Submission to DPIE on ‘Draft Greater Sydney Water Strategy

I wish to comment on some of the issues scoped in the ‘Draft Greater Sydney Water Strategy; Water for a resilient Sydney’, published in September 2021 by the NSW Department of Planning, Industry and Environment.

This draft strategy is a very comprehensive document that succinctly lays down the key challenges and priorities that need to be addressed to future-proof Sydney’s water requirements.

The following proposals are further detailed in this document and are submitted for your consideration and analyses. These proposals align with the principles and priorities stated in the draft strategy.

1. Transfer of raw water from Lake Eucumbene through a 400km long pipeline to discharge into the Warragamba reservoir.
2. Construction of water filtration plant and supply of filtered water through a 450km long pipeline to feed into the Macarthur system.
3. Irrigation of trees with treated wastewater through vertically drilled holes to achieve cooler and greener urban environment.
4. Use of microwave technology for sewage treatment.
5. An integrated system based on microwave technology for sewage treatment and phytotechnology for water reuse.

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Proposal 1: Transfer of raw water from Lake Eucumbene to supplement Warragamba storage during low flow conditions

Lake Eucumbene has a storage of 4798GL at full capacity. It receives inflow from melting snow from the Snowy Mountains. It was constructed mainly to generate electricity for irrigation. However, when there is a demand to serve potable water to people, its optimum benefit should be reconsidered. Electricity can now be generated in several ways including solar, gas and wind. Water for human consumption should take the highest priority.

During low levels in the Lake, such as when it reached 8% on 14 July 2007, it still had in excess of 400GL of effective storage in the Lake. Flow records can confirm that the Lake replenishes relatively faster from melting snows and can be a reliable source to meet Sydney water demands.

This option will require construction of an intake works, a 400km (approximate) pipeline to discharge Lake Eucumbene water into the upper reaches of Warragamba Dam. The head difference of approximately 1000m over a pipeline length of 400km would be sufficient for gravity flow. The supply can be easily turned on/off with a flow control valve. The pipeline can be laid along the existing roads.

This proposal may appear to be a far-fetched option at this stage, but its cost would be comparable (even cheaper on total lifetime cost basis) with other options such as upgrading/construction of a desalination plant.

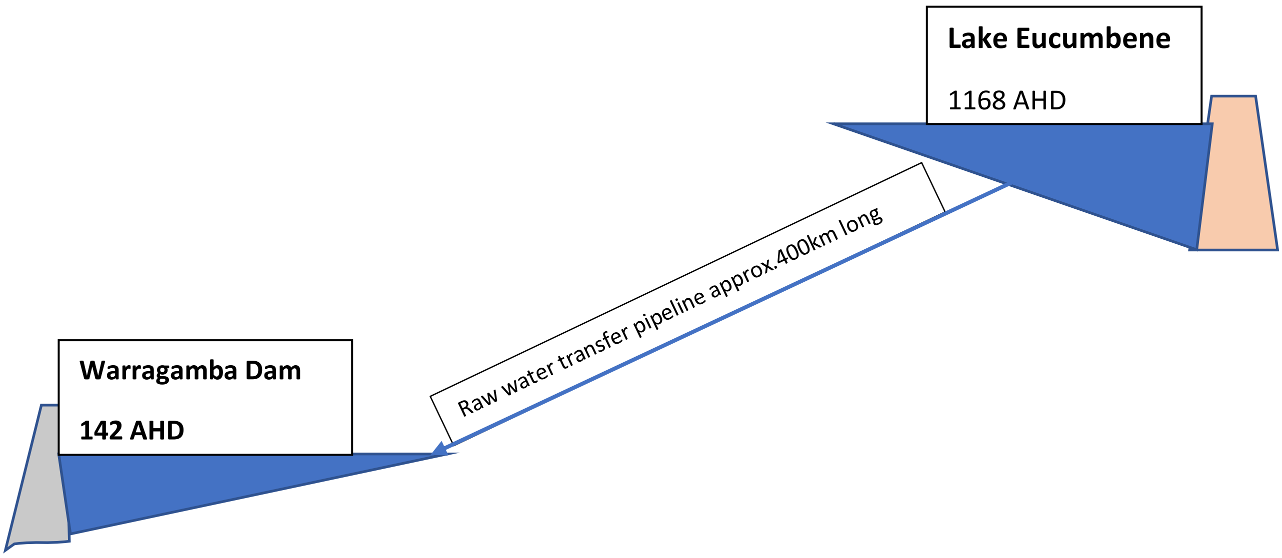

Figure 1: Schematic lay-out of raw water transfer from Lake Eucumbene to Warragamba Dam

This option, shown in Figure 1, meets the following requirement/principles/priorities specified in the draft strategy:

- Use what we have better,
- increase integration and interconnection,
- diversify supply sources,
- ready to implement when needed,
- plan for future changes.

