication), with only one exception – the base/floor of the unit. Importantly, the source and supply of most (if not all) of the raw materials required to manufacture all of the components are readily (and abundantly) available throughout Australia – and, in most (if not all) countries throughout the world.
The WS&SECU will be capable of being built at a projected theoretical benchmark rate of at least five (5) WS&SECU's per 8-hour shift day (or 25-30 WS&SECU's per 40-hour week) by a team of say, ten (10) people – comprising a supervisor, several trade-qualified personnel, with balance of the team comprising semi-skilled and unskilled adult labourers. Critically, and importantly, the building of WS&SECU's will be possible using mainly unskilled or low-skilled labour (requiring minimal training and nominal tools and equipment), complemented by a supervisor (suitably qualified and experienced), and several trade-specific personnel (a plumber, and an electrician – both suitably qualified and experienced) to complete each WS&SECU for certification and commissioning by independent, appropriately qualified and experienced, personnel. This important attribute will lend itself to WS&SECU's (and of other work required in building the infrastructure and system) being built by a supervised workforce which could comprise members of a local community, and/or by a workforce brought in from wherever – of **registered unemployed**, and/or of **eligible migrants** (as has often been the case in the successful building of other infrastructure projects over the ages – both in Australia, and overseas); and/or of **low-risk detainees**. From an Australian perspective (also, from an international perspective), this attribute has considerable (and very obvious?) advantages.

Features of The System

The primary feature of **The System (comprising a separate, but integrated, Water System and an Energy System)** – based on **The WS&SECU** – will be its capability of being able to provide an almost unimaginable degree of flexibility and adaptability (refer Appendix 5) to:

- harness/capture Water – eventually, across the entire landmass continent of Australia;
- securely-store, test/analyse, process, and transfer this Water whenever, and to wherever, in Australia,
- distribute various quantities, and various grades/quality, of this Water whenever, and to wherever, it is reasonably required in Australia;
- capture Solar Energy – eventually, across the entire landmass continent of Australia; and to convert that Energy into electricity wherever in Australia; and,
- distribute this Electricity whenever, and to wherever, it is reasonably required in Australia.

Key Statistical Information and Projections of The Project (Guide only)

The WS&SECU

- **Cost to Produce, and Build** – estimated at $15,000 (incl. GST) in current terms.
- **Average Life** – estimated to be at least 50 years.
- **Annual Depreciation (Replacement Cost) Rate** – $300 ($15,000/50 years).
- **Water Storage Capacity** – maximum 36,000 Litres; optimum 25,000 Litres
  - Projected Daily Turnover is 37,500 Litres (1.5 x optimum water storage capacity)
  - Projected Annual Turnover is >13,500,000 Litres ((365 days x Projected Daily Turnover).
  - Projected Annual Gross Value (Income) is $6,750 (13,500,000 Litres @ 50c per 1,000 Litres).
- **Solar Energy Capture Capacity** (6 solar panels per WS&SECU) – max. 1.2 KWH; opt'm 1.0 KWH.
  - Projected Daily Turnover (8 x optimum SE capture capacity) is 8 KWH.
  - Projected Annual Turnover is 2,000 KWH (250 (of 365) days x Projected Daily Turnover).
  - Projected Annual Gross Income is $200 (2,000 KWH x 10c/unit).

  Note: The Water & Power unit cost used in these calculations is <u>>50% less</u> than the current (Dec 2013) charge rates to a private consumer in Perth, W.A. – Water @$1.38 per 1,000 Litres; Electricity @ 23.55c per unit (KWH), the latter substantially subsidised by the State Govt.
- **<u>Net</u> Annual Return** (Gross Operating Income <u>less</u> Operating Expenses) is $6,950.
- **Annual Rate of Return on Investment of >45%** ($6,950/$15,000).

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The Project

- **Cost to Build** is estimated at $AUD1,500 billion in current terms.
  The following is an estimate of the costings for each of The Project's System infrastructure:
  - **The Water System ($1,000 billion)** – comprising the Drainage System, the Water Storage Units of the WS&SECU's (50 million units), the Pipelines, the Water Pumping System:
    - Componentry.........$750 billion, incl GST ($30 billion per year x 25 years)
    - Labour ....$150 billion ($6 billion per year x 25 years)
    - Other ....$100 billion ($4 billion per year x 25 years)
  - **The Energy System ($350 billion)** – comprising the Solar Energy Capture Units of the WS&SECU's (50 million), the Solar Energy Invertors, the Electricity Transmission Lines:
    - Componentry..........$300 billion, incl GST ($12 billion per year x 25 years)
    - Labour .... $50 billion ($2 billion per year x 25 years)
  - **Other ($150 billion,** incl some GST) ($6 billion per year x 25 years) – comprising the Security System, the preparation of sites, the peripheral infrastructure of The Project.

  Given that the Project is to be built over a 25-year period, the average annual cost to build The Project is estimated at $AUD 60 billion in current terms ($1,500/25 years).
- **Average Life** is estimated to be at least 50 years.
- **Annual Depreciation (Replacement Cost) Rate** is $30 billion ($1,500 billion/50 years).
- **Net Average Annual Return** (Gross Operating Income less Operating Expenses) is estimated to exceed $100 billion.
- **Average Annual Rate of Net Return on Investment** of >6% (>$100 billion/$1,500 billion).

Funding of The Project

The Funding required to build The Project (estimated at $AUD 1,500 billion in current terms) – at an average rate of $AUD 60 billion per year – will be from the issuing of **Commonwealth of Australia (sovereign-backed) bonds ("Australian/National Water & Energy Infrastructure Bonds")** at a face value of $AUD 1,000 each. Most (if not all) of the investors will be from a variety of Australian sources, including the Wealth Management industry, the Superannuation Funds industry, The Future Fund, and private investors (both corporate and individual, and large and small).

WHY will Australian investors be attracted to invest this amount of Capital into The Project?
Other than the altruistic appeal for any Australian citizen to support a truly worthwhile National project which will significantly increase the net wealth of this country, the combination of the Security, and the Return on Investment, on these bonds will be vastly superior to any other form of comparable investment offered – either in Australia, or overseas.

The Security of the investment The Bonds will be guaranteed by the Commonwealth of Australia which has a AAA rating (by all of the recognised international ratings agencies) – more secure than any bank). It is considered that the ratings agencies will favourably regard this Capital Raising.

The Return on Investment This will be a combination of an Income Tax Concession to the bond holder during each tax year – a 100% deduction of the Face Value of the Bond, spread equally over the term of the Bond; and, a Non-taxable Rebate (on any Australian Water and/or Energy Charges) of 10% per annum of the Face Value of each Bond over the term of the Bond. Rebate Vouchers will be issued quarterly to the bond holder at 30 Sept, 31 Dec, 31 Mar, 30 June respectively.

Other than the repayment of the Face Value of these Bonds at their respective maturity dates, there will be no other liability. Thus, the only Cash Payment will be the repayment of the Face Value of the Bond on maturity. **Thus, appropriations from the Net (Cash) Operating Income of The Project will be:**

1 **to repay the Face Value of bonds to the bond holders** on the maturity of the Bonds issued – $1,500 billion in total but, at the average rate of $60 billion per year commencing at least 10 years from when Bonds are first issued**; and.**

2 **to provision/reserve for the Replacement of Infrastructure of The Project** – $1,500 billion in total, but at an average rate of $30 billion per year.

With a Projected Average Annual Net Operating (and Cash) Income expected to exceed $100 billion per year, it is considered that there will be an Average Annual Cash Surplus of >$10 billion per year.

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NOTE: The Annual Net Operating Income will be derived from Gross Receipts from the Sale of Water and Energy produced from the Water & Energy System less the Expenses of Operating the Total System of The Project. When completed, The Project will need to stand alone financially – that is, it must (when completed and fully operational) pay for itself – even though there will be significant material (and sustainable) benefits throughout the economy and society generally (including environmentally).
An example of this is exemplified in C Y O'Connor's Mundaring to Coolgardie Water Pipeline in Western Australia – built at the beginning of the C20th. At the time, the cost to build this infrastructure was enormous (the biggest infrastructure project ever built in Australia), ... and, extremely controversial. Today, more than 100 years after the project was completed (and is still operating!!!), the economic, social, and environmental benefits which have been reaped (and continue to be reaped) have more than justified the trials and tribulations which it caused at the time.

Conclusion

This project – ***The R-G WAREA Project for Australia*** - is epic in both its scope and in its magnitude – undoubtedly, the most significant in Australia's history (and, no doubt, in the history of the world).
But, just as crucial and critical, is what The Project will mean to the immediate and foreseeable future of Australia, and for its citizens – a future based on real and sustainable hope and opportunity for all Australians (both for the current generation, and for future generations). Without doubt, not only will it transform this country (economically, socially, and environmentally) into a 'New Australian' future – but, through embarking on this venture, Australia will also demonstrate, and possibly lead, a transformation movement throughout the world (also economically, socially, and environmentally) into a sustainable 'New World' future – a future based on the same real and sustainable hope and opportunity but, for all of the world's current and future citizens.
A specific example for the application of a similar project to that proposed for Australia, but on an international level, is the United Nation's Millenium Development Goals ("MDG's") – refer Appendix 6). At this point in time, the target date of 2015 for the eight MDG's must now be seen to be completely unrealistic and unachievable – and, this has obviously been the case for some time, especially post-The GFC. However, given those same objectives, it would be realistic (and achievable) to re-set these same MDG's possibly with a target date of 2040 – with the incorporation of the same National Water & Energy Infrastructure & System for Australia (based on ***"The R-G AWARE Project for Australia")*** being separately adopted, and simultaneously established and conducted – possibly as ***"The United Nations' R-G AWARE Project for The World".***
From both an Australian perspective, and an international perspective, the fundamentals of The Project provides a 'valid, feasible, and viable' means for **a real, and a sustainable hope and opportunity** to not only develop (in some cases, redevelop) areas which have long been regarded as being impossible to develop (or redevelop) – for example, the Sahara Desert, and other vast areas which are considered to be wastelands – but to ensure that whatever the development, it is sustainable (economically. socially, and environmentally).
The Project will give real hope and a real opportunity to effectively manage and control these crucial source(s) and critical resources of ***Water and Renewable Energy*** in this country (and, potentially, throughout the world) – which, up until that proposed in this initiative, has been at the core of many of Australia's (and, of all countries throughout the world) issues/problems, including of drought, bushfire management, soil erosion, desertification, various diseases (especially water-related diseases), famine, undernourishment, starvation, flood, economic migration, social unrest, terrorism, climate change, diminishing standards of living and rising costs of living, fiscal management, unemployment and under-employment (especially of the younger generation), etc., etc., etc..
Finally, reflecting further on an important episode in Australian history, and of Western Australian history in particular – one needs to read the story of C.Y. O'Connor in his epic struggle for the Perth-Kalgoorlie Water Pipeline, which ultimately contributed to his tragic death (refer Appendix 7). In more-recent times, several other prominent Western Australian politicians – notably the late Ernie Bridges (refer Appendix 8); and the current Premier, Colin Barnett – had, quite independently of each other, proposed their own concept of a

water scheme (the former, a pipeline; the latter, a canal) to transfer water from the north of Western Australia to the increasingly water-deficient south-west of Western Australia, and beyond. They, like C Y O'Connor, also attracted unnecessary criticism and maligned ridicule – although C Y O'Connor was vindicated (unfortunately, after his tragic suicide) because his particular vision was realised. Unfortunately, Ernie Bridges, and Colin Barnett have not seen their visions realised – YET!. At this time, I would like to think that, 'across-the-board' there is a much more-informed and receptive audience – of politicians; of 'captains of industry'; of advisors to both; and of a general public (especially of the younger generation, who will inherit the results of their forebears' actions (or inactions)) – to demand that this initiative (or, at least, what this initiative has as its objective) is considered and delivered as a 'carpe diem'.

Concerned people of Australia and, indeed, concerned people in all countries of the world, deserve and want responsible affirmative action from their leaders – from their politicians, from the captains of industry, and from their other leaders across the spectrum of their societies – to determinedly strive for (and ensure) the provision of a better quality of sustainable life (and of living).

