NEBRASKA

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DEPT. OF NATURAL RESOURCES

Jim Pillen, Governor

OFFICIAL ELECTRONIC MAIL SENT VIA EMAIL. NO HARD COPY TO FOLLOW

July 12, 2024

Mr. Jason Ullmann
State Engineer
Colorado Division of Water Resources
1313 Sherman Street, Suite 821
Denver, CO 80203

RE: Water Administration on the South Platte River in Colorado

Dear Jason,

I am writing today to renew the request that was made last year, in which I sought information from Colorado regarding its water administration activities in the South Platte River Basin. As you may know Western Irrigation District ("Western"), which holds an 1897 priority right under Article IV of the South Platte River Compact ("Compact"), has experienced numerous days in the last few years when flows available at their headgate were significantly less than the 120 cfs Compact right. It is our understanding that while this was occurring, junior groundwater wells were allowed to continue pumping in Colorado's Lower Section. Western and other water users have asked my Department to review the mechanisms by which Colorado is complying with its obligations under the Compact, and in particular those relating to Article IV.

Colorado officials have publicly stated numerous times that Colorado has never violated the Compact. We believe it is very important that Colorado be transparent with Nebraska and clearly demonstrate how its compliance obligations are met, particularly at the daily timescales required by the Compact.

My Department has invested significant efforts in reviewing publicly available information, including data and records on the Colorado Decision Support System (CDSS), along with the evaluation of several augmentation plans using that information. Unfortunately, the results of such efforts does not provide a clear picture of compliance by Colorado. In fact, statements can be found throughout Colorado's own reviews of those same plans that question the consistency

Thomas E. Riley, P.E., Director

Department of Natural Resources

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of some augmentation plan operations and reporting, pursuant to the state court decrees that granted them. All the while, we are being assured that those same plans serve as the primary mechanism that Colorado relies on for its Compact compliance. Our review of those plans and their reported operations would suggest several key deficiencies, including an apparent lack of daily accounting that we believe would be necessary for Colorado to fulfill is Compact administration duties.

I have attached a report summarizing some of our findings in conducting those reviews. I would ask that you please review these findings and either confirm them or explain to us why they are inaccurate. If your analysis is based on information not made available to the general public, we respectfully request that you share such information with us, so that we might better understand (and attempt to independently replicate) Colorado's reported conclusions.

These more thorough reviews have only served to heighten our compliance concerns, which is why I renew our request for Colorado to provide a complete picture of how it implements its daily water administration activities under Article IV of the Compact (*See attached April 3, 2023 letter to Kevin Rein*). More specifically:

1) Which users in Colorado are junior to Western's 1897 right and which of these junior users are authorized to continue their use under the Compact Call?
2) How does Colorado notify junior users that they must cease diverting when a Compact Call is in effect (i.e., less than 120 cfs at the Interstate Station) and what procedures are used to notify those juniors?
3) How does Colorado monitor water users' compliance with a Compact Call?
4) To the extent Colorado authorizes a junior user to divert out of priority, how does Colorado ensure:
    a. That the daily flows at the state line are not being diminished by junior use (both surface water and groundwater withdrawals);
    b. That any mitigation project's daily operations are providing proper quantities of replacement water at the Interstate Station; and
    c. That all planned mitigation is being conveyed to Western Irrigation District when flows are less than 120 cfs.
5) What enforcement actions are taken against users that Colorado determines are violating a Compact Call?

As previously explained, answers to these questions are necessary to facilitate an understanding between our respective states of how Colorado is administering its Compact requirements each day when Nebraska's Article IV Compact Call is in effect. Additionally, it is my understanding that Colorado, through its own administrative proceedings, determined that it can authorize out of priority water use and still meet its Compact obligations. Therefore, it is only reasonable that Colorado can provide answers to the questions posed above and demonstrate how those intra-state administrative processes are consistent with the requirements of Article IV of the Compact.

I fear the difficulties experienced in recent years by our South Platte water users could re-occur during this summer's irrigation season as flow at the Interstate Station as recently as July 8th were below 60 cfs. In my capacity as Nebraska's Compact representative and the person tasked with enforcing its provisions, I would appreciate the opportunity to better understand Colorado's administration process so that such might be better communicated to Nebraska's water users.

Sincerely,

Thomas E. Riley

Thomas E. Riley, P.E., Director

Enclosures or Attachments (2):

- *April 3, 2023 letter to Kevin Rein*
- *Initial Review of Select Augmentation Plans Relative to Article IV South Platte River Compact Requirements*

CC: Western Irrigation District

NEBRASKA

Good Life. Great Water.

DEPT. OF NATURAL RESOURCES

Jim Pillen, Governor

April 3, 2023

Mr. Kevin Rein
State Engineer
Colorado Division of Water Resources
1313 Sherman Street, Suite 821
Denver, CO 80203

RE: Water Administration on the South Platte River in Colorado

Dear Kevin,

I am writing today to request your assistance in addressing concerns raised to me by some of our water users on the South Platte River. As you know, last summer was particularly difficult for some of our producers, including the Western Irrigation District ("Western"), which holds an 1897 priority right under Article IV of the South Platte River Compact ("Compact"). Western and other water users have asked my Department to review the mechanisms by which Colorado complies with her obligations under the Compact, and in particular those under Article IV.

You have assured Nebraskans multiple times that Colorado has never violated the Compact. In response to several inquiries from our stakeholders, we are asking for additional information to support this claim. My Department has reviewed the available public information, including data and records available on the Colorado Decision Support System (CDSS), but it does not provide a complete picture of how Colorado implements daily water administration.

For example, we would like to better understand the following:

1) Which users in Colorado are junior to Western's 1897 right and which of these junior users are authorized to continue their use under the Compact Call?
2) How does Colorado notify junior users that they must cease diverting when a Compact Call is in effect (i.e., less than 120 cfs at the Interstate Station) and what procedures are used to notify them?
3) How does Colorado monitor water users' compliance with a Compact Call?
4) To the extent Colorado authorizes a junior user to divert out of priority, how does Colorado ensure:
    a. That the daily flows at the state line are not being diminished by junior use (both surface water and groundwater withdrawals);

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b. That any mitigation project's daily operations are providing proper quantities of replacement water; and
c. That all planned mitigation is being conveyed to Western Irrigation District when flows are less than 120 cfs.

5) What enforcement actions are taken against users that Colorado determines are violating a Compact Call?

Answers to these questions are necessary to facilitate an understanding between our respective states of how Colorado is administering its Compact requirements each day when the Compact Call is in effect. Additionally, it is my understanding that Colorado, through its own administrative proceedings, has determined that it can authorize out of priority water use and still meet its Compact obligations. Therefore, it is only reasonable that Colorado can provide answers to the questions posed above and demonstrate how those in-state administrative processes are consistent with the requirements of Article IV of the Compact.

With projected water supply conditions looking unfavorable I fear the difficulties experienced in 2022 could carry over into the upcoming summer irrigation season. In my capacity as Nebraska's Compact representative, and the person tasked with enforcing its provisions, I would appreciate the opportunity to better understand Colorado's administration process so that I might communicate that information to Nebraska's water users with the irrigation season upon us.

Sincerely,

Thomas E. Riley

Thomas E. Riley, P.E., Director

Initial Review of Select Augmentation Plans Relative to Article IV South Platte River Compact Requirements

Introduction

The South Platte River Compact[1] (the "Compact") represents an agreement between the State of Colorado and the State of Nebraska that establishes rights and responsibilities for each party pertaining to sharing and management of South Platte River flows. Key elements of the Compact include the following:

According to *Article IV, paragraph 2* of the Compact, between April 1st and October 15th of each year, Colorado is responsible for not allowing "diversions from the Lower Section of the river, to supply Colorado appropriations having adjudication dates of priority subsequent to [i.e., junior to]" June 14th, 1897, that would cause the South Platte River to be reduced to a mean discharge of less than 120 cubic feet per second (cfs) at the Interstate Station (noting applicable limitations provided in *Article IV, paragraph 3*).

Based on the language summarized above, during a certain annual period and under certain river conditions, it is Colorado's responsibility to limit diversions resulting in depletions to South Platte River flows by water rights holders junior to the Compact.

Augmentation Plans

As noted above, under *Article IV, paragraph 2* of the Compact, for Colorado's responsibility to curtail diversions to be triggered, a variety of conditions must be met (e.g., the date must be between April 1 and October 15, the diversions in question must be associated with a water right junior to June 14th, 1897, etc.). If mitigating actions could be taken by a junior water user to prevent these depletions, Colorado has determined that those diversions can continue outside the doctrine of prior appropriation.

A detailed review of augmentation plan history in Colorado is neither necessary nor useful here. Instead, it is adequate to recognize augmentation plans are intended to establish practices to offset depletions, and in attempting to do so, they typically leverage differential timings of effects, such as the difference between delayed effects from groundwater pumping (i.e., resulting in river flow depletions) and rapid responses to direct augmenting releases (i.e., creating river flow accretions). Augmentation plans are allowed to operate in the State of Colorado via decrees issued by the state's Water Court. The decrees typically detail operation plans and identify information collection and performance tracking requirements, including performing water accounting in certain cases. These decrees do not consider Colorado's independent interstate obligations.

Select augmentation plans were reviewed that are operating or have operated within Colorado Water District 64 (WD 64), which spans the lower section of the South Platte River extending to the Nebraska border near Julesburg, as shown below in **Figure 1**. Plans selected used available information, that was electronically available.

[1] Refer to Nebraska Revised Statute 1-105: https://nebraskalegislature.gov/laws/appendix.php?section=1-105

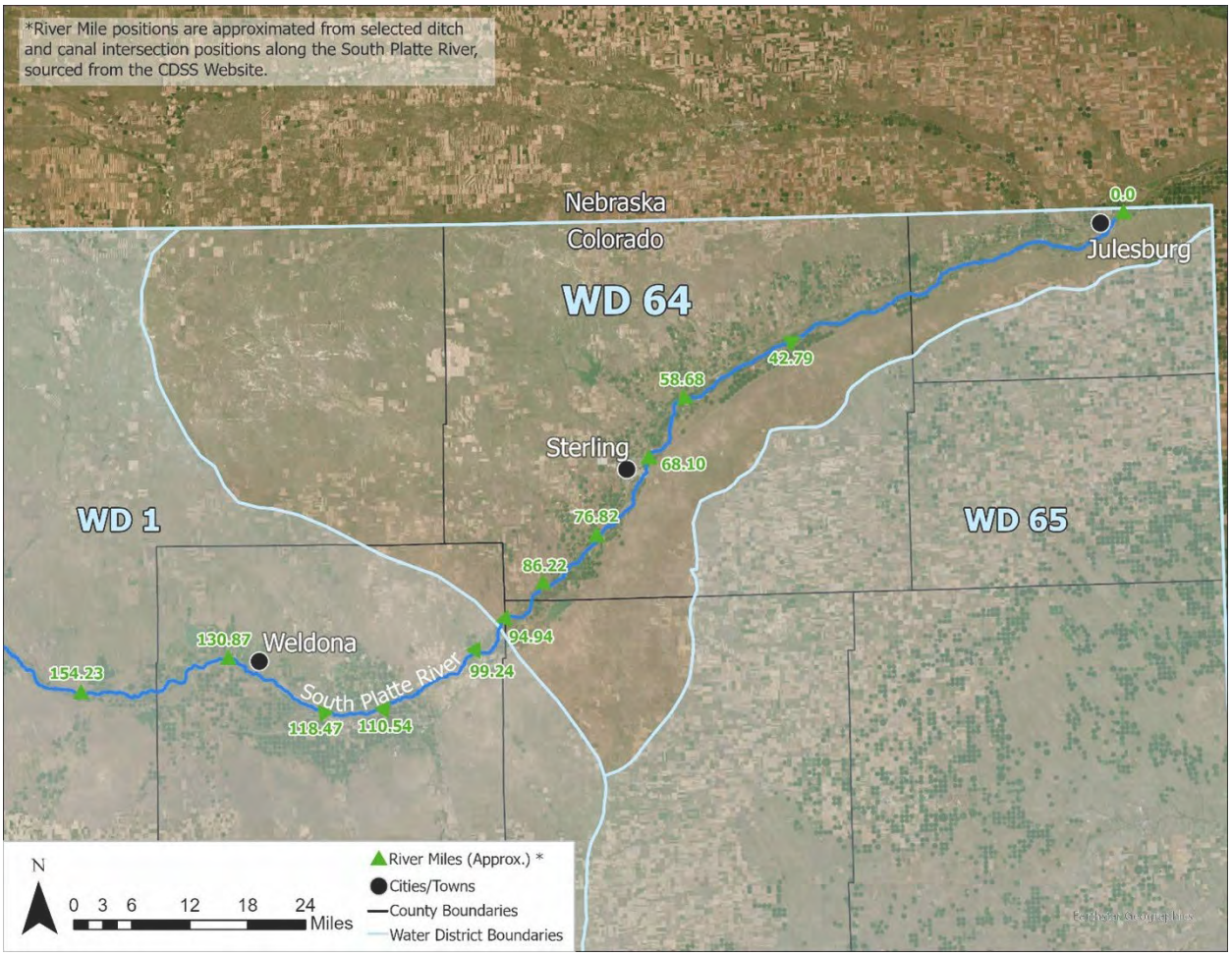

Figure 1: *Eastern Colorado Water Districts*

As illustrated by **Figure 1**, WD 64 contains nearly one hundred miles of the South Platte River, with the City of Sterling, Colorado, residing near river mile 70 (i.e., measured in an upstream direction from the Nebraska border).

The Colorado Decision Support System (CDSS) website[2] reports records for more than 70 augmentation and replacement plans within WD 64; however, many of these plans are coded as being inactive or incorrectly located[3]. Accounting information is available for approximately 30 of the nearly 50 augmentation (and replacement) plans coded as "Active Structure with contemporary diversion records (A)" [4]. In a number of plans, the assumptions and/or inputs used in the accounting are unclear, thus preventing complete reviews of accuracy and independent assessments of quantitative reliability[5].

Figure 2, shown below, depicts a subset of the augmentation plans included in the group of 30 described above and selected for review as part of this report.

[2] https://cdss.colorado.gov/
[3] Incorrect location suggested by coding as "Structure used as FROM number - located in another District (F)".
[4] Based on review of information available via the CDSS website. The estimated total does not include plans for which incomplete accounting (e.g., reports of monthly well withdrawals) is provided.
[5] As determined through an initial review of accounting information posted to the CDSS website.

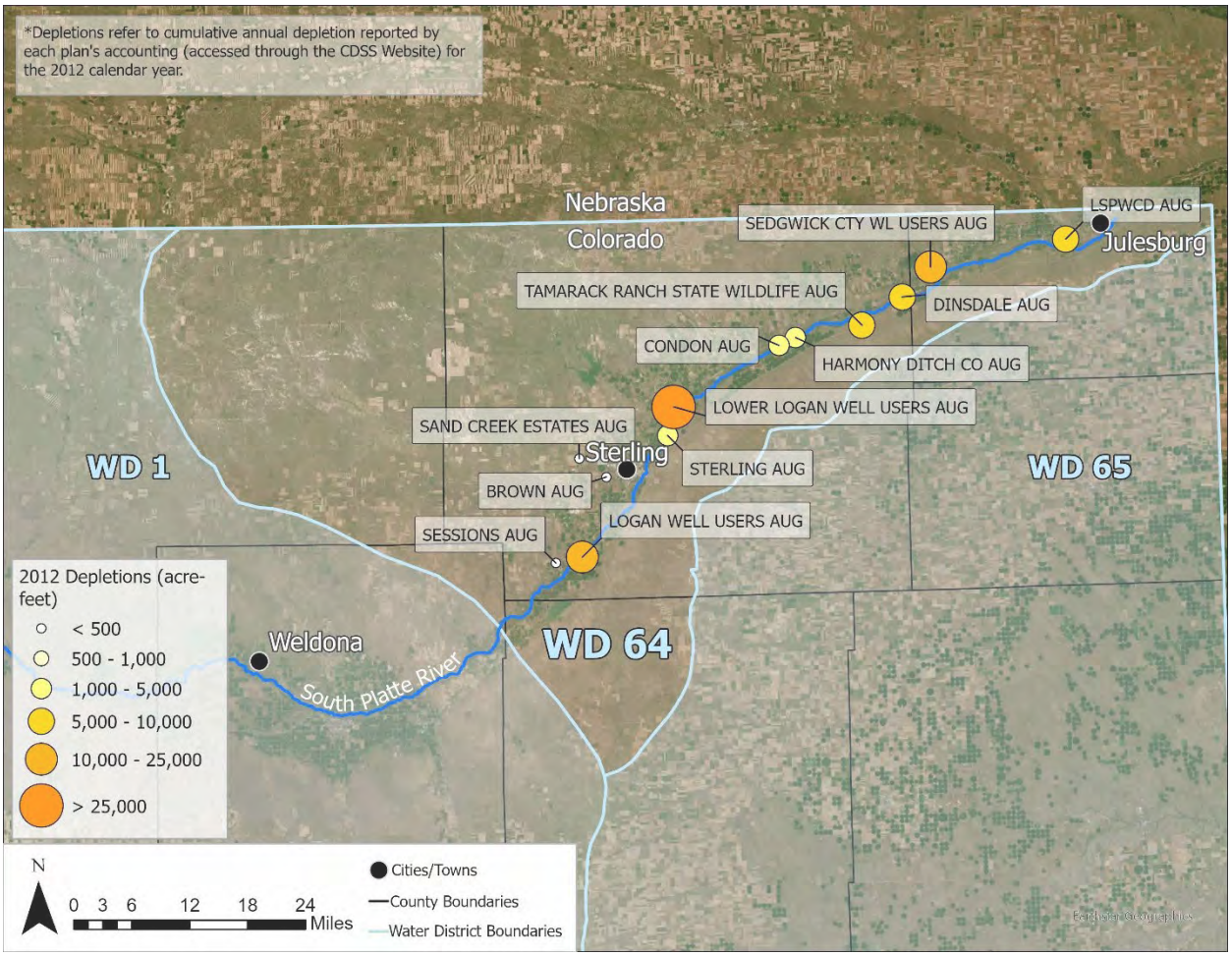

Figure 2: *Selected Water District 64 Augmentation Plans*

As illustrated by **Figure 2**, the subset includes a number of relatively large augmentation plans (e.g., Lower Logan Well Users), based on reported total annual depletions created by plan operations during a selected year (i.e., 2012). Also included in the subset are a few smaller augmentation plans – those being; Brown, Sand Creek Estates, and Sessions. A common trait of the plans included in this subset is the availability of generally continuous records of historical accounting via the CDSS website. While many aspects of the procedures, assumptions, and basis for inputs are unclear, some plans in this subset do possess accounting principals that can be understood enough to support limited reviews for errors and testing of the sensitivity of results (i.e., unremedied depletion predictions) to variation of uncertain inputs. Plans which are adequate to support such limited reviews are used in the period-specific representative reviews described in the following section.

