

TECHNICAL CONSULTANT RECOMMENDATION REPORT

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SENT VIA: EMAIL

TO: Board of Directors,
Borrego Springs Watermaster

CC: Technical Advisory Committee; Environmental Working Group

FROM: Andy Malone, PG (West Yost)
Technical Consultant, Borrego Springs Watermaster

SUBJECT: Technical Review of the UCI GDE Study Report and Recommendations for Next Steps

EXECUTIVE SUMMARY

In the early 1900s, prior to significant groundwater pumping in the Borrego Springs Subbasin (Basin), groundwater levels were much higher compared to current conditions, and a large groundwater dependent ecosystem (GDE)¹ existed in the vicinity of the Borrego Sink (BS) where groundwater levels were at or within about 10 feet of the ground surface. The phreatophytes that comprised the GDE consisted of Mesquite trees, salt grass, willow, and rushes, collectively referred to herein as the “BS Mesquite Bosque.” Subsequent groundwater pumping in the Basin caused significant declines in groundwater levels, which resulted in widespread degradation in the health of the BS Mesquite Bosque. Figure ES-1 shows the mapped extent of the BS Mesquite Bosque in 2016.

The Sustainable Groundwater Management Act (SGMA) requires that all beneficial uses and users of groundwater, including environmental users of groundwater (GDEs) as of the passage of the law in 2014, be considered in Groundwater Sustainability Plans (GSPs). That consideration is specified in SGMA as follows:

- Water Code Section 10723.2 provides that a SGMA Agency “shall consider the interests of all beneficial uses or users of groundwater including (e) Environmental users of groundwater.”
- Water Code section 10727.4 (f) requires a Groundwater Sustainability Plan to include the subject of the impacts of the plan on groundwater dependent ecosystems. Accordingly, if a GDE is recognized in a Basin subject to SGMA, the beneficial use of basin water to support that GDE must be considered a beneficial use of that water. That beneficial use would be required to be considered by the SGMA Agency with all other identified beneficial uses when exercising its discretion in making decisions to avoid undesirable results.

¹ The GSP Regulations define GDEs as “ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface”

Appendix D4 of the Borrego Springs Watermaster’s current Groundwater Management Plan ([GMP](#))², published in 2020, states that the rooting depths of the BS Mesquite Bosque became largely disconnected from the regional aquifer of the Basin by about 1985 because of the long-term declines in groundwater levels that occurred across the Basin since the 1940s. Therefore, the BS Mesquite Bosque was not identified as a beneficial user of groundwater in the GMP, and hence, sustainable management criteria were not developed (e.g. minimum thresholds for groundwater levels to avoid undesirable results).

A study was recently conducted by the University of California Irvine (UCI) to generate more information on the groundwater dependency of the BS Mesquite Bosque, which has been documented in a report ([UCI GDE Study Report](#)).³ Through the analysis of multiple lines of evidence, the main conclusions of the UCI GDE Study Report were:

- The BS Mesquite Bosque is connected to the regional aquifer system, functions as a beneficial user of the Basin groundwater, and therefore, should be recognized as a GDE.
- The BS Mesquite Bosque is continuing to decline in health during the post-SGMA period (2015-2024), which is primarily driven by declining groundwater levels.

The main recommendations of the UCI GDE Study Report are:

- The Watermaster should designate the BS Mesquite Bosque as an environmental beneficial user of Basin groundwater in the GMP
- The Watermaster should allocate 645 acre-feet per year of groundwater to the BS Mesquite Bosque in the Basin water budget
- The Watermaster should establish minimum thresholds for groundwater elevations and rates of groundwater-level decline at key wells to protect the BS Mesquite Bosque
- Future hydrologic and biologic monitoring of the BS Mesquite Bosque should include:
 - Groundwater levels at key wells
 - Changes in groundwater levels
 - Changes in vegetation health via remote-sensing and field surveys
 - Evapotranspiration (ET) of the BS Mesquite Bosque
- Restore mesquite bosque habitat
- The Watermaster should explore potential strategies to improve groundwater conditions

The Watermaster directed its Technical Consultant to perform a technical review of the UCI GDE Study Report to determine if it is “best available science” (BAS) that can be relied upon by the Watermaster to take action or make policy decisions, as stated in its policy regarding the use of BAS.⁴

This Technical Consultant Recommendation Report documents the review of the UCI GDE Study Report, including each line of evidence presented and the validity of the conclusions and recommendations by

² https://borregospringswatermaster.com/wp-content/uploads/2022/10/Exhibit-1_GMP.pdf

³ https://borregospringswatermaster.com/wp-content/uploads/2025/07/GDE-Final-report_15May2025-1.pdf

⁴ https://borregospringswatermaster.com/wp-content/uploads/2025/02/BSWM-Policy-on-Use-of-Best-Available-Science_final.pdf

the study authors. Table ES-1 presents a summary of our assessment of each line of evidence in the UCI GDE Study Report used by UCI to draw the above noted conclusions and recommendations.

In summary, we identified several data gaps and/or gaps in understanding that call into question UCI's ability to interpret the data and arrive at its *definitive* conclusions that the current BS Mesquite Bosque is a GDE and the extent and health of the BS Mesquite Bosque will experience degradation caused by the pumping Rampdown, which allows for a gradual stabilization of groundwater levels from 2020 through 2040. The most important of the identified gaps in understanding is the role of deep soil moisture within the vadose zone as a potential water source that supports the BS Mesquite Bosque. In our assessment of the UCI GDE Study Report, and all available data and information on this topic, it remains an open and important question whether what remains of the BS Mesquite Bosque today is dependent on:

1. Soil moisture in the vadose zone, which is periodically replenished by infiltrating precipitation and stormwater runoff that accumulates in the vicinity of the Borrego Sink.
2. The deeper saturated zone of the regional aquifer system.
3. Or both of the above in different areas of the Bosque and to different degrees.

Therefore, we believe it is premature of the UCI GDE Study Report to: (i) conclusively identify the BS Mesquite Bosque as a GDE; (ii) to recommend allocation of 645 acre-feet per year of Basin groundwater to the BS Mesquite Bosque; (iii) to conclude that future declines in groundwater levels caused by the pumping Rampdown will degrade the BS Mesquite Bosque; and (iv) to recommend establishing specific sustainable management criteria to protect the BS Mesquite Bosque.

To elaborate, the UCI GDE Study Report did not sufficiently recognize the gaps and limitations in the currently available data and did not appropriately consider/analyze the alternative sources of water that could be satisfying the current ET demands of the BS Mesquite Bosque. Therefore, the unqualified and *definitive* conclusions of the UCI Study Report, and the accompanying management recommendations, are not consistent with scientific and engineering professional standards of practice; and hence, should not be considered BAS that, by itself, should be relied upon by the Watermaster to take action or make policy decisions.

While it does not meet the BAS standard of the Watermaster's policy, the UCI GDE Study Report is an advancement in the scientific understanding of the BS Mesquite Bosque. In our opinion, the report presents evidence that indicates the current BS Mesquite Bosque could be, at least in part, a GDE, particularly in areas surrounding the Borrego Sink where depth to groundwater is presumably the shallowest and where the healthiest stands of Mesquite exist. Based on this potential, we recommend the Watermaster consider the BS Mesquite Bosque a "potential GDE" and implement an adaptive management framework to first determine if declining groundwater levels caused by the pumping Rampdown are causing or could cause significant and unreasonable degradation of the BS Mesquite Bosque, and if shown to be necessary, implement adaptive management actions to protect the environmental beneficial uses in the Basin.

It should be emphasized here that the Watermaster is already implementing a significant management action to Rampdown pumping to stop the chronic lowering of groundwater levels that has been occurring since the 1940s. The Rampdown requires an incremental annual reduction in pumping over a 20-year period such that aggregate pumping by all BPA parties is equal to the Sustainable Yield by 2040. The reduction in pumping through WY 2025 is significantly ahead of schedule and has resulted in a gradual

stabilization of groundwater levels, which should be beneficial to the BS Mesquite Bosque, if and where it is a GDE.

Herein, following our assessment of the lines of evidence presented in the UCI Study Report, we provide several recommendations for Board consideration to address the gaps in understanding identified in this recommendation report to help determine: (i) if and where the BS Mesquite Bosque is a GDE; (ii) if declining groundwater levels caused by the pumping Rampdown is causing or could cause significant and unreasonable degradation of the BS Mesquite Bosque; (iii) if the Watermaster is accurately estimating groundwater evapotranspiration in the Basin water budget as a component of the Sustainable Yield; and (iv) if Watermaster's management and monitoring programs satisfy SGMA requirements regarding potential GDEs. These recommendations are noted in Table ES-1 and summarized below:

- Prepare a "Monitoring Work Plan for the BS Mesquite Bosque" with TAC/EWG input. The objectives of the monitoring program should be to:
 - Prioritize and fill gaps in understanding identified in this recommendation report.
 - Track the extent and health of the BS Mesquite Bosque during implementation of the pumping Rampdown.
 - Track additional relevant factors that could be affecting the extent and health of the BS Mesquite Bosque. These could include changes in groundwater levels, temperature, precipitation, surface water inflows, pests, human disturbance, and others that may be identified as relevant.

The monitoring program results could improve the understanding of the groundwater dependency of the BS Mesquite Bosque (or lack thereof) and could be used to adapt the Watermaster's groundwater management actions to protect the Bosque from significant and unreasonable degradation, if the monitoring program results indicate the degradation is being caused by declining groundwater levels associated with the pumping Rampdown.

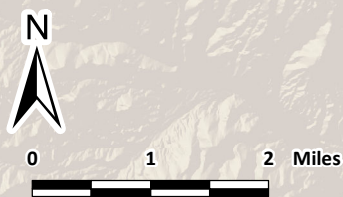
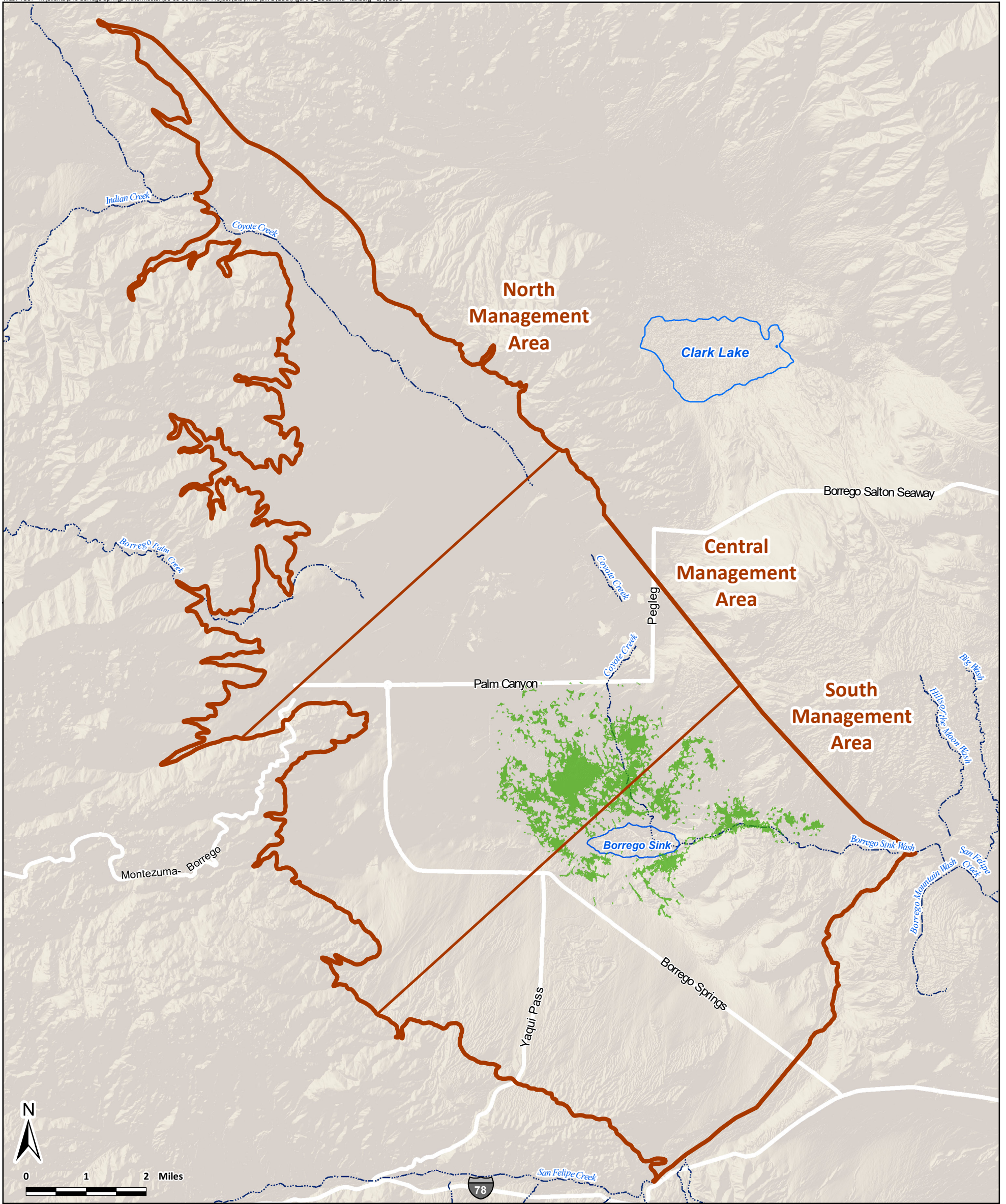
- The Borrego Valley Hydrologic Model (BVHM) simulates groundwater evapotranspiration as part of the water budget of the groundwater basin. For example, the BVHM estimated about 331 acre-feet of groundwater evapotranspiration in WY 2022. This functionality of the BVHM could be evaluated against what is currently known about the BS Mesquite Bosque, which could lead to recommendations to update the BVHM and improve its ability to estimate the water budget of the Basin that is used in the 5-year redeterminations of the Sustainable Yield required by the Judgment.
- The BVHM could also be used to predict future changes in groundwater levels beneath the BS Mesquite Bosque and groundwater evapotranspiration during the SGMA planning horizon (through 2070).
- Prepare a legal opinion as to whether the Watermaster's management and monitoring programs satisfy SGMA requirements regarding consideration of potential GDEs. The memorandum would describe:
 - The history and current understanding of the BS Mesquite Bosque as a potential GDE
 - The Watermaster's current management program to achieve sustainability (e.g., pumping Rampdown and expected stabilization of groundwater levels, implementation of monitoring programs, etc.)
 - The proposed monitoring and modeling efforts for the Mesquite Bosque area (bulleted above)

- SGMA statutory and regulatory provisions governing sustainable groundwater management, including consideration of potential GDEs

The memorandum should be prepared by Watermaster legal counsel, with support from the Technical Consultant.

This report is organized into the following sections that describe the above information in greater detail:

- Background and Objectives
- Technical Approach
- Technical Review and Findings
- Conclusions and Recommendations



Mesquite Bosque Habitat near Borrego Sink
As mapped by UCI using air photo from National Agriculture Imagery Program, April 2016

Other Features
Borrego Springs Subbasin with Management Area Divisions

Surface Water Features
Stream Channel
Playa Lake



Figure ES-1

Extent of Mesquite Bosque Habitat in the Borrego Springs Subbasin

Borrego Springs Watermaster
Borrego Springs Subbasin
GDE Study Report Review

Table ES-1. Summary of Assessment of UCI GDE Study Report and Recommendations for Next Steps

UCI GDE Study Report Section	UCI Line of Evidence	Assessment of Best Available Science	Recommendations
Mapping of Mesquite Bosque	About 350 acres of live Mesquite tree canopy was mapped in the BS Mesquite Bosque using image classification of a 2016 air photo in ArcGIS Pro.	BAS determination: Partially Met The mapping approach appears to produce reasonable results and could be used as a repeatable, objective method for change detection over time. However, before use, the mapping approach should be validated by a remote-sensing specialist.	Before using this mapping approach for change detection over time, an independent remote-sensing specialist should evaluate and validate the approach and offer any recommended adjustments.
Study Site and Tree Selection for Ecological Data Collection	Four (4) sites in the BS Mesquite Bosque were selected for habitat and tree-specific study. Site 1 (southern portion of the BS Mesquite Bosque) was selected for more intensive study of isotopic chemistry and water potential. Site 5 was located in the CDL Mesquite Bosque as a comparison.	BAS determination: Partially Met Site selection was appropriately distributed across the BS Mesquite Bosque. However, Site 4 would have been a more appropriate choice for more intensive study. This is because the depth-to-groundwater is deeper, so if groundwater dependency is demonstrated at Site 4, it would follow that other areas within the BS Mesquite Bosque where groundwater is shallower are also GDEs. In addition, Site 4 is closer to the main areas of pumping in the Basin and the locations of monitored wells.	A new monitoring well(s) could be used to improve confidence in the data analyses and interpretations.
Mapping Depth to Groundwater	Depth-to-groundwater in the Basin for Fall 2024 was estimated by subtracting a groundwater-elevation raster provided by Watermaster from a 1-meter USGS DEM in ArcGIS Pro. The analysis indicated that depth-to-groundwater was closest to the surface near the Borrego Sink, with depths as shallow as 18 ft-bgs in Fall 2024.	BAS determination: Partially Met The mapping of depth-to-groundwater used Watermaster’s readily available groundwater-elevation raster. However, this raster was generated from sparse measured data within the BS Mesquite Bosque area and its purpose is for regional analysis; hence, the raster is an approximate estimate of depth-to-groundwater. Therefore, it should not be used for site-specific analyses and interpretations in the report, such as recommending minimum thresholds for groundwater levels.	Measured depth-to-groundwater within the BS Mesquite Bosque area is a data gap that should be filled to increase confidence in the estimation of depth-to-groundwater and the assessment of the BS Mesquite Bosque as a GDE.
Mesquite Tree Rooting Depth and Connection to Groundwater	The report cites references where Mesquite trees have developed deep roots to tap groundwater, ranging from approximately 39 to 175 ft-bgs, which is comparable to or exceeds the current estimates of depth-to-groundwater underlying the BS Mesquite Bosque (22 to 134 ft-bgs).	BAS determination: Met The main conclusion of this report section that Mesquite trees in the BS Mesquite Bosque have deep tap roots that could reach the capillary fringe above the regional aquifer system is supported by the cited references.	The maximum rate of groundwater-level decline that Mesquite tree tap roots can follow downward without compromising Mesquite tree health should be researched and understood better. This rate should be compared against current and predicted future rates of groundwater-level decline to better understand the potential impact of the pumping Rampdown on the BS Mesquite Bosque, if it is a GDE.
Shallow Soil Conditions	The study used soil moisture sensors and field soil moisture data to characterize soil moisture conditions to 5 ft-bgs during “sampling” events. The results indicated relatively “dry” shallow soil conditions (<10% soil moisture).	BAS determination: Not Met Mesquite trees are adapted to arid desert environments, and their roots can access soil moisture of <10%. The sampling and analysis of soil conditions to depths of only 5 ft-bgs leaves a gap in understanding of soil conditions from 5 ft-bgs to the saturated zone (i.e., >100 ft-bgs). Soil moisture within this depth interval could be a source of water for the Mesquite tree roots but was not analyzed in the study.	Fill the gap in understanding of the texture, moisture content, and isotopic water chemistry of the soil profile from 5 ft-bgs to the saturated zone.
Isotopic Analysis	The study employed an analysis of hydrogen and oxygen isotopes in Mesquite tree tissue (and Creosote and Saltbush) versus the same isotopes in groundwater and shallow soil water to assess and quantify the contribution of these two source waters to the vegetation. The main results and conclusions were: -- Mesquite trees draw water from both shallow soil water and the regional aquifer system. -- The percentage of groundwater in Mesquite tree tissue in the BS Mesquite Bosque ranged from 54% to 82%. -- Creosote and Saltbush also draw water from soil moisture and another water source(s).	BAS determination: Partially Met The isotopic data suggest there must be another water source for the Creosote and Saltbush that is deeper than 5 ft-bgs with an isotopic signature like the regional aquifer. However, the isotopic analysis did not include sampling, analysis, and consideration of soil moisture deeper than 5 ft-bgs as a potential source water for the vegetation (i.e., Mesquite, Creosote, and Saltbush). Soil moisture within this depth interval could be a source of water for the vegetation but was not analyzed. This data gap adds uncertainty to the conclusion of the study that the BS Mesquite Bosque is a GDE.	Fill the gap in understanding of the isotopic composition of soil moisture from 5 ft-bgs to the saturated zone. These data could more definitively describe and quantify the relative roles of shallow soil moisture (<5 ft-bgs), deeper soil moisture (>5 ft-bgs) and/or the regional aquifer in supplying the ET demands of the Mesquite trees.

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Water Potential	<p>The study measured leaf water potential of Mesquite and Creosote across the summer months to assess differences in water availability and water stress between in the BS Mesquite Bosque and CDL Mesquite Bosque (the comparison site with comparatively shallow groundwater levels). The main conclusion was that the Mesquite trees in the BS Mesquite Bosque are dependent on groundwater because of the following observations:</p> <p>-- The Mesquite trees at the BS site and the CDL site exhibited similar water availability and water stress, with the BS site showed slightly less water availability and greater water stress than the CDL site. The report suggests that this observation was likely due to higher groundwater levels at the CDL site.</p> <p>-- The Creosote showed less water availability and greater water stress than Mesquite. The report suggests that this observation was likely due to groundwater availability for the Mesquite.</p>	<p><i>BAS determination : Partially Met</i></p> <p>The water-potential data and analyses produce reasonable results. However, we disagree with the conclusion that these data indicate that the Mesquite trees are using the regional aquifer. An alternative explanation is that the Mesquite trees at the BS site are using deeper soil moisture (>5 ft-bgs) which could explain:</p> <p>-- Lower water potential for Mesquite at the BS site versus the CDL site.</p> <p>-- Lower water potential for the shallow-rooted Creosote vs. the deeper-rooted Mesquite.</p>	
Remote-Sensing Analysis (NDVI)	<p>The study employed three analytical approaches using the remote-sensing metric NDVI to assess the greenness (health) of the Mesquite trees. The conclusion was that various areas within the BS Mesquite Bosque have high NDVI signals that indicate access to groundwater, similar to the CDL site, with the strongest indicators of groundwater use concentrated around the Borrego Sink where groundwater is shallowest.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree that NDVI can be used to assess the greenness (health) of vegetation, and that the NDVI analyses in the study could be indicating that groundwater is supporting the healthy stands of Mesquite near the Borrego Sink. However, the analyses in the study do not represent conclusive proof of groundwater dependency. An alternative explanation is that these areas of lowest land-surface elevation also receive the highest accumulation of surface-water runoff and infiltration, which could be supporting the Mesquite trees. In our experience, we believe there are more scientifically-defensible methods to use NDVI data to better understand the water sources available to the Mesquite and the stresses that have (or are currently) affecting the health of the Mesquite trees. See the Technical Consultant Recommendations.</p>	<p>NDVI data from the mid-1980s to the present should be analyzed for site-specific areas of the BS Mesquite Bosque on time series charts and compared against all potential stresses to the Mesquite trees (e.g., changes in groundwater levels, precipitation, surface water availability, temperature, human disturbance, etc.) to better understand: how the health of the Mesquite trees has changed over time in different areas of the BS Mesquite Bosque, and how the various stresses may have influenced the observed changes in Mesquite health over time. This type of analysis may reveal more information about which water sources were most important for Mesquite tree survival and health in different areas of the BS Mesquite Bosque since the mid-1980s.</p>
Dry Period Evapotranspiration in the GDE	<p>The study employed instrumentation to directly measure ET rates in the BS and CDL Mesquite Bosques from May 2024 to January 2025. The monitoring results showed that despite extremely low rainfall, ET rates remained consistently high across all monitored sites, well beyond the amount of available rainfall, which confirms that Mesquite trees rely on groundwater to support growth and transpiration.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree that the ET rates measured by the sensors are greater than the rates of direct precipitation; and hence, other source(s) of water must be necessary to satisfy the measured ET rates in the BS Mesquite Bosque over the dry, hot growing season.</p> <p>However, we disagree with study conclusion that the ET sensors provide direct evidence of groundwater use by Mesquite trees. The other source(s) of water could be:</p> <p>-- The deep regional aquifer.</p> <p>-- Soil moisture within the unsaturated zone that is fed by infiltration of precipitation and stormwater runoff that flows through and accumulates in the BS Mesquite Bosque.</p> <p>-- Both above.</p>	<p>This method of ET monitoring generates site-specific estimates of ET, which could be used to better constrain the BVHM estimates of groundwater ET. The ET estimates from the ET sensors should be compared more thoroughly to other ET estimation methods (e.g. OpenET, CIMIS, etc.). Uncertainty in the ET estimates should be described and quantified, as well as the uncertainty in the type of water being utilized by the Mesquite trees (e.g., soil moisture vs. aquifer).</p>