Appendix 1

The following statistics were extracted from ***"Worldometers – real time statistics"*** (www.worldometers.com) at 20 April 2012:

Population – World Population (at 20 April 2012) – 7,035,593,832

Food:

- Undernourished People in the World (for the 2012 year at 20 April 2012) – 911,935,291
- People Who Died of Hunger (for the 2012 year to 20 April 2012) – 13,277

Water:

- Water Consumed (for the 2012 year to 20 April 2012) – 1,500,481 Mega Litres
- Deaths from Water-related Diseases (for the 2012 year to 20 April 2012) – 545,022
- People with No Safe Drinking Water (for the 2012 year at 20 April 2012) – 828,629,149

Energy:

- Energy Used (on 20 April 2012) – 170,061,473 MWH
  - from Non-Renewable Sources – 137,749,044 MWH
  - from Renewable Sources – 32,312,429 MWH
- Solar Energy Striking the Earth (on 20 April 2012) – 1,269,727,221,325 MWH

Health – Deaths Caused by Malaria (for the 2012 year to 20 April 2012) – 296,851

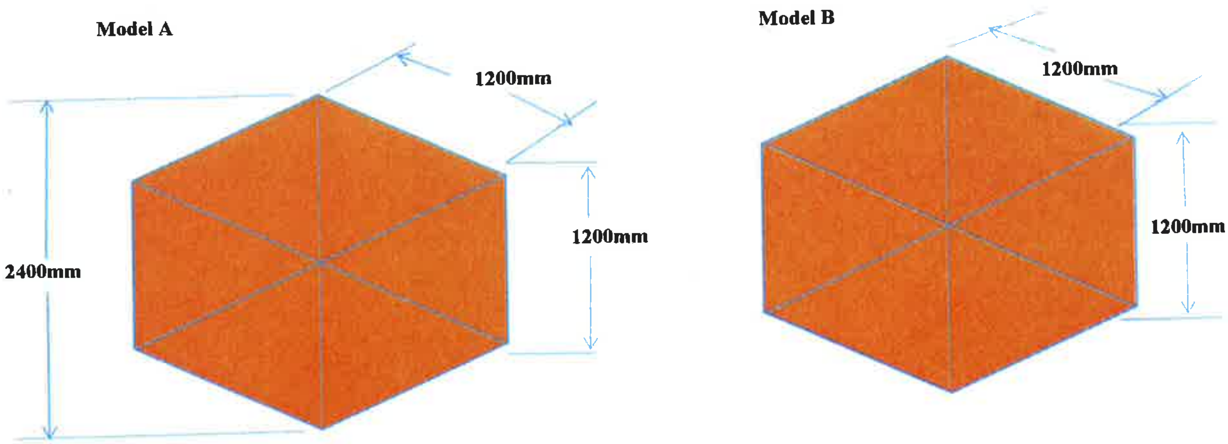
Environment:

- Forest Loss (for the 2012 year to 20 April 2012) – 1,573,977 hectares
- Land Loss to Soil Erosion (for the 2012 year to 20 April 2012) – 2,118,999 hectares
- Carbon Dioxide Emissions (for the 2012 year to 20 April 2012) – 10,155,924,667 tons
- Desertification (for the 2012 year to 20 April 2012) – 3,631,888 hectares

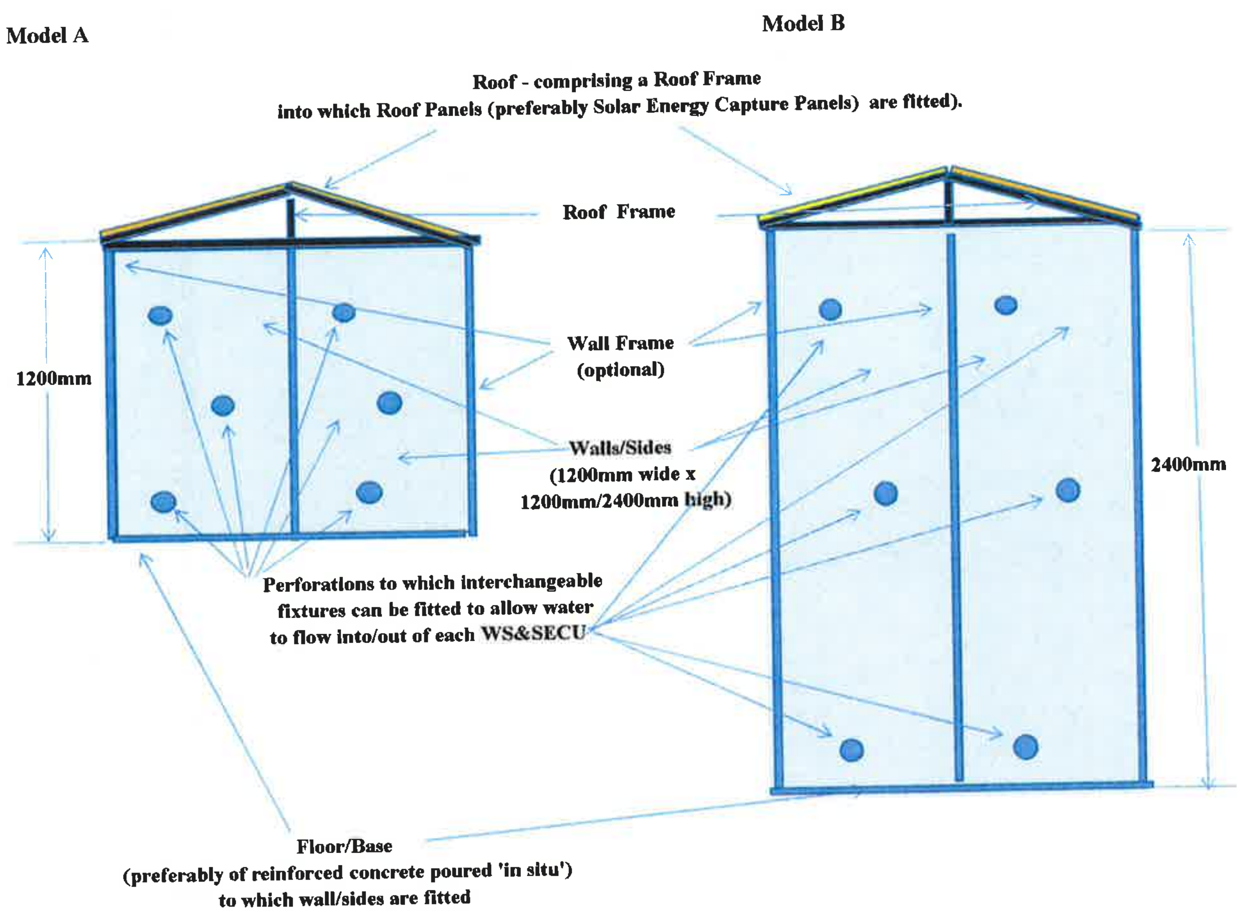
Appendix 2

Diagram 1 - The Water Storage & Solar Energy Capture Unit ("WS&SECU")

Plan of WS&SECU



Elevation of WS&SECU



The Design and Componentry of the WS&SECU

The WS&SECU is an innovatively-designed hexagon cubicle (a 'hexicle').

The components of each WS&SEC hexicle are as follows, and are described in order of its proposed assembly/construction:

- **Base/Floor** – preferably of reinforced concrete poured 'in situ' into a temporary frame shaped to form a hexagon with a proposed 'point to point' axis of 2,400mm;
- **Sides/Walls** (six in total per stand-alone WS&SECU) – specially-designed, but to be mass-produced (pre-fabricated reinforced concrete panels), the proposed dimensions of which will be 1,200mm wide x 2,400mm in depth which, when fitted/attached to the base/floor and to the adjoining panels, will form a hexicle;
- **Cover/Roof Frame** of suitable material (probably, of appropriate quality steel) which will be fitted/attached to the top of the sides/walls of the hecxicle
- **Roof Panels** (six in total per stand-alone WS&SECU) which will be specially-designed, but to be mass produced, to be fitted into the roof frame to securely cover the hexicle. Preferably, the panels will be solar panels – to capture solar energy but, if determined otherwise (and only(?) on the basis that the location and position of the hexicle is not considered to be conducive to optimally capture sufficient solar energy to warrant the expense of the fitting of solar panels), then a panel of another suitable material would be fitted.

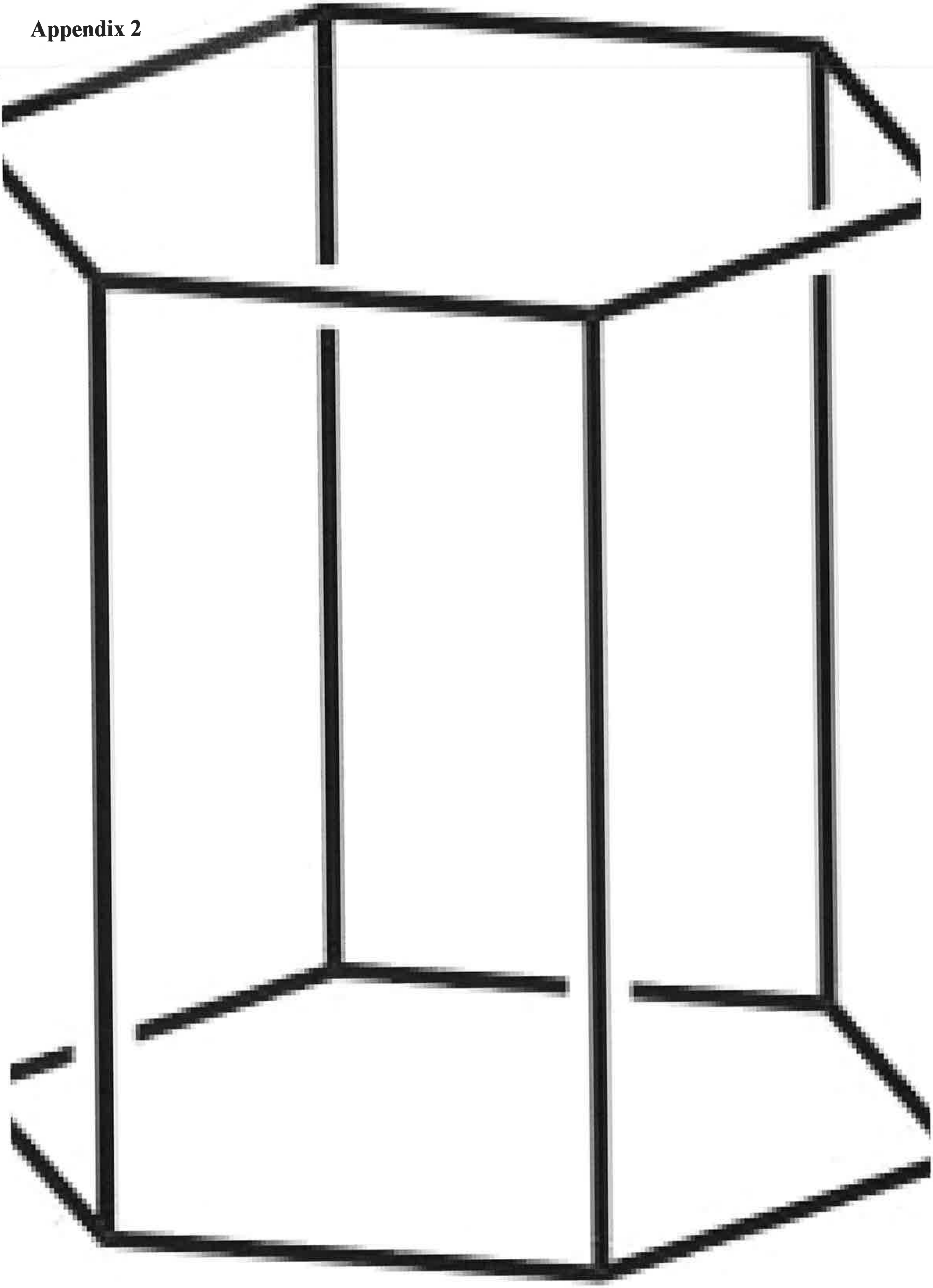
  NOTE: Roof panels, other than solar panels, might be considered as being relevant in the instance of providing a temporary measure to meet a short-term measure/solution to ensure the complete enclosure of the hexicle, e.g. because of damage to any solar panel(s) which requires immediate replacement.

