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DRAFT FOR REVIEW AND COMMENT

April 30, 2010 (Revised June 7, 2010)

Colorado Water Conservation Board
Office of Water Conservation & Drought Planning
Attn: Ms. Veva Deheza
1313 Sherman Street, Room 721
Denver, CO 80203

Re: Review of Sterling Ranch Precipitation Harvesting Pilot Study Application

Dear Ms. Deheza:

At your request, Wright Water Engineers, Inc. (WWE) has reviewed the *Sterling Ranch Precipitation Harvesting Pilot Study Application* (Sterling Ranch Application) dated March 1, 2010 prepared by Leonard Rice Engineers, Inc. The purpose of our review is to determine whether the Application is in conformance with the Colorado Water Conservation Board (CWCB) Criteria and Guidelines for rainwater harvesting projects and to provide comments and recommendations, as needed. Our review has focused primarily on hydrology, landscape water conservation, project monitoring, and transferability aspects of the pilot. Per your direction, we understand that the State Engineers Office (SEO) will be reviewing water rights aspects of the project, so we have not conducted a detailed review of water rights associated with the project.

Background

The Sterling Ranch development project encompasses approximately 3,000 acres in Northwest Douglas County, Colorado. The land is located south of Chatfield Reservoir, and portions of its west boundary lie adjacent to Roxborough Park. A rainwater harvesting pilot project is proposed for the development.

Colorado House Bill (H.B.) 09-1129, *Act Concerning an Authorization of Pilot Projects for the Beneficial Use of Captured Precipitation in New Real Estate Development, and Making an Appropriation in Connection Therewith*, called for the CWCB to establish Criteria and Guidelines for the applications and selection of pilot projects and, in consultation with the State Engineer, select pilot project sponsors. The CWCB definition of a rainwater harvesting pilot project is:

> *Rainwater harvesting pilot projects collect precipitation from rooftops and other impermeable surfaces and utilize the collected water for non-potable uses to evaluate water conservation potential. Pilot projects must be designed such that data collection supports the purposes identified in Section 37-60-115(6)(a), C.R.S. and further evaluates water conservation potential through pairing*

> *rainwater harvesting with advanced outdoor water demand management. Projects must be located in new residential or mixed-use development.*

This rainwater harvesting pilot program is separate from Senate Bill 09-08 which authorized limited exemptions for water collection from roofs of residences that are served by wells permitted for domestic uses as provided in C.R.S. 37-92-602.

Appendix A of the Pilot Project Application provides the CWCB Criteria and Guidelines and then gives a brief description of how the pilot project would meet the criteria and guidelines. Reference is also given to specific sections of the report that apply to the subject criteria and guideline.

General Comments

Overall, we found that the Sterling Ranch Application was in reasonable conformance with the intent of the CWCB Criteria and Guidelines. Our comments generally relate to providing additional detail on some methodologies that would improve the scalability and transferability of the pilot project monitoring results.

Based on the schedule given in the Application (p. 73) with the "Natural Conditions" and the installation of the experimental precipitation harvesting facilities, it appears that the baseline data collection for the Sterling Ranch Project (identified as Phases 1 and 2) would be in a position to begin fairly soon after authorization. The project schedule indicates one-half year to two years required for planning and implementation of Phases 1 and 2. Phase 3 is the implementation portion of the pilot rainwater harvesting system associated with new development. A clear understanding of the definition of a pilot project with regard to timeframes in the CWCB Criteria and Guidelines for the Rainwater Harvesting Pilot Project Program is important, including the following criteria:

- "The minimum two year data collection period begins once water collected through rainwater harvesting, under an approved SWSP, is applied to nonpotable demands in combination with additional demand management." (p.4)

- "…Projects must be located in new residential or mixed-use development.[6]" (p. 2) Footnote 6 (p. 11): "… Section 29-20-103, C.R.S. indicates that a development permit is generally limited to an application regarding a specific project that includes new water use in an amount more than that used by fifty single-family equivalents, or fewer as determined by the local government."