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<p>Historical Precipitation Trends</p>	<p>To better understand how surface-water availability to the BS Mesquite Bosque has changed over time, the study assessed historical trends in precipitation using monthly data downloaded from PRISM over the period September 1981 to December 2024. The study concluded that there have not been dramatic declines in precipitation which might explain the decline in the extent and health of the BS Mesquite Bosque, and that the trend towards lower water year precipitation is not statistically significant.</p>	<p><i>BAS determination : Not Met</i></p> <p>We disagree that the declining trend in precipitation over the last few decades is not statistically significant. Our analysis of the historical precipitation data indicates the region has been experiencing a 30-year dry period since 1995, punctuated by a few wet years.</p>	<p>Climatic data (e.g., precipitation and temperature) should be compared against NDVI data over time to better understand the relationship between climate and the health/extent of the BS Mesquite Bosque.</p>
<p>Considering GDEs in Minimum Thresholds</p>	<p>The study calculated the mean NDVI across the BS Mesquite Bosque during the dry season (1 May –30 June 2024) and analyzed its relationship to depth-to-groundwater in 2024 in an effort to recommend minimum thresholds for depth to groundwater. NDVI values declined substantially at depths greater than 60-75 feet bgs, suggesting that Mesquite tree health is impaired beyond this range—likely due to reduced access to groundwater.</p>	<p><i>BAS determination : Not Met</i></p> <p>The highest NDVI values are concentrated in areas surrounding the Borrego Sink. This spatial pattern of healthy Mesquite trees is likely due to greater access to the various water sources in these areas, including: relatively shallow groundwater; relatively abundant stormwater runoff that preferentially accumulates in the Borrego Sink area and percolates to the underlying soils; or both.</p> <p>Currently, there are too many data gaps to establish numeric minimum thresholds for groundwater levels, including: (i) a paucity of measured depth to the groundwater table and its capillary fringe; (ii) knowledge of the maximum depth and growth rates for Mesquite tree tap roots; and (iii) the role of soil moisture as a water source for the Mesquite trees.</p>	<p>Minimum thresholds for groundwater levels are not recommended at this time until the data gaps are sufficiently filled.</p>
<p>Mesquite Bosque Health and Ecological Condition Assessment</p>	<p>The study calculated cumulative annual NDVI in the BS Mesquite Bosque and compared it with cumulative annual NDVI in the CDL Mesquite Bosque as a reference to a likely GDE over the period WY 2019-2024. The results showed the BS Mesquite Bosque experienced significant declines in NDVI compared to relatively stable NDVI in the CDL Mesquite Bosque. The study concluded that the NDVI declines in the BS Mesquite Bosque reflect its high susceptibility to decreasing groundwater levels.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree that the NDVI data from 2019-2024 indicate a degrading trend in the greenness of the BS Mesquite Bosque, which could be caused by declining groundwater levels.</p> <p>However, we disagree that declining groundwater levels were the only possible cause. Climate was not considered in this analysis. WYs 2021, 2022, and 2024 were relatively dry years. The declines in NDVI in the BS Mesquite Bosque during 2021, 2022, and 2024, while the NDVI of the CDL Mesquite Bosque remained stable, may be indicating the reliance of the BS Mesquite Bosque on surface water to replenish soil moisture, which was low in these dry years.</p>	<p>NDVI analyses should be performed over space and time and then be compared against all the stressors that can affect the BS Mesquite Bosque (e.g., changes in groundwater levels, precipitation, temperature, human disturbances, etc.).</p>

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<p>Field Assessments of Live and Dead Trees</p>	<p>The study surveyed live and dead Mesquite trees at BS Site 1 and CDL Site 5, and noted several dead trees at BS Site 1 and all live trees at CDL Site 5. The report claims that these findings highlight the negative effects of declining groundwater levels on the BS Mesquite Bosque.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree that the available evidence indicates that historical widespread Mesquite tree mortality across the BS Mesquite Bosque was due, at least in part, to the historical overdraft of the Basin and the associated declines in groundwater levels.</p> <p>However, the air photo map in the report shows stands of dead Mesquite trees directly adjacent to stands of live Mesquite trees, which raises challenges with the study conclusion that the BS Mesquite Bosque is a GDE that is being adversely impacted by declining groundwater levels:</p> <p>-- If Site 1 of the BS Mesquite Bosque is a GDE with access to the regional aquifer, should we expect to see continuous stands of live Mesquite trees, rather than the “patchwork” of live and dead trees shown on air photo?</p> <p>-- Does the “patchwork” of live and dead trees indicate that the Mesquite trees are disconnected from the regional aquifer and instead are accessing surface water and soil moisture that is only available in certain areas of surface-water flow and/or the requisite underlying hydrogeology that preferentially retains soil moisture?</p>	<p>NDVI analyses should be performed over space and time and then be compared against all the stressors that can affect the BS Mesquite Bosque (e.g., changes in groundwater levels, precipitation, temperature, human disturbances, etc.).</p>
<p>Quantification of Mesquite Groundwater Transpiration</p>	<p>The study estimated the annual volumes of groundwater ET (ET_{gw}) that support the BS Mesquite Bosque using data derived from OpenET and the ET sensors and the equation [$ET_{gw} = \text{Total ET} - \text{Precipitation}$]. The study results and conclusions were:</p> <p>-- OpenET substantially underestimates ET relative to the ET sensors.</p> <p>-- ET_{gw} of the BS Mesquite Bosque is at least 645 afy.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree that the estimates of total ET in the study indicate that the BS and CDL Mesquite Bosques are using significantly more water than is provided by direct precipitation, and that the main source of water needed to support the ET demands of the Mesquite trees is stored in the subsurface.</p> <p>However, the study methods ignored:</p> <p>-- The potential role of soil moisture in the vadose zone as a water source that is satisfying at least a portion of the ET_{gw} demands of the Mesquite trees</p> <p>-- The ET demands of other non-Mesquite vegetation.</p>	<p>Continue the monitoring and estimation of ET of the BS Mesquite Bosque. These data can be used to constrain future BVHM updates and recalibrations to more accurately simulate the water budget of the Basin. However, additional consideration and analyses should be performed to address the following:</p> <p>-- OpenET estimates of ET are derived from six different models plus an “ensemble mean.” More expert analysis is necessary to choose the OpenET models best suited for estimating ET in natural desert environments.</p> <p>-- The potential role of soil moisture in satisfying at least a portion of the ET demands.</p> <p>-- The ET demands of other non-Mesquite vegetation.</p>
<p>Chronic Lowering of Groundwater Levels</p>	<p>The study assessed rates/trends in historical changes in groundwater levels at wells near the BS and CDL Mesquite Bosques for pre- and post-SGMA periods. The main observations and conclusions were:</p> <p>-- Historical and recent declines in groundwater levels were greatest near the BS Mesquite Bosque, primarily due to over-pumping of the Borrego Springs Subbasin.</p> <p>-- The high rates and magnitudes of groundwater declines indicate a high likelihood that these declines are responsible for the past and current adverse impacts on the BS Mesquite Bosque, which will continue unless without actions to reduce the groundwater-level declines.</p>	<p><i>BAS determination : Partially Met</i></p> <p>We agree with the observations that historical groundwater-level declines have been substantial, and that these declines have been responsible for adverse impacts to the BS Mesquite Bosque which was once a thriving GDE.</p> <p>We disagree with conclusion of the study that current declines in groundwater levels are responsible for current trends in degradation of the BS Mesquite Bosque. There are other alternative explanations, such as the recent relatively dry climate that could be adversely affect Mesquite trees that do not have access to the regional aquifer system.</p>	<p>The Watermaster is already implementing the pumping rampdown (and is substantially ahead of schedule) to stabilize groundwater levels across the Basin. The Watermaster should continue these efforts to stabilize groundwater levels and continue its current groundwater-level monitoring program to track its progress towards groundwater-level stabilization.</p> <p>Additional monitoring wells within the BS Mesquite Bosque are needed to understand depth-to-groundwater and ongoing changes in depth-to-groundwater. In addition, other important understanding on the soil profile, and its role in supporting the Mesquite trees, could be collected if a new monitoring well is constructed.</p>

Table ES-1. Summary of Assessment of UCI GDE Study Report and Recommendations for Next Steps

UCI GDE Study Report Section	UCI Line of Evidence	Assessment of Best Available Science	Recommendations
<p>Changes in Mesquite Bosque Health</p>	<p>The study assessed long-term trends in Mesquite Bosque health in relation to groundwater levels by analyzing annual average NDVI over the dry season (May 1-June 30) for the pre-SGMA period (1984-2015) and post-SGMA period (2015-2024). The main results and conclusions were:</p> <ul style="list-style-type: none"> -- For the pre-SGMA period, NDVI declines were widespread and coincided with about 45 ft (~1.5 ft/yr) of groundwater-level declines. Concentrated strongholds of healthy Mesquite habitat were noted around the Borrego Sink, where groundwater is closer to the surface, and near the WWTP percolation ponds. -- For the post-SGMA period, NDVI declines and groundwater-level declines continued, but at reduced rates. -- The areas of NDVI stability and improvement coincide with current strongholds of healthy mesquite habitat, particularly around the Borrego Sink and near the percolation ponds of the WWTP. -- Other factors also contributed to the observed NDVI declines: development, Mesquite removal, soil erosion, off-road traffic, climate change, disease, and pests. 	<p><i>BAS determination : Partially Met</i></p> <p>We agree that this analysis indicates that groundwater-level declines during the pre-SGMA period (1984-2015) were largely responsible for the declines in NDVI and widespread die-off of Mesquite trees, except in areas of surface water availability (e.g., WWTP ponds and Coyote Creek floodplain).</p> <p>The analysis does not necessarily confirm that groundwater-level declines during the post-SGMA period (2015-2024) were responsible for the concurrent declines in NDVI, based on the following:</p> <ul style="list-style-type: none"> -- The patterns of NDVI increases and decreases are “patchy” across the BS Mesquite Bosque, which is inconsistent with the proposed cause of declines in regional groundwater levels, but may be more consistent with site-specific availability (or lack thereof) of surface water, soil moisture, and/or perched groundwater, which are controlled by the surface-water flow patterns and the underlying hydrogeology. -- 2015-2024 was a relatively dry period, which could be responsible for observed NDVI declines for Mesquite that can no longer access the regional groundwater table. 	<p>NDVI analysis using Landsat-derived NDVI data (1984-2025) should be performed at specific cells (or groups of cells) where the Mesquite trees in BS Mesquite Bosque were once or are currently dense, so that other non-mesquite vegetation is screened out. Time-series charts should be prepared for these focused areas to compare the changes in NDVI vs. all factors that could influence the health of the Mesquite trees, such as: changes in groundwater levels; temperature; precipitation; surface water inflows; etc. This analysis may better describe the most relevant factors that have affected the BS Mesquite Bosque over time.</p> <p>Other factors that could have also contributed to the decline of BS Mesquite Bosque need to be better characterized and mapped relative to the changes in NDVI, such as: areas of human development; areas where Mesquite trees were removed; areas of soil disturbances, erosion, and off-road traffic; diseases; and pests.</p>
<p>Perched Aquifer Evaluation</p>	<p>The study evaluated the hypothesis that that “perched groundwater” conditions beneath the BS Mesquite Bosque support its ET demands, rather than the deeper regional aquifer system. The evidence evaluated included: well driller’s logs, AEM surveys, soil moisture data of the top 5 ft of soil profile, and historical groundwater-level monitoring data. The study concluded that perched groundwater conditions do not exist beneath the BS Mesquite Bosque.</p>	<p><i>BAS determination : Not Met</i></p> <p>We disagree with the methods and conclusions of the evaluation:</p> <ul style="list-style-type: none"> -- Perched groundwater conditions have been documented to exist in the vicinity of the BS Mesquite Bosque (e.g., in the vicinity of the BWD WWTP percolation ponds). -- The interpretations of the AEM survey resistivity profiles were incorrect. -- The soil profile has not been physically explored or characterized, which is a significant data gap. -- Well driller’s logs are sparse and the borehole sediment descriptions are typically of low resolution and poor quality; hence, these logs are not good information to identify perched groundwater. -- Water-levels measured at wells screened across the saturated zone are not good indicators of the presence/absence of perched groundwater conditions. 	<p>The gap in understanding of the soil profile should be filled, potentially through the installation of a new monitoring well(s) in the BS Mesquite Bosque. This work could include:</p> <ul style="list-style-type: none"> -- Characterization of the soil profile from the ground surface to/through the saturated zone, including the presence or absence of “perched” groundwater conditions. -- Collection of soil samples to analyze for soil moisture and isotopic water chemistry across the vadose zone. -- Inspection of the vadose zone and saturated zone for evidence of live Mesquite tree roots. -- Installation and monitoring of soil-moisture sensors across the entire thickness of the vadose zone to track seasonal and long-term changes in soil moisture.

Table ES-1. Summary of Assessment of UCI GDE Study Report and Recommendations for Next Steps

UCI GDE Study Report Section	UCI Line of Evidence	Assessment of Best Available Science	Recommendations
<p>Monitoring Recommendations</p>	<p>The study included various recommendations for future hydrologic and biologic monitoring of the BS Mesquite Bosque, including:</p> <ul style="list-style-type: none"> -- Groundwater levels at key wells. -- Changes in groundwater levels. -- Changes in vegetation health via remote-sensing and field surveys. -- ET 	<p><i>BAS determination</i> : Partially Met</p> <p>We believe that hydrologic/biologic monitoring of the BS Mesquite Bosque over time should be performed to:</p> <ul style="list-style-type: none"> -- Improve the understanding the relationship (or lack thereof) between changes in groundwater levels and the health of the BS Mesquite Bosque. -- Inform adaptive management strategies to protect the BS Mesquite Bosque, if the monitoring results deem this necessary. <p>However, we suggest monitoring methods that are somewhat different than those recommended in the UCI GDE Study Report (see Technical Consultant Recommendations to the right).</p>	<p>The Watermaster should consider the development of a <i>Monitoring Work Plan for the BS Mesquite Bosque</i>, which could include the following:</p> <ul style="list-style-type: none"> -- Tracking the extent and health of BS Mequite Bosque via remote-sensing and field surveys. -- Identification of additional existing wells in the bosque for groundwater monitoring. -- Construction of a new monitoring well(s) that could also include efforts to characterize the vadose zone. -- Tracking of all factors that could affect the health of the BS Mesquite Bosque. -- Characterization of the role of soil moisture within the vadose zone as a potential water source that supports the BS Mesquite Bosque. -- Monitoring ET and estimating ET_{gw} of the BS Mesquite Bosque.
<p>Management Recommendations</p>	<p>The study included various recommendations for management actions to protect the BS Mesquite Bosque, including:</p> <ul style="list-style-type: none"> -- Designate the BS Mesquite Bosque as a GDE. -- Establishing minimum thresholds for groundwater levels and rates of change in groundwater levels. -- Allocation of at least 645 afy of ET_{gw} to the BS Mesquite Bosque in the Subbasin water budget. -- Explore potential strategies to improve groundwater conditions. 	<p><i>BAS determination</i> : Partially Met</p> <p>We believe the available data/information suggest that the existing BS Mesquite Bosque could be a beneficial user of the regional aquifer system, at least in part.</p> <p>However, there are important gaps in understanding (that the report does not acknowledge) that must be filled before a conclusion can be reached regarding the groundwater dependency, or lack thereof, of the BS Mesquite Bosque.</p> <p>Therefore, until the gaps in understanding are filled, we believe it's premature to:</p> <ul style="list-style-type: none"> -- Establish minimum thresholds for groundwater levels at wells and/or rates of groundwater level decline. -- Allocate 645 afy to the BS Mesquite Bosque in the Subbasin water budget. 	<p>A memorandum should be prepared that describes:</p> <ul style="list-style-type: none"> -- The history and current understanding of the BS Mesquite Bosque as a potential GDE. -- The Watermaster's current management program to achieve sustainability (e.g., pumping Rampdown, stabilization of groundwater levels, implementation of monitoring programs, etc.). -- The monitoring and/or modeling efforts proposed for the Mesquite Bosque area. -- SGMA statutory and regulatory provisions governing sustainable groundwater management, including consideration of potential GDEs. <p>The memorandum should be reviewed by legal counsel to evaluate whether the Watermaster's management program satisfies SGMA requirements regarding potential GDEs.</p>

BACKGROUND AND OBJECTIVES

In the early 1900s, prior to significant groundwater pumping in the Borrego Springs Subbasin (Basin), groundwater levels were much higher compared to current conditions, and a large groundwater dependent ecosystem (GDE)⁵ existed in the vicinity of the Borrego Sink (BS) where groundwater levels were at or within about 10 feet of the ground surface. The phreatophytes that comprised the GDE consisted of Mesquite trees, salt grass, willow, and rushes, collectively referred to herein as the “BS Mesquite Bosque.” Subsequent groundwater pumping in the Basin caused significant declines in groundwater levels, which resulted in widespread degradation in the health of the BS Mesquite Bosque.

The Sustainable Groundwater Management Act (SGMA) requires that all beneficial uses and users of groundwater, including environmental users of groundwater (GDEs) as of the passage of the law in 2014, be considered in Groundwater Sustainability Plans (GSPs). That consideration is specified in SGMA as follows:

- Water Code Section 10723.2 provides that a SGMA Agency “shall consider the interests of all beneficial uses or users of groundwater including (e) Environmental users of groundwater.”
- Water Code section 10727.4 (f) requires a Groundwater Sustainability Plan to include the subject of the impacts of the plan on groundwater dependent ecosystems. Accordingly, if a GDE is recognized in a Basin subject to SGMA, the beneficial use of basin water to support that GDE must be considered a beneficial use of that water. That beneficial use would be required to be considered by the SGMA Agency with all other identified beneficial uses when exercising its discretion in making decisions to avoid undesirable results.

Appendix D4 of the Borrego Springs Watermaster’s current GMP⁶ states that the rooting depths of the BS Mesquite Bosque became largely disconnected from the regional aquifer of the Basin by about 1985 because of the long-term declines in groundwater levels that occurred across the Basin since the 1940s. Therefore, the BS Mesquite Bosque was not considered a GDE or beneficial user of groundwater in the GMP.

A study of the BS Mesquite Bosque was recently conducted by the UCI to generate more information on the groundwater dependency of the BS Mesquite Bosque, which has been documented in the UCI GDE Study Report.⁷ Through the analysis of multiple lines of evidence, the main conclusions of the UCI GDE Study Report were:

- The BS Mesquite Bosque is connected to the regional aquifer system, functions as a beneficial user of the Basin groundwater, and therefore, should be recognized as a GDE.
- The BS Mesquite Bosque is continuing to decline in health during the post-SGMA period (2015-2024), which is primarily driven by declining groundwater levels.

The main recommendations of the UCI GDE Study Report are:

⁵ The GSP Regulations define GDEs as “ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface”

⁶ https://borregospringswatermaster.com/wp-content/uploads/2022/10/Exhibit-1_GMP.pdf

⁷ https://borregospringswatermaster.com/wp-content/uploads/2025/07/GDE-Final-report_15May2025-1.pdf

- The Watermaster should designate the BS Mesquite Bosque as an environmental beneficial user of Basin groundwater in the GMP
- The Watermaster should allocate 645 acre-feet per year of groundwater to the BS Mesquite Bosque in the Basin water budget
- The Watermaster should establish minimum thresholds for groundwater elevations and rates of groundwater-level decline at key wells to protect the BS Mesquite Bosque
- Future hydrologic and biologic monitoring of the BS Mesquite Bosque should include:
 - Groundwater levels at key wells
 - Changes in groundwater levels
 - Changes in vegetation health via remote-sensing and field surveys
 - Evapotranspiration (ET) of the BS Mesquite Bosque
- Restore mesquite bosque habitat
- The Watermaster should explore potential strategies to improve groundwater conditions

In May 2024, the Watermaster approved a policy regarding the use of “best available science.”⁸ This policy permits the use of technical information not generated by the Watermaster to inform its policy decisions; however, the Watermaster shall not rely on or use such technical information to take action or make policy decisions without an independent review and recommendation from the Technical Advisory Committee (TAC), the Environmental Working Group (EWG), and/or Watermaster technical consultants. Pursuant to the Watermaster’s policy, and to be consistent with SGMA, technical information and data shall constitute the “best available science” only if it is:

- Relevant to the decision being made by the Watermaster,
- Available to the Watermaster within a reasonable time in advance of the Watermaster’s decision, and
- Consistent with scientific and engineering professional standards of practice.

While the UCI GDE Study Report may provide useful new information, the Watermaster had not yet formally reviewed the report, and hence, had not yet determined that the UCI GDE Study Report constitutes “best available science” that should be relied upon by the Watermaster to take action or make policy decisions.

At its November 3 and 19, 2025 meetings, the Watermaster Board approved a scope of work and budget for West Yost (as the Watermaster’s Technical Consultant) to: (i) perform a technical review of UCI GDE Study Report; (ii) prepare a recommendation report for the Board; and (iii) facilitate the preparation of recommendation reports to the Board from the TAC and EWG. The scope of work is summarized in Table 1 below.

⁸ https://borregospringswatermaster.com/wp-content/uploads/2025/02/BSWM-Policy-on-Use-of-Best-Available-Science_final.pdf

Table 1. Scope of Work to Perform a Technical Review of the UCI GDE Study Report	
Task Description	Schedule
Review UCI GDE Study Report	November 2025
Review TAC/EWG comments on UCI GDE Study Report	
Prepare a Draft Technical Consultant (TC) Recommendation Report	Nov. 2025 – Jan. 2026
TAC/EWG meeting to review Draft TC Recommendation Report	February 2026
Prepare a Draft TAC/EWG Recommendation Report	March 2026
TAC/EWG meeting to review Draft TAC/EWG Recommendation Report and receive additional TAC/EWG feedback	April 2026
Prepare Draft-Final TAC/EWG Recommendation Report (based on TAC/EWG feedback)	
Prepare Final TC and TAC/EWG Recommendation Reports	May 2026
Board meeting to present the Final TC and TAC/EWG Recommendation Reports, including discussion on recommended next steps	May 20, 2026

The main objectives of this Technical Consultant Recommendation Report are to:

1. Document the technical review of the UCI GDE Study Report to determine if it is “best available science” (BAS) that should be relied upon by the Watermaster to take action or make policy decisions, as stated in its policy regarding the use of BAS.
2. Provide the Board with recommendations for next steps.

TECHNICAL APPROACH

The UCI GDE Study Report presented multiple lines of evidence—including data generated from field studies, advanced sensor technologies, and remote-sensing datasets—and *definitively* concluded that the BS Mesquite Bosque is connected to the regional aquifer system and functions as an environmental beneficial user of the Basin.

This technical review of the data, analyses, conclusions, and recommendations of the UCI GDE Study Report involved the following:

- Review of each line of evidence in the UCI GDE Study Report and preparation of a list of comments, questions, data gaps, and recommendations.
- Review of prior work related to the Mesquite Bosque and groundwater dependency, including:
 - Appendix D4 of the GMP
 - United States Geological Survey (USGS). 2015. *Hydrogeology, Hydrologic Effects of Development, and Simulation of Groundwater Flow in the Borrego Valley, San Diego County, California*⁹

⁹ USGS, 2015, *Hydrogeology, hydrologic effects of development, and simulation of groundwater flow in the Borrego Valley, San Diego County, California*: U.S. Geological Survey Scientific Investigations Report 2015–5150, 135 p., <http://dx.doi.org/10.3133/sir20155150>.

- Various references cited in the UCI GDE Study Report
- Correspondence with the report authors from UCI to ask and answer questions on the UCI GDE Study Report.
- Review of the comments prepared by various TAC and EWG members on the UCI GDE Study Report.¹⁰
- Correspondence with members of the TAC and EWG to ask and answer questions regarding their comments on the UCI GDE Study Report.
- Joint meetings of the TAC/EWG on February 26 and April 8, 2026¹¹ to discuss the UCI GDE Study Report, the draft Technical Consultant Recommendation Report, and the TAC/EWG recommendations to the Board on next steps.

To perform an unbiased and objective review of the UCI GDE Study Report, it was important to recognize there are three competing conceptual models that describe the potential source water(s) that could be supplying the evapotranspiration (ET) demands of the remaining live Mesquite trees in the currently existing BS Mesquite Bosque:

1. ***Soil moisture and/or perched groundwater within the vadose (semi-saturated) zone beneath the BS Mesquite Bosque.*** These waters exist within the pore spaces of the course-grained and fine-grained sediments within the vadose zone and would be available for uptake by the shallow lateral roots and deep tap roots of the Mesquite trees. These waters originate from percolating surface waters that accumulate in the vicinity of the BS Mesquite Bosque via direct precipitation, stormwater runoff from upstream watersheds, and wastewater percolation at constructed ponds. See Figure 1 below.
2. ***The deeper regional aquifer system (saturated zone) beneath the BS Mesquite Bosque.*** These waters exist within the fully-saturated pore spaces of the course-grained and fine-grained sediments below the groundwater table (but also in a semi-saturated state within the capillary fringe that could extend several feet above the groundwater table) and would be available for uptake by the deep tap roots of the Mesquite trees. These waters originate from all sources of recharge to the Basin, including: subsurface inflow from the surrounding mountain-front watersheds; streambed infiltration of stormwater runoff; deep percolation of precipitation and applied water on croplands, golf courses, and urban landscapes; and wastewater percolation at constructed ponds. See Figure 2 below.
3. ***Both (1.) and (2.)***. It is possible that both processes are occurring in different areas of the Mesquite Bosque. For example, in areas of the Bosque where depth to the groundwater table and capillary fringe is relatively shallow, the tap roots of the Mesquite trees may still be able to access the regional aquifer system. In contrast, in areas of the Bosque where depth to the groundwater table and capillary fringe is greater, the Mesquite tree roots may only be able to access soil moisture and/or perched groundwater.

As each line of evidence in the UCI GDE Study Report was reviewed, all three conceptual models (described above) were considered equally viable as potential sources of water supply to the Mesquite trees. Ignoring any of the conceptual models when evaluating the data and interpretations in the UCI GDE Study Report would result in a biased and subjective review of the study. Therefore, in this review of the

¹⁰ https://borregospringswatermaster.com/wp-content/uploads/2026/05/TAC-EWG_Comments_GDE3.zip

¹¹ <https://borregospringswatermaster.com/environmental-working-group/>

UCI GDE Study Report, the question was always asked: “Can the results and conclusions of the UCI GDE Study Report potentially be explained by an alternative conceptual model, or not?”

This technical approach to review of scientific data and information—namely, the equal consideration of alternative explanations—is critical to unbiased and subjective science, and in our opinion, is consistent with scientific and engineering professional standards of practice.

Figure 1 below shows conceptual model for the currently existing BS Mesquite Bosque where the Mesquite tree roots are disconnected from the regional aquifer system and instead are using soil moisture and localized perched groundwater within the vadose zone.