The pipelines, in general, have a long life and require very little on-going maintenance. This option will require revision of the 'Water sharing plan" and concurrence of various stakeholders. In Table 1, relative merits of both options are compared.

Table 1: Comparison of Lake Eucumbene Water transfer with Desalination option

	Transfer from Lake Eucumbene	**Desalination plant**
Capital cost	Similar and affordable under both options	Similar
Life span	in excess of 100 years	20-25 years
Energy requirement	Nil	High
Future-proofing	Arguably, during severe droughts, this option provides lower reliability. But with a combination of demand management, lower project demands, this option would be able to meet water demands on more than 90-95% of the time	This option offers a high reliability provided a high level of redundancy is built into the regular upgrades every 10-15 years. Ratepayers and IPART may not favour rate increases for creating and maintaining idle capacity
Disposal of wastewater	Nil	High cost and stringent regulatory requirements
Ongoing O&M	Negligible	High
Ease of turning on/off	Quick and simple	Complex; takes time to start and stop
Cost of upgrades	May not be required	High, technology changes and regulatory requirements may have big impact on upgrade costs. I
Environmental issues	Diversion of some environmental flows	Disposal of brine, contaminated wash-water and other regular replacements
Contentious issues	Concurrence of stakeholders	Regulatory approvals.
Public acceptance	Most likely, the public will favour this option because it doesn't require long-term lock-in contracts, can operate on a needs basis and requires minimal energy and with no on-going costs.	Any costly upgrade will reflect in water rates and will be resented. Disposal of waste flows may get difficult and costly in the future.

Conclusion

Subject to the concurrence of the stakeholders, the Lake option offers more benefits as compared to the desalination plant option. This is an attractive option for further analysis.

Proposal 2: Transfer of filtered water from Lake Eucumbene to feed into the Macarthur region, south-west of Sydney

The draft strategy has identified Macarthur and Illawarra as the rapidly growing areas. It may be feasible to construct a water filtration plant near the Lake. The Lake water is normally of pristine quality and has very low levels of sediments and other contaminants. A simple water filtration plant that doesn't require any addition of chemicals, should be sufficient. The backwash water may be discharged into the downstream valley as environmental flows.

This option, shown in Figure 2, will require construction of a water filtration plant and a 450km long pipeline to feed into the Macarthur system. A head difference of approximately 1000m would be sufficient for gravity flow.

