

TRC  
505 E. Huntland Drive  
Suite 250  
Austin, TX 78752

Main 512.329.6080

## Technical Memorandum

**To:** File

**From:** James L. Machin, P.E., CPESC

**Subject:** Comments on Vitruvian Water Accounting Plan dated 4/15/2015

**Date:** May 11, 2015

**Project No.:** 212892.0002

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### General Comments

- a) This plan is inappropriate for the requirements of this permit, needlessly complex, and inaccurate. There will be no useful information generated by attempting to implement this plan.
- b) There is no specific reconciliation schedule associated with the plan. As we previously recommended, groundwater make-up quantities should be reconciled on at least a weekly basis, i.e. data from the previous week should be used to establish the flow to be pumped for the next week.
- c) This is strictly a water quantity accounting plan and does not address quality. It is assumed that the Trinity Aquifer will be used for make-up water, as required by the permit.

### Specific Comments

1. Page 1 Introduction. The plan ignores evaporation losses from Reservoir 1. The amended water right requires Addison to pass all inflows of state water downstream, maintain both reservoirs full, and make up all losses of state water from evaporation. That must include losses from Reservoir 1. The statement “Replacement of the evaporation occurring in Reservoir 1 is not required” is incorrect and inconsistent with the clear language of the permit, which refers to reservoirs in the plural.
2. Page 1. Per #1, the mass balance equation for Reservoir 2 should be re-named to apply to both reservoirs, and the outflow should be over the dam from Reservoir 1 (i.e. Dam 1) and not “into Reservoir 1.” The mass balance equation for Reservoir 1 should be deleted.
3. Page 1. The installation of gages upstream of Reservoir 2 and at the outflow of Reservoir 1 is a poor way to determine losses, and it presents other problems as well.

- a. The upstream staff gage “attached to the vertical concrete wall near the upstream property boundary” will not provide precise flow estimates. That wall is in the backwater of the lake, and slight changes in stage will result in large changes in flow. Regardless of location, numerous direct streamflow measurements will need to be made to establish a calibrated rating curve, similar to what the USGS does at gaging stations. Even at a good gage location, such ratings are generally not sensitive enough for the small differences in flow that the plan proposes to determine, and this is a poor gage location. If the gage were moved upstream, it would have to be upstream of the pouroff above the reservoir headwaters, which would not be on the property, would also require numerous direct measurements for calibration, and would still have insufficient precision for the purpose required.
  - b. The downstream existing staff gage at Dam 1 is poorly located to provide a precise estimate of outflow over the weir. It is in the weir opening itself in an area of turbulent flow and changing velocity. Plus there are two weir openings, and they convey different flows. It will not be possible to apply a weir equation as proposed to measure flow accurately. Even if the staff gage were moved upstream into the reservoir pool away from the influence of the drawdown from the weir, it would have to be calibrated with direct measurements, and slight changes in stage will result in large changes in flow, similar to #3a.
  - c. Streamflow is a continuous variable, meaning it changes continuously. The numerous discharge measurements made by TRC showed that flows varied during each day. To make a single reading each day and assume it is representative of the mean daily flow is inappropriate. Selection of the time of such a reading would influence the calculations.
  - d. Measuring inflows and outflows requires steady-state conditions. Most of the time that will not exist, and even if accurate instantaneous measurements could be made, they would not likely be representative of mean daily inflows and outflows per #3c.
4. Page 1. Evaporation is being ignored on days when there is significant runoff (storm events). Evaporation occurs at all times and should not be ignored on any day.
  5. Pages 1-2 and spreadsheet EVAP DATA tab. The reservoirs lie in TWDB Quad 511 (page 5 of the plan mentions Quad 411). Gross lake evaporation data for Quad 511 for 1954-2013 from the TWDB indicate an average annual evaporation rate of 57.20 inches. The “TWDB Average Monthly Rates” on the tab sum to an annual rate of only 53.45 inches. Every single month on the tab is lower than the TWDB monthly averages.
  6. Pages 2-5 Elements Of The Accounting Plan and spreadsheet.
    - a. Net evaporation is inappropriately being used instead of gross evaporation. They are taking credit for rainfall; net evaporation is gross evaporation minus rainfall.

All calculations and discussions to date have used gross evaporation. All gross evaporation losses must be made up with the alternate source of water, which is groundwater from the Trinity Aquifer.

- b. Monthly tabs use an effective surface area for evaporation of 2.43 acres. The total effective area to be used should be  $2.43 \text{ (Res. 2)} + 0.63 \text{ (Res. 1)} + 0.08 \text{ (enhanced—water features)} = 3.14$  acres. Forced evaporation adds additional amounts ranging from 1600 to 6000 gallons per month.
7. A more accurate and far simpler method to determine evaporation losses is to take the daily pan evaporation data from Lake Grapevine times the appropriate TWDB pan coefficient and apply it to the effective surface area to determine the amount of make-up water required.