Period Identification and Example Plan Selection

Historical South Platte River flow records were obtained from publicly available sources, including the CDSS website. These records were used to identify time periods representative augmentation plans could be matched. Daily mean discharge records covering the period of 1953 to 2023 were obtained for the gaging stations located at or near Weldona, Colorado, and Julesburg, Colorado.

The mean discharge data sets for the two stations were independently accumulated at daily intervals and plotted against one another, generally following a double-mass curve approach[6]. In this implementation, the independent variable is the discharge at the Weldona station, and the dependent variable is the discharge at the Julesburg station (since it is downstream from Weldona). Visual inspection of the resultant plot revealed distinct period-specific trends, which were then isolated and further evaluated via piece-wise linear regression. The result of this effort is illustrated below by **Figure 3**, which highlights an early period extending from 1953 to 2001; an intermediate period from 2001 to 2009; and a recent period extending from 2009 to 2023.

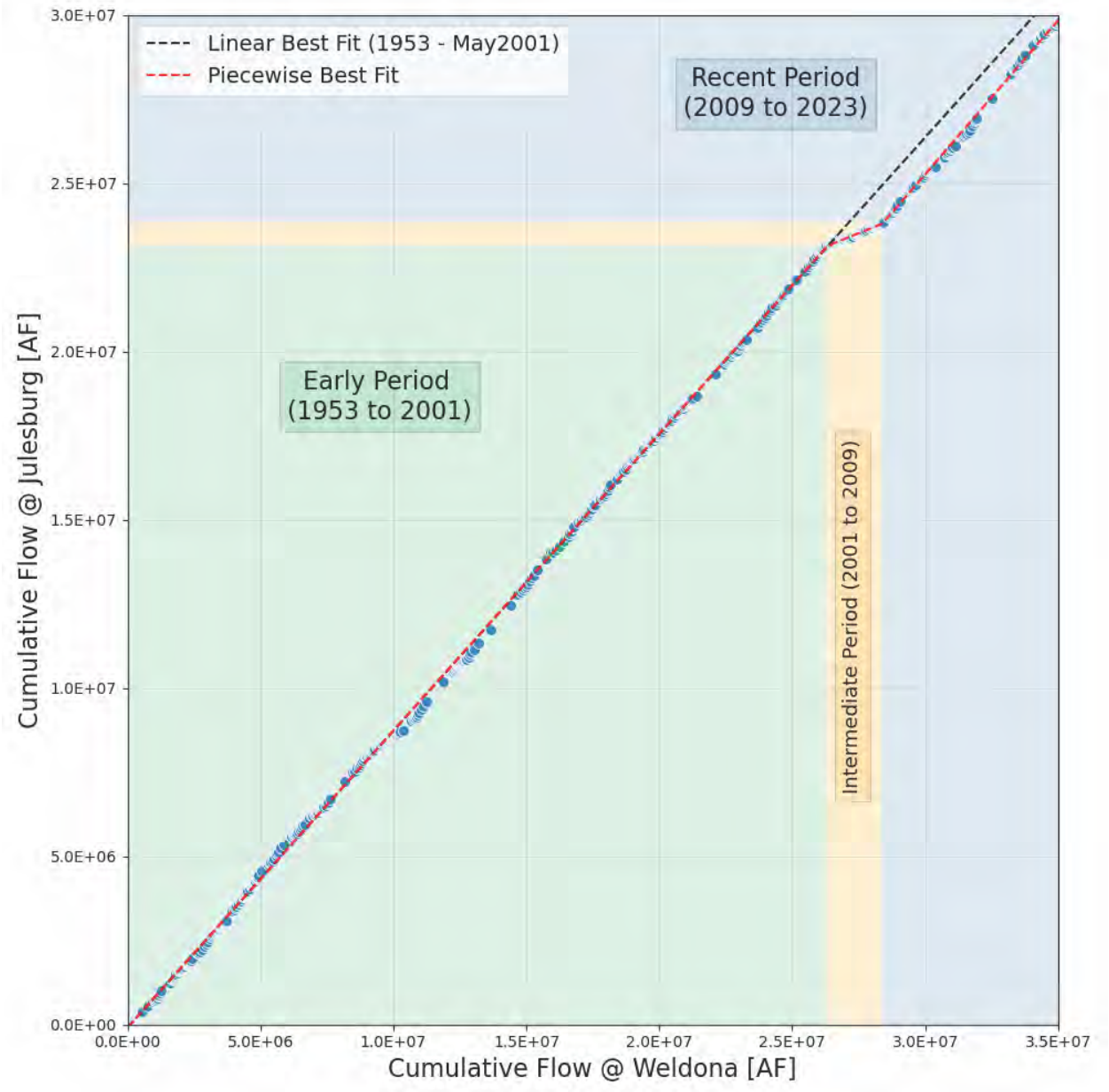

Figure 3: *Flow Accumulation Comparison – Weldona and Julesburg South Platte River Stations*

[6] See *Double-Mass Curves, Manual of Hydrology: Part 1. General Surface-Water Techniques.* Geological Survey Water-Supply Paper 1541-B. 1960.

The isolated periods and representative augmentation plans are discussed individually as follows:

Early Period (1953 to 2001)

During the identified "Early Period" from 1953 to 2001, water management practices and the associated regulatory structure were evolving within Colorado's South Platte River Basin. This evolution included promulgations of the Groundwater Management Act of 1965 and the Water Rights Determination and Administration Act of 1969. Also occurring during this was the "Substitute Supply Plan Era", as it was called, in which the State Engineer's authority extended to approving temporary plans similar to how the Colorado Water Court currently approves augmentation plans through decrees[7].

Referring to **Figure 3**, it is important to recognize that, while the generally stable slope of double-mass plot may suggest general temporal consistency during this period, it does not provide evidence that junior Colorado depletions were not occurring. A review of accounting associated with an augmentation plan operating during this period provides further insight into this potential. Amongst the subset of plans identified through initial review, the Condon (Augmentation) Plan serves as a good example during the Early Period in which significant unreplenished river depletions may have occurred. A summary of the Condon Plan accounting review is provided as **Attachment A**.

Intermediate Period (2001 to 2009)

Water management practices within the basin changed rapidly during the identified "Intermediate Period" running from 2001 to 2009. Drought conditions occurred during the early part of this period, combined with revisions to the State Engineer's authority, forced many water users to react and swiftly seek decreed augmentation plans. As these decreed plans began to operate under new requirements, accounting procedures were tested, with a variety of issues and errors becoming apparent as State administrators began to perform accounting audits[8].

As depicted by **Figure 3**, a significant deviation from the Early Period trendline is evident in the double-mass plot. This deviation indicates lower rates of River flow accumulation at Julesburg relative to Weldona, which were potentially exacerbated by depletions occurring between the two points. Again, review of accounting associated with an augmentation plan operating during this period provides further insight into this potential. Amongst the subset of plans identified through initial review, the Sterling (Augmentation) Plan appears to serve as a good example. A summary of the Sterling Plan accounting review is provided as **Attachment B**.

Recent Period (2009 to 2023)

As illustrated by **Figure 3**, following the "Intermediate Period", the slope of the double-mass plot increases and returns to a magnitude similar to the "Early Period" portion of the data series. This response may suggest the effects of improved water management practices; however, as was the

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[7] Refer to Jones, Andrew P., *South Platte Well Crisis, 2002-2010, Evolving Alluvial Groundwater Regulation*. The Water Report, Issue #78. August 15, 2010.
http://southplatte.colostate.edu/files/11132012%20water%20report%20Jones%20TWR%2078.pdf

[8] For example, refer to *RE: Notice of Accounting Review – City of Sterling & Case No. 98CW0450 & 00CW0253*. Letter to Laurel Stadjuhar and the City of Sterling from Caren Aguilar, Augmentation Coordinator, Office of the State Engineer. Dated January 15, 2008. https://dnrweblink.state.co.us/dwr/DocView.aspx?id=2202138&dbid=0

case relative to the "Early Period", it does not provide evidence that depletions were not occurring or had been eliminated. Again, review of accounting associated with an augmentation plan operating during this period can provide further insight into this potential. Amongst the subset of plans identified through initial review, the group of small augmentation plans (i.e., Brown, Sand Creek Estates, and Sessions) appears to serve as a good example. A summary of the accounting review for the group of small plans is provided as **Attachment C**.

Summary of Key Findings

The following points summarize the key findings derived from this review:

- Under certain river conditions and during a certain annual period, Colorado is responsible for limiting depletions to South Platte River flows by water rights holders junior to the Compact.

- Colorado has historically deviated from the doctrine of prior appropriations by allowing junior water users to divert even when Compact constraints apply. Water management practices, such as those enabled by Water Court decreed augmentation plans, represent attempts on the part of Colorado to prevent these diversions from resulting in river depletions.

- Colorado's current practice is not consistent with the plain language of the Compact. Indeed, under Colorado's current practice, strict adherence to the Compact is not even possible because Colorado does not employ a daily timestep to ensure replacement water arrives at the Interstate Station at the correct time. Therefore, Nebraska does not concede that Colorado's reliance on augmentation and replacement is allowable under the Compact. But assuming such a practice were determined to be valid, a substantive violation of Article IV's requirements can only be avoided if Colorado conducts accurate and reliable quantitative analyses and tracking of a variety of activities and outcomes, including diversions, depletions, make-up activities, and South Platte River flow conditions.

- Information availability limitations and unclear/inconsistent water accounting practices preclude a comprehensive independent review and quantification of river shortages or excesses during Compact call periods. However, limited reviews of accounting information can be performed to generally evaluate the adequacy of Colorado's administrative practices.

- A review of accounting associated with example augmentations plans operating during three temporal intervals suggest evidence of seemingly unreplaced depletions occurring during Compact call periods.

Attachment A

Early Period – Condon Augmentation Plan

Executive Summary

Early Period - Condon Augmentation Plan

- Historical depletions from and accretions to the South Platte River for the Condon Augmentation Plan (the "Plan") were estimated for the 1980 to 2022 period. These historical impacts account for the effects of fifteen irrigation wells, five pumping plants ("recharge wells"), four recharge ponds, and an "augmentation well."

- A review of available information identified several issues that appear to impact calculations of the Plan's monthly net effect on the river, namely:
  1. Apparent errors in representing the number of call days used in prorating the Plan's monthly net effects on the river[9];
  2. Inconsistent prorating (based on number of call days per month) of pumping from "recharge wells"; and
  3. Inconsistencies between historical lagged depletion and accretion rates represented in monthly accounting reports and rates in Alluvial Water Accounting System (AWAS) input files[10].

- Due to inconsistencies through time in the Plan's accounting procedures and disagreements with other data and information sources, it is unclear exactly what effects Plan operations had on the river. However, to generally assess accounting outcomes and demonstrate the influence of the aforementioned areas of uncertainty, two accounting methods were applied to three combinations of call day and lagged depletion/accretion information to produce a total of six different estimates of the Plan's net effects:
  1. Call days and lagged depletions/accretions submitted to the State (of Colorado) including call days from 2003 to present cited in accounting reports;
  2. Lagged depletions/accretions submitted to the State with corrected number of Compact call days (based on information from the Colorado Decision Support System [CDSS] website); and
  3. Lagged depletions/accretions from AWAS files provided to the State with corrected numbers of Compact call days (based on information from the CDSS website).

- Cumulative unreplenished depletions (river shortages) on Compact call days from 1980 to 2022 range from 9,051 to 10,199 acre-feet for the tested accounting scenarios described above. It should be noted these estimates are based on several assumptions made in the Plan's accounting that were retained but may not be appropriate/justified (e.g., accuracy of depletion and accretion lagging method).

[9] The number of call days per month according to records on CDSS frequently did not align with the number of call days used in the Plan's monthly accounting.
[10] Both sources of lagged depletion and accretion estimates were acquired from CDSS.

Early Period - Condon Augmentation Plan

Historical depletions from and accretions to the South Platte River ("river") for the Condon Augmentation Plan (WDID = 6402525; "Plan" hereafter) were aggregated from records[11] on Colorado's Decision Support System (CDSS) website from the Plan's initiation in 1980 through 2022. Records included monthly values for depletions, accretions, and replacements (as appropriate) for the period relevant to Article IV of the South Platte River Compact . Accounting spreadsheets posted on the CDSS website were used to estimate resultant water balances (e.g., depletions) from 2005-2022, and data tables in scanned reports were used to estimate resultant water balances for the 1980-2004 period.

Background / Plan Overview

The Plan uses the stream depletion factor (SDF) method to estimate lagged depletions and accretions for the following structures (**Table 1**):

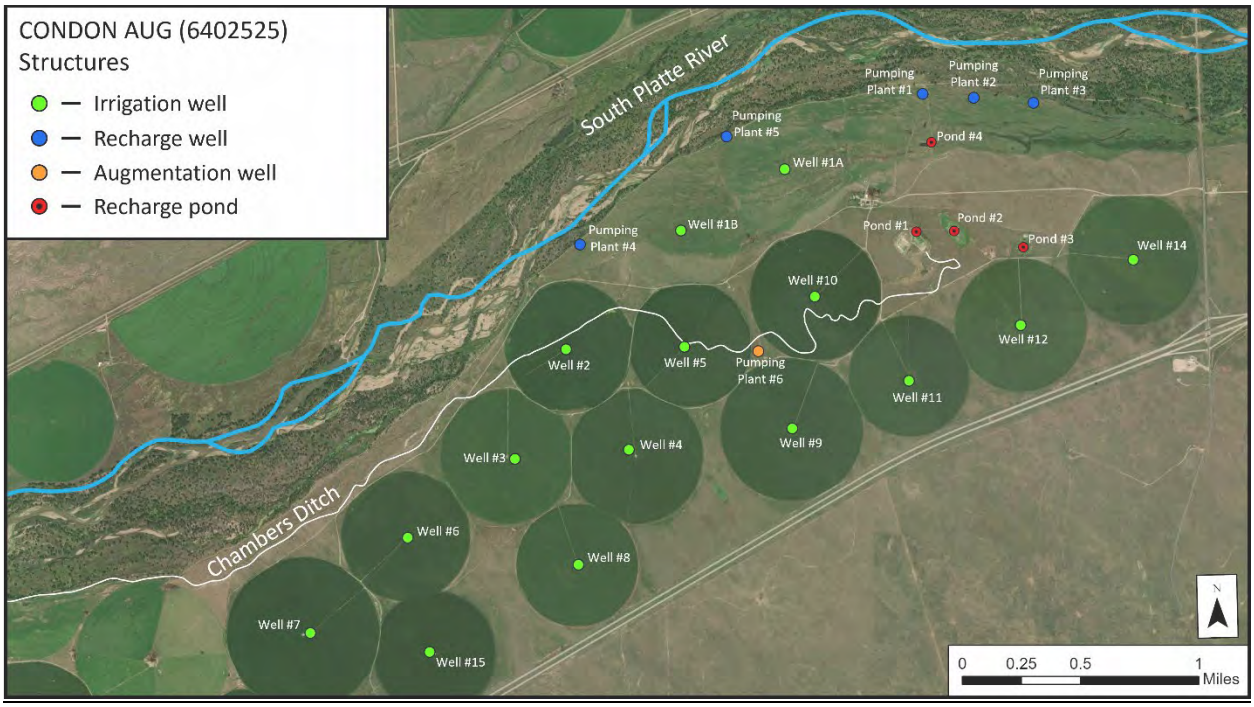
- Fifteen (15) irrigation wells;
- Five (5) pumping plants (alternatively referred to as "recharge wells") intended to "recapture" estimated[12] alluvial groundwater accretions in excess of the Plan's augmentation obligation[13];
- Four (4) recharge ponds to which surface water and groundwater accretions "recaptured" by the five pumping plants were diverted; and
- One (1) additional pumping plant (alternatively referred to as the Plan's "augmentation well") used beginning in 2002 to pump alluvial groundwater directly to the river (via piping) to offset unreplenished depletions on call days[14].