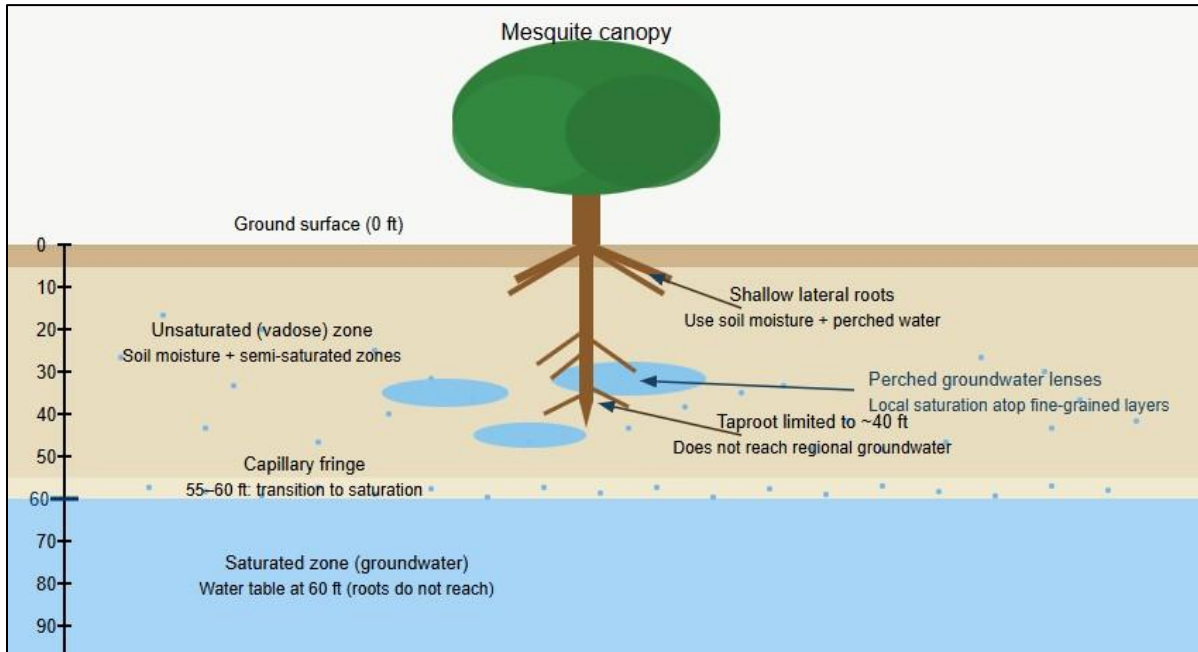


Figure 1.

Figure 2 shows a conceptual model for the currently existing BS Mesquite Bosque where the Mesquite tree roots are using waters derived from the regional aquifer system (as well as soil moisture and localized perched groundwater within the vadose zone).

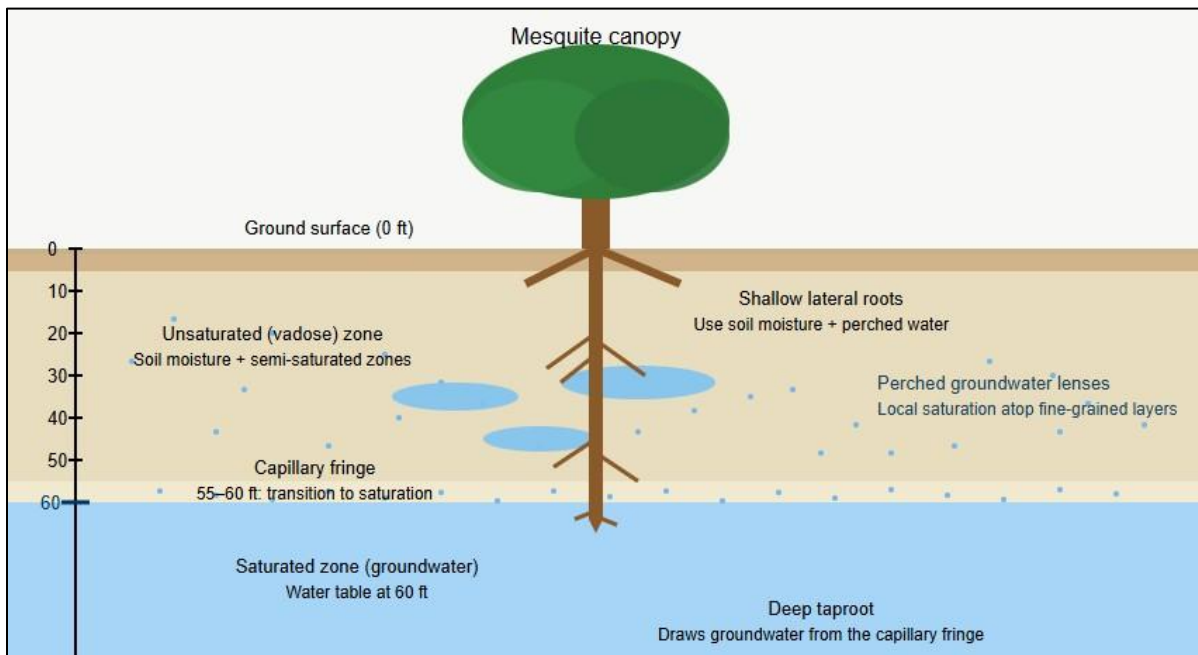


Figure 2.

TECHNICAL REVIEW AND FINDINGS

Herein, we summarize each main section of the UCI GDE Study Report that caused the report authors to: (i) *definitively* identify the BS Mesquite Bosque as a GDE; (ii) to recommend allocation of 645 acre-feet per year of Basin groundwater to the BS Mesquite Bosque; (iii) to conclude that future declines in groundwater levels caused by the pumping Rampdown will degrade the BS Mesquite Bosque; and (iv) to recommend establishing specific sustainable management criteria to protect the BS Mesquite Bosque.

We also describe our assessment of each section of the report as “best available science” (BAS) and assign a BAS rating:

- **Met** – We agree with the scientific methods used, interpretations of the data, and the conclusions of the analysis.
- **Partially Met** – We agree with some but not all scientific methods used, interpretations of the data, and/or the conclusions of the analysis.
- **Not Met** – We disagree with the scientific methods used, interpretations of the data, and the conclusions of the analysis.

Of the 19 report sections, we rated BAS for one section as Met; 14 sections as Partially Met; and four sections Not Met. In many cases, we identified data gaps and/or gaps in understanding that hindered the interpretation of the data, and therefore, do not support arriving at the definitive conclusions and recommendations in the UCI GDE Study Report. Hence, **we do not consider the UCI GDE Study Report as BAS that the Watermaster should exclusively rely on to take action or make policy decisions.** In this section, we also provide several recommendations to fill the gaps in understanding, which are meant to kickstart a discussion with the TAC, EWG, and Board on recommended next steps.

Mapping of Mesquite Bosque

The UCI GDE Study Report included new base maps of live Mesquite tree canopy and BS Mesquite Bosque habitat for April 2016, which represented the closest year to SGMA implementation (2015) that contained high-quality imagery when plants were active. The mapping approach used 0.7-meter resolution National Agriculture Imagery Program imagery (NAIP) visualized in the near infrared and an object-based supervised image classification in ArcGIS Pro (v. 3.1.0) with the Support Vector Machine (SVM). Supervised image classification involves creating training samples which the software then learns from to classify the entire image into set categories (e.g., live mesquite, dead mesquite, barren land, etc.).

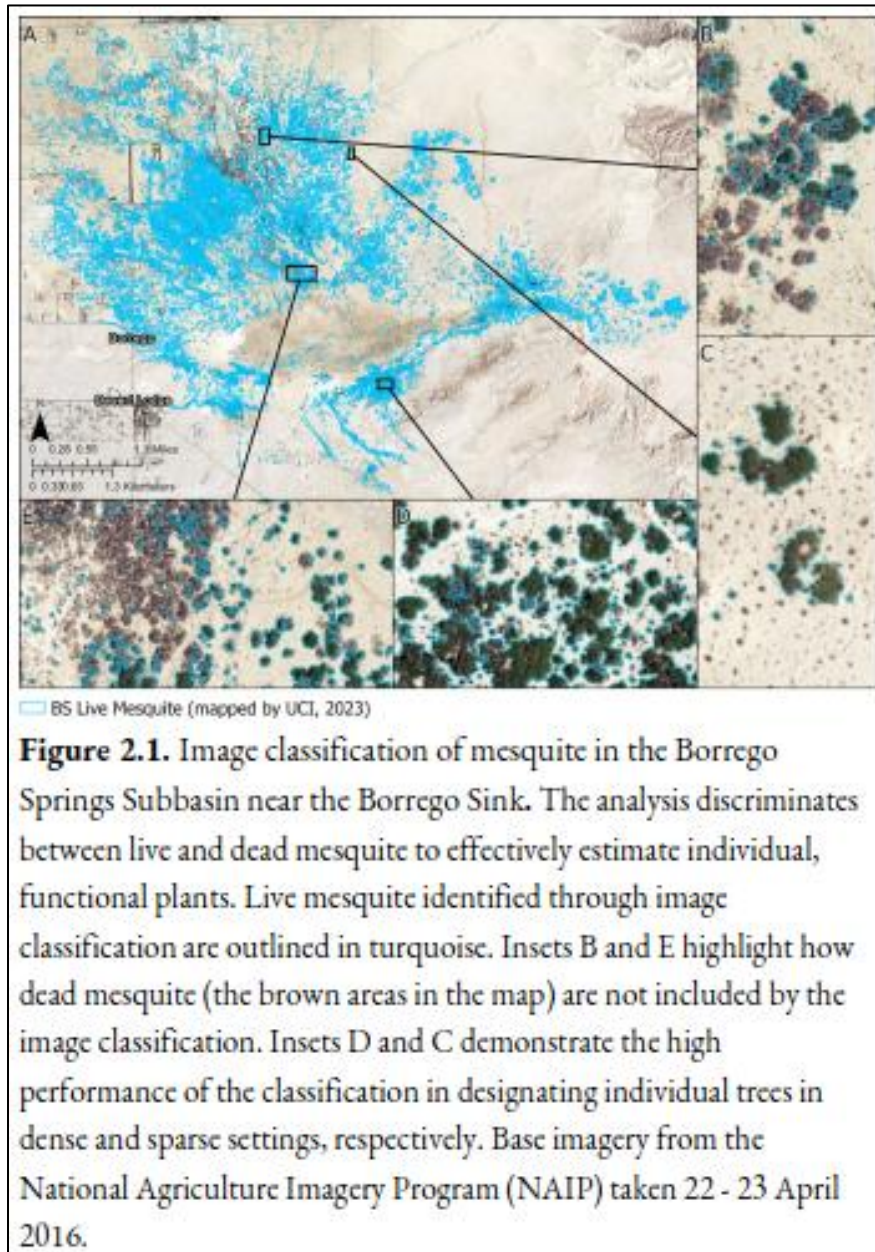
The mapping was performed in two defined areas where Mesquite trees are present: (i) the main study area surrounding the Borrego Sink in the Basin and (ii) a reference area where groundwater is relatively shallow in the adjacent Clark Dry Lake (CDL) groundwater subbasin. The main findings from this mapping effort were:

- *Borrego Sink*: 350.1 acres of live mesquite tree canopy (see Figure 2.1 from the report below)
- *Clark Dry Lake*: 86.2 acres of live mesquite tree canopy (see Figure 2.3 in the report)

The UCI GDE Study Report referenced a 1995 effort that mapped the extent of the BS Mesquite Bosque at 2,800 acres. Although different mapping methods were used in the 1995 effort, the comparison to the 2016 map indicates a reduction in live Mesquite tree canopy but also could be due to a difference in mapping methods.

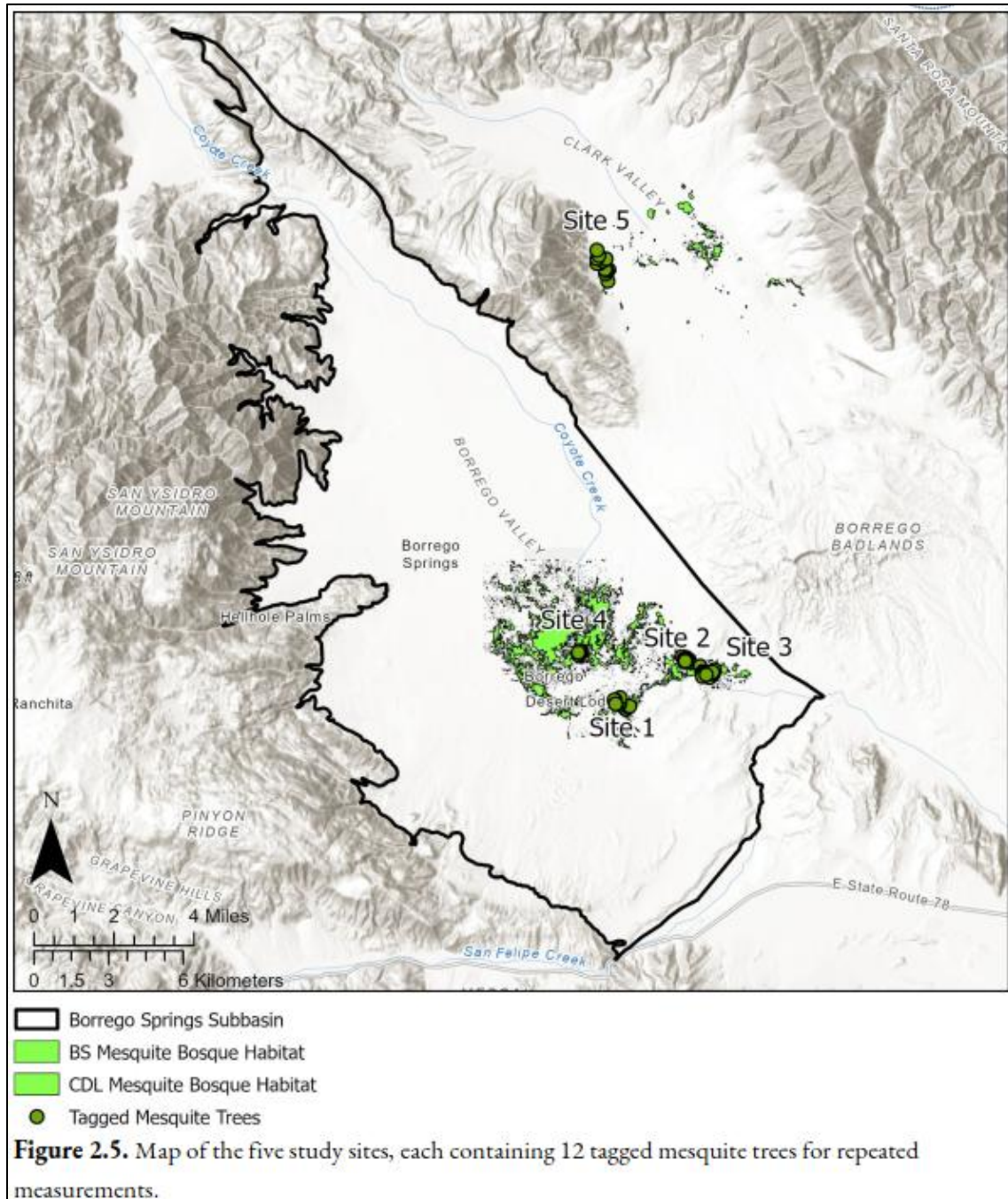
Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - The mapping approach of the live Mesquite tree canopy using image classification in ArcGIS Pro appears to produce reasonable results.
 - The resulting maps represent an improved understanding of locations of live Mesquite tree canopy in the BS Mesquite Bosque as of 2016, which establishes a “2016 baseline.”
 - However, the mapping approach should be validated by a remote-sensing specialist.
- Recommendations:
 - The mapping approach in ArcGIS Pro appears to be repeatable and objective, and if so, could be used as a monitoring technique for change detection of the extent and health of the live Mesquite tree canopy over time.
 - Before using this mapping approach for change detection over time, an independent remote-sensing specialist should evaluate and validate the approach and offer any recommended adjustments.



Study Site and Tree Selection for Ecological Data Collection

The UCI GDE Study identified five (5) sites that were selected for habitat and tree-specific study (see Figure 2.5 from the report below). Sites 1-4 are in the BS Mesquite Bosque and Site 5 is in the CDL Mesquite Bosque for comparison. These sites were selected based on the mapped Mesquite Bosque habitat, parcel ownership (Anza Borrego Desert State Park or Anza Borrego Foundation), and accessibility. Site 1 (southern portion of the BS Mesquite Bosque) and 5 (CDL) were selected for more intensive study of isotopic chemistry and water potential.



Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - Site selection was appropriately distributed across the BS Mesquite Bosque. However, Site 1 is located south of the Borrego Sink adjacent to the uplifted and folded sedimentary rocks in the SMA. This area has complex underlying hydrogeology which may not be representative of the hydrogeology in other locations of the BS Mesquite Bosque. And unfortunately, there are no nearby monitoring wells that could be used to better describe the underlying hydrogeology, depth-to-groundwater, and groundwater chemistry at Site 1.
 - In retrospect, Site 4 would have been a more appropriate choice for more intensive study. This is because the depth-to-groundwater is deeper, so if groundwater dependency is demonstrated at Site 4, it would follow that other areas within the BS Mesquite Bosque where groundwater is shallower are also GDEs. In addition, Site 4 is closer to the main areas of pumping in the Basin and the locations of monitored wells.
- **Recommendations:**
 - A new monitoring well(s) could be used to improve confidence in the data analyses and interpretations.

Mapping Depth to Groundwater

The UCI GDE Study generated estimates of depth-to-groundwater in the Basin for Fall 2024 by subtracting a groundwater-elevation raster provided by the Watermaster from a high-resolution 1-meter digital elevation model (DEM) across the Basin from the USGS in ArcGIS Pro (see Figure 2.7 from the report below). The analysis indicated that depth-to-groundwater is closest to the surface near the Borrego Sink, with depths as shallow as 18 feet below ground surface (ft-bgs) in Fall 2024.

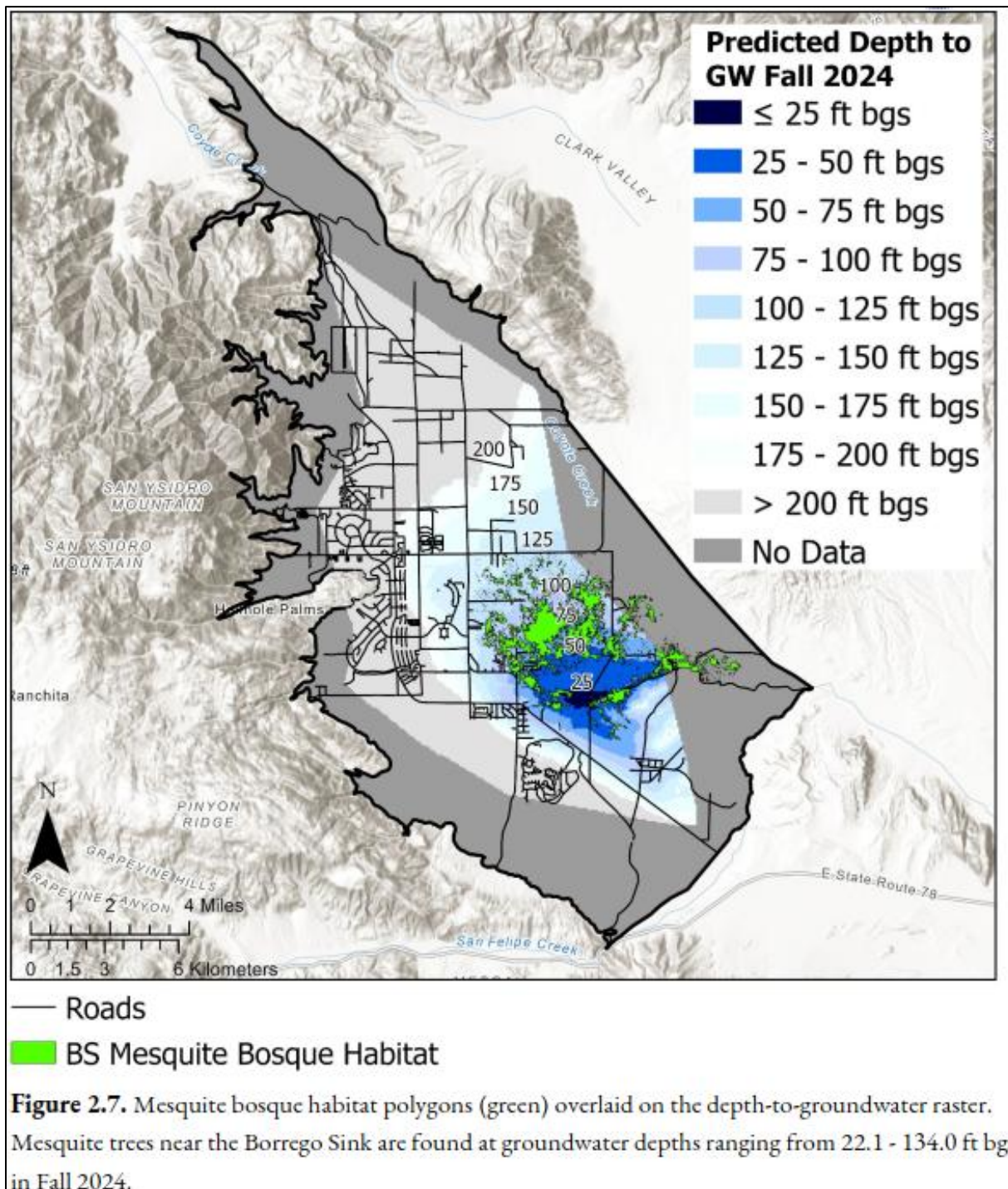


Figure 2.7. Mesquite bosque habitat polygons (green) overlaid on the depth-to-groundwater raster. Mesquite trees near the Borrego Sink are found at groundwater depths ranging from 22.1 - 134.0 ft bgs in Fall 2024.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - This mapping technique provides a reasonable first-order estimate of depth-to-groundwater in the vicinity of the BS Mesquite Bosque. However:
 - The Watermaster’s groundwater-elevation raster was generated based on limited field measurements because wells are sparse within the BS Mesquite Bosque area.
 - The groundwater-elevation raster was generated for specific Watermaster purposes to characterize basin-wide groundwater conditions within the regional aquifer system (e.g., change in groundwater storage and groundwater flow directions).

Hence, the Watermaster’s groundwater-elevation raster should be considered an approximate estimate, which limits the accuracy of UCI’s calculated depth-to-groundwater within the BS Mesquite Bosque area.

- Recently collected data by the Watermaster from new monitoring wells in the area indicate that depth-to-groundwater may be greater than estimated in the UCI GDE Study:
 - Depth-to-groundwater at WWTP-3 = 55 ft-bgs on 3/8/2023
 - Depth-to-groundwater at Not-Broom Well = 81.7 ft-bgs on 3/19/2025
 - In summary, the mapping of depth-to-groundwater used Watermaster’s readily available groundwater-elevation raster. However, this raster was generated from sparse measured data within the BS Mesquite Bosque area and its purpose is for regional analysis; hence, the raster is an approximate estimate of depth-to-groundwater. Therefore, it should not be used for site-specific analyses and interpretations in the report, such as setting minimum thresholds for groundwater levels.
- *Recommendations:*
 - Measured depth-to-groundwater within the BS Mesquite Bosque area is a data gap that should be filled to increase confidence in the estimation of depth-to-groundwater and the assessment of the BS Mesquite Bosque as a GDE.

Mesquite Tree Rooting Depth and Connection to Groundwater

The UCI GDE Study Report referenced multiple studies to confirm that Mesquite trees can develop deep roots to tap groundwater, with documented rooting depths ranging from approximately 39 to 175 ft-bgs:

- In the Borrego Sink, Jenkins et al. (1988) recorded Mesquite tree roots extending at least 39.4 feet.
- Phillips (1963) observed *Prosopis juliflora* roots reaching depths of 175 feet near Tucson, Arizona.

The UCI GDE Study claims that the capillary fringe may also extend from 6-11 feet above the saturated zone, which makes groundwater available at even shallower depths.

The study cites these references to demonstrate the potential for Mesquite tree species to access groundwater at depths (39 to 175 ft-bgs), which is comparable to or exceeds the current estimates of depth-to-groundwater underlying the BS Mesquite Bosque (22 to 134 ft-bgs).

Technical Consultant Assessment and Recommendations:

- *BAS determination: Met*
 - The main conclusion of this report section that Mesquite trees in the BS Mesquite Bosque have deep tap roots that could reach the capillary fringe above the regional aquifer system is supported by the cited references.

Shallow Soil Conditions

Sampling events for water potential and isotopic analyses in the UCI GDE Study were preferentially conducted during the “dry” season to increase the likelihood that groundwater use was captured. The study used nearby weather stations, soil moisture sensors, and field soil moisture data to characterize soil moisture conditions to 5 ft-bgs during “sampling” events.

Field soil samples were collected during April 2024 to August 2024 at 22 locations within all five study sites and were “homogenized” before subsampling for a range of depths: 0–10 cm (0–3.9 in), 10–40 cm (3.9–15.7 in), 40–70 cm (15.7–27.6 in), 70–100 cm (27.6–39.4 in), and 100–150 cm (39.4–59.1 in). Soil wet weight and soil dry weight were measured to assess gravimetric soil moisture using the following equation: $[(\text{soil wet weight} - \text{soil dry weight}) / \text{soil dry weight}]$. Soil dry weight was determined by drying soils at 105°C for 48 hours. See Figure A3 from the report below.

Continuous soil moisture sensors were installed at the primary Borrego Springs site (Site 1) from June 2023 to September 2024 at depths of 30 cm (11.8 in), 50 cm (19.7 in), 70 cm (27.6 in), 90 cm (35.4 in), 110 cm (43.3 in), 130 cm (51.2 in), and 150 cm (59.1 in). These sensors measure soil moisture by average volumetric water content. See Figure A2 from the report below.

The main results and interpretations from the soil moisture analyses were:

- The top 5 ft of soil profile was relatively dry (<10 percent soil moisture) throughout the dry season. Sandy, well-drained soils were consistently observed across all depths and sites with no signs of clay layers, water-logged soils, or any impermeable layers indicative of a perched aquifer.
- The continuous sensors recorded a steady increase in soil moisture following the leaf-out period (mid-April) suggesting a role of “hydraulic lift” in increasing soil moisture at deeper depths (>50 cm or 19.7 in).