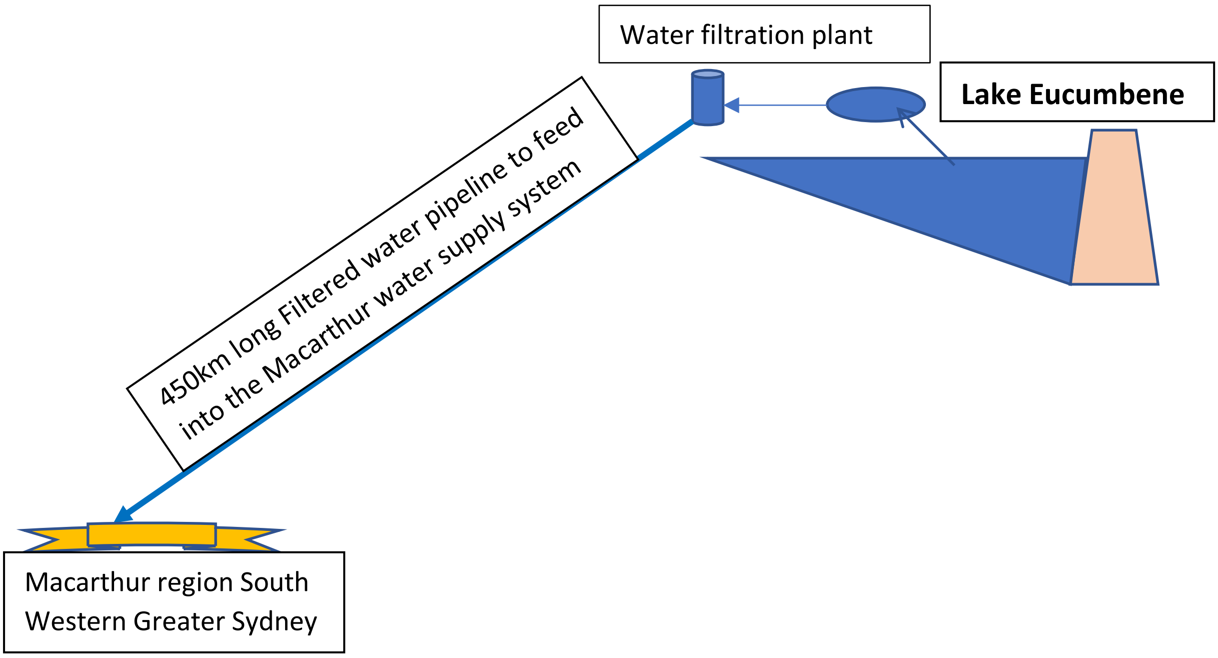

Figure 2: Schematic lay-out of filtered water transfer from Lake Eucumbene to Macarthur region.

Advantages

- It will be a supplementary source and therefore will provide some relief to the existing network.
- Other consumers along the pipeline route may benefit.
- Extension to feed into the Illawarra system could be feasible.
- A reliable source and most likely a cheaper source of water in the long run.
- It will facilitate integration and optimisation of the overall water system in Greater Sydney.

Conclusion

Due to long distance, this option may have been overlooked. But under the prevailing conditions, this option deserves detailed analysis.

Proposal 3: Using treated wastewater to irrigate trees through vertically drilled holes.

The draft strategy proposes to create quality green and cooler open spaces by increasing tree canopy and enhancing green cover by planting one million trees by 2022 and five million trees by 2030. The strategy requires to achieve this objective 'while minimising additional demand on drinking water supplies' with the use of smart irrigation technology (p.79).

Trees require water and a range of macronutirents {nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulphur (S), magnesium (Mg), carbon (C), oxygen (O), hydrogen (H)} and micronutrients {(or trace minerals): iron (**Fe**), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), nickel (Ni)}. Plants need a steady input of both macronutrients and micronutrients to achieve optimum growth. Sewage contains these nutrients in a balanced proportion. However, during treatment, these constituents are removed along with many beneficial microorganisms. In that respect, recycled water (from both wastewater and stormwater) is deficient and often leads to spindly trunks and small canopies. Nevertheless, wastewater treatment is necessary to reduce pathogen load to safeguard human health. For this reason, surface irrigation is permitted only with fully treated and disinfected wastewater. A sub-surface irrigation arrangement overcomes most of the deficiencies of a normal irrigation system.

A suggested sub-surface disposal system layout is shown in Figure 3.

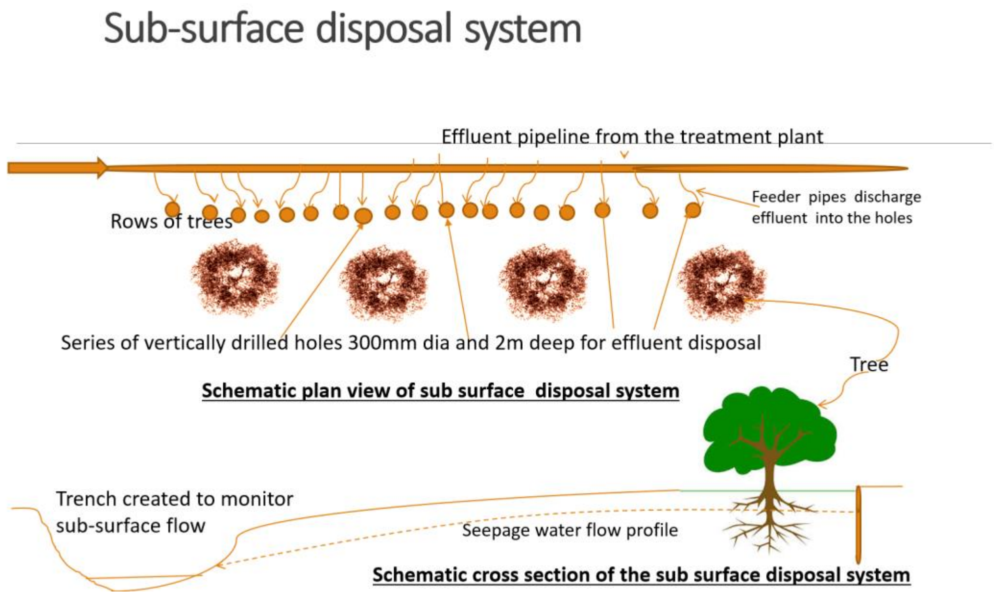

Figure 3: Schematic lay-out of sub-surface effluent reuse system

This proposal entails drilling 300mm diameter holes at a spacing of about 1.5 to 2m around each existing or a new tree. Literature suggests that each mature tree can transpire approximately 100 to 200L/day. However, to maximise the use of available effluent quantity, the input quantity should be adjusted to suit the tree size, soil characteristics, weather, tree species and ground profile.