[11] CDSS records were accessed at https://dwr.state.co.us/tools/

[12] Based on the SDF method's lagging assumptions

[13] Per the decree for Case No. W-8460-76 (emphasis added): "*the recharge program may in fact overcompensate the South Platte River during certain periods.* ***To the extent that such overcompensation occurs, [Condon's] plan includes the recapture of such excess accretions by making additional diversions at*** *the Chambers Ditch headgate or* ***the pumping plants*** *… or the substituting or exchanging such water to other water users in the area.*"

[14] Per a footnote in the Final Accounting for Water Year 2003, "*[i]n July 2002, Bill Condon drilled a new well for augmentation at SDF=120 days for pumping back to the river by buried pipeline on days of call to fully augment depletions…*"



Condon augmentation plan structures.

Historical Accounting

The Plan's accounting has always been performed on a monthly basis; there is no evidence that any attempts have been made to perform daily accounting[15]. The methods used to account for monthly depletions, accretions, and replacements evolved through time as the Plan became more mature, and the level of detail included in the accounting increased similarly. Annual augmentation summaries for 1980-1997 listed a total of six (6) variables (as required by decree for Case No. W-8460-76):

A. Crop consumptive use (CU);
B. Stream depletion (cumulative for all relevant structures, lagged temporally as appropriate; always a negative number);
C. Net recharge (for all relevant structures);
D. Stream accretion (cumulative for all relevant structures, lagged temporally as appropriate; always a positive number);
E. Augmentation credits representing consumptive use (i.e., the "depletive effect") which would not occur if Plan operators elected to forego diversions from the river to the Chambers Ditch[16] (a positive number); and

[15] An accounting audit in 2014 stated that the Plan's original decree "*requires monthly reporting of daily depletions, accretions, credit from Chambers Ditch water right, and net impact. Add a worksheet that provides daily accounting of depletions, credits and net impact.*" Such a sheet was added, but the Plan's accounting simply divides monthly values of each listed quantity by the number of days in the month—effectively calculating average daily values of each quantity based on monthly values. It is unclear if this method meets the intent of the original decree; however, it is very clear this method does not align with the Compact's mandated 72-hour period to respond to Compact calls.
[16] Per the decree for Case No. W-8460-76 (emphasis added):

F. "Net Effect on River", which—according to decree W-8460-76—was calculated as:

Net Effect on River =

Stream Depletion + Stream Accretion + Chambers Ditch Augmentation Credits

Subsequent adjustments to this very simple accounting approach were made to account for the following apparent actions:

- The Plan operator(s) reached an agreement[17] on December 15, 1994, to lease accretion credits up to 539 acre-feet to the City of Central[18]. Based on the accounting available on the CDSS website, the Central City leasing began in April 1998 and occurred sporadically thereafter—and only during the month(s) of April, May, June, and/or July.
- In May 2002, "recaptured" prior accretions began to be included in monthly accounting reports. It is unclear whether this accounting adjustment signifies that earlier diversions at the five pumping plants (i.e., near-stream "recharge wells") were not accounted for, did not occur, or were previously included in the plan-wide stream depletion calculations.
- In June 2002, a trade of water with the Morgan Prewitt Reservoir Company ("Morgan Prewitt") was included in the accounting[19]. A second trade evidently[20] occurred in October 2003, when 17 acre-feet of traded Morgan Prewitt water was included in the monthly

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- "*[William E. Condon] is the **sole owner of the Chambers Ditch** and its associated water right.*"
- "***The ditch has** a single direct flow priority in the amount of 30 cfs… with **an adjudication date of May 29, 1897**.*"
- "*The monthly distribution of the historic average annual depletive effect associated with this priority as calculated by [Condon's] engineers is as follows*:"

TABLE II

MONTHLY HISTORIC AVERAGE DEPLETIVE EFFECT OF APPLICANT'S MAY 4, 1895 CHAMBERS DITCH PRIORITY

Month	Monthly Augmentation Credit (acre feet)
April	145
May	126
June	32
July	14
August	21
September	40
October	115
November	143
Total	636

- "*It is hereby found that **if applicant should hereafter forego diversions** under his May 4, 1895 priority **for the Chambers Ditch** for augmentation purposes **by leaving in the South Platte River all water available therefor during the annual period of April 1 through November 30, he should be entitled to credit such augmenting non-diversions**…*"

[17] According to a footnote in the October 1998 accounting

[18] Central City, Colorado, is approximately 35 miles west of the City of Denver. Leasing the Plan's excess accretions to such a distant municipality seems questionable.

[19] Per the Final Accounting for Water Year 2002, "*Bill Condon owns 4.25 shares of Morgan Prewitt water. Its yield in June [2002] is 12 acre-feet per share and at a CU factor of 50%, these shares yield 25.5 acre-feet [the amount included in the June 2002 accounting]. This water is traded to GASP in exchange for GASP's Tamarack accretion water…*"

[20] Per the Final Accounting for Water Year 2003, "*Bill Condon owns 4.25 shares of Morgan Prewitt water. In 2003 average yield was 13.5 acre-feet per share and at a river shrink of 60% and CU factor of 50%, these shares yield 17 acre-feet [the amount included in the October 2003 accounting]. Prewitt Reservoir was emptied in 2003 for mainly well augmentation.*" Note that "river shrink" of the traded water was considered in 2003 but not in 2002.

accounting. Based on later monthly accounting, no Morgan Prewitt exchanges occurred after October 2003.

- In July 2002, use of the augmentation well ("Pumping Plant #6") began with the expressed purpose of offsetting depletions at the river on call days. Lagged depletions from pumping the augmentation well were also incorporated into the accounting in 2002.

Several other noteworthy details regarding the accounting available on the CDSS website were also noted during the review:

- Numerous augmentation summaries prior to 2003 note that "[a]ll of Bill Condon's irrigation wells are in G.A.S.P."[21] This appears to be a justification[22] for the frequently large negative "Net Effect on River" values listed in the monthly accounting during many months when South Platte Compact calls are known to have occurred.
- In 2003, the Plan's accounting began prorating the "Remaining Net Effect on River" based on the number of call days in each month. This introduced the possibility of an incorrect number of call days being used—which was frequently the case, based on an analysis of South Platte Compact calls on the CDSS website—and a consequent misrepresentation of the actual effects on call days.
- The proration of net effects has been implemented at least three different ways since 2003:
  1. The values for "Remaining Net Effect on Days of Call" listed in the Final Accounting for Water Year 2003 could not be replicated during months in which calls were in place for less than the entire month[23].
  2. In 2004, the accounting calculations reflect proration formulae that were used through 2006. This accounting scheme is referred to hereafter as "Type 1" accounting, and it is calculated as follows:

$$\text{"Type 1"}\ Monthly\ Net\ Effect\ on\ Call\ Days = Augmentation\ well\ pumping + Morgan\ Prewitt\ trades + \frac{No.\ Call\ Days}{Days\ in\ Month}(D1 + H + I + M + P - N - L) \quad \textbf{(1)}$$

where[24]:

- Augmentation well pumping is a positive number;
- Morgan Prewitt water trades are positive numbers;

[21] G.A.S.P. is the now-defunct Groundwater Appropriators of the South Platte, a collective group of well owners established "*to provide remedy to any legitimately determined injury which may result to prior vested rights*" as a result of pumping from GASP's member's wells. GASP's shortcomings in replacing groundwater pumped out-of-priority and the permissive attitudes of the Colorado State Engineer's Office toward GASP are well-documented elsewhere (e.g., MacDonnell, L.J., 1988. Integrating Tributary Groundwater Development into the Prior Appropriation System: The South Platte Experience. Colorado Water Resource Research Institute, Completion Report No. 148, 56 p).

[22] This appears to be the case because the accounting contains no other indication (explicit or implicit) that any attempt(s) were made to offset the Plan's depletions.

[23] Note that the document containing the Final Accounting for Water Year 2003 was only available on CDSS as a scanned PDF, thus the apparent difference in proration methods is unclear.

[24] Note that the listed variable names match column identifiers in the more comprehensive 2022 accounting and do not match than the 2004-2006 accounting.

- D1 = Total depletions from all irrigation wells (negative number);
- H = Total accretions from all prior years' operations (positive number);
- I = Chambers Ditch augmentation credits (positive number);
- M = Accretions from "recharge well" pumping (positive number);
- P = Depletions from augmentation well pumping (negative number);
- N = Amount leased to Central City (positive number); and
- L = Pumping from "recharge wells" (positive number).

Note that monthly values for many of these terms are often zero.

3. In 2007, the accounting calculations were revised such that accretions "recaptured" by the recharge wells were no longer prorated. This scheme for estimating net effects on call days is referred to hereafter as "Type 2" accounting (see eq. 1, above, for variable descriptions):

$$\text{"Type 2"}\ Monthly\ Net\ Effect\ on\ Call\ Days = Augmentation\ well\ pumping + Morgan\ Prewitt\ trades - L + \frac{No.\ Call\ Days}{Days\ in\ Month}(D1 + H + I + M + P - N) \quad \textbf{(2)}$$

- Type 2 accounting was used in the July 2009 accounting submitted to the State of Colorado on August 13, 2009, immediately following an audit of the Plan's accounting.[25]
- In 2012, the Plan's accounting inexplicably switched from using Type 2 to Type 1 accounting. Net effects calculated using the Type 2 formula would have resulted in a negative net effect on the river (-10.4 acre-feet), but the Type 1 accounting scheme did not result in any negative net effects. No negative net effects were reported.
- A second accounting audit was initiated by the State of Colorado in a letter dated February 19, 2014. The "Approved Revised Accounting" for March 2014 resulting from this audit used Type 1 accounting.
- In 2018, the Plan again inexplicably switched from using Type 1 calculations to using Type 2 calculations.
- Two apparent accounting errors were discovered during the review:
  - Some hard-coded net effect values (e.g., zero values entered in place of formulas) were reported to the State from 2005-2022; and
  - A small number of arithmetic errors in calculating net effects were found during the 1980-2004 period when only scanned reports were available.

  These errors were corrected when conducting the analyses described below.

[25] The party responsible for submitting the Plan's accounting was notified an accounting audit would occur in a letter dated May 21, 2009. A letter dated July 6, 2009, stated that—after resubmission of "corrected accounting"—the state had "no issues" with the Plan's accounting.

- The number of call days used to prorate some Plan components (e.g., recapture of accretions by recharge wells) frequently did not match the South Platte River Compact call day records available via the CDSS website.
- Alluvial Water Accounting System (AWAS) input files submitted to the State of Colorado contained structure-specific diversion and recharge rate information for the 15 irrigation wells, the augmentation well, and the four recharge ponds for the entire period of Plan operation (i.e., 1980-present). The resulting AWAS outputs—lagged depletion and accretion rates—differed in many cases from the accounting reported to the State of Colorado.

Compact Shortage Estimates

The Plan's accounting reported shortages (i.e., apparently unreplenished net depletions of South Platte River flow) to the State of Colorado during at least one month in each of the first 23 years the Plan was in operation (1980-2002). No CDSS records show to what, if any, extent these shortages were ever offset by GASP or the Plan's operators. Due to the aforementioned inconsistencies through time in the Plan's accounting procedures, it is unclear exactly what effects the Plan's operation had on the river after 2002. However, to provide reasonable interim—and internally consistent—shortage estimates, the Plan's net effects through time were recalculated using:

4. Type 1 accounting applied to values in accounting reports (including call days from 2003-present cited in accounting reports);
5. Type 2 accounting applied to values in accounting reports (including call days from 2003-present cited in accounting reports);
6. Type 1 accounting applied to values in accounting reports (with corrected number of Compact call days based on information from CDSS);
7. Type 2 accounting applied to values in accounting reports (with corrected number of Compact call days based on information from CDSS);
8. Type 1 accounting applied to values calculated using AWAS files provided to the State of Colorado; and
9. Type 2 accounting applied to values calculated using AWAS files provided to the State of Colorado.

Results of these analyses are provided in **Table 2**, which lists the total amounts (by calendar year) from all months with net depletions (i.e., negative net effects to the South Platte River). The cumulative unreplenished depletions (river shortages) during Compact call days from 1980 to present range from 9,051 to 10,199 acre-feet. These estimates are based on the following assumptions, many of which are features of the original accounting procedure(s) that were retained but may not be appropriate/justified:

- Proration of monthly water budget components based on the number of call days is a reasonable approximation of the actual effects on individual Compact call days[26].

[26] The lack of accounting over periods shorter than one month necessitates this assumption.

- Pumping from the five pumping plants was accounted for in the "Stream Depletion" term for years before accretions recaptured by the near-stream "recharge wells" were listed in the reported accounting (i.e., 1980-2001).
- The monthly crop consumptive use rates (calculated using the Blaney-Criddle method) and pond seepage rates are accurate.
- Lagging consumptive use using the SDF method is a reasonable approximation of the timing and magnitude of the cumulative effects of groundwater pumping and irrigation-related return flow.
- Lagging pond seepage using the SDF method is a reasonable approximation of the timing and magnitude of the cumulative effects of groundwater recharge on the river.

Note on Chambers Ditch Augmentation Credits

A detail relevant to the South Platte River Compact, concerns the Plan's use of augmentation credits for river water not diverted to the Chambers Ditch. The Plan's original decree (W-8460-76) states that an analysis[27] by "*Applicant's engineers*" found that "*historic average annual consumptive use associated with the Chambers Ditch May 4, 1895 priority is approximately 636 acre-feet.*" These credits do not vary from year to year, and by entitling the Plan to these credits whenever river water is not diverted to the Chambers Ditch—regardless of river water availability—the water court essentially guarantees a right (in time and space) to the ditch's average historical diversion amount. The application of a credit based on annual average conditions is particularly problematic during periods of low flow during the irrigation season when Compact calls are most likely and surface flows below the historical averages (upon which the augmentation credits were based) are likely.

The effects of the Chambers Ditch augmentation credits on the Plan's accounting are not insignificant. If the Chambers Ditch credits are never applied, the range in unreplenished depletions increases from 9,051 – 10,199 acre-feet to 10,404 – 12,224 acre-feet.

Conclusion

Based on an initial review of the Condon Augmentation Plan, available information suggests it was operated with almost no oversight (i.e., two audits in the Plan's first 43 years of existence), which resulted in Plan operations and accounting changes that were not well documented (e.g., the use of and changes to proration methods) and were often questionable (e.g., use of Chambers Ditch credits regardless of surface water availability). These changes influenced the estimated impacts of Plan operations on the river, as evidenced by the range in estimates shown in **Table 2**. Ultimately, the result of this assessment is evidence of large, seemingly unreplaced depletions occurring during Compact call periods.

[27] The analysis upon which the augmentation credit was based is cited but not documented in the Plan's decree.

Table 1. Condon Augmentation Plan structure information.

Structure	WDID	SDF (days)
Recharge Pond #1	6402514	133
Recharge Pond #2	6404404	110
Recharge Pond #3	6404405	100
Recharge Pond #4	6404414	50
Pumping Plant #1	6405309	0
Pumping Plant #2	6405310	0
Pumping Plant #3	6405084	0
Pumping Plant #4	6406627	0
Pumping Plant #5	6406628	0
Pumping Plant #6 ("Augmentation Well")	6406930	120
Well No. 1A	6405352	32
Well No. 1B	6405356	15
Well No. 2	6405015	27
Well No. 3	6405350	71
Well No. 4	6405018	127
Well No. 5	6405348	69
Well No. 6	6405343	63
Well No. 7	6405330	97
Well No. 8	6405353	171
Well No. 9	6405314	189
Well No. 10	6405329	115
Well No. 11	6405342	221
Well No. 12	6405345	179
Well No. 14	6405313	131
Well No. 15	6405347	150

Table 2. Estimated Annual South Platte River Shortages (in acre-feet) Caused by Condon Augmentation Plan Operations.