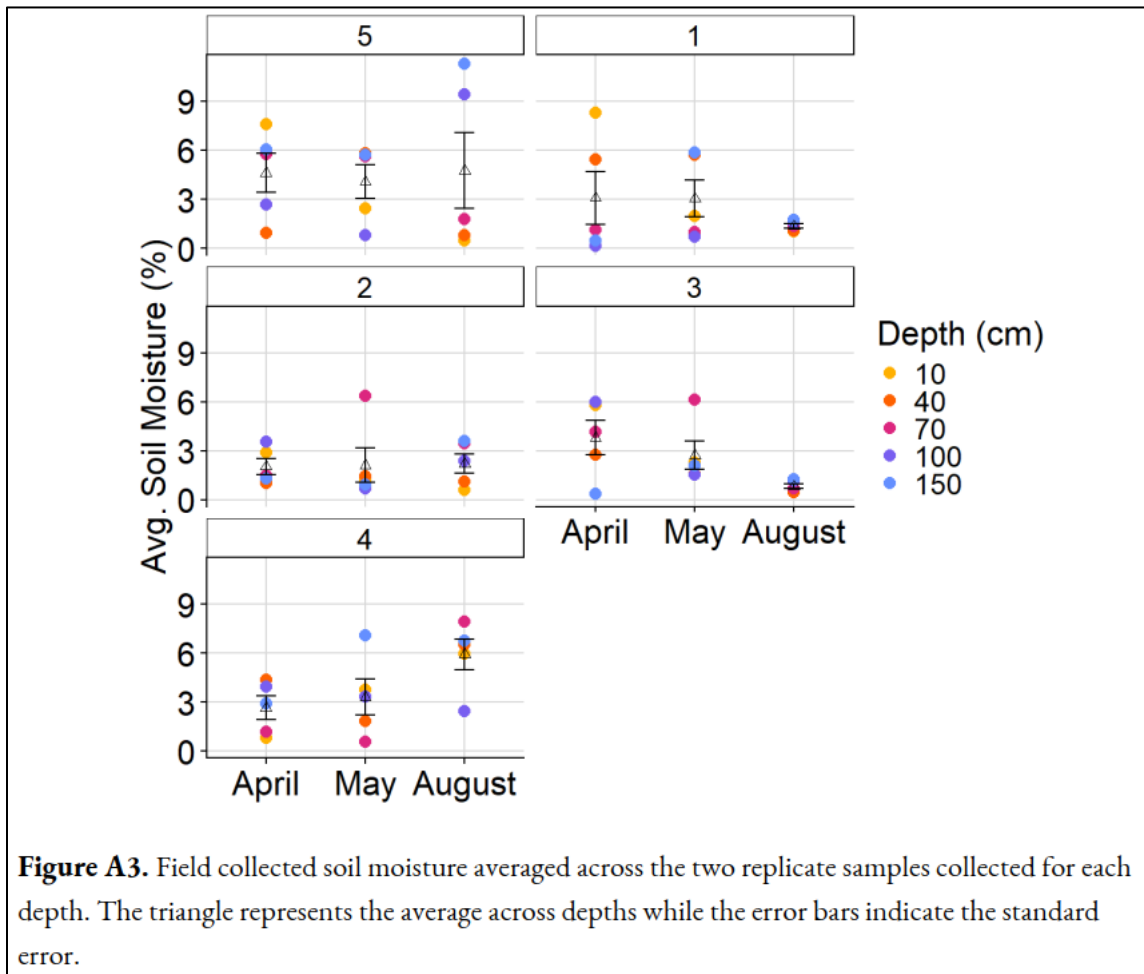


Figure A3. Field collected soil moisture averaged across the two replicate samples collected for each depth. The triangle represents the average across depths while the error bars indicate the standard error.

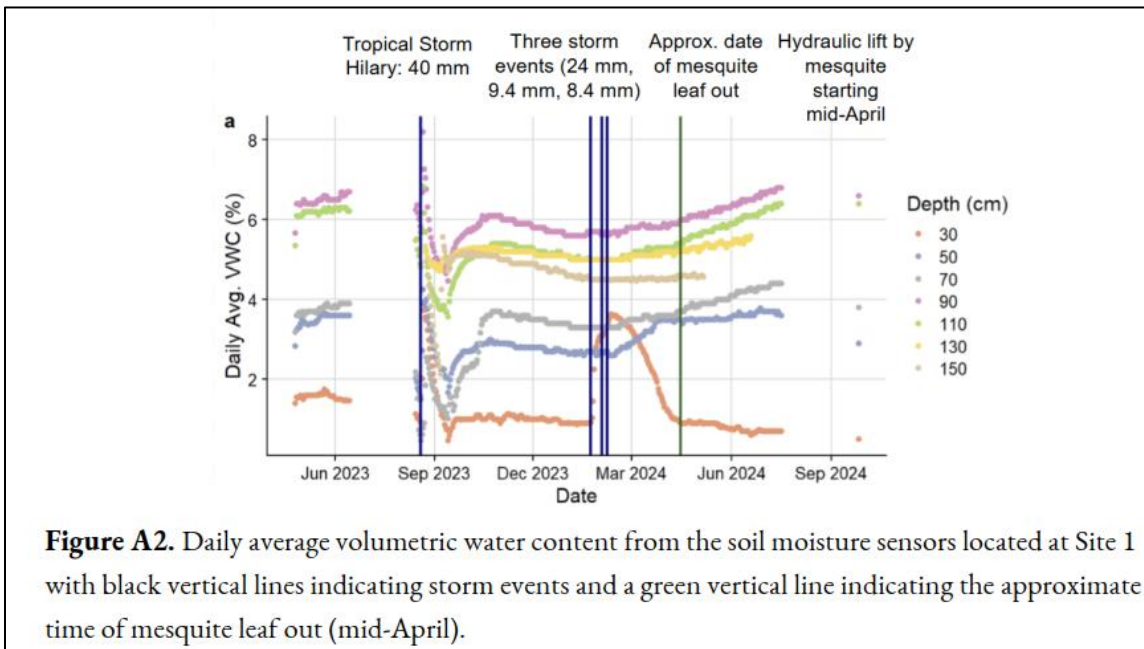


Figure A2. Daily average volumetric water content from the soil moisture sensors located at Site 1 with black vertical lines indicating storm events and a green vertical line indicating the approximate time of mesquite leaf out (mid-April).

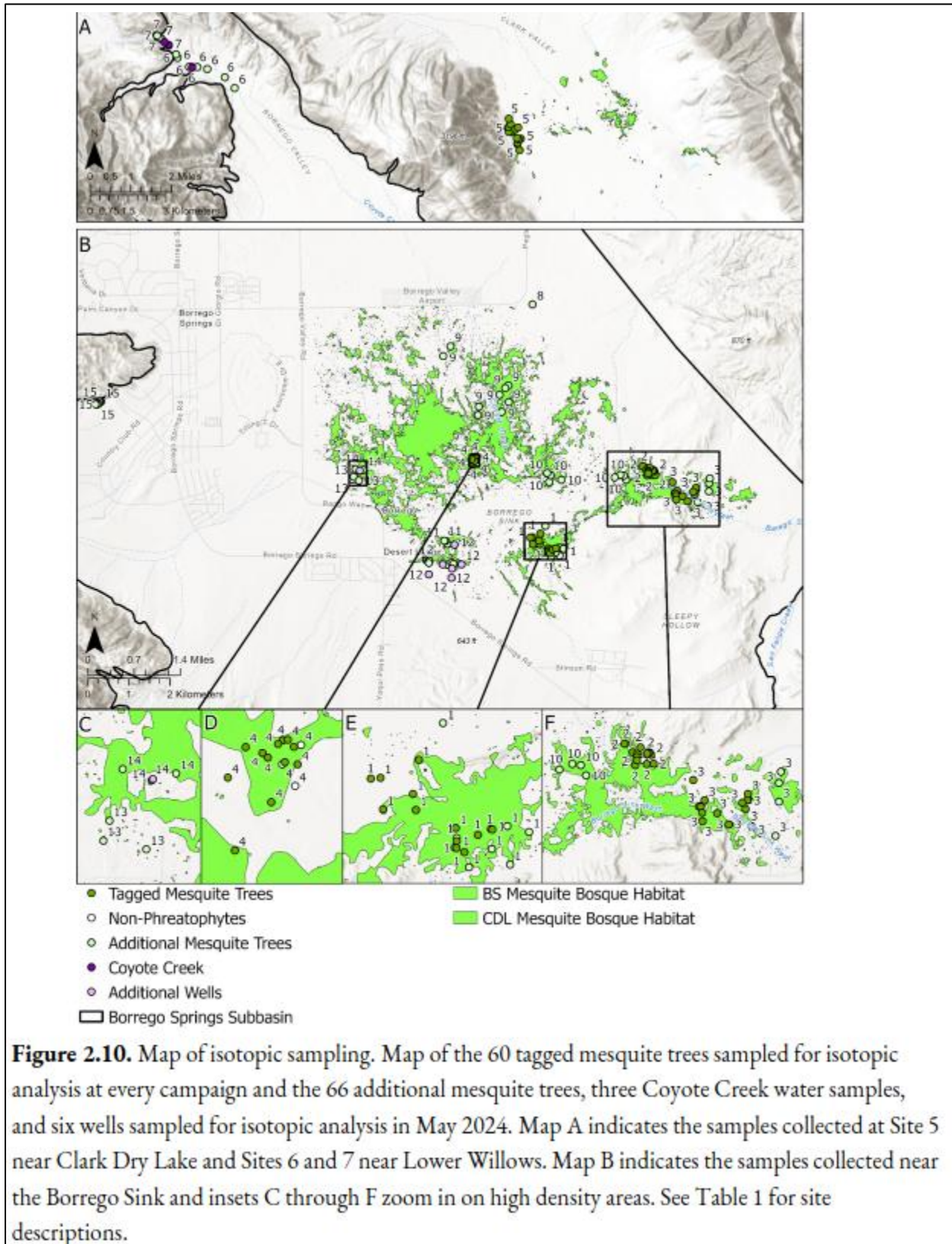
Technical Consultant Assessment and Recommendations:

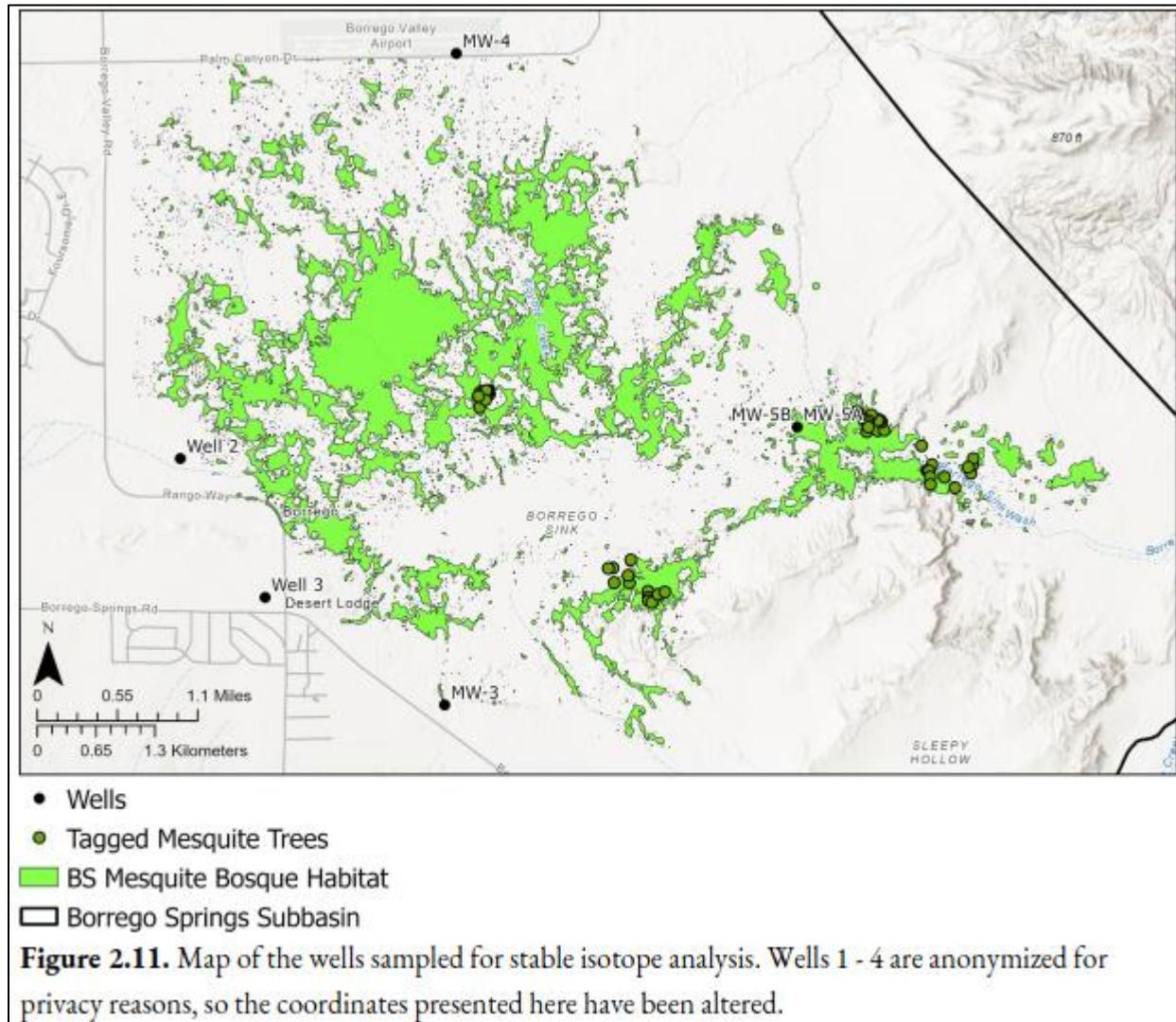
- **BAS determination: Not Met**
 - Soil moisture measured by volume (Figure A.2) is mathematically greater than soil moisture measured by weight (Figure A.3), so the two soil moisture time-series charts in the report (and shown above) cannot be directly compared. Nevertheless, soil moisture less than 10 percent, by weight or by volume, is representative of relatively dry soil conditions, as stated in the report.
 - Mesquite trees are adapted to arid desert environments, and their roots can access soil moisture that is less than 10 percent by weight or by volume.
 - Observations of progressively declining soil moisture throughout the dry season could be caused by soil moisture evaporation, evapotranspiration by the shallow plant roots, or both.
 - Observations of increasing soil moisture after rainfall and Mesquite leaf-out events could be caused by “hydraulic lift,” the downward percolation of infiltrated surface water, or both.
 - The hypothesis of “hydraulic lift” suggests the existence of a soil moisture reservoir deeper than 5 ft-bgs.
 - *Data Gap:* The sampling and analysis of soil conditions to depths of only 5 ft-bgs leaves a gap in understanding of soil conditions from 5 ft-bgs to the saturated zone (i.e., >100ft-bgs). Soil moisture within this depth interval could be a source of water for the Mesquite tree roots.
 - The soil moisture data described in the UCI GDE Study Report (i.e., relatively dry soil conditions in the upper 5 ft of soil) by itself is not indicative of GDE behavior.
 - In summary, Mesquite trees are adapted to arid desert environments, and their roots can access soil moisture of <10 percent. The sampling and analysis of soil conditions to depths of only 5 ft-bgs leaves a gap in understanding of soil conditions from 5 ft-bgs to the saturated zone (i.e., >100 ft-bgs). Soil moisture within this depth interval could be a source of water for the Mesquite tree roots but was not analyzed in the study.
- **Recommendation:**
 - Fill the gap in understanding of the texture, moisture content, and isotopic water chemistry of the soil profile from 5 ft-bgs to the saturated zone.

Isotopic Analysis

The UCI GDE Study employed an analysis of hydrogen and oxygen isotopes in Mesquite tree tissue in comparison to hydrogen and oxygen isotopes in groundwater and shallow soil water to assess the contribution of these two-source waters to the Mesquite trees. The isotopic analysis is summarized below:

- Lighter isotopes in water (e.g., ^{16}O) evaporate more readily than heavier isotopes (e.g., ^{18}O) and diffuse through similar media at higher rates.
- Different levels of exposure to evaporation will result in different isotopic signatures for different water sources (e.g., shallow soil water, which is exposed to evaporation, will preferentially lose its “light” isotopes (e.g., ^{16}O) and retain its “heavy” isotopes (e.g., ^{18}O)).
- The results of isotopic analysis are represented as a delta value relative to the heavier isotope (e.g., $\delta^{18}\text{O}$) where larger values indicate enrichment in heavy isotopes, demonstrating the signature of evaporation. The isotopic composition data can be used to calculate **deuterium-excess**, a useful indicator of the effects of evaporation.
- Values of $\delta^{18}\text{O}$ and deuterium-excess from soil water, aquifer water, and plant tissue water were used to test for the presence of groundwater in the Mesquite plant tissue.
- Repeated sampling of leaf water was performed at 60 trees across Sites 1 through 5 in 2023 and 2024, as well as an additional 66 trees during the May 2024 sampling campaign to better assess spatial variability. See Figure 2.10 from the report (below).
- Creosote and Saltbush (shallow roots) were also sampled in May 2024 as a comparison for plants that are relatively shallow-rooted and are not expected to access the deeper regional aquifer system.
- Sampling occurred over the dry season (April – November) in 2023 and 2024.
- Soil water sampling and analysis occurred at one location at Sites 1 through 5 three times per year during the spring/summer months. Isotopic values of soil water from were averaged across the sampling depths and used in the mixing models.
- Groundwater was sampled at various wells less frequently (in many cases, only one sample). See Figure 2.11 from the report (below).
- Perched groundwater was not sampled because there was no evidence to suggest it existed beneath the Mesquite Bosque habitats.
- Water isotopes were analyzed by the University of Wyoming Stable Isotope Facility.





The main results and conclusions from the isotopic analyses are that the Mesquite trees draw water from both shallow soil water and the regional aquifer system, which is consistent with other research showing that Mesquite trees are facultative phreatophytes that can utilize both surface water and groundwater depending on availability. See Figures A6 and 2.12 from the report (below).

The data also were used to estimate the percentage of groundwater in Mesquite tree tissue: 54 percent to 82 percent across the four BS Mesquite Bosque (Sites 1 through 4) and between 70 percent and 86 percent at the CDL Mesquite Bosque (Site 5). See Figure 2.15 from the report (below).

Due to the low sample size of the Creosote and Saltbush, the study did not conduct statistical tests or run the two-source mixing model. It did, however, compare the deuterium-excess values and found that the Creosote and Saltbush had deuterium-excess values ($-23.0 \pm 9.1\text{‰}$) closer to the soil profile ($-57.2 \pm 23.6\text{‰}$) than did the Mesquite ($-11.4 \pm 6.4\text{‰}$).

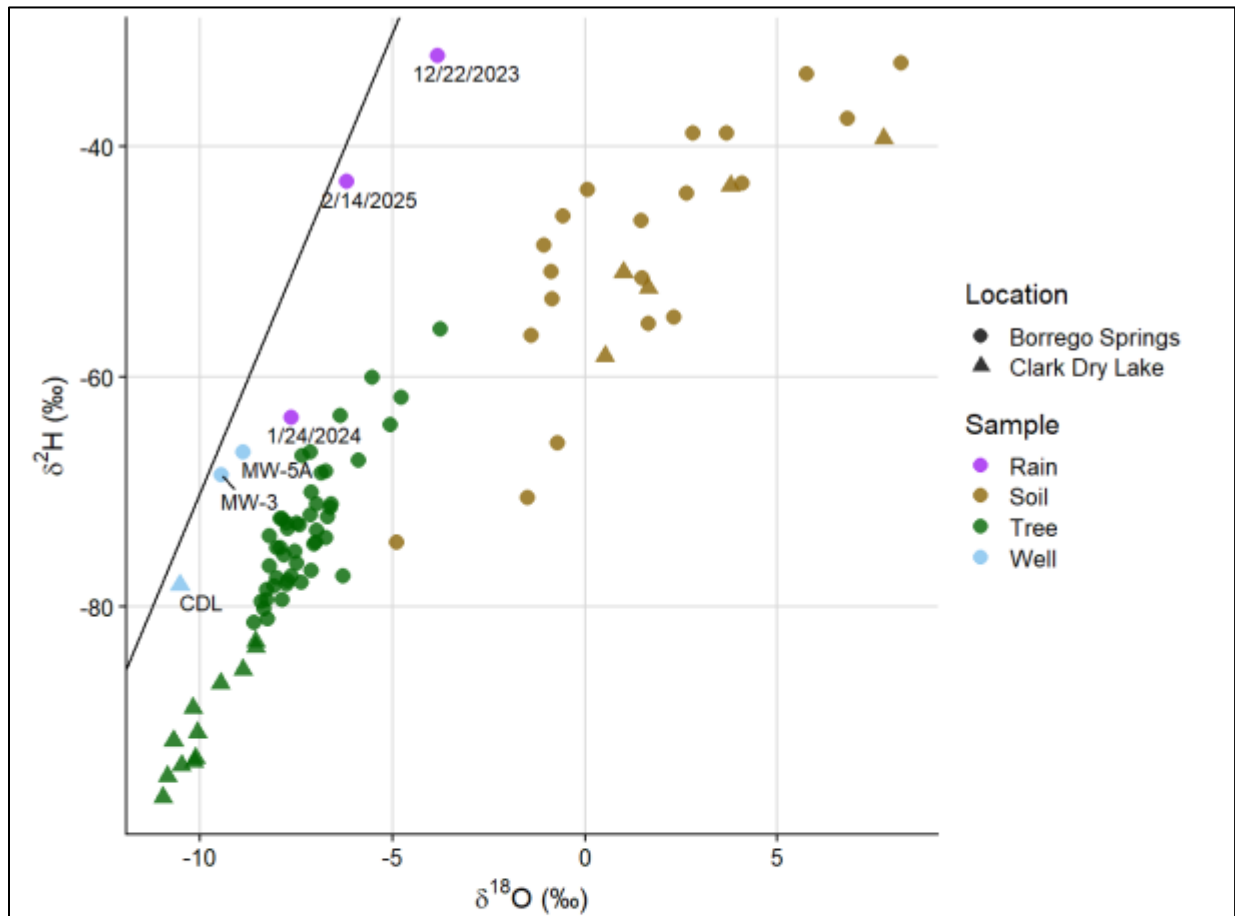


Figure A6. The relationship between $\delta^{18}\text{O}$ and $\delta^2\text{H}$ across all sample types across all six sampling campaigns for Sites 1 through 5 averaged at the level of the individual. The well labeled CDL is State Well ID 10S07E07C001S). The black line indicates the Global Meteoric Water Line (GMWL), which is described by the equation: $\delta^2\text{H} = 8 \cdot \delta^{18}\text{O} + 10$, and represents the mean global relationship between $\delta^2\text{H}$ and $\delta^{18}\text{O}$ in precipitation. The alignment of the well water samples (blue) and the precipitation samples (purple) on the GMWL line indicates groundwater that originated as precipitation through recharge processes. Points to the right of this line indicate the influence of evaporation. The brown points representing soil water are farther to the right and of a lower slope than the GMWL, indicating a stronger effect of evaporation on their isotopic signature relative to the green points. The green points representing mesquite water are also to the right of the line but show little overlap with the brown points, indicating an isotopic signature that can only be explained by the mixing of soil water and well water sources.

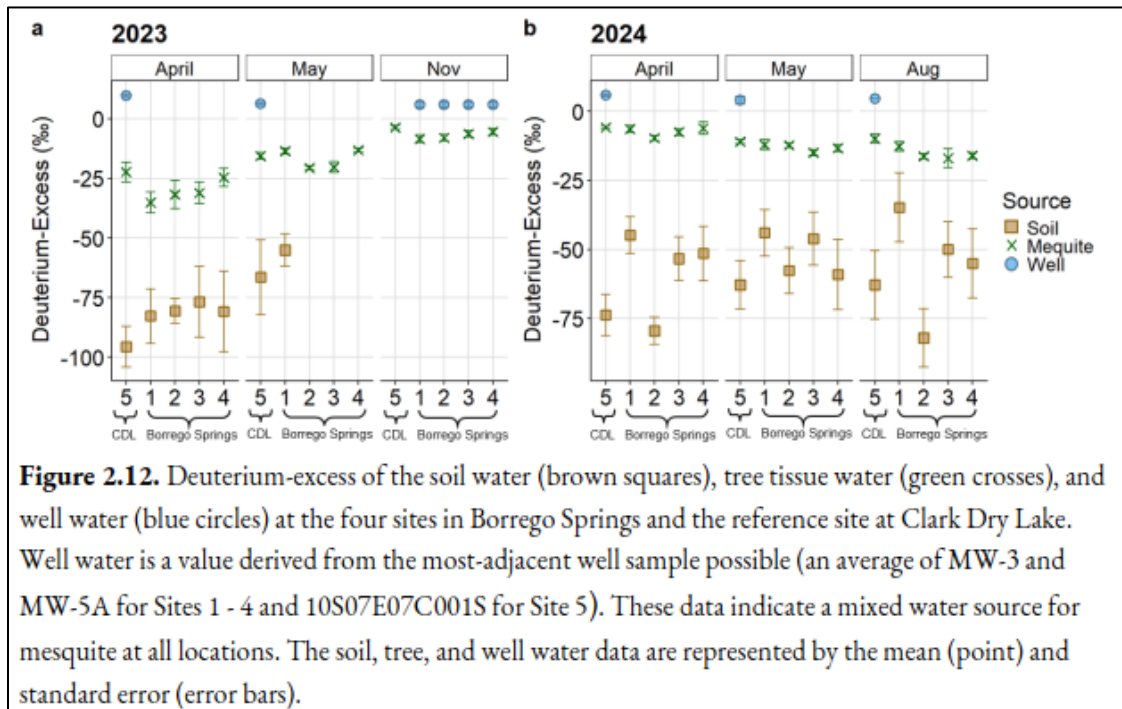


Figure 2.12. Deuterium-excess of the soil water (brown squares), tree tissue water (green crosses), and well water (blue circles) at the four sites in Borrego Springs and the reference site at Clark Dry Lake. Well water is a value derived from the most-adjacent well sample possible (an average of MW-3 and MW-5A for Sites 1 - 4 and 10S07E07C001S for Site 5). These data indicate a mixed water source for mesquite at all locations. The soil, tree, and well water data are represented by the mean (point) and standard error (error bars).