Per these criteria, for clarity, we recommend that the application clearly state that the two year time period begins with implementation of Phase 3, which involves implementation of rainwater harvesting pilot projects for new development.

The narrative of the report and the appendices differ in terms of what "will" be implemented versus what "may" or "could" be implemented, with the appendix generally being more definitive. We recommend that the terms "may" and "could" be replaced with "will" in most portions of the narrative. Where uncertainties associated with a project of this type do not enable a firm commitment, then caveats explaining the uncertainties should be provided. This is particularly important with regard to commitments for monitoring. A few examples include:

- The data collected at the Sterling Ranch site may include solar radiation, air temperature, wind speed, relative humidity/vapor pressure, and precipitation data. (p. 44)

- Daily summarized climate station data may be used to develop empirical reference ET estimates using methods such as the standardized ASCE Penman reference ET equation. (p. 44)

- A surface water monitoring program may be implemented to quantify the site-specific streamflow that accrues to the natural stream system through surface and ground water return flows from native precipitation. (p. 46)

Similarly, for the Phase 3 Pilot Project Implementation, it is not clear whether all three pilot project concepts (residential, commercial and regional) will be implemented. Given the costs of the systems presented in the report, if the project sponsors realistically envision only implementing one of the systems, then this intention should be clearly stated. Alternatively, information on the decision-making process regarding which of the alternative approaches will be implemented should be provided. As currently written, it is not clear what the Pilot Project stage (Phase 3) is currently expected to include. For context, representative language creating this uncertainty includes:

- Phase 3: New Precipitation Harvesting Designs – To represent a mixed use development, three scenarios may be used to represent precipitation harvesting in the new Sterling Ranch development. A model home may be used to represent a residential system, a commercial complex may be used to represent a commercial system, and a 10-acre neighborhood or equivalent may be used to evaluate regional precipitation harvesting. The new sites can be designed using the insight gained from Phase 1 of precipitation harvest designs. The new designs may be constructed to incorporate the best equipment, materials, and designs to effectively harvest precipitation in Colorado. (p. 40).

- As a mixed use development, Sterling Ranch could incorporate several different designs of precipitation harvesting systems. For the purposes of this application and cost estimating, three scenarios were chosen to be representative of the Sterling Ranch development. Results from this portion of the Pilot Project would help determine the cost effectiveness of precipitation harvesting for the entire Sterling Ranch development and which precipitation harvesting designs are the best. The three scenarios that could be studied at Sterling Ranch are…(p. 60)

- Within the first permitted filing at Sterling Ranch, a model home or homes would likely be built. The home could be equipped with a self-contained precipitation harvesting system that would include rooftop capture gutters, filtering, downspouts, cistern, and a pump to deliver water to the irrigation system… (p. 60)

We recognize that there is much uncertainty and natural evolution associated with a pilot project, but the ambiguity in current wording of the project may create later difficulties in reviewing the annual project reports and differences in expectations regarding what the pilot project will include.

Given CWCB's stated intent that the pilot projects pair rainwater harvesting with advanced outdoor water demand management, we believe that it would be appropriate to include the Headwaters Corporation's April 2009 report "Sterling Ranch Water Conservation (Excerpts from the Sterling Ranch Water Plan)" as an appendix to the application because it provides more descriptive and definitive information related to landscape water conservation aspects of the project.

Specific Comments

Our comments on specific aspects of the Application follow and note where additional detail would be helpful in facilitating scalability and transferability. The relevant CWCB Criteria and Guideline reference is given in bold text in parentheses.

1. (**7.b**) The water use per residential unit given in the Application is summarized below:

Residential Water Demand	0.22 AF/yr	200 gal/day
+10% System Loss	0.022	20
+20% Security Factor	0.044	40
Total[1]	0.286 AF/yr	260 gal/day
Landscaping Portion	0.082 AF/yr for 1500 square feet irrigated area	
	17.4 gal/sf	
	27.9 inches	

[1] Engineers representing the Douglas Planning Department have discussed a surcharge of some amount, such as 0.1 AF/yr per unit until metered water use data from Sterling Ranch is available.