The hexagon-design of an individual hexicles will enable optimalisation from:

- **minimising the economic cost of the materials (but, only of the sides/walls)** from being able to use the common side(s)/wall(s) of hexicles which form any conglomeration of hexicles, viz. the honeycomb of a beehive (refer Appendices ….);
- **maximising the stability of each hexicle** (and, of any conglomeration of hexicles) from the pressure of any lateral forces:
  - **either from within each hexicle** – such as any internal forces which might occur within from the storage and movement of water and/or from any other material which might be stored within – for example, a variety of material(s) to treat water within a hexicle, or conglomeration of hexicles);

    and/or, from outside of each hexicle or conglomeration of hexicles , e.g. from natural forces such as strong winds.

Appendix 2

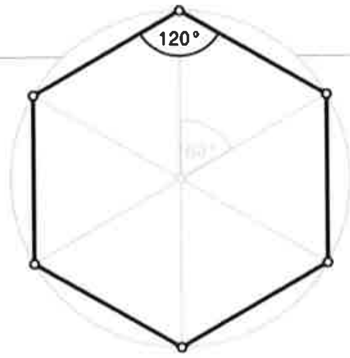


Hexagon

From Wikipedia, the free encyclopedia

In geometry, a **hexagon** (from Greek ἕξ *hex*, "six" and γωνία, gonía, "corner, angle") is a polygon with six edges and six vertices. A regular hexagon has Schläfli symbol {6}. The total of the internal angles of any hexagon is 720°.

Regular hexagon



A regular hexagon

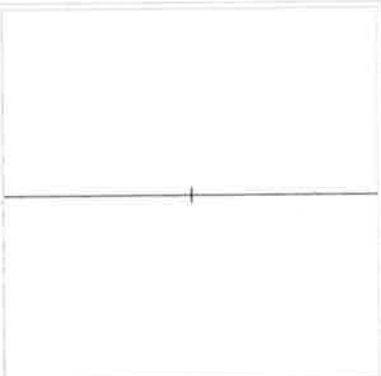
Type	Regular polygon
Edges and vertices	6
Schläfli symbol	{6}
Coxeter diagram	
Symmetry group	D_6, order 2×6
Internal angle (degrees)	120°
Dual polygon	self
Properties	convex, cyclic, equilateral, isogonal, isotoxal

Contents

Hexagonal structures

From bees' honeycombs to the Giant's Causeway, hexagonal patterns are prevalent in nature due to their efficiency. In a hexagonal grid each line is as short as it can possibly be if a large area is to be filled with the fewest number of hexagons. This means that honeycombs require less wax to construct and gain lots of strength under compression.

Regular hexagon



A step-by-step animation of the construction of a regular hexagon using compass and straightedge, given by Euclid's *Elements*, Book IV, Proposition 15.

A regular hexagon has all sides of the same length, and all internal angles are 120 degrees. A regular hexagon has 6 rotational symmetries (*rotational symmetry of order six*) and 6 reflection symmetries (*six lines of symmetry*), making up the dihedral group D_6. The longest diagonals of a regular hexagon, connecting diametrically opposite vertices, are twice the length of one side. From this it can be seen that a triangle with a vertex at the center of the regular hexagon and sharing one side with the hexagon is equilateral, and that the regular hexagon can be partitioned into six equilateral triangles.

Like squares and equilateral triangles, regular hexagons fit together without any gaps to *tile the plane* (three hexagons meeting at every vertex), and so are useful for constructing tessellations. The cells of a beehive honeycomb are hexagonal for this reason and because the shape makes efficient use of space and building materials. The Voronoi diagram of a regular triangular lattice is the honeycomb tessellation of hexagons. It is not usually considered a triambus, although it is equilateral.

The area of a regular hexagon of side length t is given by

$$A = \frac{3\sqrt{3}}{2}t^2 \simeq 2.598076211t^2.$$

An alternative formula for area is $A = 1.5dt$ where the length d is the distance between the parallel sides (also referred to as the flat-to-flat distance), or the height of the hexagon when it sits on one side as base, or the diameter of the inscribed circle.

Another alternative formula for the area if only the flat-to-flat distance, d, is known, is given by

$$A = \frac{\sqrt{3}}{2}d^2 \simeq 0.866025404d^2.$$

The area can also be found by the formulas $A = ap/2$ and $A = 2a^2\sqrt{3} \simeq 3.464102a^2$, where a is the apothem and p is the

Appendix 3

Networks and Spatial Economics
March 2005, Volume 5, Issue 1, pp 5-20

On the Genesis of Hexagonal Shapes

Abstract

Hexagonal shapes for market areas have been dominant in spatial economics ever since Christaller observed them and Lösch explained their emergence in terms of optimality. It is observed in the following that, though hexagons are best, the differences to for instance squares in terms of efficiency are negligibly small. As the existence of hexagonal shapes—in the space economy, as well as in beehives or other patterns of the physical world cannot be denied—a different cause for their emergence is proposed. Such an explanation is structural stability, which allows three market areas, but not four or six, to come together in each common vertex. The focus is hence the way market areas are organized in space, rather than their shape.

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Networks and Spatial Economics, 5: (2005) 5–20

On the Genesis of Hexagonal Shapes

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Abstract

Hexagonal shapes for market areas have been dominant in spatial economics ever since Christaller observed them and Lösch explained their emergence in terms of optimality. It is observed in the following that, though hexagons are best, the differences to for instance squares in terms of efficiency are negligibly small. As the existence of hexagonal shapes—in the space economy, as well as in beehives or other patterns of the physical world cannot be denied—a different cause for their emergence is proposed. Such an explanation is structural stability, which allows three market areas, but not four or six, to come together in each common vertex. The focus is hence the way market areas are organized in space, rather than their shape.

Keywords: Market areas, tessellations, transversality

Introduction

Hexagonal shapes for market areas have been generally accepted ever since Christaller (1933) observed them empirically, and Lösch (1954) explained their emergence in terms of their optimality in terms of compactness, hence economy of minimal total transportation cost.

Circular market areas would be the best solution for isolated firms, so the famous reasoning goes, but in aggregate circles cannot pave the plane or any portion of it. There would result overlaps or empty interstices. When pushed together, deformable circles would change their shapes to polygons. Obviously, there cannot be any concave section of the common boundaries. Any consumers located in the area enclosed by a concave boundary section and its tangent, could be supplied at a lower transportation cost by the firm inside the boundary rather than by the competitor. Hence, if exclusively convex areas meet, the boundaries must be made up of straight line segments. Supposing further that the firms are identical, and hence have market areas of equal size, we are left with a choice among the three regular tessellations by equilateral triangles, squares, or regular hexagons, as well known from geometry.

A hexagon has 120 degree angles, so three of them can come together in each corner, making the total of 360. Likewise, four squares with 90 degree angles, or six triangles with 60 degree angles again make up 360. But this exhausts the possibilities. The pentagon will not do, because three of their 108 degree angles only make 324 degrees, so the plane has to be warped to fit three pentagons. Twelve such pentagons actually make up a regular closed surface in three dimensions, and polygons with more corners than six cannot even be fitted

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on a curved surface. All this was known to Kepler, and, as for the plane, even to Greek antiquity. See Coxeter (1969) and Fejes Tóth (1964) for more detail.

Once we have this choice among the three tessellations, it is easy to show that the hexagon is more compact and more economical than the square, which in its turn is better than the triangle. This is easily acceptable for intuition, because, the hexagon comes closer to the ideal circular shape than the square and the triangle. Of course, an octagon would be even better, but, unfortunately, as we know, it is not admitted as a candidate.

We have to be more explicit as to what compactness means. In the traditional context of the isoperimetric problem, it means maximum area enclosed by a boundary of given length, or minimum boundary length that encloses a given area size. According to legend, Queen Dido of Carthage, when defeated, was offered as much land as could be covered by the hide of an ass. Cunningly, she cut it in as a thin a thread as possible, and laid it out in the shape of a circle. If we had plenty of Didos, competing for space, they would be squeezed together in hexagons. Apart from legend, medieval cities, surrounded by defence walls, often took a circular shape.

Of course, the relation of boundary length to area enclosed is not the same as the relation of transportation cost to area. We have to make this explicit, and, even if the result often is the same for compactness in terms of minimal boundary length and minimal transportation cost, there are differences. In particular two important issues are involved.

(i) As soon as we talk of transportation cost in two dimensions, we have to specify which kind of transportation metric we assume. Given a suitable Manhattan metric, the square is even more economical than the circle, as we will see below.

(ii) Even assuming the Euclidean metric, which Lösch took for granted, the actual advantage of a hexagon over a square is much smaller in terms of transportation cost (about 1.4 percent saving), than in terms of boundary length (about 7.8 percent saving), which is remarkably small already.

In the sequel we will argue that the actual differences in terms of compactness are so small that it is questionable whether hexagons, when they turn up in the real world, should be attributed to optimality. As a matter of fact they turn up with surprising frequency: See Weyl (1951), Tromba (1985), and Ball (1999).

The most well known everyday experience is the hive of the honeybee, whose cells are hexagonal in crossection. Darwin attributed this to a "wonderful instinct" which was the ultimate evidence for his evolution theory, as it even selected those bees who could best "economize with labour and wax" as those fittest to survive. From biology we also know of the radiolarians (Aulonia Hexagona), tiny spherical organisms whose silicon skeletons are made of hexagonal cells, as illustrated by d'Arcy Wentworth Thompson (1961) in his beautiful book.

From physics we know of Bénard's famous experiment, where a shallow viscous liquid in a cylinder is heated from below, and organizes into hexagonal convection cells, where the liquid rises in the centre of each cell and falls at its boundary. Sometimes atmosphere works as a Bénard liquid, and hexagonal imprint of the winds have been photographed in desert sand. And, from chemistry, similar structures in diffusion have been reported.

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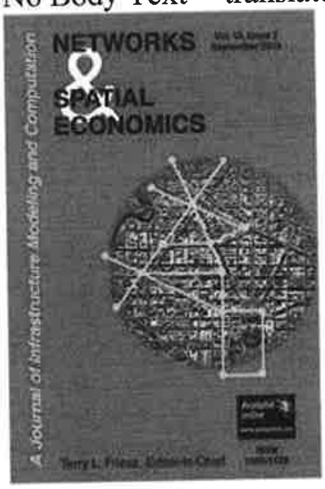