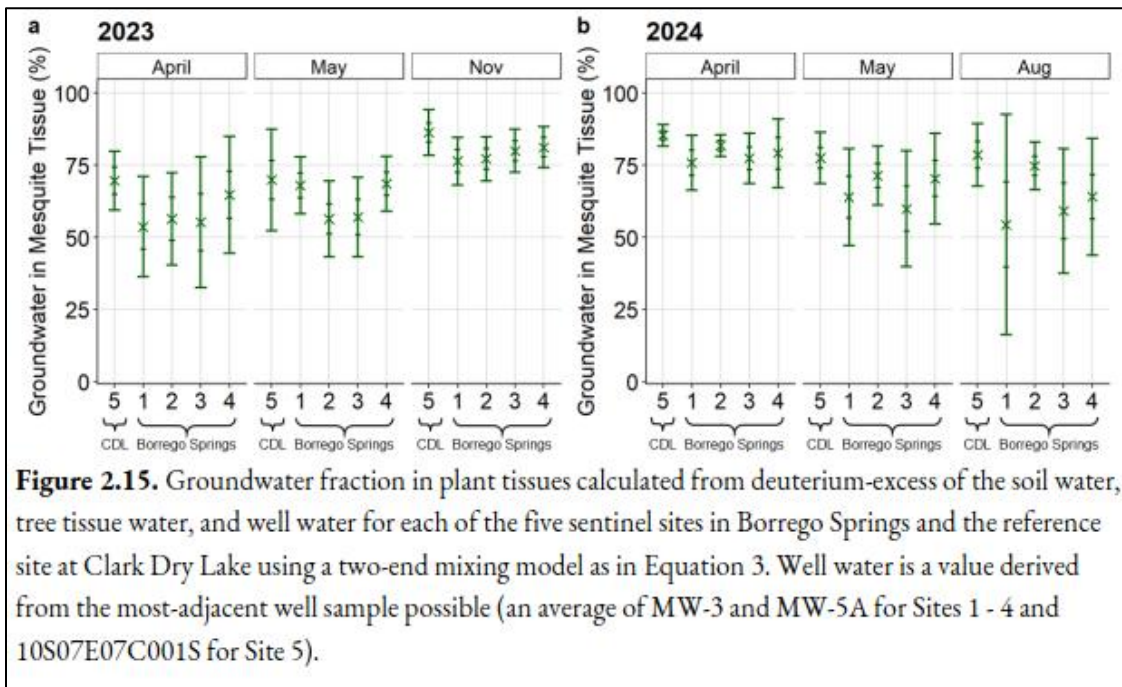


Figure 2.15. Groundwater fraction in plant tissues calculated from deuterium-excess of the soil water, tree tissue water, and well water for each of the five sentinel sites in Borrego Springs and the reference site at Clark Dry Lake using a two-end mixing model as in Equation 3. Well water is a value derived from the most-adjacent well sample possible (an average of MW-3 and MW-5A for Sites 1 - 4 and 10S07E07C001S for Site 5).

Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - We agree that the available isotopic data indicate that the ET demands of the Mesquite trees are not being 100 percent satisfied by the shallow soil moisture (<5 ft-bgs) nor 100 percent satisfied by the regional aquifer system. Instead, there appears to be a mixed water source that supplies the ET demands of the Mesquite trees.
 - The isotopic analysis of Creosote and Saltbush tissue also indicates a mixed water source, but with deuterium-excess values ($-23.0 \pm 9.1\text{‰}$) closer to the soil profile ($-57.2 \pm 23.6\text{‰}$) than the Mesquite trees ($-11.4 \pm 6.4 \text{‰}$). However, Creosote and Saltbush have shallow roots compared to Mesquite trees, which are not expected to reach and access the deeper regional aquifer. Therefore, the isotopic data suggest there must be another water source for the Creosote and Saltbush that is deeper than 5 ft-bgs with an isotopic signature like the regional aquifer. This source water could be the soil moisture within the vadose zone below 5 ft-bgs. This hypothesis makes sense if the origin of the deeper soil moisture is episodic infiltration of surface water after large storm events that percolates past the upper 5 feet of soil, and hence, escapes the evaporative stresses that influence the isotopic composition of soil moisture in the upper 5 ft of soil during the subsequent hot, dry months.
 - The isotopic analysis in the UCI GDE Study did not include sampling, analysis, and consideration of soil moisture deeper than 5 ft-bgs as a potential source water for the vegetation (i.e., Mesquite, Creosote, Saltbush). Soil moisture within this depth interval could be a source of water for the vegetation but was not analyzed. This data gap prohibits arriving at the *definitive* conclusion of the UCI GDE Study that the BS Mesquite Bosque is a GDE.
- **Recommendation:**
 - Fill the gap in understanding of the isotopic composition of soil moisture from 5 ft-bgs to the saturated zone. These data could more definitively describe and quantify the relative roles of shallow soil moisture (<5 ft-bgs), deeper soil moisture (>5 ft-bgs) and/or the regional aquifer in supplying the ET demands of the Mesquite trees.

Water Potential

The UCI GDE Study used leaf water potential as an indicator of water availability and moisture stress, reflecting the balance between soil moisture supply, atmospheric demand, and plant water uptake:

- “At predawn, when transpiration is minimal and water flow is equilibrated within the plant-soil system, leaf water potential is closely aligned with soil water potential, offering a baseline measure of water availability for plants. Lower, or more negative, predawn leaf water potential values indicate lower water availability.
- At midday, when transpiration is highest, leaf water potential approximates a measure of water stress. Lower, or more negative, midday leaf water potential values indicate greater water stress.
- Similar values between conditions, sites, or plants reflect similar water availability in the soil-plant system.”

The study measured predawn and midday leaf water potential of Mesquite trees across the growing season to assess differences in water availability and water stress between Mesquite trees in the BS Mesquite Bosque and CDL Mesquite Bosque (the comparison site with comparatively shallow groundwater levels). Sampling was conducted at Sites 1 (BS) and 5 (CDL) over the spring/summer months of 2023 and 2024.

Additionally, in 2024 only, the study compared leaf water potential for Mesquite trees to a comparatively shallow-rooted plant species (Creosote) to compare water availability and water stress as the dry season progressed.

The results of the water potential analysis in the report show:

- The Mesquite trees at the BS Site and the CDL Site exhibited similar water availability and water stress, with the BS Site showed slightly less water availability and greater water stress than the CDL Site. The report suggests that this observation was likely due to higher groundwater levels at the CDL Site. See Figure 2.17 from the report (below).
- As expected, water stress increased from pre-day to mid-day and from April to August. See Figure 2.17 from the report (below).
- The Creosote showed less water availability and greater water stress than Mesquite. The report suggests that this observation was likely due to groundwater availability for the Mesquite.

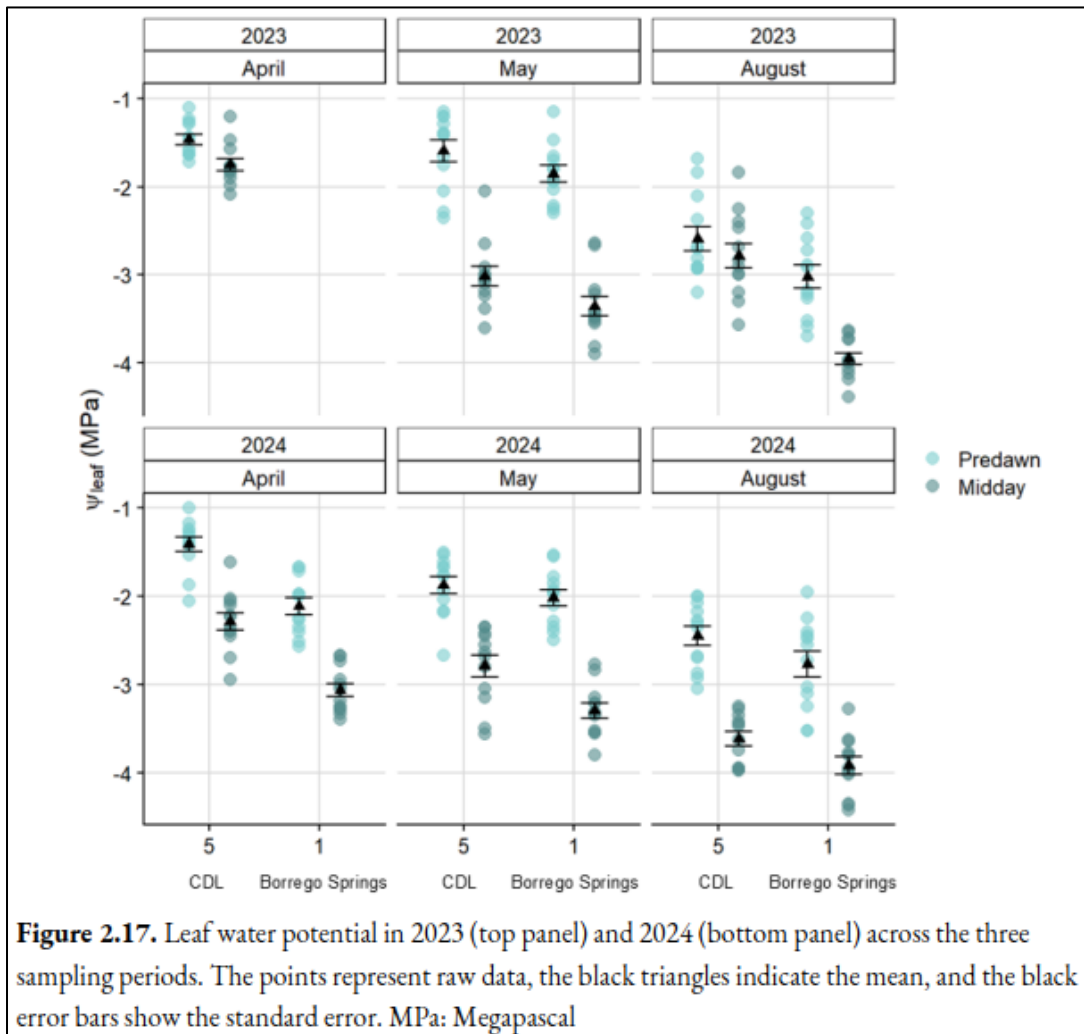


Figure 2.17. Leaf water potential in 2023 (top panel) and 2024 (bottom panel) across the three sampling periods. The points represent raw data, the black triangles indicate the mean, and the black error bars show the standard error. MPa: Megapascal

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - The water potential data and analyses produce reasonable results which indicate:
 - Leaf water stress in Mesquite increased from pre-day to mid-day and from April to August, indicating greater water stress as temperature and sunlight increase.
 - Mesquite trees at CDL have greater water potential than at the BS Site, indicating greater water availability at the CDL Site.
 - Deeper-rooted Mesquite trees have greater water potential than the shallow-rooted Creosote shrubs, indicating greater water availability.
 - However, we disagree with the conclusion of the study that these data necessarily indicate that the Mesquite trees are using the regional aquifer. An alternative explanation is that the Mesquite trees at the BS Site are using deeper soil moisture (>5 ft-bgs) which could explain:
 - Lower water potential for Mesquite at the BS Site versus the CDL Site.
 - Lower water potential for the shallow-rooted Creosote vs. the deeper-rooted Mesquite.

Remote-Sensing Analysis (NDVI)

The UCI GDE Study used the remote-sensing metric Normalized Difference Vegetation Index (NDVI) as a proxy for vegetation health and greenness. In short, the UCI interpretation was that areas with relatively high or increasing NDVI over dry periods indicate that the vegetation has access to groundwater.

The study methods called for NDVI analysis in three areas of interest:

- *Potential GDE*: Borrego Springs Mesquite Habitat Polygons (BS)
- *Known GDE*: Clark Dry Lake Mesquite Habitat Polygons (CDL)
- *Non-GDE*: A polygon of non-GDE community near Coyote Creek (non-GDE)

The study methods used three separate approaches for the NDVI analyses:

- *Approach 1* used NDVI data from 25 May - 24 June 2024 (a dry period after Mesquite leaf-out that typically occurs in April) and identified pixels with increasing Mann-Kendall trends ($\tau > 0$) to identify areas where vegetation has access to groundwater sources that are supporting the increasing “greenness” of the vegetation.
- *Approach 2* used NDVI data from 24 June - 3 August 2024 and identified pixels with maximum NDVI > 0.19 to identify areas of relatively high “greenness” over the growing season drought, which would indicate access to groundwater sources that are supporting the “greenness” of the vegetation.
- *Approach 3* used cumulative NDVI over WY 2024 (NDVI > 16) to identify areas of relatively high “greenness” over the water year, which would indicate access to groundwater sources that are supporting the “greenness” of the vegetation.

The conclusion of the NDVI analyses was that various areas within the BS Mesquite Bosque have NDVI signals that indicate access to groundwater, similar to the CDL Site, with the strongest indicators of groundwater use concentrated around the Borrego Sink where groundwater is shallowest.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - The results of Approach 1 identified areas in the BS Mesquite Bosque with increasing NDVI trends during May-June to indicate “GDE behavior.” We agree that increasing NDVI during springtime could be an indication of a groundwater source. However, this is the typical time of year when Mesquite trees develop peak canopy and produce flowers and seed pods after the winter rains. Could the increasing NDVI trends identified in Approach 1 be a result of the normal annual cycle of Mesquite leaf-out, flowering, and pod development after the winter rains, even without access to groundwater? If so, Approach 1 should not be used as a conclusive indicator of groundwater dependency for the Mesquite trees.
 - The results of Approach 2 identified areas in the BS Mesquite Bosque with maximum NDVI > 0.19 to indicate “GDE behavior.” We agree that relatively high NDVI values during hot, dry summer months are an indication of a source of groundwater for the Mesquite trees. However, other scientific literature state that NDVI ranging from 0.20-0.30 are indicative of partial canopy loss or drought stress and that NDVI values > 0.30 are indicative of healthy Mesquite canopy at peak leaf-out. Therefore, it seems

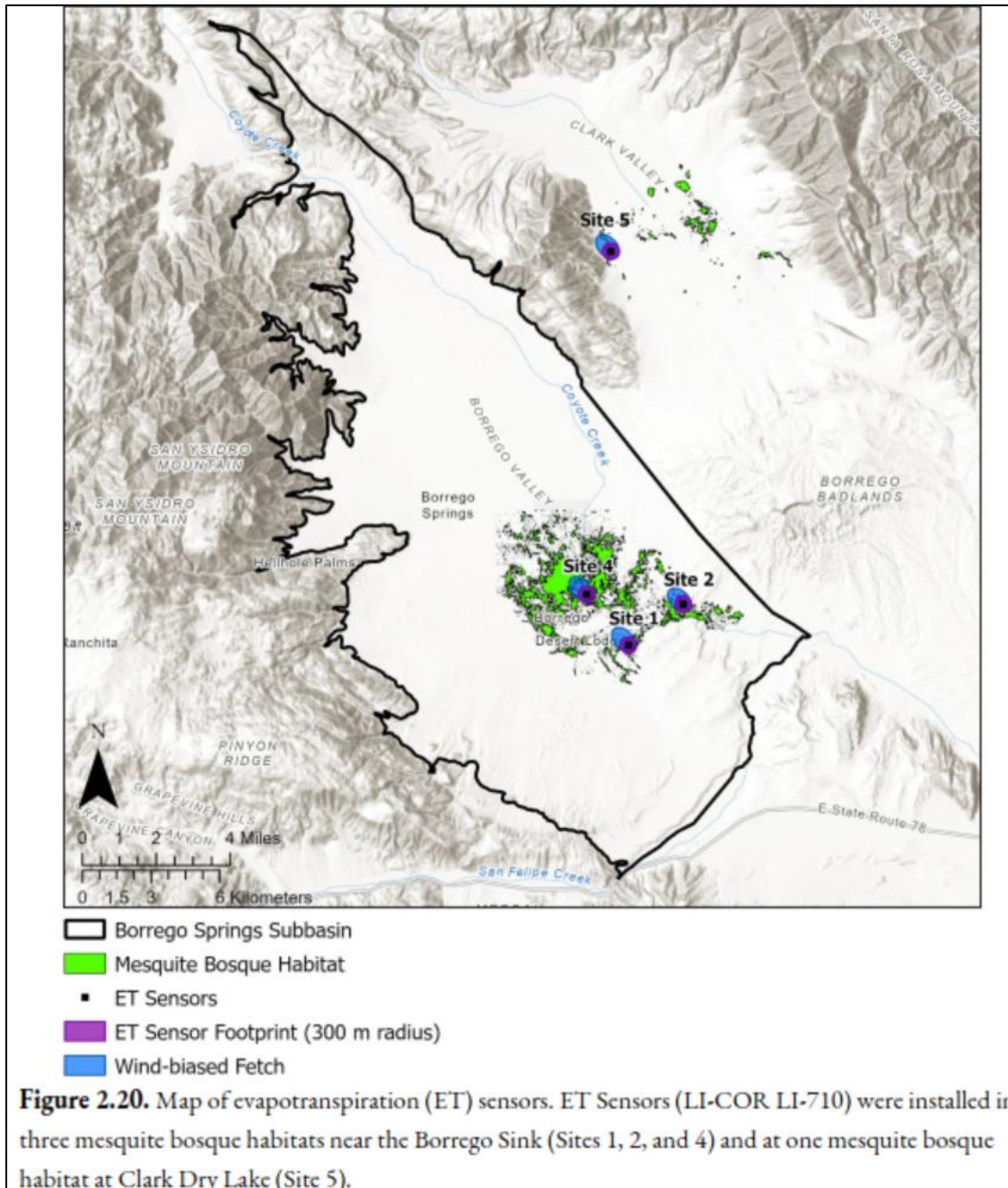
possible that NDVI values in the range of 0.19-0.30 could be indicative of moderately stressed Mesquite trees without access to groundwater but instead are dependent on semi-saturated soil moisture above the capillary fringe. If so, Approach 2 should not be used as a conclusive indicator of groundwater dependency for the Mesquite trees.

- The results of Approach 3 identified areas in the BS Mesquite Bosque with cumulative NDVI >16 during WY 2024 to illustrate the areas of highest “greenness” as an indicator of “GDE behavior.” We agree that relatively high cumulative NDVI values over a water year is an indication of a source of groundwater for the Mesquite trees. However, the report does not justify why NDVI >16 is an important threshold for indicating GDE behavior. It also seems possible that relatively high cumulative NDVI could be indicating Mesquite trees with greater access to surface water during the winter rains/floods and soil moisture that is fed by percolating surface water (instead of access to deeper regional aquifer). If so, Approach 3 should not be used as a conclusive indicator of groundwater dependency for the Mesquite trees.
 - The report focuses on an NDVI analysis of the BS Mesquite Bosque but does not include explicit comparisons of NDVI in the BS Mesquite Bosque to the other two areas of interest (i.e., the CDL Mesquite Bosque and the non-GDE community near Coyote Creek).
 - In summary, we agree that NDVI can be used to assess the greenness (health) of vegetation, and that the NDVI analyses in the study could be indicating that groundwater is supporting the healthy stands of Mesquite near the Borrego Sink. However, the analyses in the study do not represent conclusive proof of groundwater dependency. An alternative explanation is that these areas of lowest land surface elevation also receive the highest accumulation of surface water runoff and infiltration, which could be supporting the Mesquite trees. In our experience, we believe there are more scientifically-defensible methods to use NDVI data to better understand the water sources available to the Mesquite and the stresses that have (or are currently) affecting the health of the Mesquite trees. See the Recommendation below.
- *Recommendation:*
 - NDVI data from the mid-1980s to the present should be analyzed for site-specific areas of the BS Mesquite Bosque on time-series charts and compared against all potential stresses to the Mesquite trees (e.g., changes in groundwater levels, precipitation, surface water availability, temperature, human disturbance, etc.) to better understand: how the health of the Mesquite trees has changed over time in different areas of the BS Mesquite Bosque, and how the various stresses may have influenced the observed changes in Mesquite health over time. This type of analysis may reveal more information about which water sources were most important for Mesquite tree survival and health in different areas of the BS Mesquite Bosque since the mid-1980s.

Dry Period Evapotranspiration in the GDE

The UCI GDE Study installed instrumentation to directly measure ET in the BS and CDL Mesquite Bosques to see if ET rates exceed precipitation or remain stable or even increase during seasonal drought, which would confirm that the Mesquite trees are utilizing groundwater.

LI-COR LI-710 ET sensors were installed at four sites: Sites 1, 2, and 4 (BS Mesquite Bosque) and Site 5 (CDL Mesquite Bosque). See Figure 2.20 from the report (below). Monitoring of ET was performed from May 2024 - January 2025.



All sites maintained consistent and sustained ET rates throughout the deployment period that exceeded precipitation totals. Site 1 at CDL recorded the highest total monthly ET in June, indicating peak water use in early summer. BS Sites 2 and 4 exhibited peak ET in July, further reinforcing the pattern of active Mesquite water use throughout the dry summer months. Across all sites, ET began to decline in November, signaling the end of the Mesquite growing season as cooler winter temperatures set in.

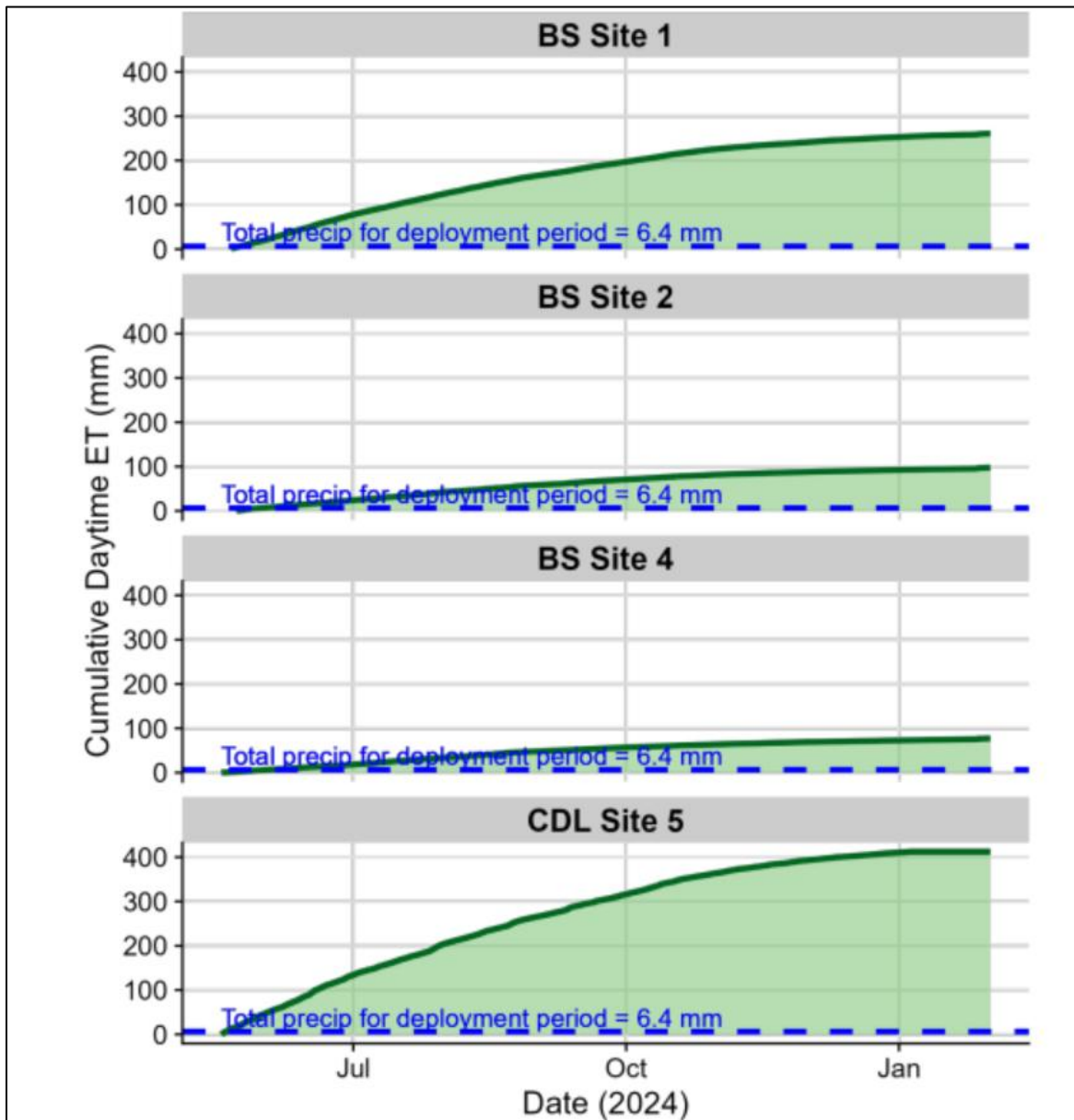


Figure 2.23. Cumulative Total Evapotranspiration (ET) from each site. The dotted lines show the total precipitation for the deployment period (6.4 mm or 0.25 in). All sites transpired far more than the total precipitation that fell during the deployment period, confirming groundwater use across the dry deployment period. BS: Borrego Springs; CDL: Clark Dry Lake.

The UCI GDE Study Report noted that despite extremely low rainfall from May 2024 to January 2025, ET rates remained consistently high across all monitored sites, well beyond the amount of available rainfall, which confirms that Mesquite trees rely on groundwater to support growth and transpiration. The study concluded that the ET sensors provide direct evidence of groundwater use by Mesquite trees, and hence, the BS Mesquite Bosque should be recognized as a GDE within the Subbasin's water budget. The study also recommended that monitoring of ET should continue to calculate total annual ET, and to detect potential shifts in groundwater availability or Mesquite health to minimize undesirable impacts.

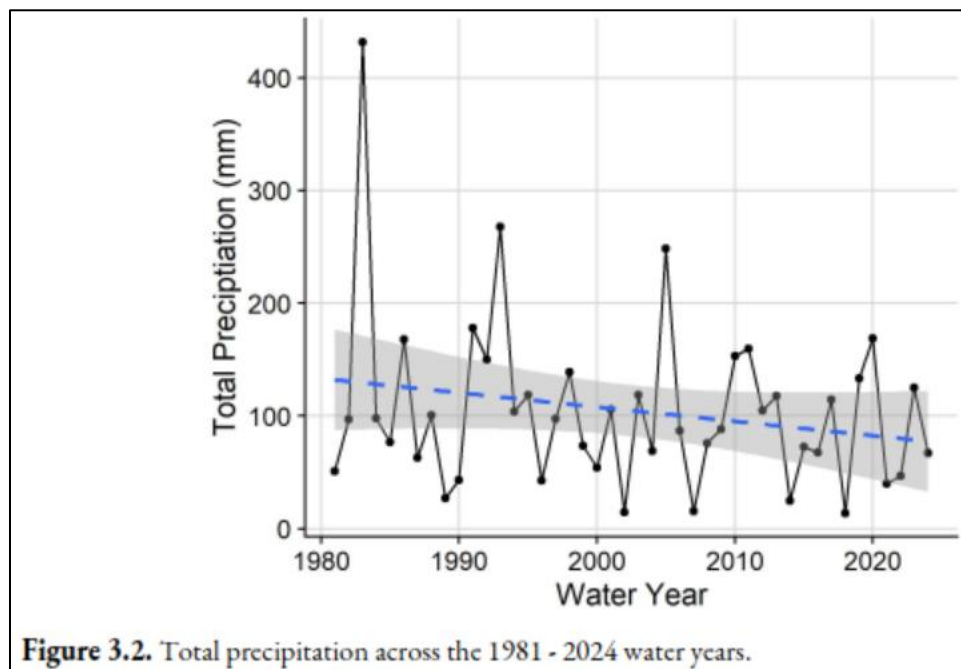
Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - We agree that the ET rates measured by the sensors are greater than the rates of direct precipitation; and hence, other source(s) of water must be necessary to satisfy the measured ET rates in the BS Mesquite Bosque over the dry, hot growing season.
 - However, we disagree with study conclusion that the ET sensors provide direct evidence of groundwater use by Mesquite trees. The other source(s) of water could be:
 - The deep regional aquifer.
 - Soil moisture within the unsaturated zone that is fed by infiltration of precipitation and stormwater runoff that flows through and accumulates in the BS Mesquite Bosque.
 - Both above.
 - The cumulative ET at the CDL site is significantly greater than at the BS sites – particularly compared to Sites 2 and 4. This could be indicating that the Mesquite trees at the BS sites are using soil moisture from the unsaturated zone, which is not as abundant compared to the shallow groundwater at the CDL site.
 - The report does not describe the accuracy of the ET sensors, considering that: (i) other plant species are present; (ii) atmospheric turbulence and mixing from other areas; (iii) lack of match with other ET monitoring methods (OpenET, CIMIS, etc.).
 - The study did not employ an ET sensor in a non-GDE area as a comparison.
- **Recommendations:**
 - This method of ET monitoring generates site-specific estimates of ET, which could be used to better constrain the BVHM estimates of groundwater ET. The ET estimates from the ET sensors should be compared more thoroughly to other ET estimation methods (e.g. OpenET, CIMIS, etc.). Uncertainty in the ET estimates should be described and quantified, as well as the uncertainty in the type of water being utilized by the Mesquite trees (e.g., soil moisture vs. aquifer).