Depletion and Accretion Source	Accounting Reports*		Accounting Reports*		AWAS Files			
Call Days per Month (for Proration)	CDSS Call Records (1980-2002) and Accounting Reports* (2003-Present)		CDSS Call Records		CDSS Call Records			
Other Factors (Offsets, etc.)	Accounting Reports*		Accounting Reports*		Accounting Reports*			
Acct. Type / Year	**Type 1**	**Type 2**	**Type 1**	**Type 2**	**Type 1**	**Type 2**	**Min**	**Max**
1980	-716.45	-716.45	-716.48	-716.48	-700.42	-700.42	-716.48	-700.42
1981	-1054.62	-1054.62	-1054.59	-1054.59	-1026.20	-1026.20	-1054.62	-1026.20
1982	-424.67	-424.67	-424.66	-424.66	-414.18	-414.18	-424.67	-414.18
1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	-78.51	-78.51	-78.50	-78.50	-76.88	-76.88	-78.51	-76.88
1985	-415.77	-415.77	-415.81	-415.81	-405.65	-405.65	-415.81	-405.65
1986	-567.32	-567.32	-567.38	-567.38	-576.94	-576.94	-576.94	-567.32
1987	-360.80	-360.80	-360.85	-360.85	-362.43	-362.43	-362.43	-360.80
1988	-1010.78	-1010.78	-1010.76	-1010.76	-1026.99	-1026.99	-1026.99	-1010.76
1989	-667.46	-667.46	-667.56	-667.56	-680.22	-680.22	-680.22	-667.46
1990	-883.69	-883.69	-883.72	-883.72	-862.95	-862.95	-883.72	-862.95
1991	-599.85	-599.85	-599.84	-599.84	-605.03	-605.03	-605.03	-599.84
1992	-86.47	-86.47	-86.49	-86.49	-83.48	-83.48	-86.49	-83.48
1993	-251.98	-251.98	-252.02	-252.02	-234.69	-234.69	-252.02	-234.69
1994	-776.42	-776.42	-776.31	-776.31	-748.88	-748.88	-776.42	-748.88
1995	-35.36	-35.36	-35.32	-35.32	-31.50	-31.50	-35.36	-31.50
1996	-182.17	-182.17	-182.18	-182.18	-172.84	-172.84	-182.18	-172.84
1997	-6.13	-6.13	-6.13	-6.13	-5.89	-5.89	-6.13	-5.89
1998	-124.16	-124.16	-124.12	-124.12	-108.83	-108.83	-124.16	-108.83
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	-679.80	-679.80	-679.76	-679.76	-652.89	-652.89	-679.80	-652.89
2001	-256.84	-256.84	-256.87	-256.87	-239.72	-239.72	-256.87	-239.72
2002	-100.02	-106.84	-100.02	-106.84	-10.86	-10.86	-106.84	-10.86
2003	0.00	0.00	-59.90	-59.90	-23.69	-23.69	-59.90	0.00
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	0.00	-579.80	0.00	-774.00	0.00	-733.37	-774.00	0.00
2006	0.00	-47.83	0.00	-47.88	0.00	-28.37	-47.88	0.00
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.00	-10.36	0.00	-10.28	0.00	-1.32	-10.36	0.00
2013	0.00	0.00	0.00	-20.44	0.00	-3.69	-20.44	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.06	-0.05
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL (1980-2022)	-9,279	-9,924	-9,339	-10,199	-9,051	-9,818	-10,199	-9,051

* Indisputable errors discovered in the accounting reports were corrected and are reflected in these estimates.

Attachment B

Intermediate Period – Sterling Augmentation Plan

Executive Summary

Intermediate Period - Sterling Augmentation Plan

- Historical depletions of South Platte River flows associated with operation of the Sterling Augmentation Plan (the "Sterling Plan") were estimated during South Platte River Compact (Compact) call periods for the 2006-2020 period, under several accounting scenarios. The results highlight key deficiencies in Sterling Plan conceptualization, implementation, and administration/oversight and also provide a "ballpark" or "order-of-magnitude" estimate of depletions that occurred between 2006 and 2020 during the Intermediate Period.

- Sterling Plan accounting attempts to consider the effects of thirty-two municipal and industrial production wells (i.e., one of which is categorized as an augmentation well), other sources of river depletions (e.g., ponds resulting in evaporation), and a variety of potential sources of augmentation, including direct returns, diversions tied to water rights, and delayed/lagged accretions associated with recharge ponds.

- A review of available water accounting information identified several factors that could meaningfully impact calculations of the Sterling Plan's monthly net effect on the river, including:
  1. Apparent errors in representing the number of Compact call days used in prorating the Plan's monthly net effects on the river[28];
  2. Use of a physically unrealistic method for lagging recharge from the Sterling Wastewater Recharge Storage System (SWRSS) to river accretions; and
  3. Apparent errors/oddities in the methodology used to estimate credits attributable to Lawn Irrigation Return Flows (LIRFs).

- Due to inconsistencies through time in the Plan's accounting procedures and limitations on data/information availability, it is unclear exactly what effects the Plan's operation had on the river. However, to generally assess accounting outcomes and demonstrate the influence of the aforementioned areas of error/uncertainty, different accounting approaches were used to produce a total of eight (8) different estimates of the Plan's net effects:
  1. A "base case" representative of original accounting where call days and river debit and credit calculations are consistent with results submitted to the State of Colorado and uploaded to the CDSS website;
  2. River debit and credit calculations submitted to the State of Colorado with corrected numbers of Compact call days during the period of 2006 through 2012 (based on information from CDSS website);
  3. The case described under item 2, above, but with modified lagging of SWRSS recharge using the following methods:

[28] The number of call days per month according to records on the CDSS website frequently did not align with the number of call days used in the Plan's monthly accounting.

- Applying a uniform percentage applied to reported monthly estimates of recharge, which reflect inflows less evaporation (i.e., 8.33% per month)
- Applying the Glover analytical model/solution using assumed inputs and reported total monthly recharge estimates; and
- Applying the so-called "Alluvial Aquifer" version of the Glover analytical model/solution using assumed inputs and reported total monthly recharge estimates.

4. All of the cases described under item 3, above, but further modified to include scaled LIRF estimates that attempt to reduce suspected high bias in LIRF credits used in early accounting forms.

- The depletions (i.e., River shortages) during singular Compact call days (i.e., no call senior to the Compact in effect), estimated under the scenarios described above, range from 66 to 393 acre-feet over the 2006-2020 period. It should be noted that these estimates are based on a number of assumptions and decisions made in the Plan's accounting that were retained in our analysis but may not be appropriate/justified (e.g., accuracy of depletion and accretion lagging method). Furthermore, these estimates do not include consideration of accretions after a Compact call has passed that may contribute to offsetting depletions within the allowable 72-hour period.

- This example indicates there were depletions occurring during Compact call periods, particularly during the Intermediate Period.

Intermediate Period - Sterling Augmentation Plan

Historical depletions from and accretions to the South Platte River ("River") for the Sterling Augmentation Plan (WDID = 6402526; "Sterling Plan") were aggregated over a selected time period using Colorado Water Court decree information and accounting and diversion records[29] available via the Colorado's Decision Support System (CDSS) website. Accounting information posted to the CDSS website covers a period starting in the late 1980s and extending through December 2022. The structure or "form" of the accounting changes over time; however, it generally includes monthly and daily estimates of depletions, accretions, and credits (as applicable/appropriate) for the annual periods relevant to the South Platte River Compact (i.e., "Compact" hereafter with restrictions/requirements generally applying between April 1st through October 15th of each year).

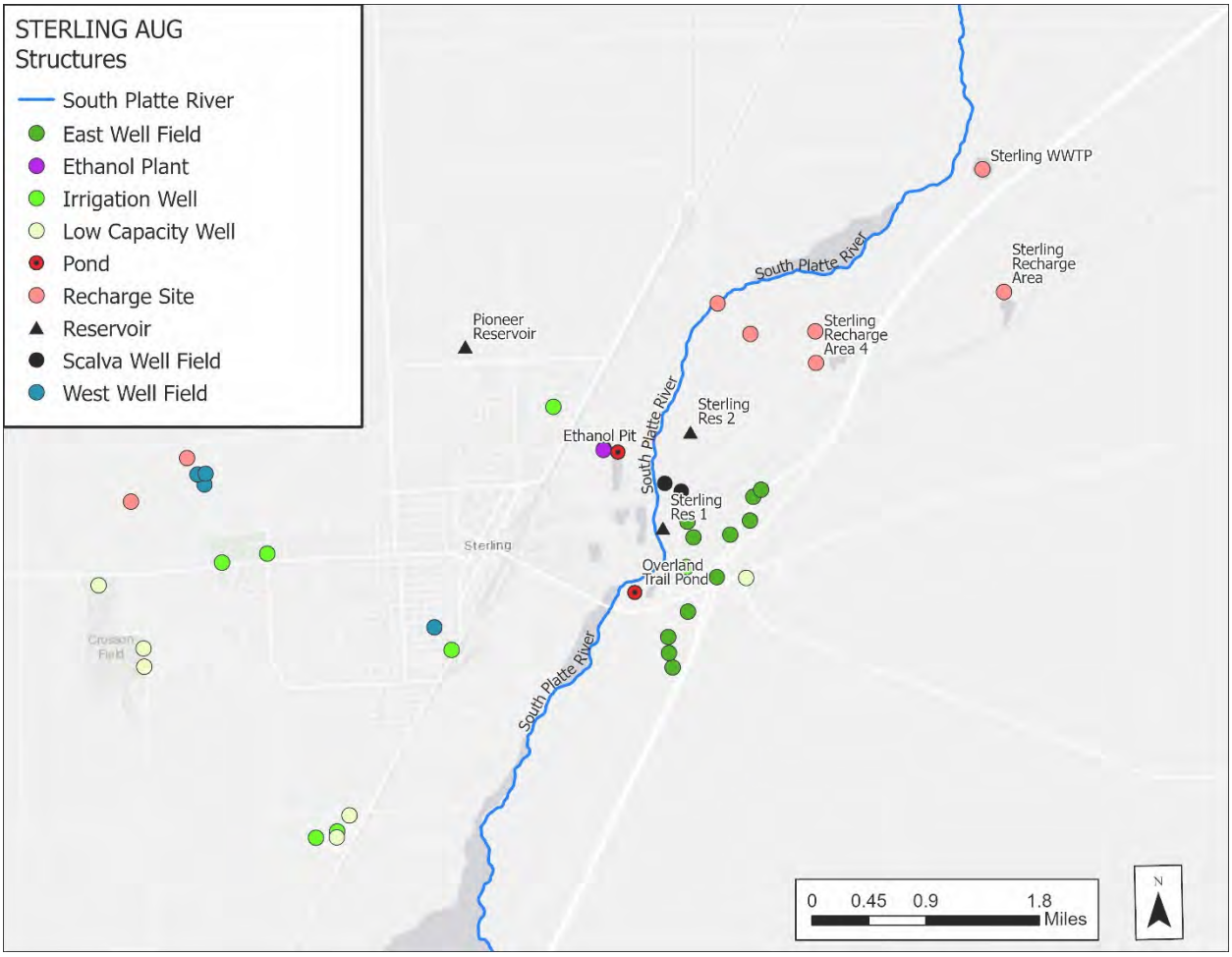
Information available via the CDSS website was used to produce an estimated range of unreplenished, out-of-priority River depletions occurring during active and singular Compact call periods between 2006 and 2020. The estimated range is considered to be "preliminary and subject to refinement" for several reasons, including the fact that much of the originally applied accounting methodology may contain consequential deficiencies that were retained due primarily to information availability limitations. For example, while depletions caused by operation of the Sterling Plan would be relevant at any time during an active Compact call because Sterling's rights are junior to the Compact, due to the structure of the existing accounting, only depletions predicted at times where the Compact call was the singular limiting condition (i.e., no calls associated with rights senior to the Compact) were considered. Therefore, the results presented herein should not be viewed as providing an accurate or bounding independent estimate of depletions occurring as a result of operation of the Sterling Plan. The development of such an estimate would require additional information and a refined and/or expanded approach beyond what is described herein. Instead, the results of this effort serve to highlight key deficiencies in Sterling Plan conceptualization, implementation, and administration/oversight, while also providing a "ballpark" or "order-of-magnitude" estimate of depletions that occurred between 2006 and 2020 to illustrate the apparent occurrence of these depletions during the Intermediate Period.

Background / Plan Overview

The Sterling Plan is intended to allow the City of Sterling to "*maintain and increase the amount of water that will be produced through its Municipal Well System to meet its current and future needs for water, and to replace out of priority depletions to the River from the Municipal Well System* [and other depletion sources]…", as stated in the decree pertaining to consolidated cases 98CW450 and 00CW253 (referred to hereafter as the "Consolidated Decree"). Accounting information available via the CDSS website is consistent with this description, as, in general, it attempts to consider potential River depletions caused by pumping of Sterling's wells, as well as other incidental losses (e.g., evaporative losses from certain ponds) and return flow maintenance obligations. Against these potential depletions, the accounting attempts to balance accretions generated by direct returns (e.g., of treatment plant effluent), direct and indirect discharges tied to exercised water rights, and other potential sources of River flow augmentation (e.g., recharge

[29] CDSS records were accessed at https://dwr.state.co.us/tools/

practices, lawn irrigation return flows, etc.). The following figure depicts the locations of key structures associated with the Sterling Plan based on information presented on the CDSS website:



The following list describes the primary structures and features considered to be components of the Sterling Plan along with their generalized contemplated role within water accounting:

Structures and Features Resulting in Lagged River Depletions

- Municipal, industrial (i.e., ethanol), and augmentation wells producing groundwater and resulting in River depletions (lagged):
  - Eleven (11) wells identified under the "East Well Field" category
  - Four (4) wells identified under the "West Well Field" category
  - Seven (7) wells identified under the "Irrigation Wells" category
  - Six (6) wells identified under the "Low Capacity Wells" category
  - Two (2) "Scalva Well Field" production wells
  - Two (2) "Ethanol Plant" production wells
- Evaporation from the ethanol plant excavation pit and the Overland Trail fishing pond, where evaporative loss represents River depletions (note that evaporative loss from Rothe Pond is also an auxiliary consumptive use that is contemplated under a separate but affiliated decreed augmentation plan)

- Return flow obligations associated with claimed credits for releases from Prewitt Reservoir and exercised canal/ditch rights

Structures and Features Resulting in Direct River Depletions

- Ethanol plant holding pond effective precipitation replacement
- Transit losses for water conveyed through certain River reaches (i.e., reaches 1, 2, and 3, as defined within Sterling Plan accounting)

Structures and Features Resulting in Lagged River Accretions

- Recharge via the Sterling Wastewater Recharge Storage System (SWRSS)
- Recharge via Recharge Site No. 4 (in addition to other less utilized recharge sites)
- Recharge via canal/ditch seepage
- Lawn Irrigation Return Flows (LIRFs). Note that the total LIRF credit claimed on a monthly basis appears to reflect a combination of direct and indirect (lagged) components, as discussed below.

Structures and Features Resulting in Direct River Accretions

- Direct returns of treated wastewater via wastewater treatment plant (WWTP) discharges
- Direct deliveries to river augmentation stations associated with claimed credits for releases from Prewitt Reservoir and exercised canal/ditch rights
- Augmentation well deliveries
- Runoff component of LIRF credit (refer to the discussion below)

<u>Sterling Plan Accounting</u>

Accounting information is available via the CDSS website in varying forms over a period starting in the late 1980s and extending through recent (i.e., 2023 calendar year) months. Though information is typically available in monthly increments over this period, there are many instances where information is either incomplete or completely missing (e.g., daily accounting sheets presented, but accompanying monthly sheets missing/unavailable).

The process of accounting for water debits and credits under the most recent iteration/version of Sterling Plan accounting involves interactive use of three separate spreadsheets:

1. The "Rothe Pond" spreadsheet, which is intended to track the balance of depletions due to evaporation from Rothe Pond against application of excess credits estimated via the accounting for the Sterling Plan (i.e., Rothe Pond operates as a quasi-separate but dependent augmentation plan where the only potential augmentation mechanism available is repurposed excess credits estimated under Sterling Plan accounting).

2. "Monthly" accounting spreadsheets for the Sterling Plan. In general, the monthly spreadsheets – and the individual tabs/tables contained therein – are designed to estimate key volumetric terms at a monthly time interval for use as input to daily accounting, which is performed separately. These terms include cumulative monthly well depletions (i.e., then converted to lagged depletions), certain return flows (e.g., WWTP returns, LIRFs,

etc.), and credits (e.g., direct canal/ditch deliveries). The monthly spreadsheets also include an attempt to apportion/distribute monthly values amongst four (4) River reaches, thus supporting estimates of "transit" losses and providing a means of considering the influences of "dry-up" points and bypasses around such conditions.

3. "Daily" accounting spreadsheets for the Sterling Plan. These spreadsheets attempt to track the balance of water debits and credits at daily intervals under different River call conditions. The call conditions identified in the daily accounting spreadsheets can influence the manner in which monthly totals are distributed over the days in a given month, and, in some cases, they can influence term magnitudes (e.g., priority-based return flow obligations). It is important to note the daily accounting appears to be designed to estimate net water balance in consideration of priority structure (as represented by the call conditions included in the spreadsheets, which are potentially erroneous/not representative) at a daily interval; it is not designed to comprehensively estimate the magnitude of net depletion/accretion at a daily interval. That is, setting aside potential methodological issues and other errors, the daily accounting cannot be used without modification to estimate if a net depletion occurring during Compact call conditions is replaced within the required 72-hour timeframe. It is also worth noting that certain quantities derived from the daily accounting spreadsheets are returned to the monthly accounting and Rothe Pond accounting spreadsheets, as applicable. That is, quantities impacted by monthly calls (e.g., lagged depletions requiring augmentation) are returned in an effort to strike balance between monthly and daily accounting summaries.

Water accounting required by the Water Court decrees associated with the Sterling Plan appears to have changed in form over the period of availability via the CDSS website. For example, a significant change in accounting spreadsheet format occurred between the months of April 2013 and May 2013. For the purposes of the descriptions provided below, the period prior to this change is referred to as the "early" form of accounting, and the period following the change is referred to as the "recent" form of accounting (i.e., because accounting spreadsheets available via the CDSS website for the most recent periods relative to the issuance date of this document generally follow the post-May 2013 format).

Key Higher-Level Observations of Accounting Procedures:

- "Early" accounting suggests depletions to River flows occurred as a result of Plan operations without evidence of mitigating actions commensurate with Compact requirements.
- "Early" accounting also suggests, during certain times where unreplaced depletions were occurring, water available to partially mitigate the depletive effect was inappropriately categorized as "excess credit" and re-routed to recharge thus exacerbating the depletive effect.
- The accounting appears to use inaccurate representations of river call records, at least for Compact calls, thus impacting water balance calculations during Compact call periods.
- Updates to accounting, if applied in a hindcasting sense, would likely alter the results of historical accounting and increase depletion estimates.