The proposed unit landscaping water use of 17.4 gal/sf/yr is slightly higher than the water budget goal of 15 gal/sf/year given in Division of Local Affairs (DOLA) model landscape ordinance. The *GreenCO BMP Manual* notes that a water budget of 15 gal/sf/yr is a common outdoor allocation target; however, GreenCO does not specify a target water budget. The 17.4 gal/sq ft/yr includes a 33% safety factor, so the underlying

water budget is 13.1 gal/sq ft/yr, which is a reasonable (moderate) basis for design of a conservation-oriented landscape.

Irrigation efficiencies are assumed to be 85 percent for rotor irrigation and 95 percent for drip irrigation (p. 30). (Note: Appendix A [p. 80] gives 80 percent for sprinkler irrigation which likely should be 85 percent to be consistent with the report text.) The irrigation efficiencies used are reasonable.

2. (**5**) The Sterling Ranch (Dominion) Water Plan is described as being currently developed as a conjunctive water supply. Figure 2-4 (page 13) gives the "Framework" of the water supply, but there are no specifics on the water rights to be used. In Table 2-1 "Total Planned Water Supply," "Tributary Consumptive Use Water" at 1,600 af/yr is identified as a water supply source with the footnote "to be acquired plus additional supply to cover conveyance losses for Tributary CU Water Supply TBD after acquisition." We understand that the SEO will review and assess the adequacy of the water rights aspects of the Application.

3. (**7.b**) Table 4-1 "Water Savings from pairing precipitation harvesting with outdoor water demand management" (p. 28) combines water savings from 1) reduced lawn irrigation area, 2) reduced irrigation application, and 3) savings from cistern supply. Providing the individual savings attributable to the three items would be helpful and would provide the potential savings due to rainwater harvesting alone.

4. (**4.b and 4.c**) The Kassler Weather Station near Sterling Ranch's average annual precipitation for the 1950-2004 period of 17.54 inches is reported, but the range of precipitation (minimum to maximum) should be discussed (Monthly Records given in Appendix F). The potential firm yield is based on 15 inches or 86 percent of the annual precipitation (p. 30). Little background information is provided as to how the 15-inch or 86 percent figure was selected. The SEO guidelines for estimating net evaporation from a water surface use a 70 percent factor for effective precipitation. With a goal of the pilot study to be methodology transferability, it would be helpful to outline how the 15-inch firm yield was determined. Footnote Nos. 5 in Tables 3-3 and Table 3-4 (p. 23-25), which both have an identical column "Potential Capture Firm Yield, (AF/Year)," appear contradictory:

   Table 3-3. *5. Firm yield is estimated as 86% of average annual yield based on preliminary annual deficit evaluation.*

   Table 3-4. *5. Potential capture is based on average annual precipitation, not on a firm yield.*

What is the methodology for determining the deficit over a longer term drought such as the 1952-1956 or 1962-1964?

5. (**4.b, 4.c and 8.a**) No discussion of hydrologic patterns based on the Kassler station is presented. Many of the storm events will be quite small, and with depression losses and evaporation, there will be little or no runoff for these small events. The Urban Drainage and Flood Control District *Drainage Criteria Manual - Volume 3* presents data on the Denver Stapleton precipitation and on an average annual basis, 46 of 75 storms are less than 0.1 inch, which will produce practically no runoff. The pilot program's proposed measurements of precipitation and runoff into storage vessels provides a means to calculate these losses, and these losses may be accounted for in the 15-inch firm yield (86 percent capture) figure. A cursory analysis of precipitation patterns would be helpful in methodology transfer.

   Overall, our impression is that the 15-inch firm yield figure is overly optimistic.