Historical Precipitation Trends

The UCI GDE Study states that Mesquite trees are facultative phreatophytes meaning that they can utilize both surface water and groundwater. To better understand how surface water availability to the BS Mesquite Bosque has changed over time, the study assessed historical trends in precipitation using monthly data downloaded from PRISM over the period September 1981 to December 2024.

Between 1981 and 2024, total WY precipitation in the Borrego Springs study area averaged 102.5 mm (4.03 in) with about 70 percent falling during the December - March winter rainy season. Much of the remaining rainfall occurs during the July - September summer growing season. The rainy seasons are separated by dry periods, with the May - June dry period typically the driest. See Figure 3.2 from the report (below).

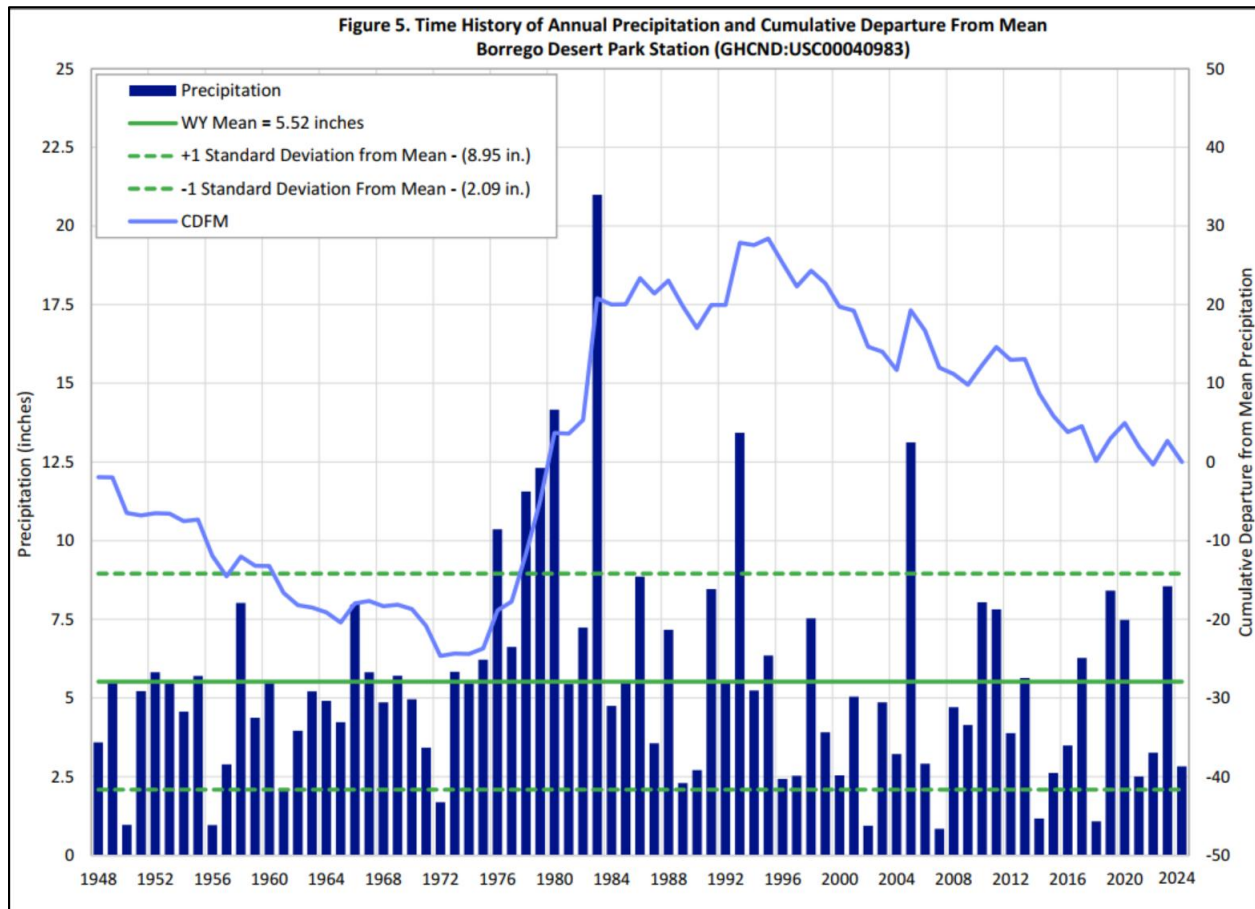


The UCI GDE Study concluded that there have not been dramatic declines in precipitation which might explain the decline in the extent and health of the BS Mesquite Bosque, and that the trend towards lower water year precipitation is not statistically significant.

Technical Consultant Assessment and Recommendations:

- **BAS determination: Not Met**
 - We disagree that the declining trend in precipitation over the last few decades is not statistically significant. Figure 5 (below) is a plot from the Watermaster's most recent annual report, which illustrates WY precipitation totals, the long-term annual mean precipitation and standard deviation from the mean, and the cumulative departure from mean (CDFM) precipitation for WYs 1948 to 2025. The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods (relative to the mean): positive sloping segments (trending upward from left to right) indicate wet periods, and negative sloping segments (trending downward from left to right) indicate dry periods. As shown by the CDFM curve on Figure 5, the region has been experiencing a 30-year dry period since 1995, punctuated by a few wet years.

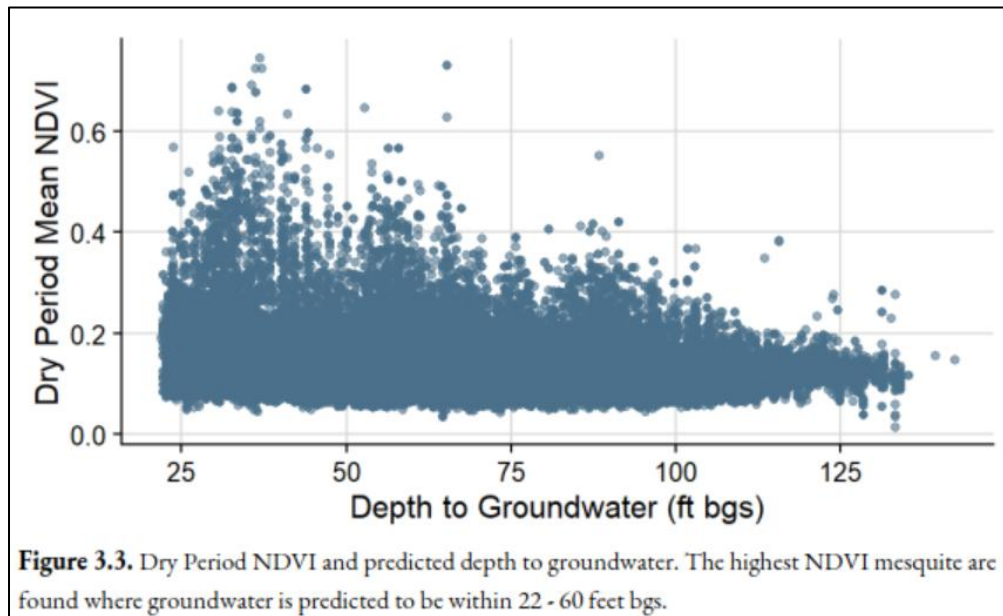
- In our experience of monitoring GDEs in other groundwater basins, annual precipitation can influence NDVI signatures of the vegetated areas.
- **Recommendation:**
 - Climatic data (e.g., precipitation and temperature) should be compared against NDVI data over time to better understand the relationship between climate and the health/extent of the BS Mesquite Bosque.

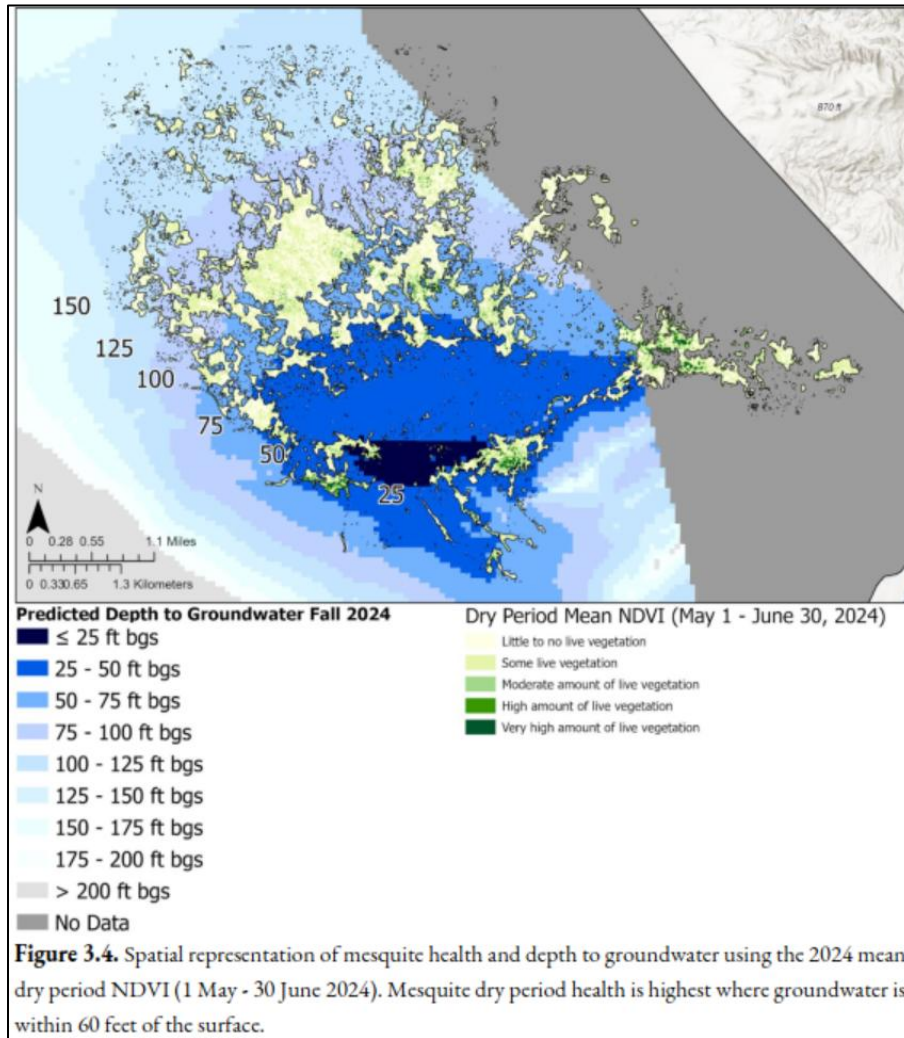


Considering GDEs in Minimum Thresholds

The UCI GDE Study explored a “thought experiment” for setting minimum thresholds for groundwater levels near the BS Mesquite Bosque to protect its access to groundwater, and hence, its extent/health. The study calculated the mean NDVI across the BS Mesquite Bosque during the dry season (1 May – 30 June 2024) and analyzed its relationship to depth-to-groundwater in 2024.

The study results indicated that the highest NDVI values occurred where groundwater depths ranged from approximately 22 to 60 ft-bgs. In contrast, NDVI values declined substantially at depths greater than 60-75 feet bgs, suggesting that Mesquite tree health is impaired beyond this range—likely due to reduced access to groundwater. See Figures 3.3 and 3.4 from the report (below).





Technical Consultant Assessment and Recommendations:

- **BAS determination: Not Met**
 - Figure 3.4 indicates that the more healthy, dense stands of Mesquite trees occur directly surrounding the Borrego Sink. This spatial pattern of healthy Mesquite trees is likely due to greater access to the various water sources in these areas, including:
 - Relatively shallow depth to the regional groundwater table and its capillary fringe.
 - Relatively abundant stormwater runoff that preferentially accumulates in the Borrego Sink area and percolates to the underlying soils.
 - Both above.
 - **Data Gaps:** Currently, there are too many data gaps to establish numeric minimum thresholds for groundwater levels, including:
 - *A paucity of measured depth to the groundwater table and its capillary fringe.* As noted earlier in this memorandum, depth to the regional groundwater table is not accurately known in some areas of Figure 3.4. This is particularly true in the areas of the healthiest stands of Mesquite trees surrounding the Borrego Sink due to a lack of monitoring wells. In addition, the thickness of the capillary fringe above the

groundwater table is unknown, which the report claims is the primary water source available for root uptake.

- *Knowledge of the maximum depth and growth rates for Mesquite tree tap roots.* The evidence strongly indicates that the historical rates and magnitudes of groundwater-level declines caused widespread Mesquite tree mortality. However, the current rates of groundwater-level declines have slowed due to the pumping Rampdown and are anticipated to stabilize in the future. If the Mesquite trees in this area are indeed still a GDE, certain information is not currently known with the necessary certainty to establish numeric minimum thresholds for groundwater levels, including:
 - The rate of decline in groundwater levels that the tap roots can follow downward without compromising Mesquite tree health.
 - The maximum depth that the Mesquite trees can extend their tap roots to access the capillary fringe of the regional aquifer.
- *The role of soil moisture as a water source for the Mesquite trees.* As noted earlier in this memorandum, the study did not explore or document the soil texture, moisture content, and isotopic water chemistry in the soil profile below 5 ft-bgs. This source of water could be supporting the remaining healthy stands of Mesquite trees regardless of the depth to the regional aquifer.
- *Recommendation:*
 - Minimum thresholds for groundwater levels are not recommended at this time until the data gaps described above are sufficiently filled.

Mesquite Bosque Health and Ecological Condition Assessment

The UCI GDE Study used NDVI as an indicator of Mesquite tree health and gross primary productivity (GPP). The study calculated cumulative annual NDVI for all pixels in the BS Mesquite Bosque polygon (~1,850 acres) and compared it with the cumulative annual NDVI for pixels in the CDL Mesquite Bosque (~227 acres) as a reference to a likely GDE over the period WY 2019-2024.

The results of the NDVI analysis were categorized into areas of high, medium, and low vegetative productivity by year. See Table 3.2 of the report (below).

Table 3.2. Mesquite productivity acreage. Summary of total acreage found in each productivity category for Borrego Springs (BS) and Clark Dry Lake (CDL) for the 2019 - 2024 water years.

Year	High Productivity (Acres)	Moderate Productivity (Acres)	Low Productivity (Acres)
Borrego Springs			
2019	329.34	998.28	889.94
2020	302.92	1,037.42	877.22
2021	117.03	1,134.47	966.06
2022	94.30	760.48	1,362.77
2023	99.29	829.82	1,288.45
2024	82.23	589.61	1,545.73
Clark Dry Lake			
2019	138.47	107.57	26.06
2020	143.58	105.99	22.53
2021	136.30	110.16	25.64
2022	132.24	103.15	36.70
2023	132.34	99.98	39.77
2024	136.81	99.71	35.57

The main conclusions of the analysis were:

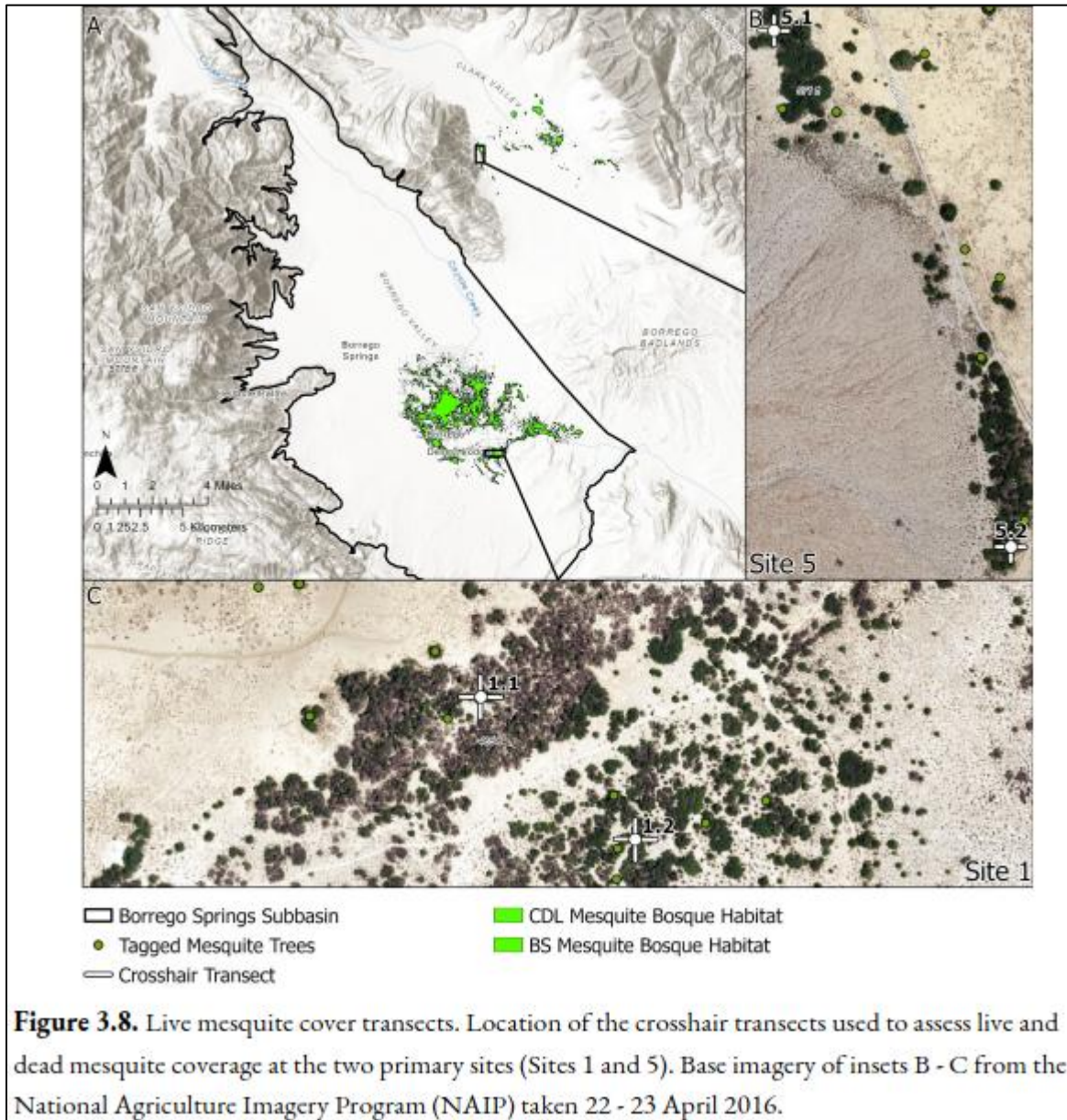
- In 2023, the BS Mesquite Bosque was relatively less productive than CLD Mesquite Bosque.
- In 2024, an extremely dry year, the BS Mesquite Bosque experienced significant declines in productivity. In contrast, CDL Mesquite Bosque showed relatively stable productivity.
- Across 2019-2024, the BS Mesquite Bosque exhibited a consistent decline in the acreage of high and moderate productivity vegetation, aligning with reports of widespread Mesquite decline and mortality, while the CDL Mesquite Bosque remained stable.
- The decline in the BS Mesquite Bosque productivity reflects its high susceptibility to decreasing groundwater levels and suggests a corresponding reduction in the ecosystem services provided.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - We agree that the NDVI data from 2019-2024 indicate:
 - A degrading trend in the productivity of the BS Mesquite Bosque (in aggregate), while groundwater levels gradually declined.
 - A stable trend in the productivity of the CDL Mesquite Bosque (in aggregate), while groundwater levels remained relatively stable.
 - However, we disagree with the study's conclusion that declining groundwater levels are necessarily the cause of the declines in NDVI for the following reasons:
 - Climatic factors were not considered in the analysis. Water years 2021, 2022, and 2024 were relatively dry years in the Basin.
 - The declines in NDVI could be explained by:
 - The gradual declines in groundwater levels are reducing BS Mesquite Bosque access to the regional groundwater table.
 - The tap roots of the BS Mesquite trees are already detached from the regional aquifer and are surviving on comparatively less abundant soil moisture during the "dry" years from 2019-2024.
 - Or, both processes are occurring in various locations to various degrees.
 - The significant declines in NDVI in the BS Mesquite Bosque during dry years (2021, 2022, and 2024), while the NDVI of the CDL Mesquite Bosque remained stable, may be indicating the reliance of the BS Mesquite Bosque on surface water to replenish soil moisture, which was low in these dry years.
- *Recommendations:*
 - NDVI analyses should be performed over space and time and then be compared against all the stressors that can affect the BS Mesquite Bosque (e.g., changes in groundwater levels, precipitation, temperature, pests, etc.).

Field Assessments of Live and Dead Trees

The UCI GDE Study surveyed live and dead Mesquite trees at BS Site 1 and CDL Site 5. See Figure 3.8 of the report (below).



The results of the surveys were:

- At BS Site (Site 1.1): ten living trees and nine dead trees.
- At BS Site (Site 1.2): ten living trees and zero dead trees.
- At CDL sites (Site 5.1 and 5.2): nine and twelve living trees at the two sampling and zero dead trees.

The report claims that these findings highlight the negative effects of declining groundwater levels on the BS Mesquite Bosque near the Borrego Sink. However, the report notes that there is spatial variability in the health of Mesquite trees across the BS Mesquite Bosque, with some remaining healthy stands, but that these trees may be subject to future stress if groundwater levels continue to decline.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - Figure 3.8 from the report (above) illustrates the presence of dead Mesquite trees at BS Site 1. And we agree that the available evidence indicates that historical widespread Mesquite tree mortality across the BS Mesquite Bosque was due, at least in part, to historical overdraft of the Basin and the associated declines in groundwater levels.
 - However, Figure 3.8 from the report (above) shows stands of dead Mesquite trees directly adjacent to stands of live Mesquite trees. This observation raises challenges with the study conclusions that the BS Mesquite Bosque is a GDE that is being adversely impacted by declining groundwater levels:
 - If Site 1 of the BS Mesquite Bosque is a GDE with access to the regional aquifer, should we expect to see continuous stands of live Mesquite trees, rather than the “patchwork” of live and dead trees shown on Figure 3.8? Or,
 - Does the “patchwork” of live and dead trees indicate that the Mesquite trees are disconnected from the regional aquifer and instead are accessing surface water and soil moisture that is only available in certain areas of surface water flow and/or the requisite underlying hydrogeology that preferentially retains soil moisture?
- *Recommendations:*
 - Periodic field monitoring of Mesquite tree health is a useful method to spot check and verify the results from remote-sensing methods of vegetation monitoring (e.g., NDVI, air photos, etc.).

Quantification of Mesquite Groundwater Transpiration

The UCI GDE Study included an effort to understand the volumes of groundwater ET (ET_{gw}) that support the BS Mesquite Bosque, so that it can be appropriately included in the water budget of the Borrego Springs Subbasin. The report describes estimates of ET_{gw} derived from OpenET, followed by a validation of OpenET estimates using available data from ET sensors that were installed during the study.

Annual ET_{gw} for the BS Mesquite Bosque was estimated using OpenET data from 2015 to 2023 using a simplified water balance equation:

$$ET_{gw} = Total\ ET - Precipitation\ (P)$$

OpenET integrates remote-sensing data, such as vegetation indices (e.g., NDVI) and land surface temperature, with climate variables, including temperature, humidity, and solar radiation, to estimate ET. OpenET was used to estimate monthly ET for both the BS and CDL Mesquite Bosque areas over WY 2015 to 2023. See Table 3.6 from the report (below).

Table 3.6. Groundwater transpiration estimates. Estimates of groundwater transpiration (ET_{gw}) for the Borrego Springs and Clark Dry Lake mesquite bosque habitats, as calculated by each OpenET model from 2015-2023. See <https://ctdata.org/methodologies/> for more information about each model.

	Model	Ensemble-mean	DisALEXI	ceMETRIC	geeSEBAL	PT-JPL	SIMS	SSEBop	Model Averages
Site	Water Year	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)
Borrego Springs	2015	547.22	349.84	198.09	1,072.90	1,028.81	29.20	434.34	522.91
	2016	339.55	197.32	136.17	565.89	1,100.21	14.72	259.15	373.29
	2017	446.97	408.98	94.83	870.27	1,252.09	3.71	286.86	480.53
	2018	770.49	455.24	320.57	1,099.89	1,332.75	12.03	667.94	665.56
	2019	175.47	167.74	39.12	301.43	1,096.31	5.63	188.00	281.96
	2020	261.52	219.58	88.56	379.61	767.27	9.90	459.42	312.27
	2021	597.53	354.57	238.76	896.17	1,081.24	14.53	605.59	541.20
	2022	490.31	174.09	273.14	761.65	1,076.15	7.41	397.87	454.37
	2023	130.34	64.29	39.30	564.62	752.61	5.86	136.45	241.92
								All-year Average	430.45
	Model	Ensemble-mean	DisALEXI	ceMETRIC	geeSEBAL	PT-JPL	SIMS	SSEBop	Model Averages
Site	Water Year	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)	Total ET_{gw} (ac-ft/yr)
Clark Dry Lake	2015	70.37	54.97	32.96	115.32	186.80	0.64	20.06	68.73
	2016	48.70	36.74	20.90	78.53	194.02	1.02	10.35	55.75
	2017	58.13	59.65	23.01	100.81	215.96	1.11	10.59	67.04
	2018	104.23	71.07	37.62	133.20	241.93	6.29	43.92	91.18
	2019	28.81	19.73	10.40	56.73	194.81	0.76	9.28	45.79
	2020	56.10	60.32	27.42	81.83	188.10	0.89	34.32	64.14
	2021	84.70	43.37	41.74	117.77	214.27	2.19	49.43	79.07
	2022	61.15	30.05	34.42	76.74	220.20	2.14	18.94	63.38
	2023	23.81	13.50	9.16	57.77	165.47	1.53	5.16	39.49
								All-year Average	63.84

To validate the OpenET estimates of ET_{gw} , the study used direct measurements from ET sensors installed in both the BS and CDL Mesquite Bosque areas from May 2024 to April 2025, and using the same water balance equation above, the study calculated ET_{gw} using the ET sensor data and PRISM precipitation records.