- Beyond the influences of changes brought about through modifications to the accounting process over time, broader approach related issues remain that are likely to be consequential relative to the reported quantitative water balance estimates, such as the following:
    - Uses of longer-term temporal averages as opposed to more finely discretized (i.e., temporally) quantities in certain lagging calculations, such as those pertaining to recharge via the SWRSS (see *Accretions from Sterling Wastewater Recharge and Storage System*, below); and
    - Unclear adaptations/modifications to certain credit calculations, such as use of the so-called "base indoor use" in LIRF estimates (see *Accretions from Lawn Irrigation Return Flows*, below).

Accretions from Sterling Wastewater Recharge and Storage System

A detail relevant to the Compact concerns the Sterling Plan's reliance on accretions stemming from recharge of treated wastewater via the SWRSS. Section 10.9.2.2.1 of the Consolidated Decree (98CW450 and 00CW253) states: "*The Court finds that returns from the SWRSS to the South Platte River have reached a steady state condition under which 8.33% of the total annual volume of recharge accruing to the South Platte River from the SWRSS reaches the river in each month of the year, and Sterling is entitled to take credit on a constant daily basis for the monthly amount of recharge for the purposes of this decree. Not all water placed into the SWRSS returns to the river in the calendar year in which the water was diverted to recharge. The Court finds that the total annual volume of recharge reaching the South Platte River from the SWRSS in any calendar year is equal to the average of the total amount of water placed into the SWRSS in the three previous calendar years, less any amount lost to evaporation".*

While the Consolidated Decree does not provide a basis for these statements, the "8.33%" rate is potentially derived from a 1983 report[30] in which a study of the SWRSS structures is detailed. The study included Glover-technique (i.e., analytical modeling) assessments of river accretion rates based on different simulated durations of recharge at the SWRSS. Table 3 from that report, which describes the results for a 30-day recharge period after 20-years of simulation time, is reproduced below (note that "Recharge Rate", as referenced in the table title, appears to refer to estimated accretion rate at the River):

[30] *Yield of Recharge Project, Water Court Case No. W-9507-78*, prepared for the City of Sterling, Colorado, by Bishop Associates, Inc. Dated August 1983.

Table 3. Recharge Rates as a Per Cent of Average Monthly Discharge to Recharge Basin

30-Day Recharge Period

Month Recharge Starts	Months Following Start of Recharge										
0	1	2	3	4	5	6	7	8	9	10	11
7.3	7.0	7.0	7.6	8.3	8.8	8.9	8.8	8.6	8.3	7.9	7.5

As illustrated by this excerpted table, estimated accretion rates range from a minimum of 7.0 percent per month to a maximum of 8.9 percent per month with a cumulative response of 96 percent over the reported 12-month period following the start of recharge (in that final year of simulation). The average of the percentages reported in Table 3 is 8.0 percent per month, and if the unaccounted for 4 percent remainder is distributed uniformly over the 12-month period, the average would increase to 8.33 percent per month, consistent with the rate utilized in Sterling Plan accounting. Alternatively, one could simply divide 100 percent by 12 months and arrive at the same result (i.e., 8.33 percent per month).

While the values reported within Table 3, above, appear to represent an approximated unit response function (URF), due to the design of the underlying analysis, it is one that is more consistent with regular, month-duration recharge pulses occurring annually, as opposed to having any apparent connection to an average of cumulative annual flows over a preceding three-year period, as it appears to be used within Sterling Plan accounting. In fact, the use of such an average in cases of temporally variable flows would likely lead to significant predictive errors, including extension of accretion credits into periods where actual accretions had dissipated long ago (e.g., a case of large recharge in year one followed by two years of zero recharge would result in non-zero accretion credit claims in year four, which would be going on three years since any flows had been delivered to the SWRSS). As noted below, lawn irrigation return flow (LIRF) credits may be calculated using a similar technique, so a similar potential for predictive error may also apply in that case. Notably, most, if not all, consumptive use and recharge lagging associated with other structures within the Sterling Plan is handled via URFs derived via the Glover analytical model/solution applied using incremental monthly totals, further highlighting the deficiency in the method used for the SWRSS (and potential LIRF) credits.

Given these observations, the following steps were completed to create several alternative time series of lagged accretions stemming from SWRSS recharge that could be inserted into the accounting to assess the sensitivity of out-of-priority depletion estimates:

1. Compile time series representing claimed total monthly “Inflow to Recharge” volumes representing assumed monthly recharge quantities for the SWRSS (i.e., from Table G-1 or Table 6 of monthly accounting spreadsheets, depending on date).
2. Develop estimated accretion data sets representative of the following scenarios:

a. Lagging using 8.33% of monthly recharge inflow totals applied to the current month and the following 11-month period, consistent with the URF described in the 1983 Bishop Associates report and used in the original accounting;
b. Lagging using the so-called Glover analytical model and assumed input parameters[31] in a manner more consistent with the lagging method applied to other sources of depletions and accretions within Sterling Plan accounting.
c. Lagging using the so-called "Alluvial Aquifer" method within AWAS (i.e., Glover analytical model modified to include an up-gradient no flow boundary condition) in recognition of the close proximity of the mapped boundary of the alluvial aquifer to the SWRSS (i.e., assumed to be 100 feet up-gradient relative to the SWRSS position, thus making the assumed value of the W parameter 5,380 feet).

Accretions from Lawn Irrigation Return Flows

Sterling Plan accounting attempts to quantify return flows from excess/unconsumed lawn irrigation, or LIRFs, to provide significant (at certain times) credits against depletions. On a monthly basis within Sterling Plan accounting, the total claimed LIRF credit is the sum of two terms: return flows associated with applied irrigation that infiltrates but is not consumed, and return flows associated with lawn irrigation runoff.

The process of estimating each of these terms starts with an approximation of total monthly irrigation water use. To get this value, Sterling Plan accounting first takes the monthly production total for wells contributing to the municipal system and subtracts the average of the three monthly production totals occurring during the preceding December through February period (i.e., the so-called "Base Indoor Use", as it appears these months are contemplated under applicable decrees to be representative of times when little to no irrigation or outdoor water use is occurring) to estimate total monthly outdoor water use. The result of the previous step is then reduced by 3% to produce the estimated monthly total irrigation use, where the 3% reduction is intended to approximate the volume lost to other "miscellaneous uses" aside from lawn irrigation.

To estimate the portion of the total LIRF credit associated with infiltrated but unconsumed irrigation, the monthly irrigation use value is reduced by an additional 7% to approximate the combination of application and runoff losses. The resultant monthly lawn irrigation application volumes are used on an annual basis to calculate—outside of the commonly reported accounting process[32]—annual "system-wide" LIRF volumes, which are then averaged over rolling three-year periods. Total monthly LIRF credits associated with infiltrated but unconsumed irrigation are estimated by multiplying the most recent three-year average value by the so-called "LIRF Factor", which varies by month from a minimum of 7.0% in April to a maximum of 9.8% in October. Though the basis for this schedule of factors is unclear based on information reviewed to-date, it

[31] Transmissivity of 35,080 gallons per day per foot and storativity/specific yield of 0.15 (dimensionless) values were assumed based on the 1983 Bishop Associates report. The linear distance between the SWRSS and the South Platte River was independently estimated to be approximately 5,280 feet (roughly 1 mile); this value was used in place of the distance presented in the 1983 Bishop Associated report (i.e., approximately 6,700 feet).

[32] Though annual calculations are indicated by decree language and notes contained within the monthly accounting sheets, these annual calculations do not appear to be available in documented form via the CDSS website.

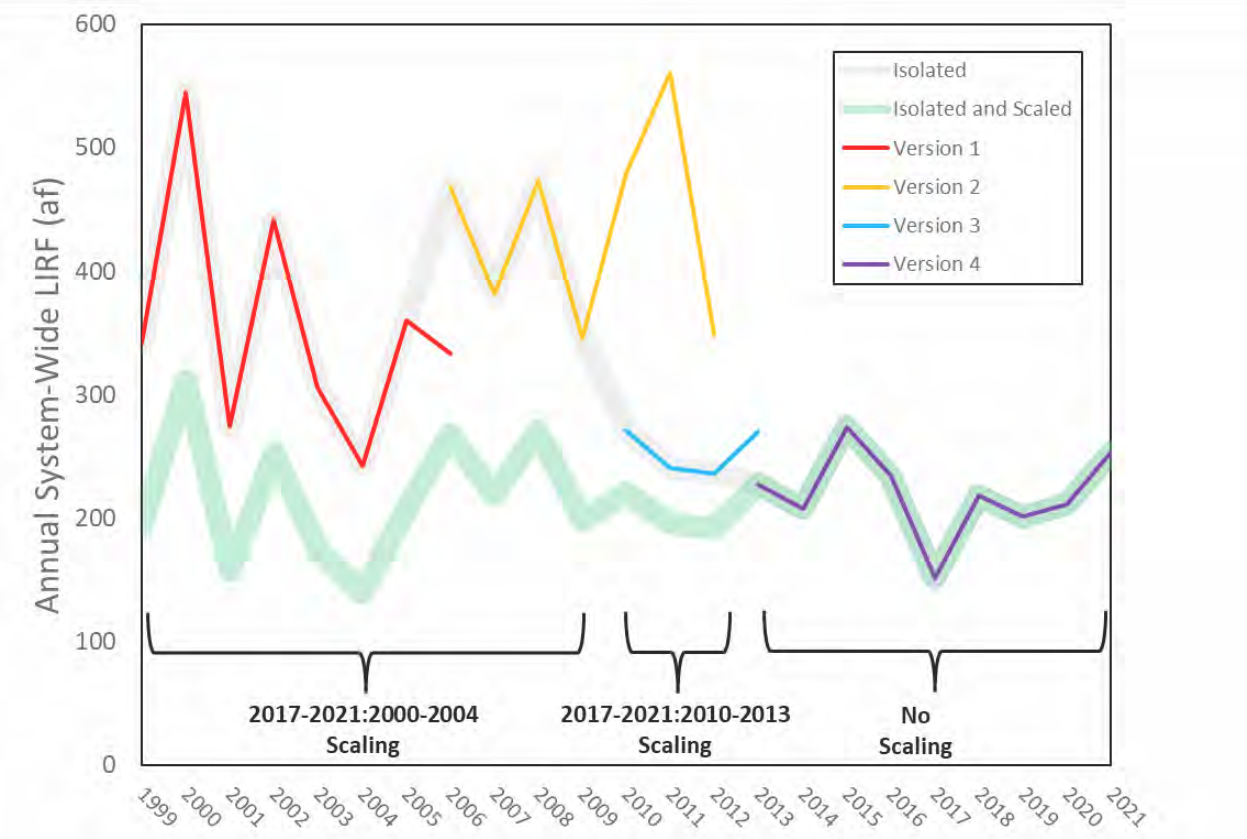
appears to be applied within the accounting as a representative steady-state unit response function akin to the one used to develop lagged accretions from the SWRSS, as described above.

The portion of the total LIRF credit associated with irrigation runoff is estimated in a much more straightforward and transparent manner. As noted above, the estimation of total monthly lawn irrigation application from total monthly irrigation use involves a 7% reduction approximating application and runoff losses. Of this 7%, 2% is assumed to be representative of runoff losses; therefore, the monthly irrigation runoff component of the total LIRF credit is simply estimated as 2% of the estimated total monthly irrigation use volume.

While details of the LIRF credit calculation remain unclear, a review of the magnitudes of claimed credits over the history of available accounting suggests updates/corrections to annual system-wide LIRF calculations have resulted in reductions that were not reflected in prior accounting. The following steps were completed to create an alternate time series of annual system-wide LIRF volumes that could be inserted into the accounting to assess the sensitivity of out-of-priority depletion estimates:

1. Compile reported annual system-wide LIRF volumes using available monthly accounting (Table B-1 or Table 5 of monthly accounting spreadsheets, depending on date) noting occurrences of inconsistent reported values during overlapping time periods.
2. Develop “isolated” time series of annual system-wide LIRF by deferring to most recent reported result in cases where inconsistencies exist during overlapping time periods.
3. Scale the isolated time series using ratios developed over selected time periods to create a more temporally consistent data set with reduced high bias potential during early accounting periods.

The following figure illustrates this process, with the gray line indicating the isolated annual system-wide LIRF volume time series and the green line indicating the effect of the scaling process, which is performed using different scaling factors for different time periods:



Compact Shortage Estimates

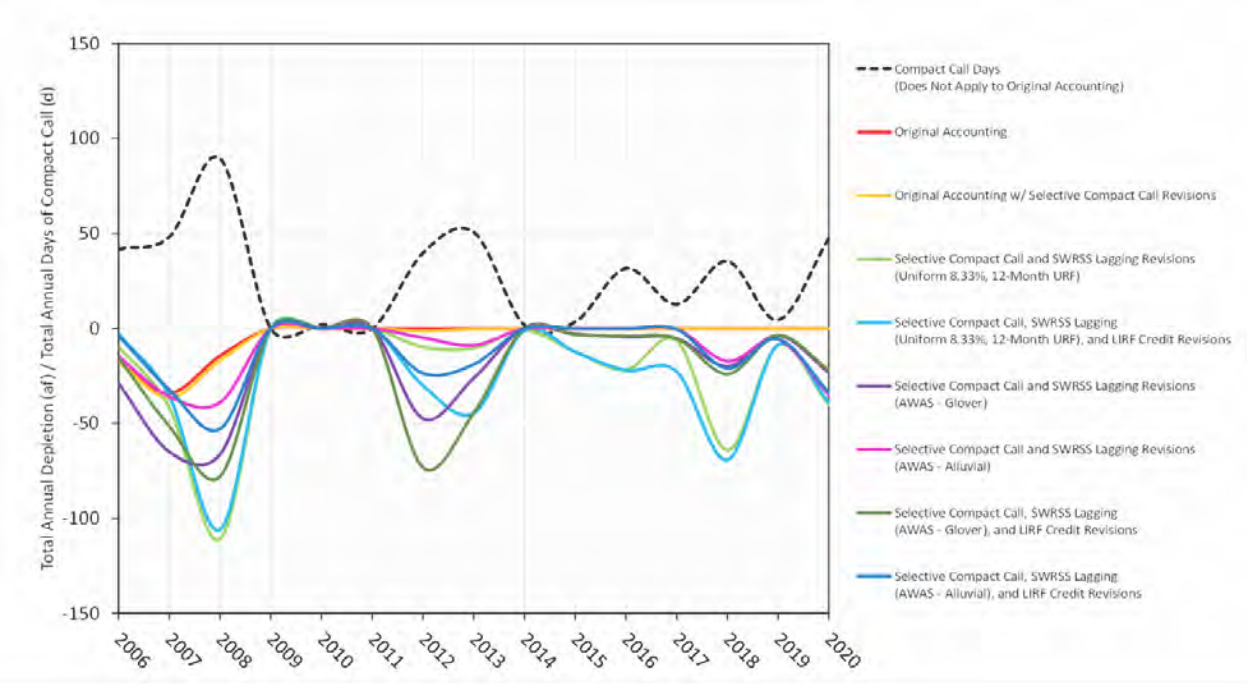
The Sterling Plan's unmodified accounting reported shortages (i.e., unreplenished net depletions of River flow) during active Compact calls to the State of Colorado in at least one month during the period of 2006 through 2008, but similar shortage reports have been extremely rare since that time. Due to reliability limitations pertaining to Sterling Plan accounting presented to-date, as evidenced by the examples of conceptual flaws and inconsistencies through time described in the previous section, it is unclear exactly what effects the Sterling Plan's operation had on the river. However, to generally assess the durations of out-of-priority depletions and their approximate magnitudes the Sterling Plan's net effects through time were recalculated on a daily basis over the period of 2006 through 2020 using:

- River debit and credit calculations submitted to the State of Colorado with adjusted/corrected numbers of Compact call days from 2006-2012 (based on call information obtained from the CDSS website[33]);
- River debit and credit calculations including modified lagging of SWRSS recharge (i.e., three different techniques) combined with corrected numbers of Compact call days from 2006-2012 (based on call information obtained from the CDSS website); and

[33] Note that corrections were based on a comparison of Compact call records available via the CDSS and existing call records presented in the historical accounting. Consistent with certain formulae employed in the accounting spreadsheets, call priority/seniority was determined based on a comparison of administrative numbers, with the smaller numbering being assumed to represent the senior call condition.

- River debit and credit calculations including modified lagging of SWRSS recharge (i.e., three different techniques) and scaled LIRF estimates combined with corrected numbers of Compact call days from 2006-2012 (based on call information obtained from the CDSS website)

The results of these assessments are summarized by the following figure and **Table 1**, the latter of which lists the total amounts (by calendar year) from all months with net depletions to the River (i.e., negative net effects).