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Appendix 4

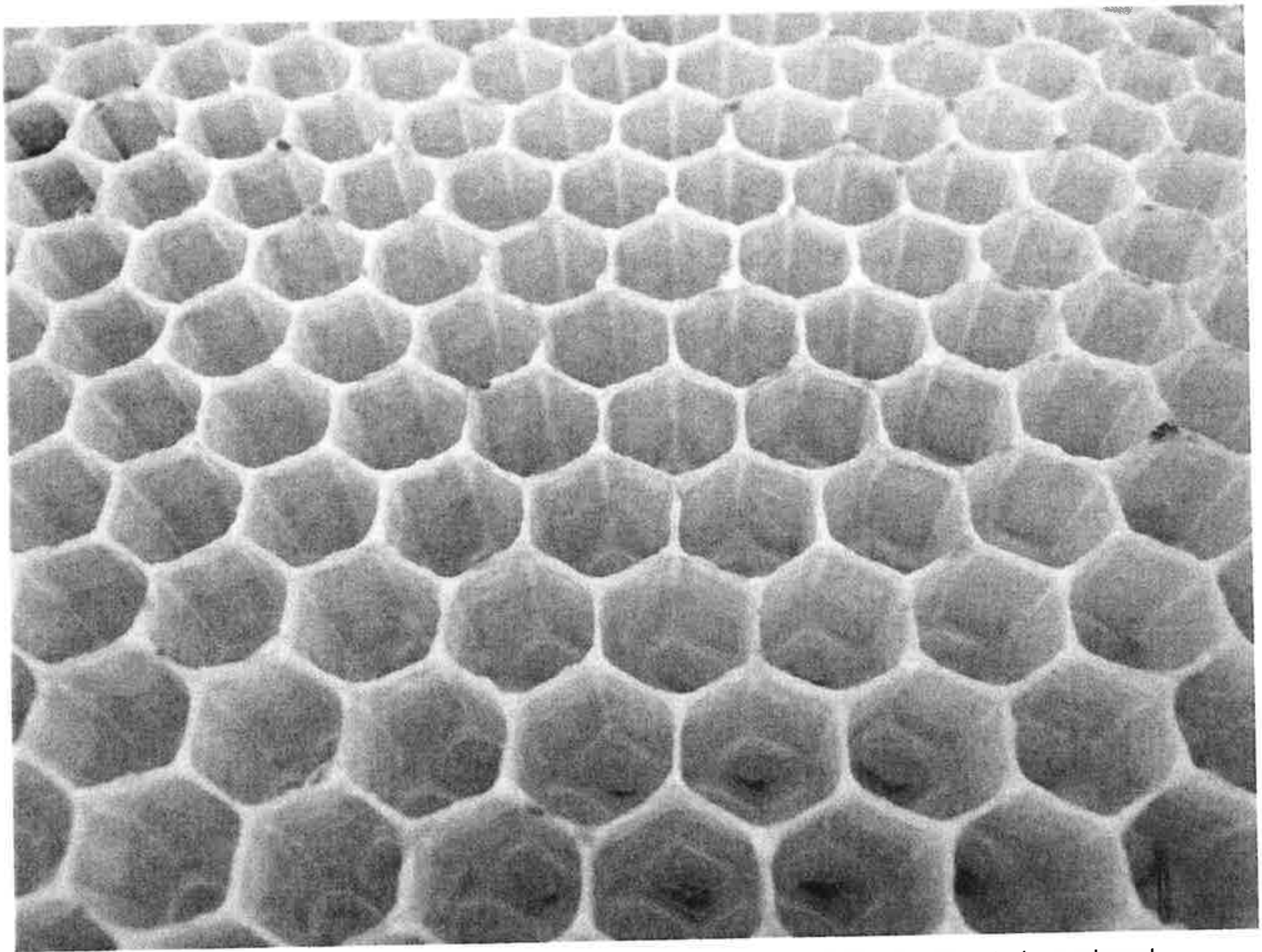
Appendix 4

How honeycombs can build themselves

Physical forces rather than bees' ingenuity might create the hexagonal cells.

Philip Ball

17 July 2013



The regular hexagons of honeycombs might owe more to the laws of physics than to honeybees' engineering prowess.

CORDELIA MOLLOY/SPL

The perfect hexagonal array of bees' honeycombs, admired for millennia as an example of natural pattern formation, owes more to simple physical forces than to the skill of bees, according to a new study.

Engineer Bhushan Karihaloo at the University of Cardiff, UK, and his co-workers say that bees simply make cells that are circular in cross section and are packed together like a layer of bubbles. According to their research, which appears in the *Journal of the Royal Society Interface*[1], the wax, softened by the heat of the bees' bodies, then gets pulled into hexagonal cells by surface tension at the junctions where three walls meet.

This finding feeds into a long-standing debate about whether the honeycomb is an example of exquisite biological engineering or blind physics.

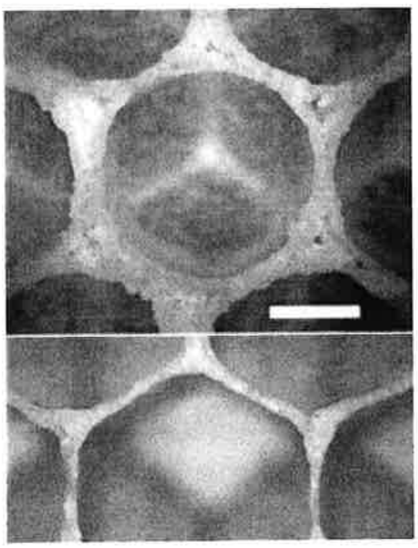
A regular geometric array of identical cells with simple polygonal cross sections can take only one of three forms: triangular, square or hexagonal. Of these, hexagons divide up the space using the smallest wall area, and thus, for a honeycomb, the least wax.

This economy was noted in the fourth century AD by the mathematician Pappus of Alexandria, who contended that the bees had "a certain geometrical forethought". But in the seventeenth century, the Danish mathematician Erasmus Bartholin suggested that the insects need no such forethought. He said that hexagons would result automatically from the pressure of each bee trying to make its cell as large as possible, much as the pressure of bubbles packed in a single layer creates a hexagonal foam.

In 1917, the Scottish zoologist D'Arcy Thompson argued, again by analogy with bubbles, that surface tension in the soft wax will pull the cell walls into hexagonal, threefold junctions[2]. A team led by Christian Pirk, then at the University of Würzburg in Germany, showed in 2004 that molten wax poured into the space between a regular hexagonal array of cylindrical rubber bungs does indeed retract into hexagons as it cools and hardens[3].

Hot wax

Karihaloo and his colleagues seem to have clinched this argument with their study. The team interrupted honeybees making a comb by smoking them out of the hive, and found that the most recently built cells have a circular shape, whereas those just a little older have developed into hexagons. The authors say that the worker bees that make the comb knead and heat the wax with their bodies until it reaches about 45 °C — warm enough to flow like a viscous liquid.



The idea that the bees might first make circular cells, which become hexagonal subsequently, was proposed by Charles Darwin. But he was unable to find convincing evidence of it. Karihaloo explains that he and his colleagues got their idea from earlier experiments they conducted on a bundle of circular plastic straws, which developed hexagonal cross-sections when heated and squeezed[4].

It might seem like there is not much left for the bees to do once they've made the circular cells. But they do seem to be expert builders. They can, for example, use their head as a plumb-line to

When first made, the comb cells of the Italian honeybee (*Apis mellifera Ligustica*) are circular (top), but after two days they already look more hexagonal (bottom).

REF 1

measure the vertical, tilt the axis of the cells very slightly up from the horizontal to prevent the honey from flowing out, and measure cell wall thicknesses with extreme precision. Might they not, then, continue to play an active part in shaping the circular cells into hexagons, rather than letting surface tension do the job?

Physicist and bubble expert Denis Weaire of Trinity College Dublin suspects that they might, even though he acknowledges that "surface tension must play a role".

Weaire adds that "if the bee's internal temperature is enough to melt wax, the temperature of the hive will always be close to the melting point, so the wax will be close to being fluid. This may be more of a nuisance than an advantage."

But Karihaloo explains that not all the bees act as 'heaters'. "The ambient temperature inside the comb is just 25° C", he says. Besides, he adds, the insects strengthen the walls over time by adding other materials to it, creating a kind of composite.

Nature doi:10.1038/nature.2013.13398

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2 comments

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Mark Fergerson • 2013-07-23 07:54 AM

So there is doubt that bees "engineer" the hexagons in their hives. Are paper wasps then the intentional geometers of the insect world? I see no potential for a surface tension effect in their nests.

Jim May • 2013-07-20 04:48 AM

Exquisite engineering or blind physics? To give this article some balance, here is an evaluation that supports the exquisite engineering idea. "If honeycombs were the product of blind physics alone, why are they so precise in beehives? Columnar basalt is an example of natural law at work without design. When some lava flows cool, they crack into polygonal shapes, usually hexagons—but not always. Displays like Devil's Postpile in California, spectacular as they are, show the limits of natural law; irregular polygons, falling into piles at the base. Nothing forces them to assemble at precise angles or thicknesses for any conceivable function. Similarly, bubbles on the surface of water can sometimes assume hexagonal borders due to surface tension, but are rarely free of defects. Honeycomb hexagons, by contrast, are very orderly and regular, maximizing space and minimizing wax, for a specified purpose: creating space for honey storage and the raising of young. Another example can be found with arches. Natural arches can be very large and spectacular, but we can tell intuitively whether an arch is natural or designed. The Arc de Triomphe in Paris, the arches in a basement supporting a building, or the arches in a Roman aqueduct spanning a canyon for miles, would never result from natural law. Why do they differ from Delicate Arch in Utah? Delicate Arch doesn't do anything. It has no specification, no purpose. There, a sandstone fin eroded, weakest part first, till the most stable structure – an arch – formed and enlarged till it stands near to collapse, joining other arches in the park where gravity took over. No mind was involved. The man-made arches, though, required a mind. They function for artistry (commemorating a military victory), for architecture, or for carrying water. Because they function, the design specs for them are more critical and precise. Some Roman aqueducts, still standing today, maintained a very, very slight declination to keep the water flowing for over 30 miles, despite hills and canyons along the route. Just because bees know how to use surface tension does not mean they are bystanders in a blind process of physics. On the contrary, knowing how to use natural law efficiently is evidence of intelligent design. If a bee can start with a round hole and use surface tension to help mold it into a hexagon, the bee is working smart, just as much as an engineer using gravity to advantage. The bee doesn't just let nature do it. The bee supervises the result, ensuring that the resulting honeycomb meets the requirements for precise wall thicknesses and inclinations of the cells. The intelligent design in the case of honeycomb construction resides not in the brains of the bees themselves, but in the instinctive abilities programmed into them. They carry out the programmed instincts like miniature robots. That presupposes a robot-maker. Who was it? That's an interesting question, but it's beyond the scope of intelligent design theory. Just as one can tell an aqueduct was designed without knowing the designer, one can infer intelligent design in honeycombs from the specified complexity observed, whether or not certain natural laws come into play during its construction. The observation of design does not require knowing the identify of the designer, but makes belief in a personal, purposeful God, such as the God of the Bible, the most reasonable step of faith in the direction the evidence points." - See more at: http://crev.info/2013/07/do-honeycombs-just-happen/#sthash.nzj04i88.dpuf So to fully support the blind physics idea, these objections addressed in this summary need to be dealt with.

See other News & Comment articles from *Nature*

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The Water System of The Project for Australia

General Notes

The Water System of The Project has been designed to optimally harvest and manage water on a landmass continental basis of the world. For Australia, The Water System of The Project has been designed to optimally harvest and manage water for the landmass continent (and sovereign nation) of Australia. On an international scale and application, The Water System of The Project has been designed to optimally harvest and manage water for, and on behalf of, each sovereign nation/state within each landmass continent throughout the world.
It is also important to point out, that the Water System is just as relevant to any island which is, in its own right, a landmass continent on a small scale.
The water targetted for harvesting will primarily (but not exclusively) be water from precipitation which begins to 'run off' anywhere on each landmass continent. The 'run off' water from precipitation is not intended to be confined to precipitation which falls in a liquid form, but to also include precipitation which falls onto land in a solid state (as snow and/or ice) but, which eventually transforms (melts) from its solid state into its liquid state.
While the primary source of the water being captured is 'run off' precipitation, The Water System of The Project will be able to harvest any other sources of water within (or adjacent to) designated catchment areas.
Other sources of water which could be considered for harvesting in the The Water System of The Project, includes aquifers, subterranean deposits/flows, public dams, river systems, sea water.
NOTE: Human sewerage for treatment should not be considered as a source of water in this Water System.

The Water System of The Project will comprise three (3) distinct phases:
Phase 1 - The capture of water from strategically-located drainage systems of The Project's Water System; and, the transfer of that water to strategically-located water storage areas of The Project's Water System.
Phase 2 - The receival, and secure holding, of water captured in Phase 1 within strategically-located water storage areas of The Project's Water System. In these areas, the water will tested and analysed, and subsequently treated to produce water for the purpose required.
Phase 3 - The water will be distributed within The Project's Water System by a system of pipelines between all areas where water is stored, and to the the point of end-use, i.e. wherever water is reasonably required.
NOTE: The energy required to constantly move the water within The Water System of The Project, will come from The Energy System of The Project.