The main results and conclusions of this effort were:

- *BS Mesquite Bosque*: OpenET estimated 242 to 666 afy of ET_{gw} , with an average of 430 afy. The ET sensor method estimated 719 afy which indicates that OpenET is substantially underestimating ET for the BS Mesquite Bosque.
- *CDL Mesquite Bosque*: OpenET estimated 39 to 91 afy of ET_{gw} , with an average of 64 afy. The ET sensor method estimated 365 afy which indicates that OpenET is substantially underestimating ET for the CDL Mesquite Bosque.
- The study recommends allocating at least 645 afy of groundwater use to the BS Mesquite Bosque in the Subbasin water budget, and potentially more, as improved data become available. This estimate is based on the all-year, all-model average (430.45 afy) plus a 50 percent error margin (215.23 afy), resulting in a total of 645.68 afy, rounded to 645 afy for simplicity.

Technical Consultant Assessment and Recommendations:

- ***BAS determination: Partially Met***
 - We agree that the estimates of total ET in the study indicate that the BS and CDL Mesquite Bosques are using significantly more water than is provided by direct precipitation, and that the main source of water needed to support the ET demands of the Mesquite trees is stored in the subsurface.
 - The study methods employed to estimate ET_{gw} ignored the potential role of soil moisture in the vadose zone as a water source that is satisfying at least a portion of the ET_{gw} demands of the Mesquite trees. Soil moisture could be fed by the infiltration of precipitation and stormwater runoff that accumulates within the BS Mesquite Bosque area. Hence, the estimates of ET_{gw} in the study likely represent a maximum upper limit of what the BS Mesquite Bosque is using from the regional aquifer system.
 - The study methods ignore the ET demands of other non-Mesquite vegetation within the Mesquite Bosque areas.
- ***Recommendations:***
 - Continue the monitoring and estimation of ET of the BS Mesquite Bosque. Estimates of ET of the BS Mesquite Bosque (including the estimates in this study and future estimates) are valuable to the Watermaster because they can be used to constrain future BVHM updates and recalibrations and more accurately simulate the BS Mesquite Bosque area and the water budget of the Basin. However, additional consideration and analyses should be performed to address the following:
 - OpenET estimates of ET are derived from six different OpenET models plus an “ensemble mean.” More expert analysis is necessary to choose the OpenET models best suited for estimating ET in natural desert environments.
 - Consideration should be given for the potential role of soil moisture in satisfying at least a portion of the ET demands of the Mesquite Bosque areas.
 - Consideration should be given to the ET demands of other non-Mesquite vegetation within the Mesquite Bosque areas.

Chronic Lowering of Groundwater Levels

The UCI GDE Study assessed rates/trends in historical changes in groundwater levels at wells near the BS Mesquite Bosque and CDL Mesquite Bosque for pre- and post-SGMA periods. See Figure 4.1 from the report (below) for the well locations where historical groundwater-level data were analyzed. See Table 4.2 from the report (below) which describes the results of the analysis.

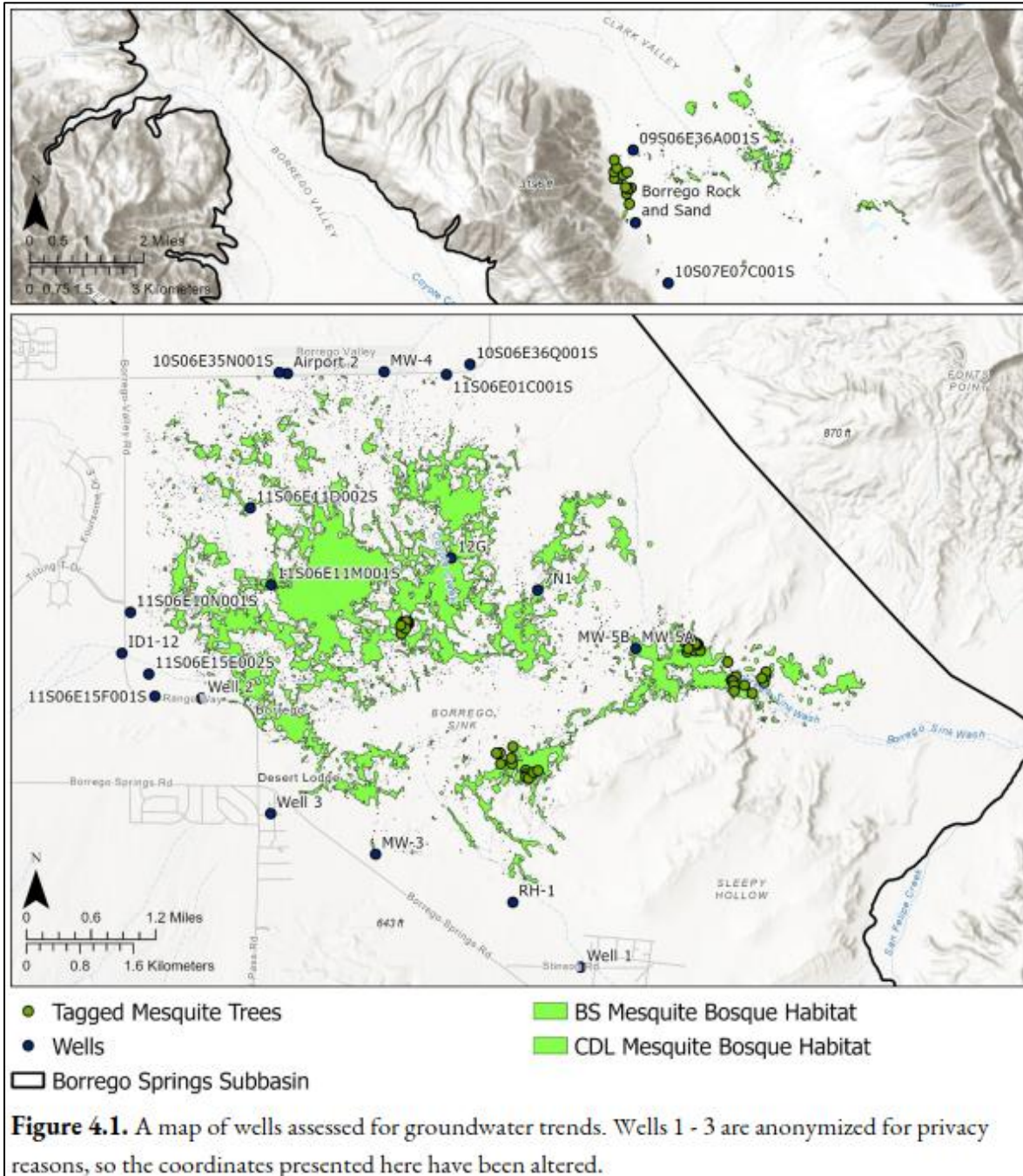


Table 4.2. Groundwater depth rate of change. For those wells with greater than 10 data points, we ran linear regressions assessing the change in depth to groundwater over time. The slope in feet/day (Slope ft/day) column indicates the slope derived from the linear regression while the slope in feet per year and feet per decade have been calculated. A bolded p-value indicates a significant relationship between the depth to groundwater and time at a significance level of 0.05.

State Well Number	Local Well Name	Slope (ft/day)	Slope (ft/year)	Slope (ft/decade)	P-value	R ²
Borrego Springs						
Long-Term Trends (mid-1950s to mid-2000s)						
10S06E35N001S	10S06E35N001S	-0.0032	-1.18	-11.85	> 0.001	0.35
10S06E36Q001S	10S06E36Q001S	-0.0019	-0.70	-7.00	> 0.001	0.45
11S06E10N001S	11S06E10N001S	-0.0032	-1.18	-11.79	> 0.001	0.91
11S06E11D002S	11S06E11D002S	-0.0012	-0.42	-4.23	> 0.001	0.18
11S06E11M001S	11S06E11M001S	-0.0034	-1.23	-12.35	> 0.001	0.87
11S07E07N001S	7N1	-0.0020	-0.72	-7.20	> 0.001	0.92
SMGA-Period Trends (2015 to 2024)						
11S06E01C001S	11S06E01C001S	-0.0043	-1.57	-15.66	> 0.001	0.993
11S06E23J002S	MW-3	-0.0053	-1.94	-19.37	> 0.001	0.594
10S06E35Q001S	MW-4	-0.0037	-1.37	-13.68	> 0.001	0.999
11S07E07R001S	MW-5A	-0.0016	-0.59	-5.94	> 0.001	0.879
11S07E07R002S	MW-5B	-0.0015	-0.55	-5.54	> 0.001	0.976
NA	Well 1	-0.0011	-0.41	-4.09	0.21	0.974
NA	Well 2	-0.0014	-0.51	-5.06	> 0.001	0.976
NA	Well 3	-0.0005	-0.20	-1.97	0.94	0.0004
Clark Dry Lake						
Long-Term Trends (mid-1950s to mid-2000s)						
09S06E36A001S	09S06E36A001S	0.000227800	0.08314700	0.8314700	> 0.001	0.87

The main results and conclusions of the analysis were:

- Historical declines in groundwater levels were greatest near the BS Mesquite Bosque, primarily due to over-pumping of the Borrego Springs Subbasin.
- Historical declines in groundwater levels were much less near the CDL Mesquite Bosque and were likely due to periods of relatively dry hydrology.
- The high rates and magnitudes of groundwater declines indicate a high likelihood that these declines are responsible for the past and current adverse impacts on the BS Mesquite Bosque.
- The adverse impacts to the BS Mesquite Bosque will continue in the absence of actions to reduce groundwater declines.

Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - We agree with the observations that historical groundwater-level declines have been substantial, and that these declines have been responsible for adverse impacts to the BS Mesquite Bosque which was once a thriving GDE.
 - We disagree with conclusion of the study that current declines in groundwater levels are responsible for current trends in degradation of the BS Mesquite Bosque. There are other alternative explanations, such as the recent relatively dry climate that could be adversely affect Mesquite trees that do not have access to the regional aquifer system.
- **Data Gap:**
 - There are not enough monitoring wells and groundwater-level data for a current assessment of the effects of ongoing/future groundwater-level declines on the extent/health of the BS Mesquite Bosque—particularly in the focused areas of study (Sites 1, 3, 4).
- **Recommendations:**
 - The Watermaster is already implementing the pumping rampdown (and is substantially ahead of schedule) to stabilize groundwater levels across the Basin. The Watermaster should continue these efforts to stabilize groundwater levels and continue its current groundwater-level monitoring program to track its progress towards groundwater-level stabilization.
 - Construct new monitoring wells near Sites 1, 3, and 4 and conduct a monitoring program to fill the Data Gap described above. A monitoring well at Site 4 would be the highest priority because depth-to-groundwater is likely the deepest at Site 4, hence, if groundwater dependency is demonstrated at Site 4, then it is also likely demonstrated at Sites 1 and 3. In addition, Site 4 is closer to the main areas of pumping in the Basin. Drilling, construction, and subsequent monitoring of the monitoring wells could be used to:
 - Characterize the soil profile from the ground surface to/through the saturated zone, including the presence or absence of “perched” groundwater conditions.
 - Characterize soil moisture and isotopic water chemistry across the vadose zone.
 - Inspect the vadose zone and saturated zone for evidence of live Mesquite tree roots.
 - Track seasonal and long-term changes in soil moisture (using installed sensors) across the entire thickness of the vadose zone.
 - Collect groundwater samples from the water table to characterize its isotopic chemistry for comparison to the isotopic chemistry of the Mesquite trees and soil moisture, which could better describe the source waters that support the Mesquite trees.
 - Track changes in groundwater levels over time compared to Mesquite tree health. Such data would be useful at the site level, as well as at the regional level, to:
 - Assist in preparing more accurate rasters of depth-to-groundwater across the BS Mesquite Bosque.
 - Assist in understanding the current and ongoing cause-and-effect relationship between groundwater-level changes and Mesquite tree health.

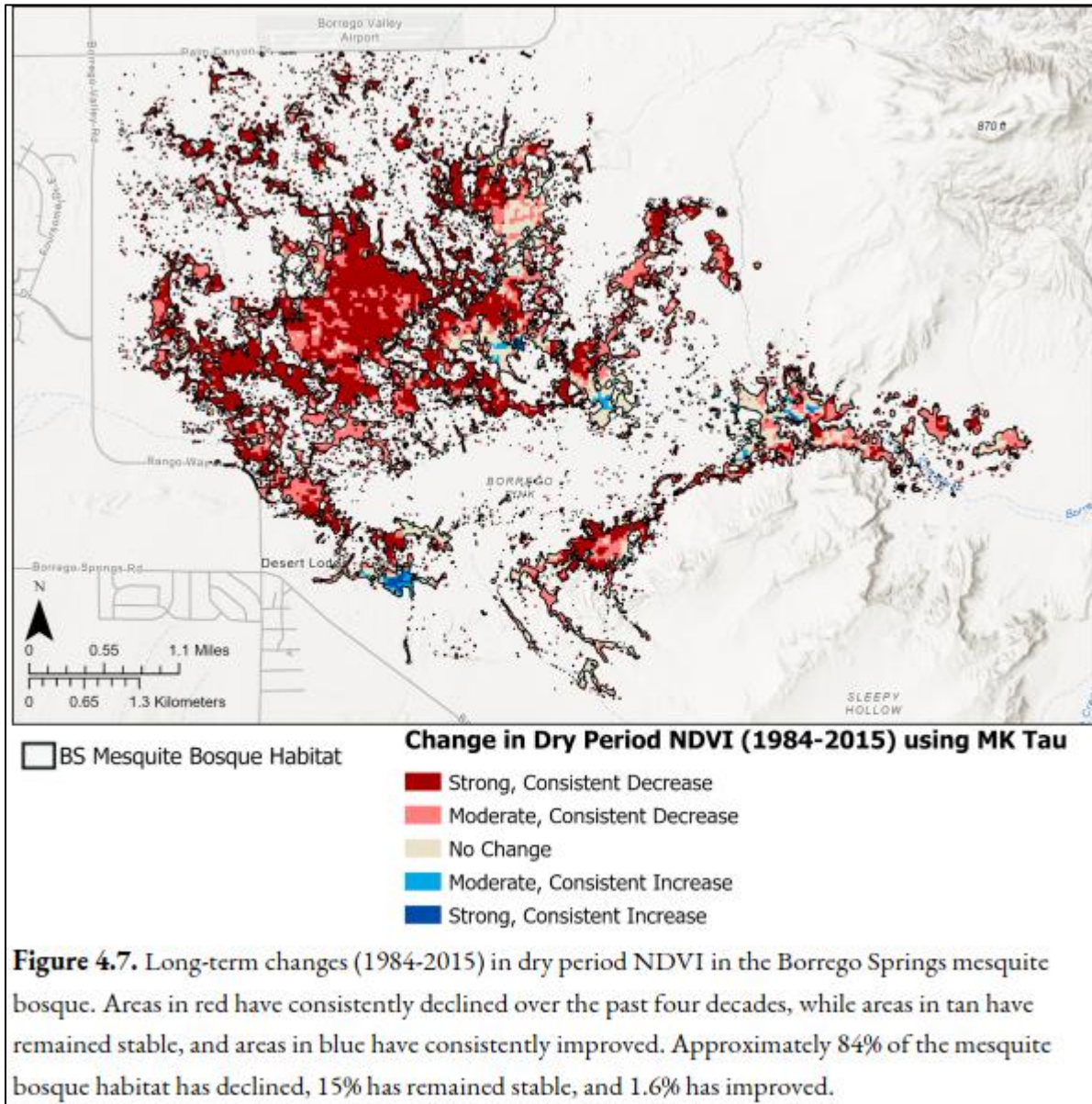
Changes in Mesquite Bosque Health

The UCI GDE Study assessed long-term trends in Mesquite Bosque health in relation to groundwater levels by analyzing annual average NDVI over the dry season (May 1-June 30) for (i) the pre-SGMA period of 1984-2015 and (ii) the post-SGMA period of 2015-2024. The dry season was chosen for the analysis because surface water is not typically available during these months, and hence, groundwater availability will be detected.

Trends in NDVI over each period were calculated/analyzed using the Mann-Kendall's Tau (MK Tau) statistical test to detect gradual, persistent shifts in vegetation health that could be obscured by short-term fluctuations in climate or other environmental factors.

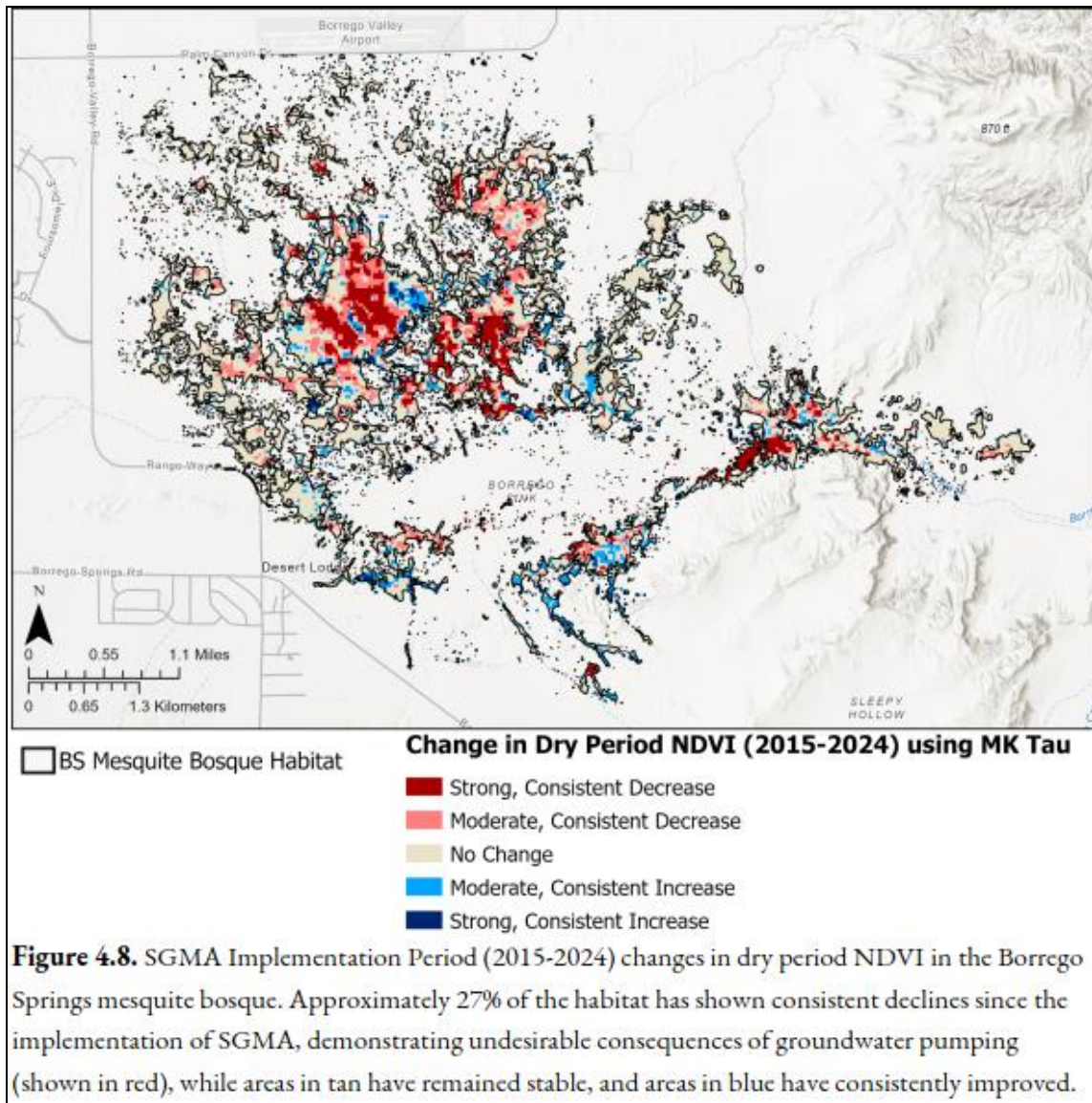
The main results and conclusions of the analysis were:

- **For the pre-SGMA period of 1984-2015:**
 - 1.6 percent of the BS Mesquite Bosque improved, 15 percent remained stable, and 83 percent declined, while groundwater levels declined by about 45 ft (~1.5 ft/yr). See Figure 4.7 from the report (below).
 - Across most of the BS Mesquite Bosque, NDVI declines were widespread and aligned with declining groundwater levels and documented reports of Mesquite die-off, particularly in areas affected by human disturbance.
 - The areas of NDVI stability and improvement in the BS Mesquite Bosque coincide with current strongholds of healthy Mesquite habitat, particularly around the Borrego Sink, where groundwater is closer to the surface, and near the WWTP percolation ponds.
 - In comparison, 19 percent of the CDL Mesquite Bosque improved, 47 percent remained stable, and 34 percent declined, while groundwater levels declined by about 3 ft (~0.1 ft/yr).



- **For the post-SGMA period of 2015-2024:**
 - 12 percent of the BS Mesquite Bosque improved, 61 percent remained stable, and 27 percent declined, while groundwater levels continued to decline but at reduced rates. See Figure 4.8 from the report (below).
 - The NDVI decline was widespread and aligned with declining groundwater levels.
 - The areas of NDVI stability and improvement coincide with current strongholds of healthy mesquite habitat, particularly around the Borrego Sink, where groundwater is closer to the surface, and near the percolation ponds of the WWTP.
 - In comparison, 64 percent of the CDL Mesquite Bosque improved, 33 percent remained stable, and 3 percent declined, while groundwater levels continued to gradually decline.
 - Other factors also contributed to the NDVI declines: human development, Mesquite removal, soil disturbances/erosion, off-road traffic, climate change, disease, and pests.

- The most significant NDVI declines align with areas of substantial human disturbance and groundwater-level reductions, indicating that many Mesquite trees may have lost access to groundwater over the past 40 years.
- While sustainable groundwater management is critical, mesquite bosque conservation is also needed to address broader environmental threats.
- To mitigate further groundwater disconnection and address the compounding threats, the study recommends establishing minimum thresholds for groundwater levels at wells near the BS Mesquite Bosque and implementing conservation measures to protect healthy, stable Mesquite areas.



Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - We agree that this analysis indicates that groundwater-level declines during the pre-SGMA period (1984-2015) were largely responsible for the declines in NDVI and widespread die-off of Mesquite trees, based on the following:
 - Historically, groundwater levels were much closer to the ground surface, and hence, likely available to Mesquite tree roots.
 - 1978-83 and the 1990s were relatively wet periods, such that the BS Mesquite Bosque had greater access to precipitation and runoff, yet the BS Mesquite Bosque still experienced degradation.
 - The rates and magnitudes of groundwater-level declines were relatively high (~1.5 ft/yr), which may have been too fast for the tap roots to follow.
 - NDVI decreases were widespread, except in areas of surface water availability, such as the WWTP ponds and the Coyote Creek floodplain.
 - The analysis does not necessarily confirm that groundwater-level declines during the post-SGMA period (2015-2024) were responsible for the concurrent declines in NDVI, based on the following:
 - The high rates/magnitudes of historical groundwater-level declines in the pre-SGMA period (1945-2015) may have detached most of the Mesquite tree roots from the regional groundwater table.
 - The patterns of NDVI increases and decreases are “patchy” across the BS Mesquite Bosque, which is inconsistent with the proposed cause of regional declines in regional groundwater levels.
 - The “patchy” patterns of change in NDVI may be more consistent with site-specific availability (or lack thereof) of surface water, soil moisture, and/or perched groundwater, which all would be controlled by the surface water flow patterns and the underlying hydrogeology.
 - 2015-2024 was a relatively dry period, which could be responsible for stressing the Mesquite trees (and other non-Mesquite vegetation within the bosque) that cannot readily access regional groundwater table (i.e., areas of decreasing NDVI).
 - It is premature to establish minimum thresholds for groundwater levels at wells for the following reasons:
 - The current state of knowledge does not conclusively prove that the Mesquite tree roots are accessing the regional groundwater table. There are other plausible sources of water that could be supporting the remaining Mesquite trees (percolating surface water runoff, deep soil moisture, and perched groundwater). These other potential sources of water should be better characterized and understood before setting minimum thresholds for groundwater levels.
 - The current rates of groundwater-level decline are slowing due to the pumping Rampdown. If the BS Mesquite Bosque is indeed a GDE, it is possible that the tap roots could follow the declining groundwater table and its capillary fringe under the reduced rates of decline.

- Implementing other conservation efforts is logical, as outlined in the study. Irrigation with wastewater and/or groundwater is a viable mitigation measure that could be explored.
- *Recommendations:*
 - NDVI analysis using Landsat-derived NDVI data (1984-2025) should be performed at specific cells (or groups of cells) where the Mesquite trees in BS Mesquite Bosque were once or are currently dense, so that other non-mesquite vegetation is screened out. Time-series charts should be prepared for these focused areas to compare the changes in NDVI vs. all factors that could influence the health of the Mesquite trees, such as: changes in groundwater levels; temperature; precipitation; surface water inflows; etc. This analysis may better describe the most relevant factors that have affected the BS Mesquite Bosque over time.
 - Other factors that could have also contributed to the decline of BS Mesquite Bosque need to be better characterized and mapped relative to the changes in NDVI, such as: areas of human development; areas where Mesquite trees were removed; areas of soil disturbances, erosion, and off-road traffic; diseases; and pests.