The cumulative unreplenished depletions (River shortages) on singular Compact call days from 2006 through 2020 range from approximately 66 acre-feet (Original Accounting case, **red** line above) to approximately 393 acre-feet (Selective Compact Call, SWRSS Lagging [Uniform 8.33%, 12-Month URF], and LIRF Credit Revision case, **light blue** line above) across the evaluated accounting scenarios (including the originally presented method). These estimates are based on a variety of assumptions and decisions, including the following:

- Accounting practices, assumptions, inputs, and other included components aside from those that have been modified as specifically noted above (i.e., River call representations over selected periods, lagging of SWRSS recharge volumes, and LIRF credit estimates) are retained as-is over the duration of the assessment.
- For the duration of the assessment, calls senior to the Compact, as suggested by administrative (i.e., admin) numbers provided in available accounting records, are left unmodified.
- For the period of May 2013 through 2020, all River call conditions are retained as they are represented in the available accounting records.

- Accounting representing periods prior to 2006 is not included in the assessment because records prior to this date are not provided in electronic form, thus preventing verification of applied formulae.
- Accounting representing periods beyond 2020 is not included in the assessment because limited testing suggested the factors evaluated as part of this assessment did not contribute to significant accounting differences after December of 2020.
- Net accretions within 72-hours of depletion occurrences (e.g., after a Compact call has expired) are assumed to be negligible relative to the overarching finding that depletions were occurring during the Intermediate Period.

Table 1a. Estimated unreplaced depletions during singular Compact call periods for tested accounting scenarios.

	Total Depletions by Year (AF)			
Year	**Original Accounting**	**Original Accounting w/ Selective Compact Call Revisions**	**Selective Compact Call and SWRSS Lagging Revisions (Uniform 8.33%, 12-Month URF)**	**Selective Compact Call, SWRSS Lagging (Uniform 8.33%, 12-Month URF), and LIRF Credit Revisions**
2006	-17.83	-17.50	-9.44	-2.64
2007	-34.18	-36.45	-41.67	-35.48
2008	-14.38	-16.75	-110.87	-105.81
2009	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00
2012	0.00	-1.32	-9.80	-29.94
2013	0.00	-0.25	-10.35	-44.61
2014	0.00	0.00	-0.92	-1.02
2015	-0.01	-0.01	-12.17	-12.33
2016	0.00	0.00	-21.79	-21.99
2017	0.00	0.00	-6.36	-22.67
2018	0.00	0.00	-64.12	-69.17
2019	0.00	0.00	-8.71	-8.51
2020	0.00	0.00	-40.21	-38.96
Totals	**-66.41 (Minimum)**	**-72.28**	**-336.40**	**-393.13 (Maximum)**

Table 1b. Estimated unreplaced depletions during singular Compact call periods for tested accounting scenarios (cont.).

	Total Depletions by Year (AF)			
Year	**Selective Compact Call and SWRSS Lagging Revisions (AWAS - Glover)**	**Selective Compact Call and SWRSS Lagging Revisions (AWAS - Alluvial)**	**Selective Compact Call, SWRSS Lagging (AWAS - Glover), and LIRF Credit Revisions**	**Selective Compact Call, SWRSS Lagging (AWAS - Alluvial), and LIRF Credit Revisions**
2006	-28.90	-14.61	-15.43	-3.75
2007	-64.96	-35.76	-51.46	-32.23
2008	-66.32	-38.88	-77.88	-52.88
2009	0.00	0.00	0.00	0.00
2010	0.00	0.00	0.00	0.00
2011	0.00	0.00	0.00	0.00
2012	-47.50	-4.78	-73.21	-23.61
2013	-26.15	-8.79	-44.39	-18.90
2014	0.00	0.00	0.00	0.00
2015	-2.96	0.00	-3.14	0.00
2016	-4.44	0.00	-3.89	0.00
2017	-5.22	-0.30	-5.28	-0.35
2018	-19.93	-17.18	-23.97	-20.99
2019	-3.67	-5.63	-3.48	-5.43
2020	-23.25	-35.01	-22.05	-33.79
Totals	**-293.30**	**-160.94**	**-324.17**	**-191.91**

Attachment C

Recent Period – Brown Aug. and Similar Plans

Executive Summary

Recent Period - Brown Aug. and Similar Plans

- Three currently operating water district 64 augmentation plans (Brown, Sand Creek Estates, and Sessions) sharing the same general conceptual framework are identified and reviewed. These plans include new (i.e., junior rights) well diversions for in-home and lawn irrigation purposes that result in depletions during times of river call. These out-of-priority depletions are to be replaced by Prewitt Reservoir releases that are available to each plan via purchases of shares and water right changes established through Colorado Water Court decrees.

- In accessing these Prewitt Reservoir releases, the plans inherit the responsibility of maintaining return flows that occurred and are tied to the historical irrigation (or irrigation offset via exchange) uses of the credits. Only the consumptive use fractions of the total reservoir releases are available to offset new depletions generated under the plans.

- The decrees pertaining to each of these plans envision temporally distributed (as opposed to temporally discrete/episodic) diversions resulting in similarly temporally distributed depletions. Therefore, during river call periods, augmentation practices would have to produce temporally distributed accretions to be effective offsetting measures in the context of the South Platte River Compact (Compact). However, a review of Prewitt reservoir records associated with each of these plans suggests releases have historically occurred as episodic events (e.g., a large volumetric release during a single day).

- The deficiency of this practice is demonstrated by summing the estimated depletions occurring on Compact call days for each plan (i.e., based on the simplifying assumptions described in each plan's decree) and subtracting estimated depletions occurring on days of reported Prewitt Reservoir releases (and within a preceding 72-hour period, thus conservatively approximating the 72-hour replacement requirement under the Compact).

- This example illustrates depletions occurring, particularly during the Recent Period.

Recent Period - Brown Aug. and Similar Plans

Historical depletions from and accretions to the South Platte River ("river") associated with the Brown Augmentation Plan (WDID = 6402799; "Brown Plan" hereafter), the Sand Creek Estates Augmentation Plan (WDID = 6402865; "SCE Plan" hereafter), and the Sessions Augmentation Plan (WDID = 6402889; "Sessions Plan" hereafter) were aggregated from Colorado Water Court decree information and accounting and diversion records[34] available on the Colorado Decision Support Systems (CDSS) website.

For the Brown Plan, available accounting information spans a period from October 2008 through December 2022 (and beyond). This accounting provides monthly estimates of depletions, accretions, and replacements (as appropriate) for the annual periods relevant to the South Platte River Compact (i.e., "Compact" hereafter, April through October 15th of each year). Accounting spreadsheets available via the CDSS website were used to produce a rough estimate of unreplenished augmentation requirements occurring between 2008 through 2022.

For the SCE and Sessions Plans, accounting information is not posted to the CDSS. Instead, available information/data appears to be limited to periodic reporting of measured/estimated groundwater diversion rates (i.e., by wells included within each plan) and conceptual information contained within applicable Water Court decrees. The latter source was paired with CDSS diversion data to produce rough estimates of unreplenished augmentation requirements for the SCE and Sessions Plans.

Background / Plan Overview

The Brown Plan relies on an analysis[35] of potential consumptive uses associated with subdivision lots, including household (i.e., in-house) water uses and exterior applications (i.e., lawn irrigation). For household uses, unit (i.e., per house) consumptive use estimates are derived based on several assumptions, including the number of persons occupying each house (3.5 persons), the rate of water use by each person within each house (100 gallons per day), and the percentage of used water that is not returned via septic infiltration (ten percent). For irrigation uses, consumptive use estimates appear to be derived based on an averaging of results produced by an application of the modified Blaney-Criddle method over a historical 41-year period (1950 through 1990)[36]. Average monthly effective rainfall is subtracted from average monthly cumulative crop water requirement to produce a monthly schedule of net crop water requirement, again reflecting an average over a 41-year historical period. These average monthly requirements are then paired with an assumed per lot irrigated lawn area of 6,000 square feet to estimate a total average annual per lot volume of consumptive use due to irrigation. The cumulative estimated household and irrigation consumptive uses are then translated, on a unit (i.e., per house/lot) basis, to estimated depletions at the South Platte River using the stream depletion factor (SDF) method.

[34] CDSS records were accessed at https://dwr.state.co.us/tools/

[35] See letter to Kim R. Lawrence, Esq. from Forrest Leaf, P.E. of Leaf Engineering, *RE: Brown, 96CW117*. Dated July 14, 1997. https://dnrweblink.state.co.us/DWR/PDF/32nb055yuclmx2fhsre45sxi/91/DWR_2169643.pdf

[36] See letter to Mr. Dave Nettles, P.E. from Forrest Leaf, P.E. of Leaf Engineering, *RE: Brown and Propst Lawn Grass Net Consumptive Use*. Dated July 24, 1997.

According to the original Brown Plan decree[37], out-of-priority depletions tied to the consumptive uses described above are proposed to be replaced by regular releases from Prewitt Reservoir. These releases are made available by changing the water right associated with, and therefore application of, owned shares of the Morgan-Prewitt Reservoir Company ("Morgan-Prewitt"). Each Morgan-Prewitt share has an annual delivery allotment[38]. The number of owned shares is multiplied by the assumed annual delivery allotment to estimate the total annual release volume available under the Brown Plan.

The shares owned under the Brown Plan[39] were historically used (i.e., reportedly exchanged) to support crop irrigation under the Riverside Irrigation District system ("Riverside"). The Brown Plan is required to maintain the historic return flows and associated accretions to the South Platte River that occurred when their Morgan-Prewitt water rights were exercised under the former use. Based on the Brown Plan's decree, Riverside's historic operations were assumed to have resulted in transmission losses totaling 30 percent of diverted water; the remainder was assumed to have been used for irrigation at a 60 percent efficiency level. Historical return flows associated with unconsumed irrigation are estimated separately through a process that uses a monthly schedule of consumptive use factors for which no basis is presented. The SDF method is applied to estimate the lagged return flow responsibility at the South Platte River based on the historical use condition (i.e., using an SDF value that approximates the location at which the historical losses and percolation of unconsumed irrigation occurred).

To summarize, the Brown Plan appears to operate under the following key conceptual assumptions:

1. Groundwater diversions for household and irrigation purposes are steady over time and will result in a consistent monthly schedule of depletions at the South Platte River. During times of senior call, including by the Compact, these depletions will be out-of-priority and will require replacement.
2. Out-of-priority depletions will be replaced through releases of Prewitt Reservoir water made available to the Brown Plan via a change in water right for shares historically exchanged to support irrigation under the Riverside system.
3. When these Prewitt releases are used under the Brown Plan, only the historical consumptive use portion of each share allotment is available to replace out-of-priority depletions. That is, return flow responsibilities tied to historical uses of this water right must be maintained.

The SCE and Sessions Plans mimic the conceptual structure of the Brown Plan. Both contemplate schedules of estimated depletions and required return flows that must be addressed and maintained,

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[37] *Findings of Fact, Conclusions of Law, Ruling of the Referee and Decree of the Water Court – Concerning the Application for Water Rights of: Thomas G. Brown in Logan, Morgan, and Washington Counties*. Case No. 96-CW-117. Dated May 13, 1996.
https://dnrweblink.state.co.us/DWR/PDF/32nb055yuclmx2fhsre45sxi/112/DWR_590167.pdf

[38] Note there is confusion on the magnitude of the assumed allotment. Refer to the 1997 Leaf Engineering letter (https://dnrweblink.state.co.us/DWR/PDF/32nb055yuclmx2fhsre45sxi/259/DWR_2169643.pdf) which reports an assumption of 16 af/year/share but provides a table (Table 2) that suggests the use of a value of approximately 13 af/year/share.

[39] The Brown Plan's shares of Morgan-Prewitt Reservoir Company are associated with appropriation dates of 1910 and later based on the 96-CW-117 decree.

respectively. Augmentation flows occur through owned access to releases from Prewitt Reservoir, which are available via water right changes established in each plan's decree.

Historical Accounting

The Brown Plan's accounting is available via the CDSS and is presented in monthly increments starting after October of 2008; there is no evidence any attempts have been made to perform accounting over finer temporal increments (e.g., daily). The accounting presents augmentation requirements based on the generalizing assumptions mentioned in the previous section. An estimated unit (i.e., per lot/home) depletion associated with groundwater diversions for household and irrigation uses is multiplied by the number of active homes/lots to generate an estimated aggregate depletion for the development as whole. This aggregated depletion is then added to the return flow maintenance requirement associated with using available Prewitt shares to represent a cumulative monthly augmentation requirement. This monthly schedule of augmentation requirements appears to be constant throughout all available accounting to-date because the utilized assumptions remain unchanged over time, and no additional homes/lots appear to have been added since accounting has started being uploaded to the CDSS.

Monthly metered pumping data is presented alongside/within the accounting; however, these data are simply aggregated on an annual basis and informally compared to the assumptions used in the accounting. These records are not directly integrated into the accounting itself (e.g., by estimating lagged depletions based on actual withdrawals). Instead, annual averages of the measured monthly values are compared to an estimated "Decree Avg." rate in what appears to be an attempt to assess the reasonableness of assumptions used in originally estimating depletions. That is, a unit/per well "Total Avg. Delivery", or total individual well annual groundwater diversion, is calculated by summing the estimated annual "Avg. In-House Delivery" of 0.39 af per home and the estimated annual "Avg. Lawn Delivery" of 0.319 af/lot, which is based on the total individual lot annual "Irrigation" water demand of 0.29 af/lot originally reported by Leaf Engineering[40]. The irrigation demand is sometimes (i.e., in later accounting) multiplied by 1.1, which presumably reflects an assumed irrigation efficiency factor. The resultant estimated "Total Avg. Delivery" value of 0.709 af/year – or 0.680 af/year in earlier accounting that does not include the 1.1 factor – is compared to annual sums of measured monthly groundwater diversions on individual well, individual decree, and overall bases, with the comparison approach varying depending on the date of the accounting[41]. Outcomes of the comparisons are presented in binary form, either being reported as "OK" if the measured average is less than the comparable assumed value or "Exceed" in the opposite case. "Exceed" outcomes are common, particularly in later accounting (e.g., December 2022), despite the biases introduced through averaging.

The Brown Plan's accounting suggests there is an attempt to address monthly augmentation requirements through routine releases of water from Prewitt Reservoir. That is, a schedule of

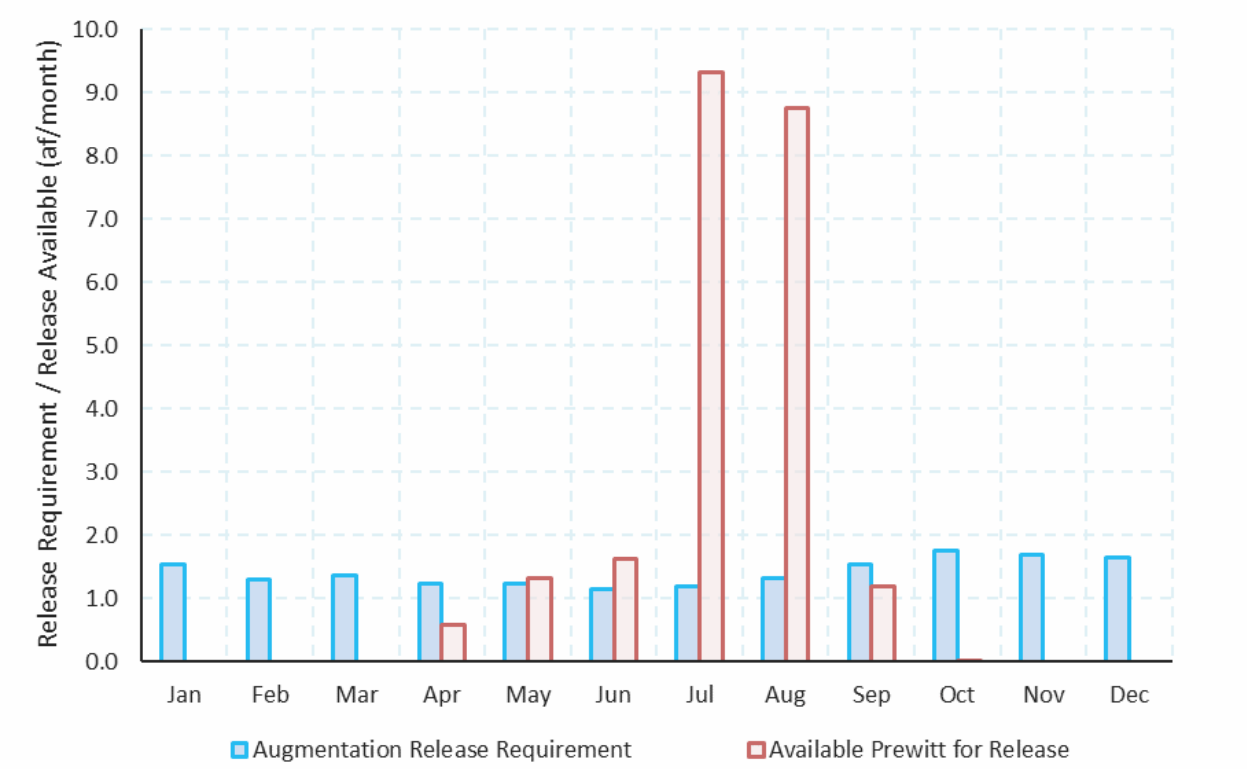
[40] See letter to Kim R. Lawrence, Esq. from Forrest Leaf, P.E. of Leaf Engineering, *RE: Brown, 96CW117*. Dated July 14, 1997. https://dnrweblink.state.co.us/DWR/PDF/32nb055yuclmx2fhsre45sxi/91/DWR_2169643.pdf