Phase 1 - Capture of Water from Drainage Systems of The Project's Water System

In this phase of The Water System of The Project, targetted sources water will be captured by an integrated drainage system purposely-designed to optimally capture water within a designated water catchment area.
While the primary source of water to be targetted for harvesting (or capture) will be 'run-off' precipitation, other sources of water will not be precluded for harvesting as, and when, required. In all cases of water sources being considered for harvesting/capture, there will be an ongoing review process of monitoring by, and reference to, appropriate authorities.
The drainage system in these catchment areas will comprise:
1 existing drainage system(s) modified/enhanced to meet the criteria of The Project's Water System; and/or,
2 new drainage system(s) purposely-constructed to meet the criteria of The Project's Water System.
The harvested water will be transferred into The Project's Water System - initially, WS&SECU's in a WS&SECA strategically-located to securely-store this water - for subsequent testing, treatment, and distribution within The Project's Water System.

Phase 2 - Secure Storage, Testing, & Treatment of Water in The Project's Water System.

In this phase of The Water System of The Project, harvested water will be securely-stored within the WS&SECU's of a WS&SECA and be subject to processing:
Process 1 - testing/analysis of the stored water to determine what materials are in the harvested water;
Process 2 - treatment of the stored water to remove/eliminate undesirable materials (soluble or insoluble) in the water; and/or, add desirable materials to the water to achieve (or exceed) a grade/quality of water to meet minimum standards required for the subsequent utilisation of that water, e.g. for agriculture, mining, other commercial, public (including environment0, and personal (incl for human consumption).
Process 3 - distributing the stored and treated water whenever, and to wherever, it is required via The Project's Water System.

Phase 3 - Distribution of Water within The Project's Water System

In this phase of The Water System of The Project, any stored water at whatever stage of processing, will be in a constant state of movement to maintain the integrity of the water in The Water System as it is being distributed:
(a) either between WS&SECU's within a WS&SECA;
(b) or, to/from WS&SECU's within other WS&SECA's;
(c) or, from WS&SECU's within a WS&SECA to an adjacent location for utilisation.

Appendix 5

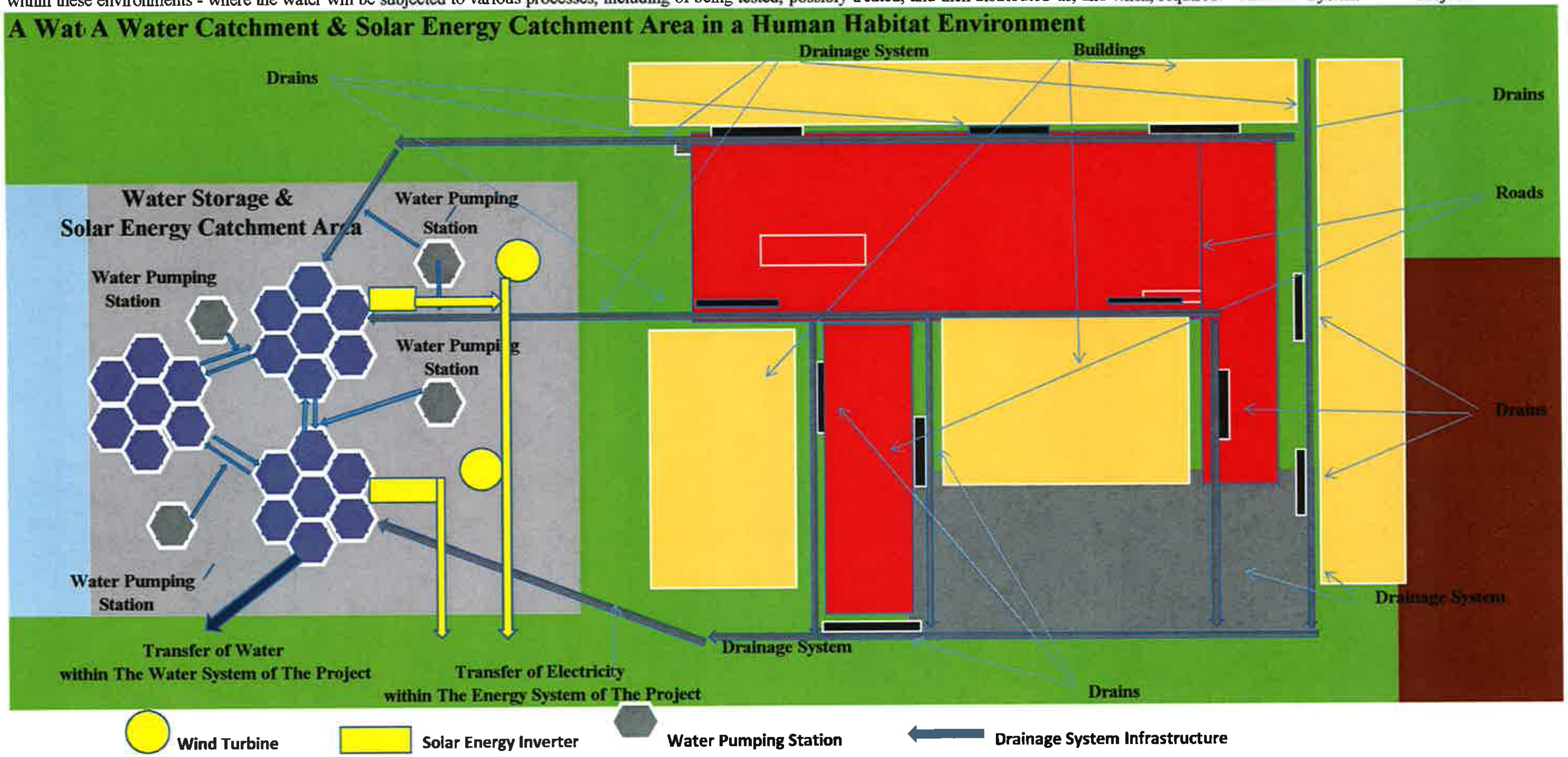
Water Capture & Solar Energy Catchment Areas ("WC&SECA's")

Plan of WC&SECA's in a Human Habitat Environments

Primarily, the WC&SECA's in these environments are integrated into a areas in which there is a wide variety of infrastructures built for human habitation, including buildings (residences, commercial premises, etc.); and, various infrastructures (roads, rail networks, airports, etc.). These environments usually include a variety of water drainage systems designed to capture water which falls as precipitation - mainly in a liquid state as rain; but, also, in its solid state (as snow and/or ice, which subsequently melts into a liquid state - and runs-off various surfaces of the infrastucture of the environment such as roads, footpaths, rooves of various buildings, etc..

The drainage systems of such environments are usually designed to transfer the captured run-off water to somewhere away from the infrastructure to prevent or minimise any potential water damage to the various infrastructures of that environment. Generally, despite some nominal examples, very little material and concerted effort is made to store any of this water for a variety of future uses.

The Project will require enhancement of all of these drainage systems so that the water captured in these systems will be initially transferred to WS&SECA's - which will be strategically-located within these environments - where the water will be subjected to various processes, including of being tested, possibly treated, and then distributed 'as, and when, required' within The System of The Project.



Water Catchment &Solar Energy Catchment Areas ("WC&SECA's")

WS&SECA in Various Natural Environments of Hills and Bushland

Primarily, the WC&SECA's in these environments will be a combination of:

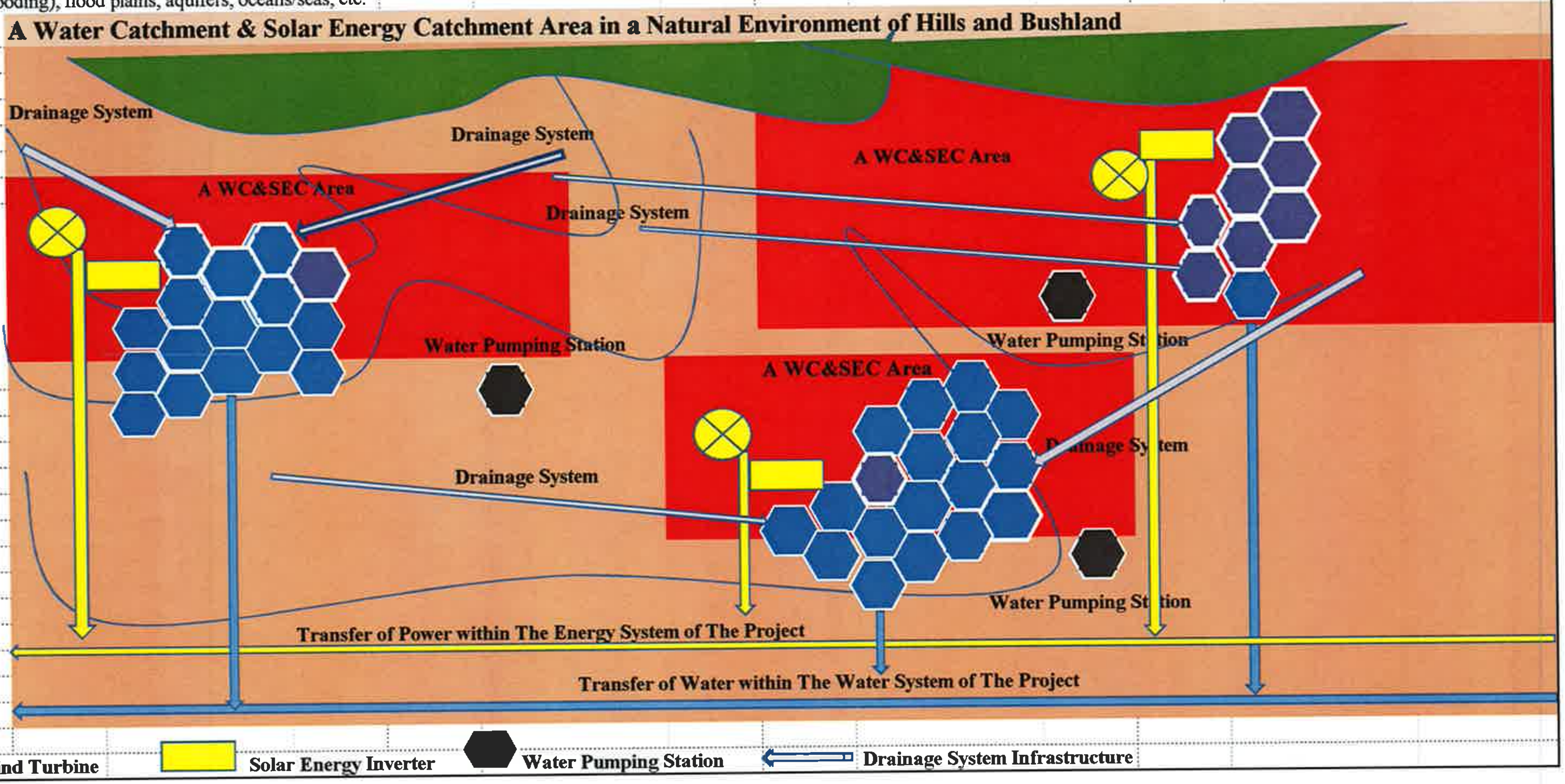
1 existing water drainage systems - which have been created naturally, and/or constructed by man to traverse the natural land environment, e.g. roads, rail lines, culverts, etc.; and,

2 new water drainage systems purposely-constructed to integrate into the adjacent natural land environment of vegetation, hills and mountains, plains, etc.

which will be adapted to optimally harness/capture water as soon as possible after it commences to 'run off' land/ground on which it falls as precipitation.

The 'run off' water will include not only precipitation which falls in a liquid state as rain but, also (where applicable) precipitation which originally fell in a solid state as snow and/or ice but, has subsequently melted into a liquid state.

The Water System of The Project will also be adapted (where desirable) to optimally harness/capture water from other sources, including from river systems (especially those that are prone to flooding), flood plains, aquifers, oceans/seas, etc.