It won't be necessary to remove all solids out of the effluent because effluent discharged underground into covered holes would remain out of contact to humans. Thus, the mixed liquor suspended solids (MLSS) would be better because it will provide all the necessary nutrients. Heavy metals, organic solids and all precipitates that settle at the bottom in the hole, will remain immobile and eventually stabilise. Soil biota species will feed on micro-organism in the effluent.

Proposal 4: Microwave technology for sewage treatment.

The 'Activated sludge process' for sewage treatment was invented in 1914 by Edward Ardern and W. Lockett. It is still being used, virtually unchanged, for designing sewage treatment plants (STP). The performance parameters for effluent discharge into rivers were based on flows in the Thames River at that time. Those parameters are still current for the design of STPs. Capital cost of a STP based on this treatment process is high and recurring operating and maintenance costs are also excessive. Disposal of effluent and sludge generated from these STPs is both expensive and environmentally challenging.

Microwave technology is a relatively development. The rapid and effective heating causes fast degradation of organic compounds, inactivation of many microorganism, and substantial reduction in pathogenic colony counts. Its destructive action on bacteria can be both thermal and non-thermal. However, the energy of microwaves is insufficient to disrupt the chemical bonds of many organic and inorganic compounds present in wastewater. Microwaves cause disruption of the bacterial cell walls, break the genomic DNA, accelerate thermal coagulation of cytoplasmic proteins and damage the cytoplasm in the bacterial cell.

Some literature suggests that with the addition of absorbents and catalysts, its treatment capacity can be enhanced and the reaction time shortened. Thus, the microwave technology presents a viable, affordable and a more efficient alternative to the activated sludge process. Figure 4 shows the conceptual lay-out of a microwave-based wastewater treatment process.

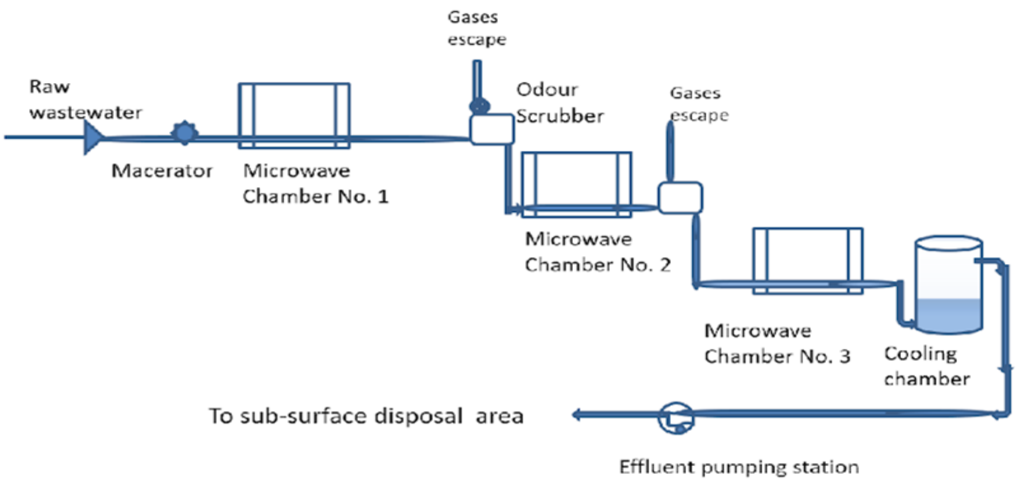

Figure 4: Conceptual lay-out of a microwave-based wastewater treatment process.

In this process, macerated sewage will flow in a sealed glass container housed in the first microwave chamber and exit at a controlled speed to ensure the desired the microwave exposure. The microwaves will heat the sewage causing some chemicals to volatilise, kill some of the pathogens and enable some chemicals to coalesce. The sewage will then flow into a vented chamber for gases to escape and flow at a controlled speed into other chambers. It will then be allowed to cool down before disposal.