[41] For example, accounting through October of 2008 includes a 'Annual Quota Check' tab that simply compares total annual (water year) measured diversions to the so-called "Annual Quota" values on an individual well basis; whereas, accounting through December of 2022 includes an 'Average Check" tab that compares these values for individual wells, individual decrees, and overall. Oddly, the so-called "Annual Quota" values are totaled to include placeholder sites with no measured diversions – this causes the totaled values to be biased low for the measured side and biased high for the assumed/"Annual Quote" side.

monthly releases is provided alongside the monthly schedule of augmentation requirements. The following figures – including the excerpted image taken from accounting completed through December 2022 – identify and compare these schedules (i.e., augmentation requirement in blue; available releases in red):

Table 1 - Accounting Form (all values in acre-feet)								Date:	1/27/2023
Case No. 96CW117 - Columbine Subdivision									
Water Year: 2022									
Dec-22									
	Unit Well Depletions (af)	Number 96-CW-117 Wells	96-CW-117 Well Depletions	Number 98-CW-366 Wells	98-CW-366 Well Depletions	Total Well Depletions	Prewitt Returns	Augmentation Release Requirement	Avalable Prewitt for Release
Month	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Jan	0.029	6	0.17	5	0.15	0.32	1.21	**1.53**	0.00
Feb	0.026	6	0.16	5	0.13	0.29	1.00	**1.29**	0.00
Mar	0.029	6	0.17	5	0.15	0.32	1.03	**1.35**	0.00
Apr	0.029	6	0.17	5	0.15	0.32	0.92	**1.24**	0.57
May	0.029	6	0.17	5	0.15	0.32	0.90	**1.22**	1.31
Jun	0.027	6	0.16	5	0.14	0.30	0.84	**1.14**	1.61
Jul	0.027	6	0.16	5	0.14	0.30	0.88	**1.18**	9.31
Aug	0.027	6	0.16	5	0.14	0.30	1.02	**1.32**	8.74
Sep	0.026	6	0.16	5	0.13	0.29	1.24	**1.53**	1.18
Oct	0.027	6	0.16	5	0.14	0.30	1.45	**1.75**	0.02
Nov	0.027	6	0.16	5	0.14	0.30	1.38	**1.68**	0.00
Dec	0.029	6	0.17	5	0.15	0.32	1.32	**1.64**	0.00
Total	0.332		1.99		1.66	3.65	13.19	**16.84**	22.74
Jan	0.029	6	0.17	5	0.15	0.32	1.21	**1.53**	0.00
Feb	0.026	6	0.16	5	0.13	0.29	1.00	**1.29**	0.00
Mar	0.029	6	0.17	5	0.15	0.32	1.03	**1.35**	0.00
[1] Unit average well depletions									
[2] Number of active wells pursuant to 96-CW-117 (14 wells total)									
[3] Column [1] x [2] = average monthly wells depletions attributed to all active 96-CW-117 wells									
[4] Number of active wells pursuant to 98-CW-366 (14 wells total)									
[5] Column [1] x [4] = average monthly well depletions attributed to all active 98-CW-366 wells									
[6] Total well depletions for all active wells, column [3] + column [5]									
[7] Historic Prewitt Returns									
[8] Augmentation release requirement, column [6] + column [7]									
[9] Amount of Prewitt available for release									
Accounting Forms prepared by Joe Frank, LSPWCD from 98CW366 decree and Forrest Leaf Engineering Report									

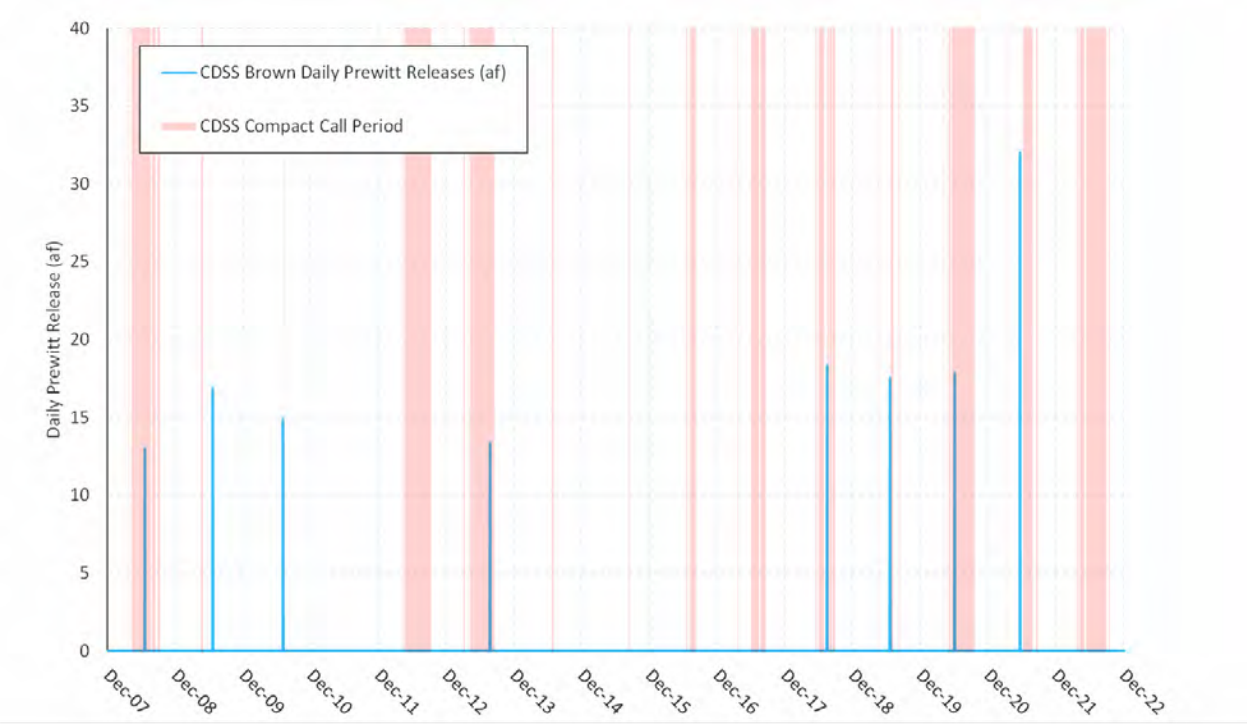
Depiction of primary accounting tab from December 2022 submittal available via the CDSS.



Comparison of augmentation requirement and available release schedules. Note inadequate available release volumes shown during April, September, and October.

Though no tracking of senior call days is provided within the accounting, a simple comparison of the two schedules reveals irrigation season months in which the augmentation requirements exceed the available release volumes (i.e., April, September, and October). This observation illustrates how, if the Brown Plan were to operate as assumed and reflected within the accounting, there would be cases where available augmentation volumes would be insufficient to replace out-of-priority augmentation requirements in a timely manner.

A review of CDSS diversion records associated with the Brown Plan suggests, however, that Prewitt releases have not occurred regularly and in a manner consistent with the release schedule represented in the accounting. Instead, releases appear to have occurred as occasional bulk events – typically over the course of a few days during a single month in a given calendar year. The following figure illustrates the timing of these releases relative to the periods during which Compact calls were in effect on the river over the period of January 1, 2008 through December 31, 2022, based on information obtained from the CDSS:



Brown Plan diversion data indicating releases from Prewitt Reservoir compared to Compact call periods based on CDSS information.

As indicated by this figure, there are certain calendar year periods where there are no records indicating any releases occurred despite Compact call conditions. Such a practice is objectively inadequate in offsetting out-of-priority augmentation requirements in space and in time since groundwater diversions and associated depletions of South Platte River flows are far less episodic in comparison to the releases suggested by CDSS records. Similarly sporadic and inadequate Prewitt Reservoir releases are evident within CDSS records associated with the SCE and Sessions Plans.

Based on the above, the operations of the Brown, SCE and Sessions Plans appear to have resulted in – and are presumably continuing to generate – unreplaced/unremedied depletions.

A number of other noteworthy details regarding the accounting available on CDSS were also noted during this review:

- The imaged documents available via the CDSS include reports authored by Leaf Engineering that describe analyses supporting certain elements of the accounting. However, there are inconsistencies between the descriptions of the analyses and the numerical outcomes of certain calculations. For example, relative to the Brown Plan, the total available Prewitt release volume is described as being calculated based on a per-share rate of 16 af/year, which should yield 28 af/year for 1.75 shares; however, other information[42] indicates 22.74 af/year of available Prewitt release volume. Furthermore, certain key accounting elements are not described by any documents available via the

[42] See Table 2 within letter to Kim R. Lawrence, Esq. from Forrest Leaf, P.E. of Leaf Engineering, *RE: Brown, 96CW117*. Dated July 14, 1997.
https://dnrweblink.state.co.us/DWR/PDF/32nb055yuclmx2fhsre45sxi/91/DWR_2169643.pdf

CDSS (e.g., the analysis used to support the return flow requirements associated with historical use of the Prewitt Reservoir shares via exchange under the Riverside System).

- The irrigation related component of depletions caused by certain Plan diversions, as opposed to return flow maintenance obligations, is based on an application of the modified Blaney-Criddle method that is described by certain documents[43] available via the CDSS. That is, the depletions requiring replacement are estimated based on an average calculated over a relatively long historical period as opposed to being representative of current climatological conditions.
- The Leaf Engineering documents state the SDF method was applied to perform lagging calculations to estimate depletions to the South Platte River associated with consumptive uses tied to the Brown Plan. The SDF method is also mentioned as being used to estimate the lagged accretions tied to return flows stemming from the historical use of the Prewitt shares. In both cases, the lagged depletions and accretions cannot be closely reproduced using AWAS and the information made available in various supporting reports.
- Relative to the Brown Plan, the two substantive decrees (96CW0117 and 98CW0366) both contain the following seemingly contradictory statements: "*Applicant shall replace the monthly augmentation requirement at such times as the well depletions are out of priority. The monthly augmentation requirements may be aggregated for release at the discretion of the Division Engineer or Water Commissioner*". Similar statements are contained within the decrees associated with the SCE and Sessions Plans. This may explain what is reflected by the diversion records available via the CDSS, which suggest releases have occurred historically as episodic (i.e., short duration) bulk events. However, while such actions may be allowable according to decree language, it is unclear how such actions comport with Compact requirements, as key timing factors (e.g., replacement of depletions during Compact call periods within a 72-hour timeframe) appear to be ignored.

Compact Shortage Estimates

A simple approximation of unreplaced augmentation requirements generated by the Brown Plan over a finite time period can be assembled using the following assumptions:

- The monthly schedule of "Augmentation Release Requirements" presented within the Brown Plan accounting provides reasonable estimates of cumulative monthly depletions and return flow maintenance requirements. This assumption is convenient but questionable, as actual measured pumping rates appear to differ from rates assumed in estimating depletions, and information is not available to review the estimated return flow accretions tied to the repurposed Prewitt shares.
- Reported monthly values can be uniformly distributed over the days in each month to approximate daily volumes. Again, this is a convenient but questionable assumption because depletions and accretions would be anticipated to vary in time as a function of actual diversions.
- Periods requiring replacement according to the Compact can be identified using information obtained from the CDSS identifying times during which the Compact call was in effect.

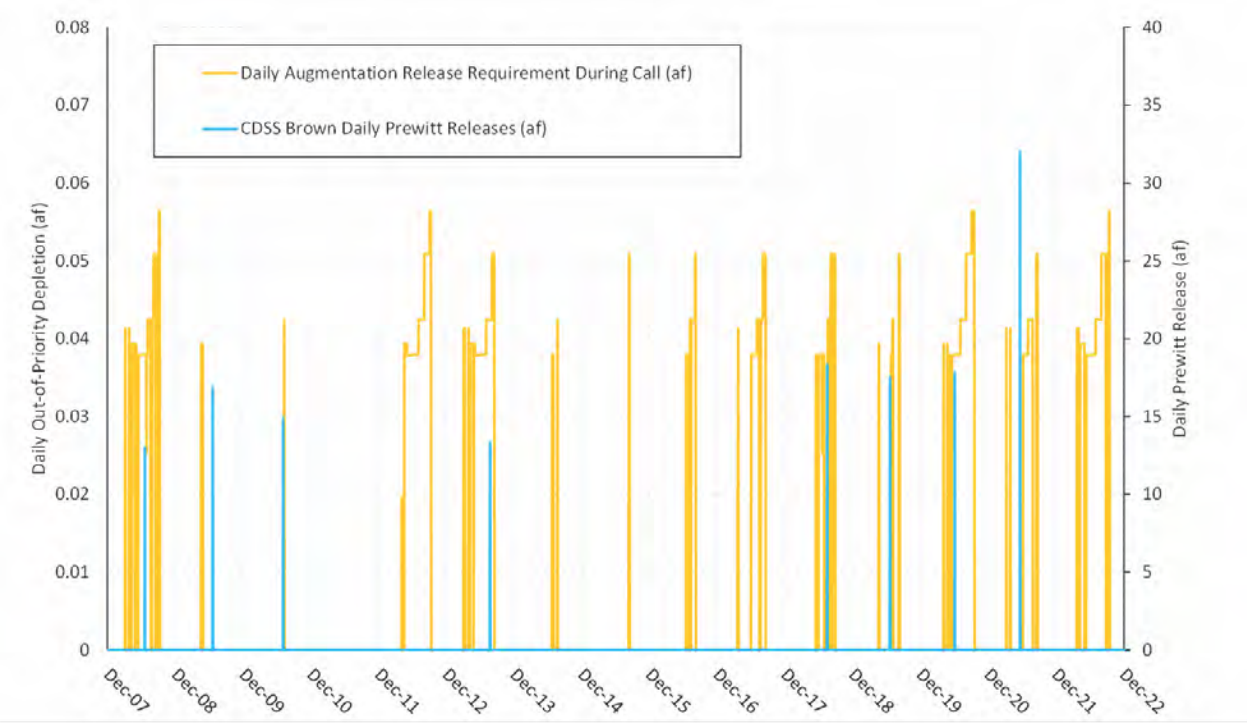
[43] See letter to Mr. Dave Nettles, P.E., from Forrest Leaf, P.E., of Leaf Engineering, *RE: Brown and Propst Lawn Grass Net Consumptive Use*. Dated July 24, 1997

- Daily diversion data from Prewitt Reservoir obtained from the CDSS are representative of the timing and quantity of releases affiliated with the Brown Plan.
- Unreplaced augmentation requirements can be identified as occurring on days when a Compact call is identified and when a Brown-affiliated Prewitt release is not occurring within a forward-looking, three-day period (i.e., conservatively representative of the 72-hour replacement window allowed under the Compact).
- Accounting and diversion information is complete for the period extending from January 1, 2008 through December 1, 2022. As suggested by this assumption, unreplaced augmentation requirements occurring outside of this period would not be included.

Under these simplifying assumptions, the following process can be followed:

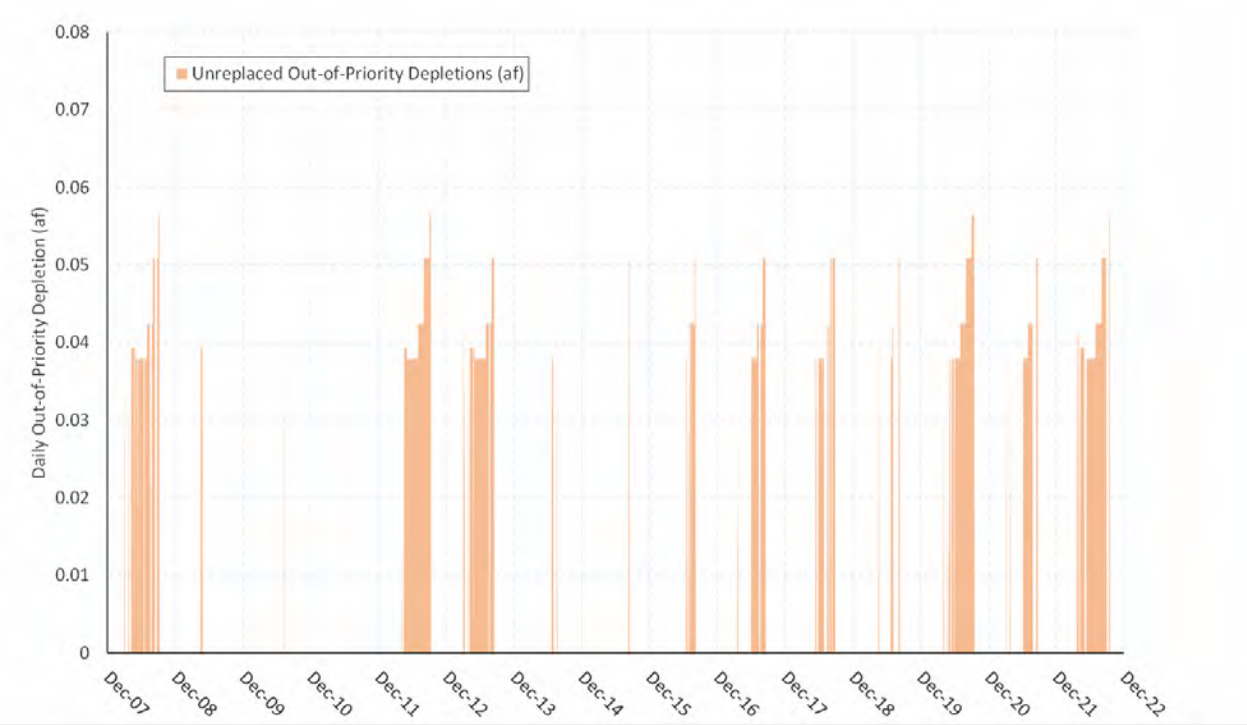
1. Daily augmentation requirements can be isolated to periods during which a Compact call was in effect to identify volumes requiring replacement.
2. CDSS records of Prewitt releases associated with the Brown Plan can be used to identify augmentation requirements that were replaced under the assumption that release volumes are typically large compared to estimated daily augmentation requirements and therefore would be adequate to offset any requirement occurring up to three days prior to the day of release.
3. Remaining augmentation requirements can be summed to estimate a total unreplaced volume occurring between January 1, 2008, and December 31, 2022.