Water Catchment &Solar Energy Catchment Areas ("WC&SECA's")

WS&SECA in Natural Environments of a River System and Flood Plain

Primarily, the WC&SECA's in these environments will be a combination of:

1 <u>existing</u> water drainage systems - which have been created naturally, and/or constructed by man to traverse the natural land environment, e.g. roads, rail lines, culverts, etc.; and,

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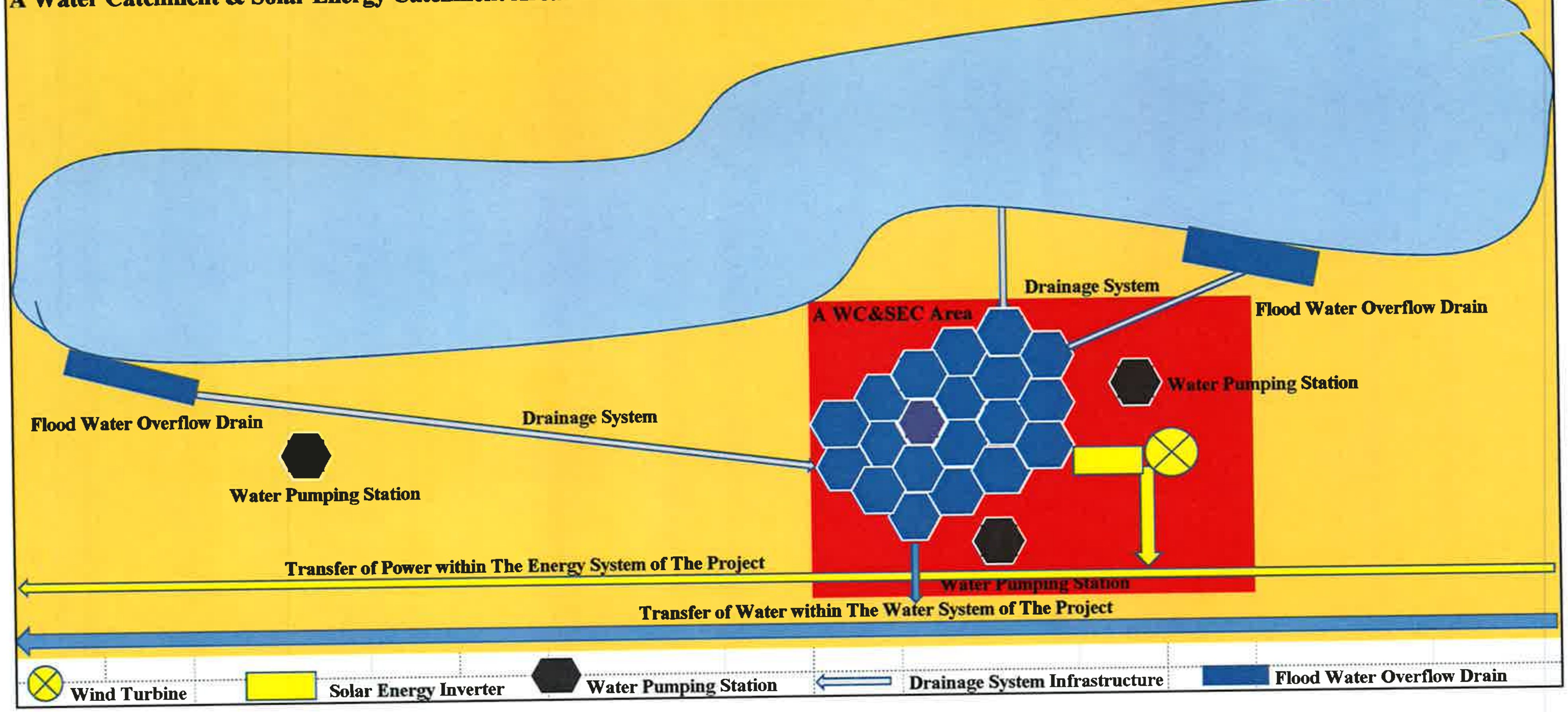
A Water Catchment & Solar Energy Catchment Area in a Natural Environment of a River System and Flood Plain



Water Catchment &Solar Energy Catchment Areas ("WC&SECA's")

Plan of WS&SECA in a Natural Environment of an Ocean/Sea and Coastline

Primarily, the WC&SECA's in these environments will be a combination of:

1 existing water drainage systems - which have been created naturally, and/or constructed by man to traverse the natural land environment, e.g. roads, rail lines, culverts, etc.; and,

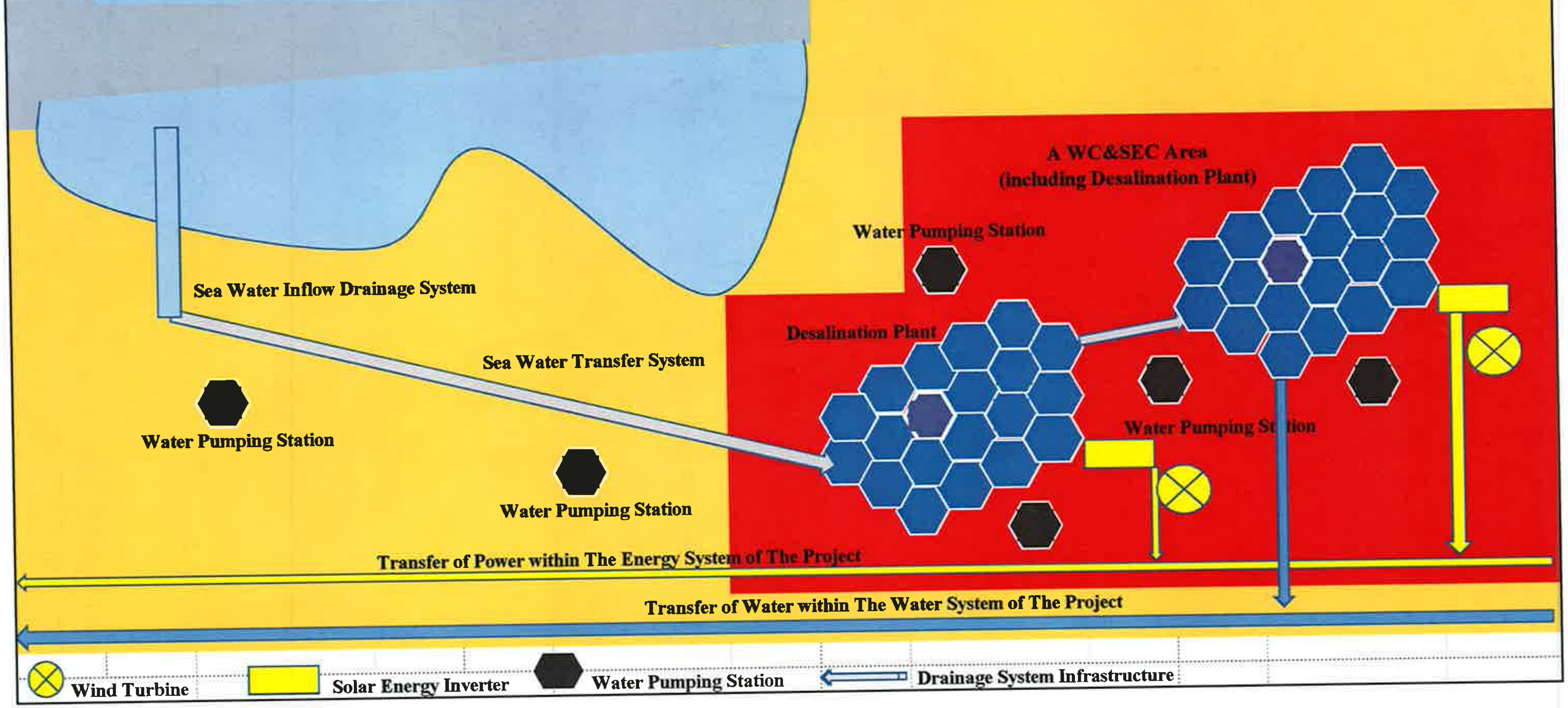
2 new water drainage systems purposely-constructed to integrate into the adjacent natural land environment of vegetation, hills and mountains, plains, etc.

which will be adapted to optimally harness/capture water as soon as possible after it commences to 'run off' land/ground on which it falls as precipitation.

The 'run off' water will include not only precipitation which falls in a liquid state as rain but, also (where applicable) precipitation which originally fell in a solid state as snow and/or ice but, has subsequently melted into a liquid state.

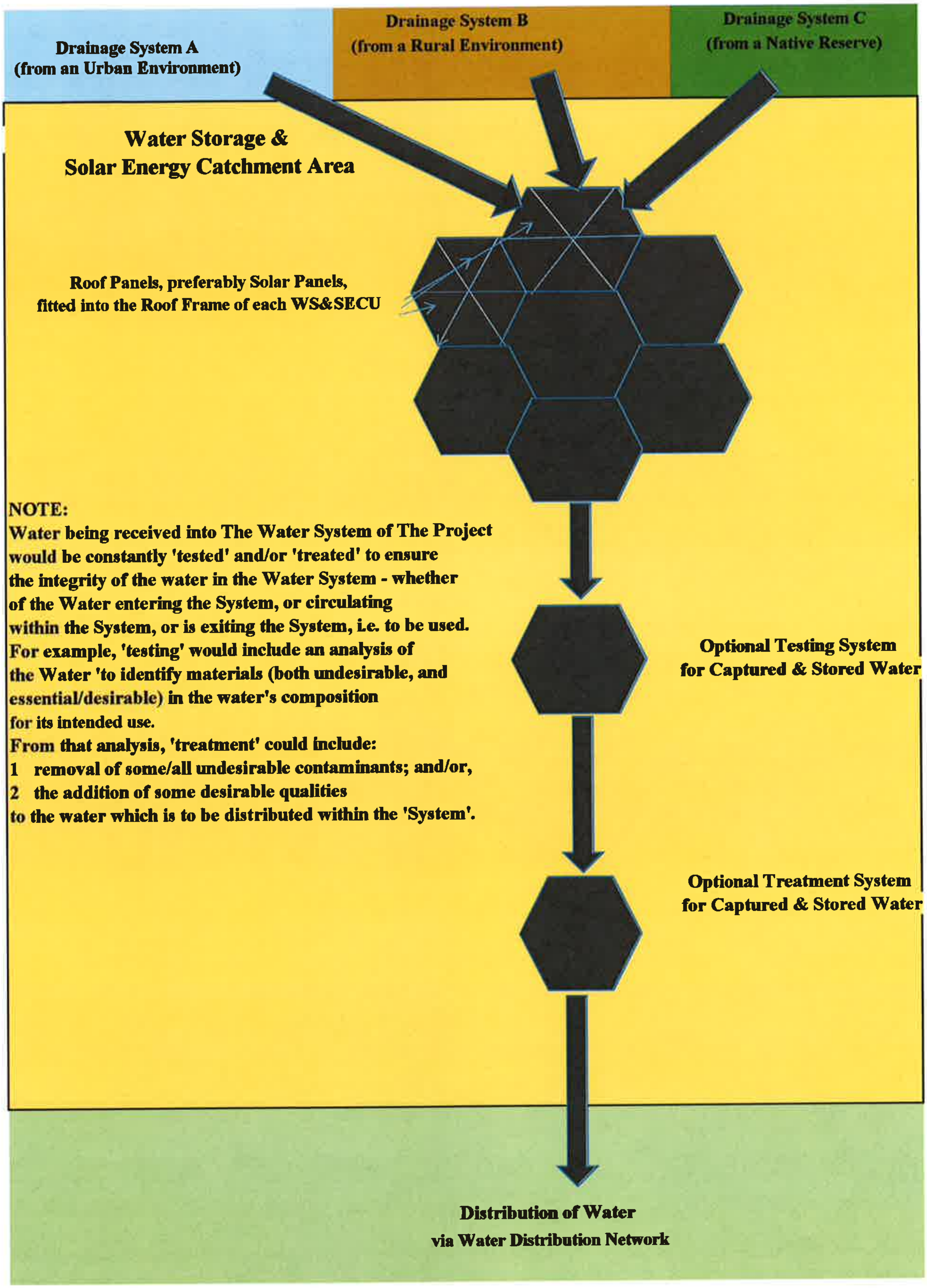
The Water System of The Project will also be adapted (where desirable) to optimally harness/capture water from other sources, including from river systems (especially those that are prone to flooding), flood plains, aquifers, oceans/seas, etc.