6. (**5 and 8.b**) A major thrust of the project will be to quantify the evapotranspiration of the existing natural vegetation, which will be replaced with impervious surfaces through the development process, and also the surface and groundwater returns to the stream. During the pilot program, 100 percent of the precipitation on impervious surfaces will be augmented under Substitute Water Supply Plans (SWSPs). One goal of Sterling Ranch is to support an augmentation plan to harvest precipitation without having to augment 100 percent of the water.

   Two lysimeters are proposed. The vegetation survey in Appendix D (p. 95) notes vegetation communities: mid-grass prairie, medium/high-density shrubland, low-density shrubland, riparian and wetland. In what vegetation community will the lysimeters be installed, and how will results be transferred to other vegetation? Will an estimation of long-term natural vegetation ET be modeled?

7. (**8.c and 8.e**) Figure 6-2 (p. 42) shows the location of three proposed groundwater level monitoring sites. The figure appears to show a section across the stream channel. The description of the groundwater monitoring is somewhat vague:

   > *Monitoring wells and ground water level monitoring equipment may be installed if sufficient ground water information does not exist. Aquifer characteristics can be defined from existing well logs or may be supplemented if monitoring wells are installed.*

   With regard to groundwater timing, the AWAS Ground Water Model is proposed for use. Aquifer parameters such as transmissivity are needed as input to the model. What will be the source for this data?

8. (**7.c**) With regard to pilot project costs, the cost for augmentation water is not included in the Summary of Pilot Project Costs (Table 6-2, p. 70).

9. (**7.b.iii**) The Application states that a "tiered water rate structure" may (emphasis added) be set in conjunction with the water budget (p. 32). In Appendix A, mandatory water saving measures listed include "Individual Water Budgets with Inclining Block Rates (p. 79)." Is there a commitment to a tiered water rate structure?

10. (**7.c**) The preliminary opinion of probable cost for new precipitation harvest designs (pp. 69-70), are summarized as follows:

Residential System, single-family home	$ 23,700
Commercial System, 10-acre site	$451,500
Regional System, 10-acre site	$332,000
(Per acre-foot costs are given on p. 83)	

The preliminary opinion of probable cost for the single family residential system is expensive. During the pilot project analyses, it may be beneficial to consider the feasibility of scaling down the system to lower the cost for an individual system. Alternatively, if pilot project is expected to focus on the commercial or regional alternatives, this should be clearly stated.

Other: A graphics error and a few typographical errors on numbers were noted as follows:

1) The location shown for Sterling Ranch in Figure 2-1 (p. 5) is not consistent with other figures.

2) In Table 3-2, (p. 22), the gross area acreage for Residential Medium Density shows, 1.196 acres, whereas we expect that 1,196 acres was intended.

3) On Table 4-1 (p. 28), 3rd column second row, the number should be "0.347" rather than "0.0347."

4) In Appendix A (p. 79), 5th line, the number should be "0.08 AF/yr/unit" rather than "0.8 AF/yr/unit."

Conclusion

Overall, the Application is responsive to the CWCB Criteria and Guidelines; however, we would recommend that additional information or clarification be sought on Items 4 through 10 above. We also recommend that the three following items be addressed:

- Include Headwater Corporation's April 2009 report "Sterling Ranch Water Conservation (Excerpts from the Sterling Ranch Water Plan)" as an appendix to the application

because it provides more definitive information related to landscape water conservation aspects of the project.

- Clarify the monitoring activities that will be implemented, as opposed to what may be implemented. WWE views all aspects of the monitoring program suggested in the report as necessary for effective evaluation of the pilot project.

- Provide a clear statement of expected direction for the Phase III pilot project implementation regarding which type(s) of rainwater harvesting are expected to be implemented and/or how the decision will be made to make this determination.

Please call us if you have any questions or comments. We have appreciated the opportunity to review this interesting project.

Very truly yours,

WRIGHT WATER ENGINEERS, INC.

By _____
Patricia K. Flood, P.E. LEED AP
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