The following figure compares the daily augmentation requirements generated under the Brown Plan during Compact call periods to the daily Prewitt release data obtained from the CDSS:



Brown Plan daily augmentation requirements compared to CDSS releases from Prewitt Reservoir.

The next figure illustrates the remaining daily augmentation requirements after removing those addressed by releases under the process described above:



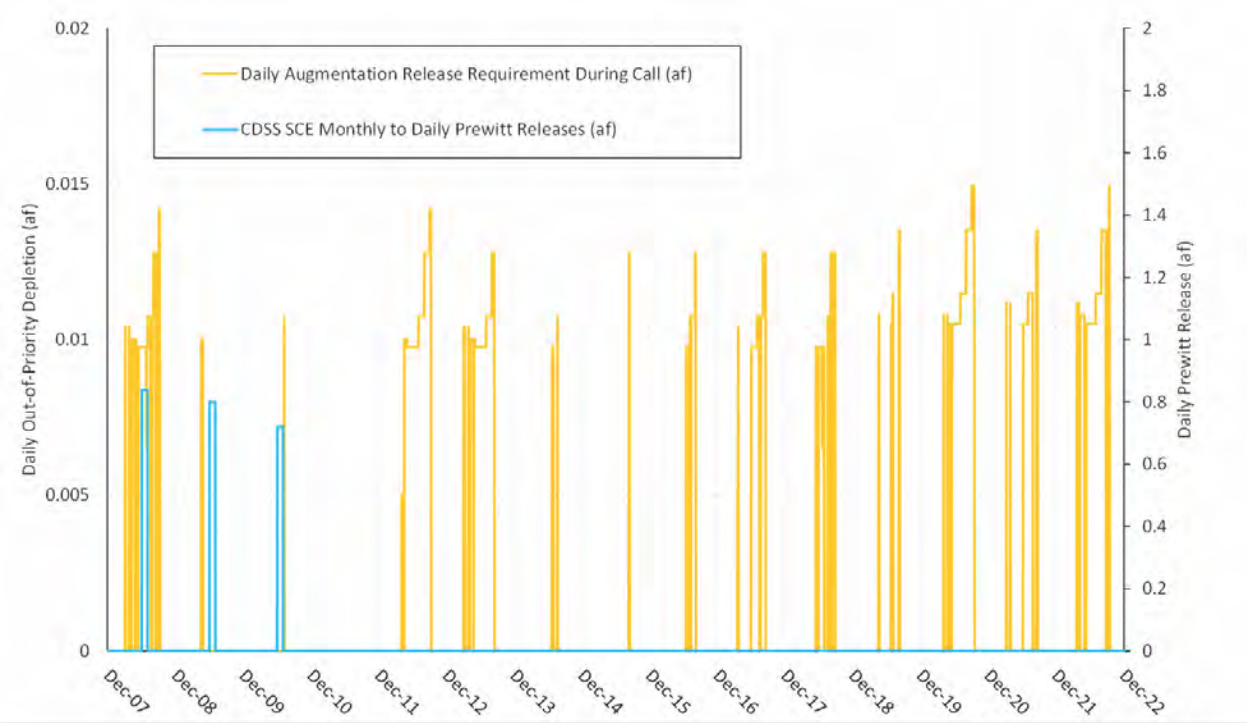
Brown Plan daily augmentation requirements after excluding Prewitt Reservoir release dates and periods within three days (72-hours) of a reported release (unreplaced).

The results plotted above are summed by calendar year in **Table 1**. The simple estimate of the total augmentation requirement that was not addressed between January 1, 2008, and December 31, 2022 is approximately 41 af. This result represents 28-35% of cumulative groundwater diversions[44] under the Brown Plan over the same period. Based on this analysis, the Brown Plan appears to have only complied with Compact requirements during one (1) of the previous 15 years (i.e., 2011; **Table 1**).

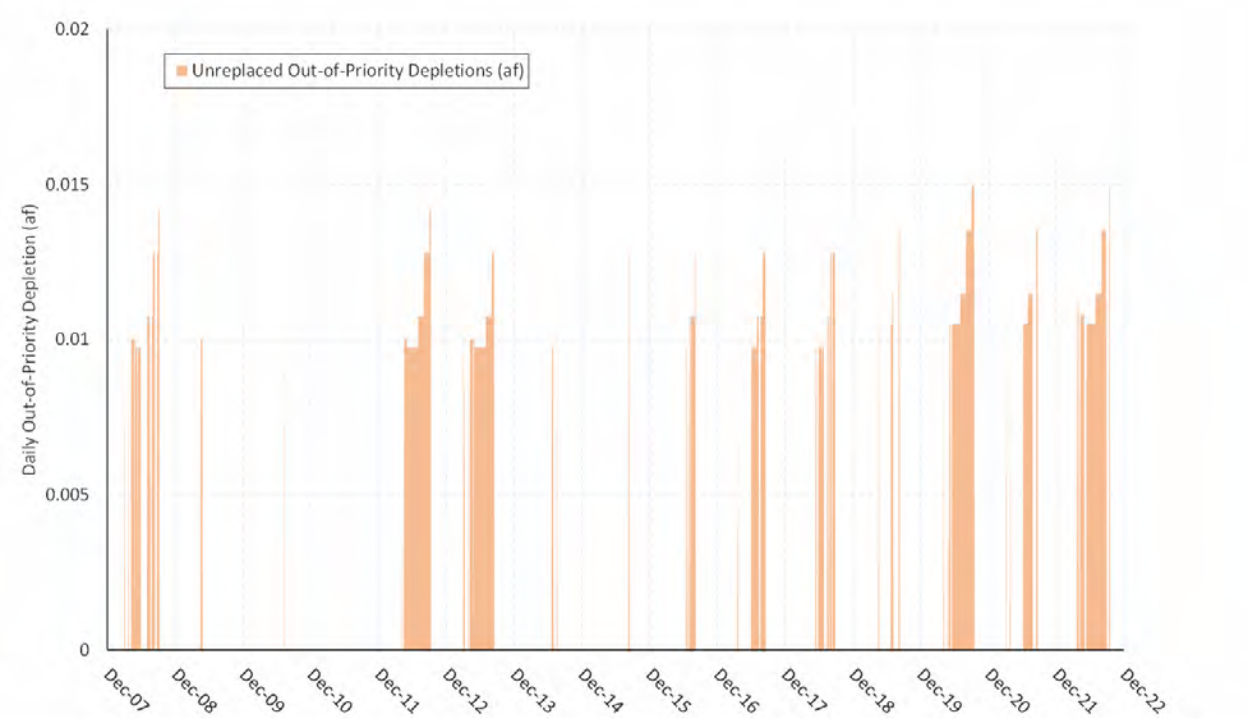
Estimates are also generated for the SCE and Sessions Plans by applying similar assumptions and methodology. In both cases, monthly Prewitt release records are substituted for daily values. The monthly release totals are conservatively assumed to be uniformly distributed over the days in the month in which a given release reportedly occurred. For the SCE Plan, the estimate is generated over a period with a different starting date (i.e., March of 2008) compared to the Brown Plan and Sessions Plan estimates. In both cases, the differences in approach are attributable to information/data availability limitations within the CDSS.

[44] The total of measured well withdrawals, as reported within the accounting over this period, is approximately 147.5 af. Total assumed well withdrawals are estimated using the approximated individual well annual withdrawal rate suggested by the accounting (0.709 af) multiplied by the total number of active wells (11) multiplied by the period length (15 years), which is approximately 117.0 af.

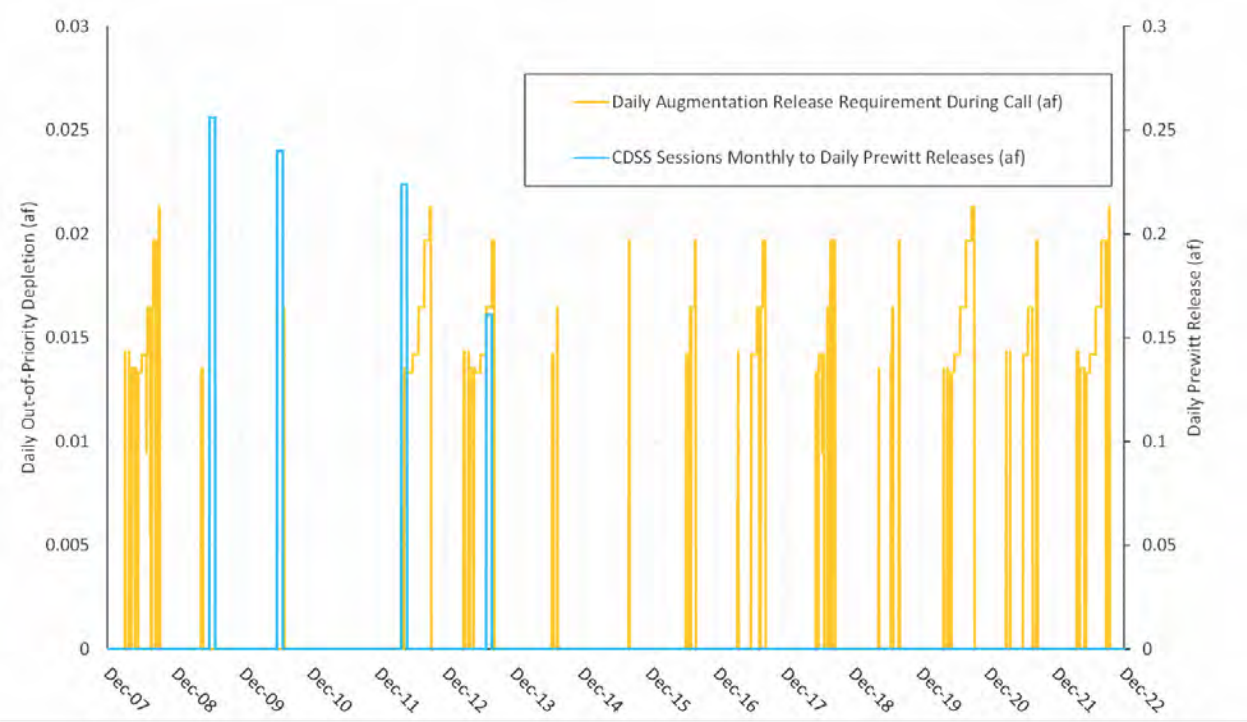
The following figures compare the daily augmentation requirements during Compact call periods to the daily Prewitt release data obtained from the CDSS for the SCE and Sessions Plans:



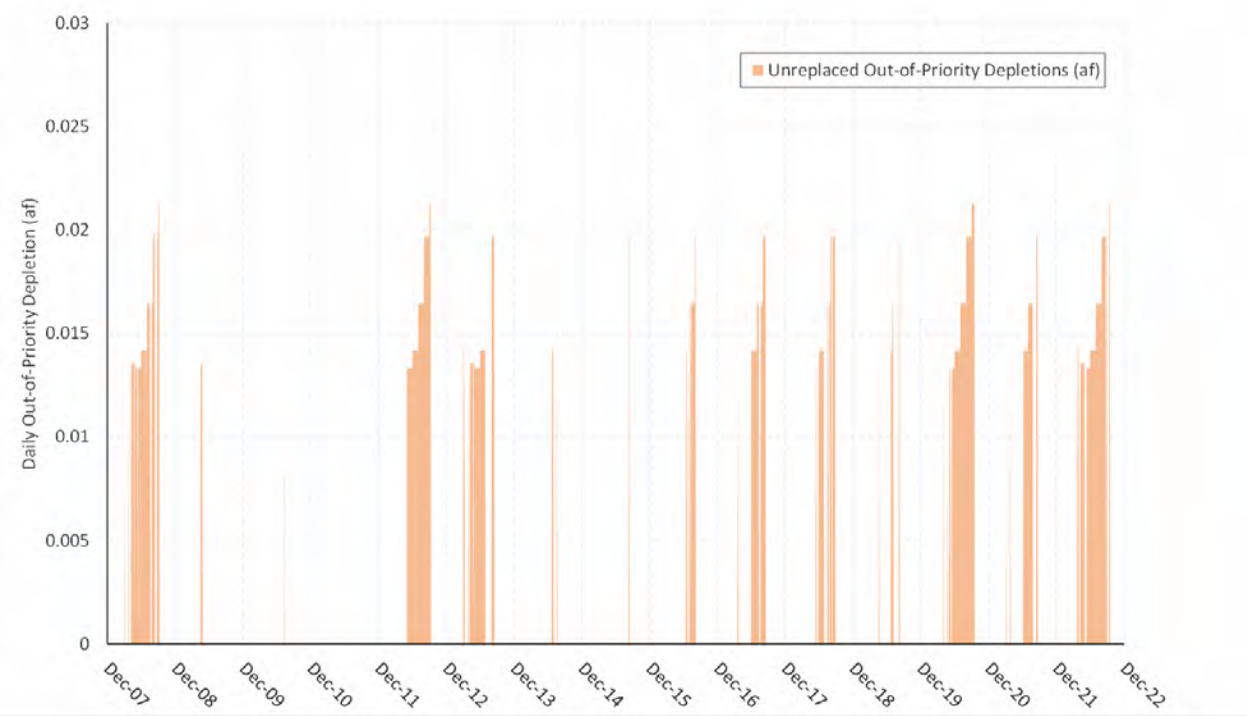
SCE Plan daily augmentation requirements compared to CDSS releases from Prewitt Reservoir.



SCE Plan daily augmentation requirements after excluding Prewitt Reservoir release dates and periods within three days (72-hours) of a reported release (unreplaced).



Sessions Plan daily augmentation requirements compared to CDSS releases from Prewitt Reservoir.



Sessions Plan daily augmentation requirements after excluding Prewitt Reservoir release dates and periods within three days (72-hours) of a reported release (unreplaced).

The results plotted above are summed by calendar year in **Tables 2 and 3**. The simple estimates of total augmentation requirements that were not addressed between January 1, 2008, and

December 31, 2022 are approximately 10 af and 15 af for the SCE and Sessions Plans, respectively. As was the case with the Brown Plan, based on this analysis, the SCE and Sessions Plans appear to have only complied with Compact requirements during one (1) of the previous 15 years (i.e., 2011; **Tables 2 and 3**).

Conclusion

The results presented above represent a simple assessment of the potential unreplaced augmentation requirements that may have occurred under the Brown, SCE and Sessions Plans during Compact call periods occurring between 2008 and 2022. The assessment relies on existing information, where available, and does not attempt to address deficiencies that may exist relative to certain supporting analyses relied upon within existing accounting frameworks (e.g., consumptive use of irrigation water, lagging of consumptive use to estimate depletion, etc.). Therefore, it should be recognized there is significant predictive uncertainty associated with the specific quantitative results. That said, the results provide additional support for the following conclusions:

- The Brown, SCE and Sessions Plans, as contemplated under their associated decrees, cannot reliably operate and satisfy Compact requirements due to inadequate availability of replacement sources during certain timeframes;
- The apparent operation of the Brown, SCE and Sessions Plans has magnified the cumulative unreplaced augmentation requirements occurring each year;
- It is possible – if not probable – that similar administrative and/or operational deficiencies exist relative to other augmentation plans and are resulting in additional unreplaced, out-of-priority augmentation requirements; and
- The Brown, SCE, and Sessions plans represent examples indicating depletions have occurred and appear to be continuing to occur during the Recent Period.

Table 1. Estimated unreplaced augmentation requirements by calendar year for the Brown Plan.

Calendar Year	Total Unreplaced Out-of-Priority Depletions (af)
2008	5.38
2009	0.39
2010	0.08
2011	0.00
2012	6.25
2013	5.38
2014	0.39
2015	0.19
2016	1.58
2017	3.07
2018	2.85
2019	0.86
2020	5.68
2021	2.64
2022	6.12
Grand Total	40.86

Table 2. Estimated unreplaced augmentation requirements by calendar year for the SCE Plan.

Calendar Year	Total Unreplaced Out-of-Priority Depletions (af)
2008	1.08
2009	0.10
2010	0.02
2011	0.00
2012	1.59
2013	1.42
2014	0.10
2015	0.05
2016	0.40
2017	0.78
2018	0.72
2019	0.23
2020	1.59
2021	0.72
2022	1.66
Grand Total	10.47

Table 3. Estimated unreplaced augmentation requirements by calendar year for the Sessions Plan.

Calendar Year	Total Unreplaced Out-of-Priority Depletions (af)
2008	2.04
2009	0.14
2010	0.03
2011	0.00
2012	2.10
2013	1.50
2014	0.15
2015	0.08
2016	0.61
2017	1.17
2018	1.08
2019	0.32
2020	2.21
2021	1.00
2022	2.27
Grand Total	14.69