A Water Catchment & Solar Energy Catchment Area in a Natural Environment of an Ocean/Sea Coastline Plain

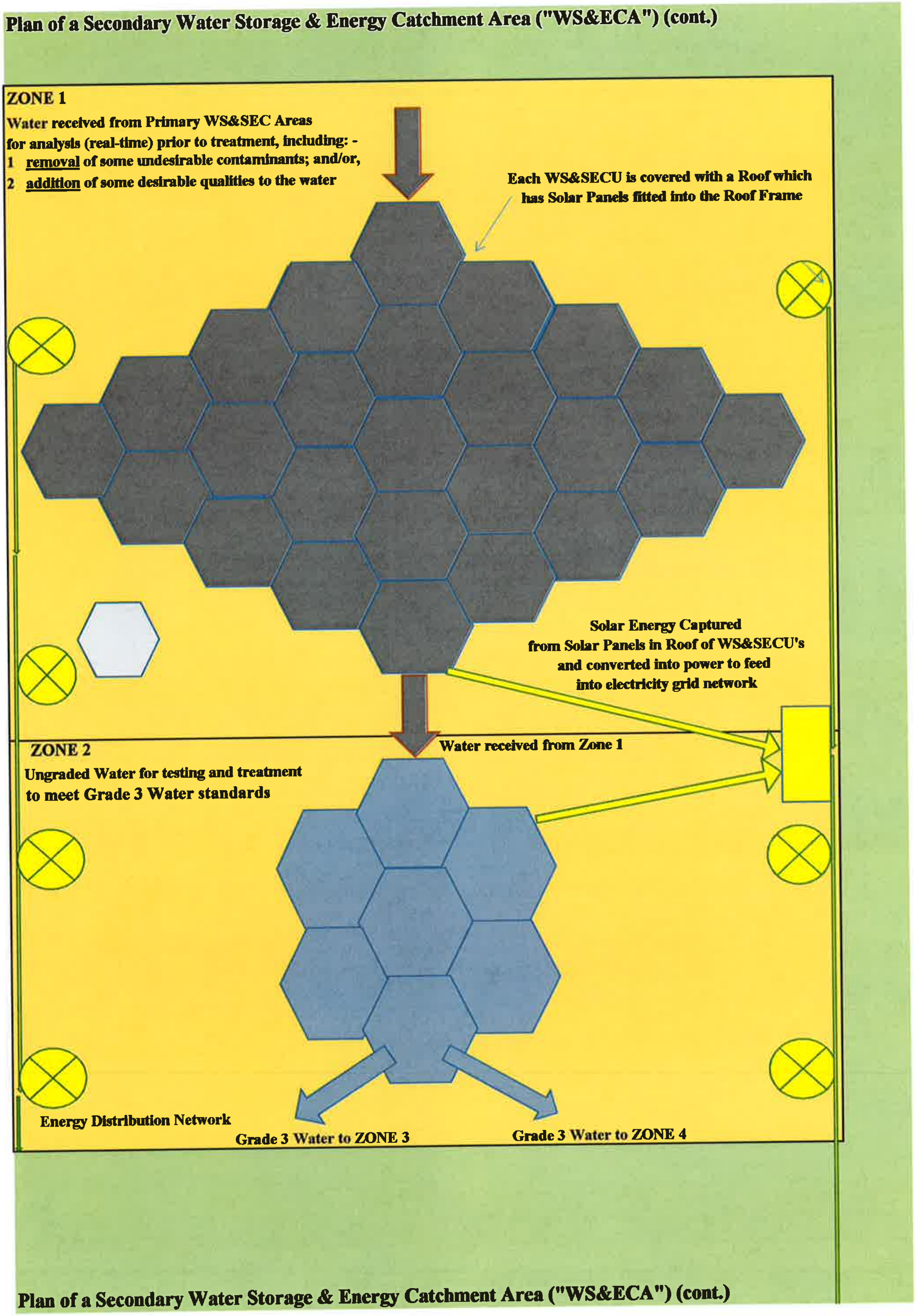


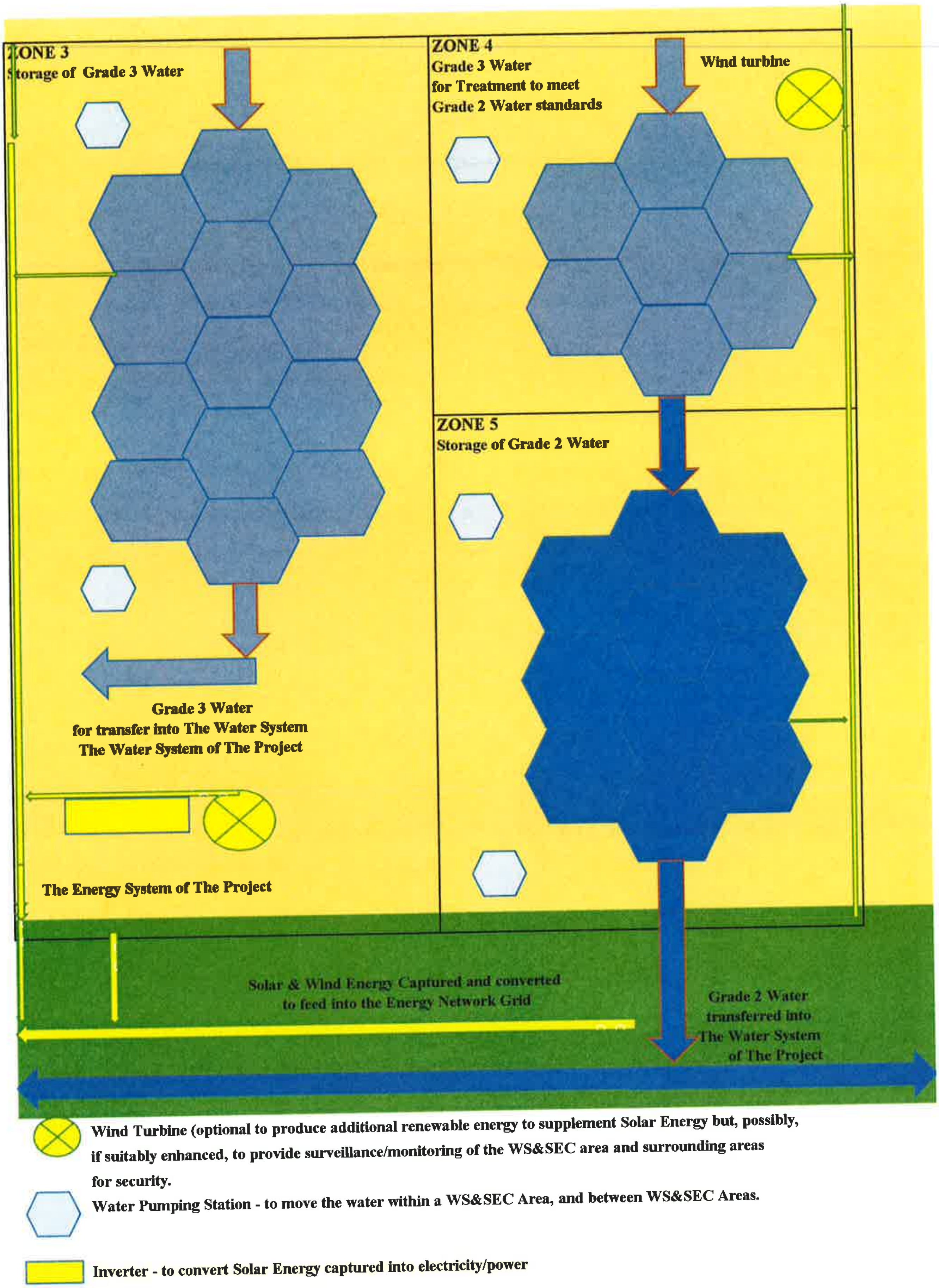
The Water System of The Project for Australia

Water Storage Facility within a Water Storage & Solar Energy Capture Area



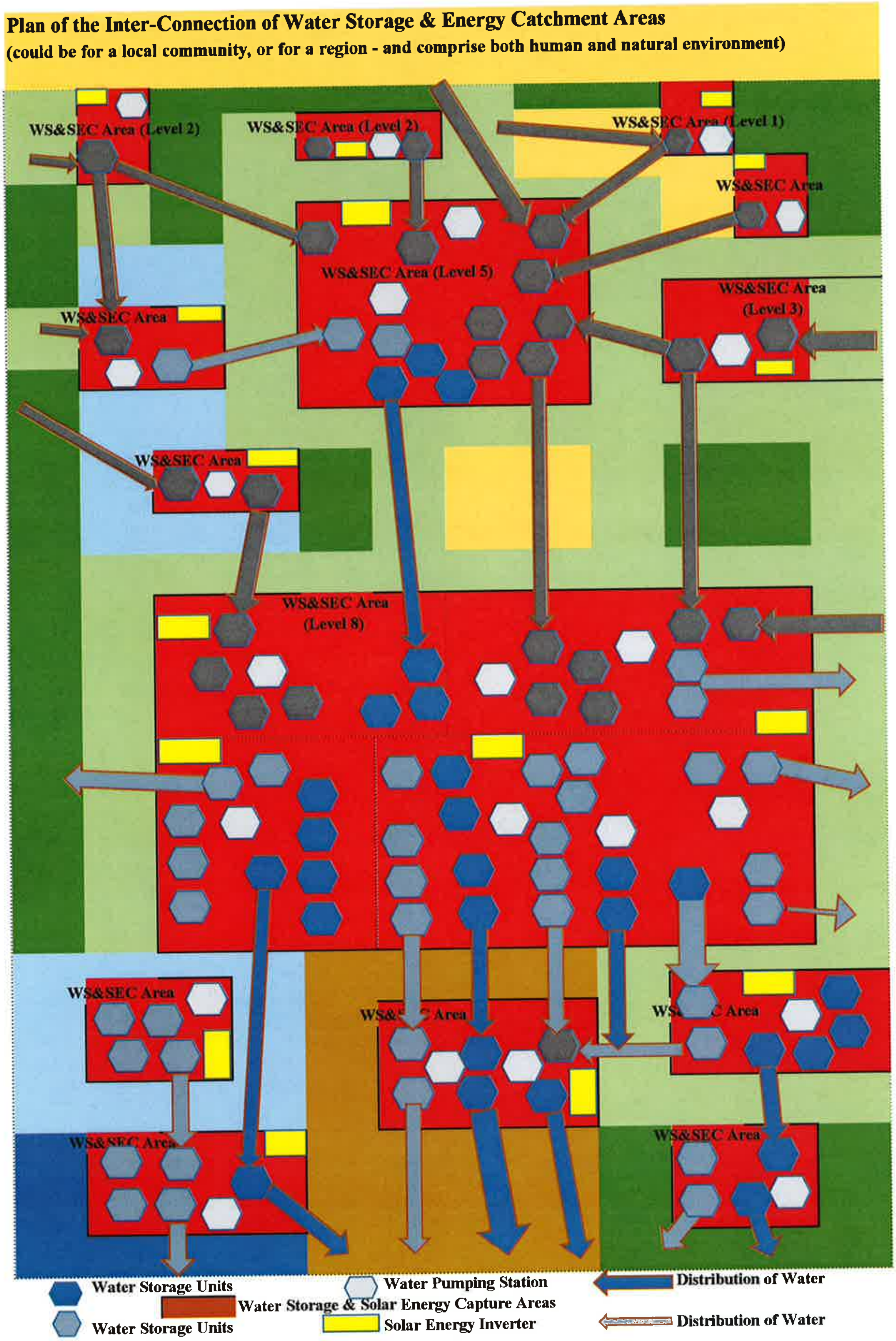
Proposed Water Storage & Solar Energy Capture Areas (WS&SECA's")




ZONE 3
Storage of Grade 3 Water
ZONE 4
Grade 3 Water
for Treatment to meet
Grade 2 Water standards
Wind turbine
ZONE 5
Storage of Grade 2 Water
Grade 3 Water
for transfer into The Water System
The Water System of The Project
The Energy System of The Project
Solar & Wind Energy Captured and converted
to feed into the Energy Network Grid
Grade 2 Water
transferred into
The Water System
of The Project
Wind Turbine (optional to produce additional renewable energy to supplement Solar Energy but, possibly, if suitably enhanced, to provide surveillance/monitoring of the WS&SEC area and surrounding areas for security.
Water Pumping Station - to move the water within a WS&SEC Area, and between WS&SEC Areas.
Inverter - to convert Solar Energy captured into electricity/power

Appendix 5

Proposed Water Storage & Solar Energy Capture Areas (WS&SECA's")



Appendix 6

United Nations' Millennium Development Goals (MDGs)

Background

The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world's countries and all the world's leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest.