The microwave concept can be easily verified in a laboratory by using a domestic microwave oven. For higher efficiency and superior results, a 2.0 kilowatt performs better than a domestic microwave (0.5 kilowatt) oven. This technology is developing rapidly and may eventually overtake current sewage treatment and effluent disposal practices.

Proposal 5: An integrated system based on microwave technology for sewage treatment and phytotechnology for water reuse.

Activated sludge wastewater treatment plants have a large footprint, high capital cost. Due to high operating costs to meet the regulatory effluent quality requirements for discharge into receiving waters, these treatment plants are expensive. Moreover, both effluent and sludge are wasted.

A new approach based on combining the microwave technology for sewage treatment and sub-surface system for disposal is proposed. The main function of microwaves will be to cause both thermal and non-thermal impacts. It is postulated that microwaves will enter the peptidoglycan cell wall, heat the cytoplasm in the cell, and cause damage to the ribosomes and chromosomes. Both chemical and organic compounds will also heat up to dispel odours and other obnoxious gases. The chamber will be designed to ensure gases escape in a controlled manner. There will be some reduction in microorganism numbers but some other microbes may proliferate. Since it is totally enclosed system, all chemical constituents will remain in suspension and would serve as a resource of vital nutrients for supporting tree growth. In order to differentiate this water from other terminologies such as recycled water, reclaimed water, greywater, blackwater, effluent or MLSS, it will be termed as 'resource-water 'in further discussion.

The drilled hole into which the resource-water will be discharged will become the main chamber for microbial activity. Here fungi will develop a symbiotic relationship with plant roots to perform an extremely important ecological role in transferring water and nutrients through mycelia into plant roots.

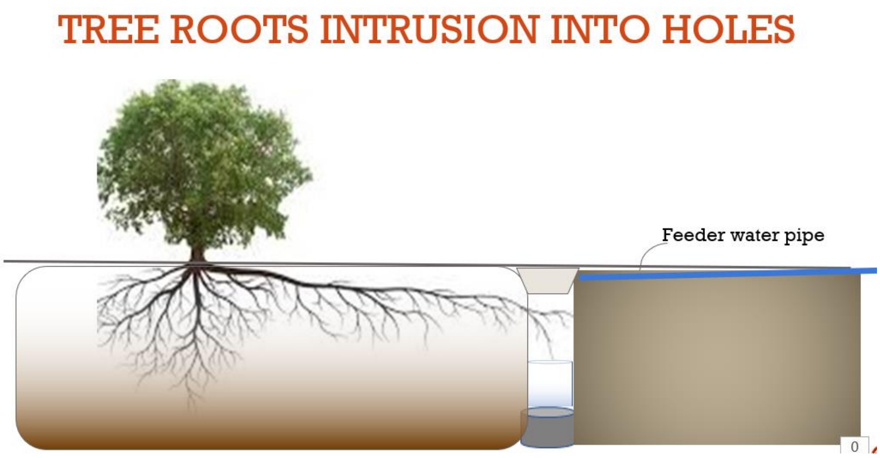

Figure 5: Root development towards the drilled hole

Roots will tend to chase the water source into the hole to take up water and nutrients at an accelerated rate. Under suitable conditions, bacteria can 'filter' out various minerals such as gold, silver, copper from the 'waste' to form concentrates. Heavy metals will tend to settle at the bottom. Chemical precipitates, and fatty acid residues will also settle at the bottom of the hole to form an impervious layer to restrict vertical infiltration. Water will tend to percolate and travel horizontally towards tree roots and surplus water will filter through the soil media and may come out at low points.

Being compact, this integrated system will be versatile that can be sized to suit the flows; from a single dwelling, to a caravan park, a high rise building to a large sub division. It will be feasible to convert a local sewage pumping station valve chamber into a microwave chamber and use resource-water locally to grow trees at a desired location. As an example, the sewage pumping station near the airport may be converted to generate resource-water for feeding shrubs in the buffer zone of the airport.

Figure 6: Drilling of holes

Trees planted along highways, roads, on creek embankments, along railway corridors, in coastal dunes, golf courses and disused lands. This method will enable trees to develop decent canopies. Resource-water can be discharged into holes as shown in Figure 6. Trees planted along highways will capture carbon dioxide and dust particles. It will assist in carbon capture and carbon sequestration.

Conclusion

Proposals presented in this submission are departures from current technology and practices. These concepts may be too confronting for consideration and adoption. For brevity's sake, in-text citations and references have been omitted. Further details will be provided upon request.

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