2010 Summit on the Millennium Development Goals

The 2010 MDG Summit concluded with the adoption of a global action plan -- Keeping the Promise: United to Achieve the Millennium Development Goals -- and the announcement of a number of initiatives against poverty, hunger and disease. In a major push to accelerate progress on women's and children's health, a number of Heads of State and Government from developed and developing countries, along with the private sector, foundations, international organizations, civil society and research organizations, pledged over $40 billion in resources over the next five years.

2008 High-level Event on the MDGs

Governments, foundations, businesses and civil society groups rallied around the call to action to slash poverty, hunger and disease by 2015, by announcing new commitments to meet the Millennium Development Goals, at a high-level event at UN Headquarters on 25 September 2008. The gathering "exceeded our most optimistic expectations," UN Secretary-General Ban Ki-moon said, noting that it generated an estimated $16 billion, including some $1.6 billion to bolster food security, more than $4.5 billion for education and $3 billion to combat malaria.

2005 World Summit

The 2005 World Summit, held from 14 to 16 September at United Nations Headquarters in New York, brought together more than 170 Heads of State and Government. It was a once-in-a-generation opportunity to take bold decisions in the areas of development, security, human rights and reform of the United Nations. The agenda was based on an achievable set of proposals outlined in March 2005 by Secretary- General Kofi Annan in his report "In Larger Freedom".

Millennium Summit

In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at United Nations Headquarters in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals.

UN Millennium Project

The Millennium Project was commissioned by the United Nations Secretary-General in 2002 to develop a concrete action plan for the world to achieve the Millennium Development Goals and to reverse the grinding poverty, hunger and disease affecting billions of people. In 2005, the independent advisory body headed by Professor Jeffrey Sachs, presented its final recommendations to the Secretary-General in a synthesis volume "Investing in Development: A Practical Plan to Achieve the Millennium Development Goals."

UN Millennium Campaign

The United Nations Millennium Campaign, started in 2002, supports and inspires people from around the world to take action in support of the Millennium Development Goals. Watch the videos by the Millennium Campaign on poverty, education, women's empowerment, maternal health and the environment and discover how the lives of ten ordinary people around the world are impacted in profound ways by the level of progress their countries have made towards achieving the Goals.

"Eradicating extreme poverty continues to be one of the main challenges of our time, and is a major concern of the international community. Ending this scourge will require the combined efforts of all, governments, civil society organizations and the private sector, in the context of a stronger and more effective global partnership for development. The Millennium Development Goals set timebound targets, by which progress in reducing income poverty, hunger, disease, lack of adequate shelter and exclusion — while promoting gender equality, health, education and environmental sustainability — can be measured. They also embody basic human rights — the rights of each person on the planet to health, education, shelter and security. The Goals are ambitious but feasible and, together with the comprehensive United Nations development agenda, set the course for the world's efforts to alleviate extreme poverty by 2015. "

United Nations Secretary-General BAN Ki-moon

Appendix 7

C.Y. O'Connor

The following is an extract of an interview conducted by George Negus in 2004
C.Y. O'Connor was one of Australia's greatest engineers.
His spectacular achievement was to pump water six hundred kilometres to Kalgoorlie. The massive pipeline is still the lifeline to the West Australian Goldfields.
Biographer Tony Evans says, "Many people at the time thought it was complete madness. It was the most expensive project in the Commonwealth, twenty one and a half million pounds!"
GEORGE NEGUS: Anyway, moving right along. Like Charles Sturt, our next historical obsessive thought he had the answers to Australia's extremely dry interior - a lot drier than where we are right now - except that he just might have been right.
TONY EVANS, AUTHOR: Many people at the time thought it was complete madness. It was the most expensive project in the Commonwealth. It eventually cost him his life. It would be the longest pipeline in the world, uphill - never been done anywhere in the world before. O'Connor was one of the great engineers of the Victorian era. He designed the Mundaring Weir to trap water to pump to Kalgoorlie. In those days there was no Green Party to insist upon ecological inquiries and so on, and it was all done in five years. O'Connor, like all geniuses, was a bit difficult to work with. He knew his subject so thoroughly, he was very confident. He didn't like red tape and he cut corners and this resulted in him making enemies. He had the most terrible criticism in Parliament - wounding criticism, ignorant criticism - and, of course, this got to him in the end. And although O'Connor might have been very difficult in many ways to work with - very exacting and very strict - he was also very considerate of his work force. If you see Mundaring pumping house today, it's a very beautiful building and it would have been a pleasant environment to work in. Steam pumps pumped the water in sections uphill until Coolgardie, and then, of course, from Coolgardie down to Kalgoorlie was downhill - the water just flowed downhill at the end.
He was accused of getting kickbacks. There were enormous contracts. The newspapers immediately thought that O'Connor was lining his own pocket. He wasn't. There were stories in the 'Sunday Times' about the dam wall possibly breaking and the whole of Perth being flooded with water. The poor man really was literally driven to his grave. The popular story that has been taught in schools for many years is that he committed suicide because the water didn't come through when he said it would and that the pipeline was a failure. But that's not true at all, of course. He knew exactly how long the water would take to get through. He knew. And the pipeline was working perfectly. The day in 1902, he rode out on the sands south of Fremantle and he shot himself. One of the tragic details that comes out of that in the inquest was that he took his teeth out and put them in his pocket before he shot himself.
After O'Connor's death, there the water came through at Mount Charlotte Reservoir in Kalgoorlie. There was great fanfare. But, of course, one person was missing from the grand photographs at the time, and that was the engineer and chief.
DIANA FRYLINCK, NATIONAL TRUST: Sir John Forrest was actually quoting the bible when he opened the scheme. He said, "We have made a way in the wilderness and rivers in the desert." 100,000 people and 6 million sheep rely on the pipeline.
TONY EVANS: Not only has Kalgoorlie and Coolgardie benefited, but all the towns, all the farms along the pipeline. And it's just expanded and expanded, and to the present day.
C.Y. O'CONNOR: "The Coolgardie scheme is alright and I could finish it if I got the chance and protection from misrepresentation, but there's no hope of that now."
TONY EVANS: He was one of Australia's great engineers. He deserves to be recognised, really, as one of the great historical figures in Australia as a whole.
GEORGE NEGUS: C.Y. O'Connor - without him and his pipeline, it's highly unlikely that dry old Kalgoorlie would exist today.

The Pipeline CY O'Connor Built tells the story of the Mundaring to Kalgoorlie pipeline designed by Engineer-in-Chief CY O'Connor. The pipeline carries fresh water from the hills on the outskirts of Perth to the eastern goldfields of Western Australia, across a distance of 560 kilometres. It took five years to build and was completed in 1903. It is still in use today and supplies water through 8000 kilometres of pipe to almost 100,000 people and 6 million sheep throughout the goldfields and surrounding agricultural areas.

Appendix 8

The R-G WAREA Project – An Overview

[redacted]

Ernie Bridges

The following is an extract of an interview conducted by George Negus in 2004
'Ernie Bridge wants the notion of water restrictions to be a thing of the past for all Australians. He believes that the major river systems of northern Australia can be harnessed to provide a renewable water source. His vision is of a pipeline that carries water from Lake Argyll to Perth, and that's just the beginning.
GEORGE NEGUS: Ernie, good to see you again.
ERNIE BRIDGE: Good to see you, George.
GEORGE NEGUS: Your view, I've been reading notes about what you feel, you've actually said that you think 75% of Australia's available water is just lying idle.
ERNIE BRIDGE: Well, it is. If you take rivers like the Clarence in NSW, you combine that with the Bradfield system in Queensland - which is a range of rivers - then you have a look at the Daly, a singular river in the NT, and your Ord and your Fitzroy rivers of WA, that's five systems I've just referred to...
GEORGE NEGUS: With plenty of water?
ERNIE BRIDGE: There's about 30 million megalitres that runs out to the sea annually out of those systems.
GEORGE NEGUS: So the Watering Australia Foundation - which you've established out of frustration as much as anything else, I imagine - the plan is to take all the rivers from the Clarence in northern NSW right up the Queensland coast, across the top, over to the Fitzroy, and somehow or other harvest that. Get it together in dams or whatever, like this one, the Tinaroo, and then pipe it to the places where it's needed.
ERNIE BRIDGE: Exactly. You just take as an example the Fitzroy... The untapped river right now is the Fitzroy River in the Kimberley. 8 million megalitres per annum run off. Let's grab a small percentage of that 8 million annual run-off and redirect it into areas of the nation where that source of water can be reasonably and appropriately applied for the needs of the existing demands and the future.
GEORGE NEGUS: Do you think we're dopes, just dopes, or in denial?
ERNIE BRIDGE: No, I think we're not dopes because if you were to take a poll of the nation's people, you would see 90-odd percent of the people of Australia believing in this concept. You've got a small percentage of decision-makers and you've got a small percentage of public servants who seem to want to deny every opportunity that people put forward to advance this concept.
GEORGE NEGUS: You've been criticised, you've been ridiculed. People have used terms like 'pipedream'. And, of course, the big no-no where you're concerned and your vision is concerned is what's it gonna cost, Ernie?
ERNIE BRIDGE: Well, that's always, of course, the negative that's thrown about. And that's seized upon by the people who oppose it to scare people out of giving serious contemplation. But the interesting thing... Even though that's been around now for the period of time that I've been engaged in this concept, George, this vision - it's about 12 or 13 years now - it has never daunted the public at large from liking the concept and wanting to support it. There's enormous support out in the public.
GEORGE NEGUS: But have you costed it?
ERNIE BRIDGE: Yes. We've costed it. It's well within the affordability range, that's what I can say.
GEORGE NEGUS: How many billion?
ERNIE BRIDGE: Well, if you look at the Kimberley's pipeline, we're looking at about $3 billion all up.
GEORGE NEGUS: That was your original idea, to take it from the Kimberley, down to the dry parts of the west.
ERNIE BRIDGE: And also to offer an extension over to SA, through Alice Springs and down through Coober Pedy and then eventually into Adelaide. Because Adelaide, at the time - and, of course, still are - talking about water problems. And it was a way of solving SA's water problems, as well as, of course, fixing up entirely the State of WA. So we've costed that project. We've looked at the others to the extent that we've looked at the engineering capacity to develop them, like the Clarence and the other...the Bradfield concept. But I suppose, in all fairness, we haven't done a precise costing of those projects.
GEORGE NEGUS: But you'd think, wouldn't you, that the problem is so huge and the consequences so dire, that allocating money now for a longer term project would be the way to go?
ERNIE BRIDGE: Well, I think this is the way we've got to say as a nation, if we're going to spend a few billion dollars now, right now, and it's an investment for 100 years down the track, 200 years down the track, it will stand to reason that it'll be a good investment and a cheap option eventually. Environmentally, it's friendly. In terms of the ecosystem, it's suitable. And yet, at the same time, it provides a source of water that meets the requirements where water is necessary as well.
GEORGE NEGUS: It's a shame you haven't thought about it, Ernie. Do you think of yourself as a visionary or a
ERNIE BRIDGE: Well, never a dreamer, George. Oh, wait a minute, half true. I suppose we all have to... When we think about big-scale projects, there's times when you sort of dream about them. But I think vision is about seeing the long-term requirements of a nation.

GEORGE NEGUS: But you come from a race of people who do a lot of dreaming.
ERNIE BRIDGE: They do.
GEORGE NEGUS: With a lot of sense.
ERNIE BRIDGE: And, the other thing, I come from a race of people who know the value of water too.
GEORGE NEGUS: Indeed. You've been around for a long while! Ernie, terrific to see you.
ERNIE BRIDGE: Bye-bye, George. Lovely to see you.