Perched Aquifer Evaluation

The UCI GDE Study evaluated the hypothesis that that “perched groundwater” conditions beneath the BS Mesquite Bosque support its ET demands, rather than the deeper regional aquifer system. The evidence evaluated included: well driller’s logs, AEM surveys, soil moisture data of the top 5 ft of soil profile, and historical groundwater-level monitoring data. The study concluded that perched groundwater conditions do not exist beneath the BS Mesquite Bosque.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Not Met*
 - Perched groundwater conditions have been documented to exist in the vicinity of the BS Mesquite Bosque—specifically, in the vicinity of the BWD WWTP percolation ponds as demonstrated by the geologic and water-level data derived from BWD monitoring wells.
 - The interpretations of the AEM survey resistivity profiles were incorrect. The report incorrectly states that high-resistivity zones in the AEM survey profiles indicate clay-rich layers, when in practice, clay-rich layers have low-resistivity signals. As such, the AEM surveys support the existence of fine-grained layers beneath the BS Mesquite Bosque.
 - The soil moisture data provided in the report is only relevant for the upper 5 ft of soil profile. The depth interval from 5 ft-bgs to the capillary fringe above the regional aquifer has not been physically explored for the existence of perched groundwater conditions, except in the vicinity of the BWD WWTP percolation ponds.
 - Well driller’s logs are sparse across the MS Mesquite Bosque, and the borehole sediment descriptions on such logs are typically of low resolution and poor quality.
 - Water-level data measured at wells are typically not capable of indicating the presence/absence of perched groundwater conditions because these wells are screened across the saturated zone (not vadose zone where perched groundwater conditions can develop).
- *Data Gap:*
 - The soil profile (texture, moisture content and chemistry) from 5 ft-bgs to the capillary fringe has not been explored, monitored, or characterized as a potential water source that supports the BS Mesquite Bosque. Monitoring of this potential water source has been virtually absent, except for at the BWD WWTP wells and the soil moisture monitoring in the study to a depth of 5 ft-bgs. This represents a significant gap in understanding that should be filled before making groundwater management decisions.
- *Recommendations:*
 - The Data Gap described above could be filled through the installation of a new monitoring well(s) in the BS Mesquite Bosque. This work could include:
 - Characterization of the soil profile from the ground surface to/through the saturated zone, including the presence or absence of “perched” groundwater conditions.
 - Collection of soil samples to analyze for soil moisture and isotopic water chemistry across the vadose zone.
 - Inspection of the vadose zone for evidence of live Mesquite tree roots.
 - Installation and monitoring of soil moisture sensors across the entire thickness of the vadose zone to track seasonal and long-term changes in soil moisture.

Monitoring Recommendations

The UCI GDE Study Report included various recommendations for future hydrologic and biologic monitoring of the BS Mesquite Bosque, including:

- Monitoring of groundwater levels at key wells within the BS Mesquite Bosque:
 - MW-5A/B
 - 11S06E12G001S (last measured in 2009)
 - 11S06E11D002S (last measured in 2009)
 - 11S06E11M001S (last unsuccessful attempt to measure was 2009)
- Tracking groundwater-level changes by preparing annual depth-to-groundwater rasters, which could be used to inform adaptive management responses if declining trends are observed near the BS Mesquite Bosque.
- Monitoring of the vegetation health in the BS Mesquite Bosque via remote-sensing:
 - Cumulative NDVI across the water year will provide the most accurate depiction of overall productivity and health of the BS Mesquite Bosque.
 - Mean NDVI across the dry season (May 1 - June 30) will provide the most accurate depiction of Mesquite health during peak groundwater use.
 - Evaluating Mesquite performance alongside changes in groundwater depth is essential for adaptive management of the system.
- Monitoring of live and dead Mesquite tree cover by field surveys:
 - Conduct surveys every 2-3 years
 - Use survey results to validate NDVI
- Monitoring ET demands of the BS Mesquite Bosque with ET sensors:
 - Collect data every 3-5 months
 - Use results to track changes in water uptake over time
- Monitoring of biodiversity within the BS Mesquite Bosque to track the secondary effects of Mesquite degradation.
- Monitoring of Mesquite age class distributions and recruitment to assist in developing restoration priorities.

Technical Consultant Assessment and Recommendations:

- *BAS determination: Partially Met*
 - We believe the totality of the study indicates that the BS Mesquite Bosque could, at least in part, be dependent on the regional aquifer system. Hence, we believe that hydrologic/biologic monitoring of the BS Mesquite Bosque over time should be performed for the following reasons:
 - The monitoring results will improve the understanding the relationship (or lack thereof) between changes in groundwater levels and the health of the BS Mesquite Bosque.
 - The monitoring results could inform adaptive management strategies to protect the BS Mesquite Bosque, if necessary.
 - However, we suggest monitoring methods that are somewhat different than those recommended in the UCI GDE Study Report (see Recommendations below).

- *Recommendations:*
 - The Watermaster should consider the development of a *Monitoring Work Plan for the BS Mesquite Bosque*. The monitoring work plan could include the following:
 - The Watermaster has identified BS Mesquite Bosque area of the Basin as a “gap” in its groundwater monitoring program and has made efforts to identify existing wells in this area to add to its groundwater monitoring network. Most of these efforts have been unsuccessful; however, the Watermaster recently added a private domestic well to the monitoring network just west of the Borrego Sink in Old Borrego (Broom Well). Depth to groundwater at Broom Well was about 80 ft-bgs in October 2025. Additional existing wells could be identified and monitored—particularly in areas near the healthy stands of Mesquite trees surrounding the Borrego Sink where depth-to-groundwater is the shallowest and groundwater dependency of the Mesquite trees is most possible.
 - New monitoring wells could be constructed near Sites 1, 3, and 4 with a subsequent monitoring program. Site 4 would be the highest priority because depth-to-groundwater at Site 4 is likely deeper than at Sites 1 and 3, and Site 4 is closer to the main areas of pumping in the Basin. Drilling, construction, and subsequent monitoring of the monitoring wells could be designed and used to:
 - Characterize the sedimentary composition and texture of the soil profile from the ground surface to/through the saturated zone.
 - Check for the presence or absence of “perched” groundwater conditions.
 - Collect soil samples and analyze soil moisture and isotopic water chemistry across the vadose zone and capillary fringe.
 - Inspect the borehole sediments through the vadose zone and capillary fringe for evidence of live mesquite tree roots.
 - Install soil moisture sensors across the vadose zone and capillary fringe to track seasonal and long-term changes in soil moisture.
 - Collect groundwater samples from the saturated zone to characterize its isotopic chemistry for comparison to the isotopic chemistry of the Mesquite trees and soil moisture, which could better describe the source waters that support the Mesquite trees.
 - Maps of annual changes in groundwater levels could be prepared to illustrate where groundwater levels are declining relative to the BS Mesquite Bosque. These maps are already prepared as interim work products for the annual change-in-storage calculations for the SGMA annual report. That said, monitoring wells are sparse within the BS Mesquite Bosque, so such maps should be classified as rough approximations. The new monitoring well(s) recommended above would improve the accuracy and resolution of such mapping efforts. The maps of changes in groundwater levels could be compared to the changes in BS Mesquite Bosque health to better understand the cause-and-effect relationship, if any.
 - Other factors that can affect Mesquite tree health (besides changes in groundwater levels) could be monitored, mapped, and described (e.g., changes in temperature; precipitation; surface water inflows; pests; human disturbance; Mesquite tree removal; etc.).

- The role of soil moisture within the vadose zone as a potential water source that supports the BS Mesquite Bosque has not been sufficiently characterized in the report. Monitoring of this potential water source is virtually absent, except for the soil moisture monitoring in the study to a depth of 5 ft-bgs. A study could be performed to better characterize the role of soil moisture within the vadose zone as a source water for the Mesquite trees. Such a study could include:
 - *Quantification of the total storage capacity and the current volume of soil moisture in the vadose zone that could be available to the Mesquite tree roots.* These storage estimates could be compared to the ET demands of the BS Mesquite Bosque to better understand the capacity of the vadose zone to supply water to the Mesquite tree roots. The drilling of the new monitoring well(s) recommended above, including the characterization of the sediment and soil moisture profile of the vadose zone, could support this effort.
 - *Quantification of the water budget of vadose zone underlying the BS Mesquite Bosque.* Rainfall and flood events that occur within the BS Mesquite Bosque can percolate to become soil moisture in the vadose zone that subsequently can become a source water that supports the Mesquite trees within the bosque. Mapping of the flood events after large storms could potentially be performed using video/photo monitoring by drones to document: (i) surface water run-on within the bosque and (ii) reservoir development, extent, and depth within the bosque. Analysis of this type of monitoring data, along with other data, not only could help characterize the potential role of soil moisture as a water source that supports the BS Mesquite Bosque, but also could be used to update the BVHM and its ability to simulate the water budget of the Basin.
- NDVI analysis using Landsat-derived NDVI data (1984-2025) could be performed at specific cells (or groups of cells) where the Mesquite trees in BS Mesquite Bosque were once or are currently dense, so that other non-mesquite vegetation is screened out. Time-series charts should be prepared for these focused areas to compare the changes in NDVI vs. all factors that could influence the health of the Mesquite trees, such as: changes in groundwater levels; temperature; precipitation; surface water inflows; pests; human disturbance; Mesquite tree removal; etc.). This analysis may better describe the most relevant factors that are affecting the BS Mesquite Bosque over time.
- Annual air photos could be collected by drone during the peak growing season across the entire BS Mesquite Bosque and at the specific NDVI analysis sites (described in the bullet above). The air photos can be used to track changes in the extent, density, and health of the Mesquite trees over time, as well as to validate the interpretations from the NDVI analysis.
- Field surveys of live/dead Mesquite trees at the specific NDVI analysis sites could be performed once every three years to validate the interpretations derived from NDVI and air photo analyses.
- Monitoring of ET could be performed over time to better understand water use within the BS Mesquite Bosque. The monitoring techniques should be evaluated and recommended by the TAC and EWG with input and advice from UCI. Currently, there is not enough information to know what portion of total ET is satisfied by the regional aquifer system, if any. Therefore, estimates of total ET of the BS Mesquite Bosque should be considered an upper limit for ET_{gw} . This information could be useful to the Watermaster in future BVHM updates and recalibrations for the simulation of ET_{gw} .

Management Recommendations

The UCI GDE Study Report included recommendations for management actions to protect the BS Mesquite Bosque, including:

- Designate the BS Mesquite Bosque as a beneficial user of groundwater (GDE).
- Establish minimum thresholds for groundwater levels at wells MW-5A/B and MW-3. The study suggests Mesquite tree productivity and/or viability declines when groundwater levels decline below the zone of 60-75 ft-bgs, which could be used to set minimum thresholds for groundwater levels.
- Establishing minimum thresholds for the rate of groundwater-level decline.
- Allocate at least 645 afy of ET_{gw} to the BS Mesquite Bosque in the Subbasin water budget.
- Explore potential strategies to improve groundwater conditions:
 - Removal of invasive species that use groundwater.
 - BVHM runs to explore different Basin-wide pumping patterns to control groundwater levels within the BS Mesquite Bosque.
- Conservation of high and moderate productivity BS Mesquite Bosque habitat.
- Minimize soil surface disturbance in BS Mesquite Bosque habitats.
- Restore BS Mesquite Bosque habitat in areas with strong potential for Mesquite regeneration (e.g., in the vicinity of the WWTP percolation ponds).

Technical Consultant Assessment and Recommendations:

- **BAS determination: Partially Met**
 - We agree that the available data and information (including the new data and information provided in the UCI GDE Study Report) indicate that long-term groundwater-level declines due to pumping-induced overdraft of the Borrego Springs Subbasin during the pre-SGMA period (pre-2015) were largely responsible for the widespread die-off and degradation in the health of Mesquite trees in the BS Mesquite Bosque.
 - The available data/information suggest that the existing BS Mesquite Bosque could be a beneficial user of the regional aquifer system, at least in part, particularly in areas surrounding the Borrego Sink where the healthiest stands of vegetation exist and the depth to the regional groundwater table is presumably the shallowest. However, not enough data/information are currently available to confirm that this is the case, as asserted in the UCI GDE Study Report.
 - There are important gaps in understanding (that the report does not acknowledge) that must be filled before a *definitive* conclusion can be reached regarding the groundwater dependency, or lack thereof, of the BS Mesquite Bosque, including:
 - The role of stormwater runoff that could flow to the BS Mesquite Bosque during large storms and percolate through the vadose zone was not considered or quantified in the report. This source of water, although highly episodic and variable in magnitude over time, could be an important component of the water budget of the BS Mesquite Bosque, in that it could periodically replenish soil moisture across

the depths of the vadose zone, and hence, be available to the deep roots of Mesquite trees.

- The soil texture, soil moisture content, and isotopic chemistry of the soil moisture within the vadose below 5 ft-bgs were not sufficiently characterized in the report to understand its role as a source water that supports Mesquite trees.
 - Depth to groundwater is generally understood beneath the BS Mesquite Bosque but is based on sparse data (both spatially and temporally), particularly in areas in the vicinity of the Borrego Sink, where groundwater levels are likely shallowest and could be supporting relatively health stands of Mesquite trees.
 - Other factors that can affect Mesquite tree health were not sufficiently characterized in the report to understand their potential influence on the health of the Mesquite trees (e.g., changes in temperature; precipitation; surface water inflows; pests; human disturbance; Mesquite tree removal; etc.).
 - If portions of the BS Mesquite Bosque are still using the regional aquifer, little is known about the rates at which the Mesquite tree tap roots may be able to follow the declining groundwater table during the pumping rampdown period.
- Therefore, we believe it is premature to establish minimum thresholds for groundwater levels at wells and/or rates of groundwater-level decline with the specific purpose to protect the BS Mesquite Bosque.
- The proposed allocation of 645 afy of ET_{gw} to the BS Mesquite Bosque in the Subbasin water budget is also not supportable, mainly because the study methods employed to estimate ET_{gw} ignored the potential role of soil moisture in the vadose zone as a water source that is satisfying at least a portion of the ET_{gw} demands of the Mesquite trees. Hence, the estimates of ET_{gw} in the study likely represent a maximum upper limit of what the BS Mesquite Bosque is using from the regional aquifer system.
- If deemed necessary in the future, we agree that the BVHM is the appropriate tool to explore different Basin-wide pumping patterns to control groundwater levels within the BS Mesquite Bosque.

CONCLUSIONS AND RECOMMENDATIONS

This section provides the Watermaster Board with the Technical Consultant’s main conclusions from its assessment of the UCI GDE Study Report to determine if it is BAS pursuant to the Watermaster’s policy; provides recommendations for various monitoring and analysis activities that are needed to fill the gaps in understanding identified in this recommendation report and provide the science needed to adapt the Watermaster’s current management framework, if the monitoring and analysis activities indicate a need to protect the BS Mesquite Bosque from declining groundwater levels during the Rampdown period; provides recommendations for the evaluation and potential update of the BVHM to improve its ability to simulate the water budget of the Basin; provides recommendations on how to identify if Watermaster’s management program satisfies SGMA requirements regarding potential GDEs; and lists options for adaptive groundwater management if it is deemed necessary in the future to protect the Mesquite Bosque as a GDE.

Conclusions

Based on the assessment presented herein, we conclude that the UCI GDE Study Report does not meet the Watermaster’s criteria for BAS as stated in its policy regarding the use of BAS. Specifically, the report did not sufficiently recognize the gaps and limitations in the currently available data and did not appropriately consider/analyze the alternative sources of water that could be satisfying the current ET demands of the BS Mesquite Bosque. Therefore, the unqualified and definitive conclusions of the UCI Study Report, and the accompanying management recommendations, are not “consistent with scientific and engineering professional standards of practice;” and hence, should not be considered BAS that, by itself, should be relied upon by the Watermaster to take action or make policy decisions.

This conclusion is based on the following:

- The report reached a *definitive* conclusion that the BS Mesquite Bosque is a GDE without acknowledging the limitations and uncertainty in the data and their interpretations, and based on this conclusion, offered several recommendations to manage the Mesquite Bosque as a GDE, such as: establish minimum thresholds for depth-to-groundwater and acceptable rates of groundwater-level decline; assign at least 645 afy of ET_{gw} to the BS Mesquite Bosque in the Basin water budget; ecological restoration activities; and others. This definitive conclusion and the associated recommendations are not supported by the available data.
- We identified several data gaps and/or gaps in understanding that call into question UCI’s ability to interpret the data and arrive at its *definitive* conclusion, with no limitations cited, that the BS Mesquite Bosque is a GDE. The most important gaps in understanding include:
 - The UCI GDE Study Report indicates that soil moisture within the vadose zone is a water source that supports the Mesquite Bosque. However, the report contained virtually no data on the soil profile from 5 ft-bgs to the saturated zone, such as: soil texture; moisture content, isotopic chemistry of moisture content, existence of perched groundwater conditions, total volume of soil moisture stored in the vadose zone, or the water budget of vadose zone. These data (and subsequent analyses of these data) are necessary to *definitively* conclude that the BS Mesquite Bosque is a GDE.
 - The role of stormwater runoff that could flow into the BS Mesquite Bosque area during large storms and percolate to become soil moisture in the vadose zone was not considered, estimated, or quantified in the UCI GDE Study Report. This source of water, although highly episodic and variable in magnitude over time, could be an important

component of the water budget of the BS Mesquite Bosque. In other words, stormwater runoff could periodically replenish soil moisture across the depths of the vadose zone beneath the BS Mesquite Bosque, and hence, could supply some (or all) of the ET_{gw} demands of the Mesquite trees.

- There is a paucity of wells and measured depth-to-groundwater within the BS Mesquite Bosque area—particularly in the focused areas of study (Sites 1, 3, 4). These data are necessary to increase confidence in the estimation of depth-to-groundwater and the assessment of the BS Mesquite Bosque as a GDE.
- Besides Jenkins et al. (1988), which recorded Mesquite tree roots extending at least 39.4 ft-bgs, there is no direct evidence in the report of Mesquite tree roots reaching the current depths to the saturated zone beneath much of the BS Mesquite Bosque (up to 134 ft-bgs).
- The maximum rate of groundwater-level decline that Mesquite tree tap roots can follow downward without compromising Mesquite tree health was not addressed in the study. This rate should be compared against current and predicted future rates of groundwater-level decline to better understand the potential impact of the pumping Rampdown on the BS Mesquite Bosque, if it is a GDE.
- Lack of these data and understanding creates sufficient uncertainty that should prohibit the report authors from arriving at their *definitive* conclusions that the current BS Mesquite Bosque is a GDE and the extent and health of the BS Mesquite Bosque will experience degradation caused by the Rampdown as groundwater levels gradually stabilize. Hence, the report’s recommendations to set groundwater management criteria to protect the BS Mesquite Bosque as a GDE, such as minimum thresholds for groundwater levels at monitoring wells, are not yet supportable.

That said, our opinion is that the UCI GDE Study Report represents an advancement in the scientific understanding of the BS Mesquite Bosque and provides compelling evidence that historical over-pumping of the Basin, and the associated declines in groundwater levels, led to widespread mortality of Mesquite trees in the BS Mesquite Bosque during the pre-SGMA period (prior to 2015). SGMA does not require mitigation of pre-SGMA impacts.

The available data/information in the post-SGMA period (2015-2024) suggest that the BS Mesquite Bosque could be an environmental beneficial user of Basin groundwater, at least in part, particularly in areas surrounding the Borrego Sink where NDVI, air photos, and field data indicate the healthiest stands of vegetation and the shallowest depths to the regional groundwater table. Therefore, we recommend the Watermaster consider the BS Mesquite Bosque a “potential GDE” and implement an adaptive management framework to first determine if declining groundwater levels caused by the pumping Rampdown are causing or could cause significant and unreasonable degradation of the BS Mesquite Bosque, and if shown to be necessary, implement adaptive management actions to protect the environmental beneficial uses in the Basin. These recommendations are described in detail below.

Recommendations to Address the Gaps in Understanding

Various monitoring and analysis activities are needed to fill the gaps in understanding identified in this recommendation report and provide the science needed to adapt the Watermaster’s current management framework, if the monitoring and analysis activities indicate a need to protect the BS Mesquite Bosque from significant and unreasonable degradation caused by declining groundwater levels associated with the pumping Rampdown. The activities should focus on developing a better

understanding of: changes in the extent and health of the BS Mesquite Bosque over time; the water sources that supply the ET demands of the BS Mesquite Bosque; and the relative impact of all factors that could be affecting the extent and health of the BS Mesquite Bosque since the mid-1980s and going forward through the Rampdown period (e.g., changes in groundwater levels; temperature; precipitation; surface water inflows; pests; human disturbance; etc.).

In consideration of our assessment of the UCI GDE Study Report and our prior experience conducting monitoring and mitigation programs for GDEs in other groundwater basins, the following activities are recommended for consideration by the Watermaster:

- The Watermaster has identified the area of the Basin in the vicinity of the BS Mesquite Bosque as a “gap” in its groundwater monitoring program and has made efforts to identify existing wells in this area to add to its groundwater monitoring network. Most of these efforts have been unsuccessful; however, the Watermaster recently added a private domestic well to the monitoring network just west of the Borrego Sink in Old Borrego (Broom Well). Depth to groundwater at Broom Well was about 80 ft-bgs in October 2025. Potentially, additional existing wells could be identified and monitored—particularly in areas near the healthy stands of Mesquite trees surrounding the Borrego Sink where depth to the regional aquifer system is presumably the shallowest.
- Maps of annual changes in groundwater levels could be prepared to illustrate where groundwater levels are declining relative to the BS Mesquite Bosque. These maps are already prepared as interim work products for the annual change-in-storage calculations for the SGMA annual report. That said, monitoring wells are sparse within the BS Mesquite Bosque, so such maps should be classified as rough approximations. The new monitoring well(s) recommended above would improve the accuracy and resolution of such mapping efforts. The maps of changes in groundwater levels could be compared to the changes in BS Mesquite Bosque health to better understand the cause-and-effect relationship, if any.
- Other factors that can affect Mesquite tree health (besides changes in groundwater levels) could be monitored and described (e.g., changes in temperature; precipitation; surface water inflows; pests; human disturbance; Mesquite tree removal; etc.).
- NDVI analysis using Landsat-derived NDVI data (1984-2025) could be performed at specific cells (or groups of cells) where the Mesquite trees in BS Mesquite Bosque were once or are currently dense, so that other non-mesquite vegetation are screened out. Time-series charts could be prepared for these focused areas to compare the changes in NDVI vs. all factors that could influence the health of the Mesquite trees, such as: changes in groundwater levels; temperature; precipitation; surface water inflows; pests; human disturbance; Mesquite tree removal; etc.). This analysis may better describe the most relevant factors that are affecting the BS Mesquite Bosque over time.
- Monitoring and analysis of ET data could be performed over time to better understand water use within the BS Mesquite Bosque. The monitoring/analysis techniques should be evaluated and recommended by the TAC and EWG with input and advice from UCI (since UCI is currently conducting ET monitoring within the BS Mesquite Bosque). Currently, there is not enough information to know what portion of total ET is satisfied by the regional aquifer system, if any. Therefore, estimates of total ET of the BS Mesquite Bosque should be considered an upper limit for ET_{gw} . This information could be useful to the Watermaster in future BVHM updates and recalibrations for the simulation of ET_{gw} . Additional consideration for the monitoring/analysis techniques should be given to the following:

- OpenET estimates of ET are derived from six different OpenET models plus and “ensemble mean.” More expert analysis is necessary to choose the OpenET models best suited for estimating ET in natural desert environments.
- Consideration should be given for the potential role of soil moisture in satisfying at least a portion of the ET demands of the BS Mesquite Bosque.
- Consideration should be given to the ET demands of other non-Mesquite vegetation within the Mesquite Bosque areas.
- The role of soil moisture within the vadose zone as a potential water source that supports the BS Mesquite Bosque has not been sufficiently characterized in the UCI GDE Study Report. Monitoring of this potential water source is virtually absent, except for the soil moisture monitoring in the study to a depth of 5 ft-bgs. A study could be performed to better characterize the role of soil moisture within the vadose zone as a source water for the Mesquite trees. Such a study could include:
 - *Quantification of the total storage capacity and the current volume of soil moisture in the vadose zone that could be available to the Mesquite tree roots.* These storage estimates could be compared to the ET demands of the BS Mesquite Bosque to better understand the capacity of the vadose zone to supply water to the Mesquite tree roots. The drilling of the new monitoring well(s) recommended above, including the characterization of the sediment and soil moisture profile of the vadose zone, could support this effort.
 - *Quantification of the water budget of vadose zone underlying the BS Mesquite Bosque.* Rainfall and flood events that occur within the BS Mesquite Bosque can percolate to become soil moisture in the vadose zone that subsequently can become a source water that supports the Mesquite trees within the Bosque. Mapping of the flood events after large storms could potentially be performed using video/photo monitoring by drones to document: (i) surface water run-on within the Bosque and (ii) reservoir development, extent, and depth within the Bosque. Analysis of this type of monitoring data, along with other data, not only could help characterize the potential role of soil moisture as a water source that supports the BS Mesquite Bosque but also could be used to update the BVHM and its ability to simulate the water budget of the Basin.
- New monitoring wells could be constructed near Sites 1, 3, and 4 with a subsequent monitoring program. Site 4 would be the highest priority because depth-to-groundwater at Site 4 is likely deeper than at Sites 1 and 3, and Site 4 is closer to the main areas of pumping in the Basin. Drilling, construction, and subsequent monitoring of the monitoring wells could be designed and used to:
 - Characterize the sedimentary composition and texture of the soil profile from the ground surface to/through the saturated zone.
 - Check for the presence or absence of “perched” groundwater conditions.
 - Collect soil samples and analyze for soil moisture content and soil-water isotopic chemistry across the vadose zone and capillary fringe.
 - Inspect the borehole sediments through the vadose zone and capillary fringe for evidence of live mesquite tree roots.
 - Install soil moisture sensors across the vadose zone and capillary fringe to track seasonal and long-term changes in soil moisture.

- Collect groundwater samples from the saturated zone to characterize its isotopic chemistry for comparison to the isotopic chemistry of the Mesquite trees and soil moisture, which could better describe the source waters that support the Mesquite trees.
- Annual air photos could be collected by drone during the peak growing season across the entire BS Mesquite Bosque and at the specific NDVI analysis sites. The air photos can be used to track changes in the extent, density, and health of the Mesquite trees over time, as well as to validate the interpretations from the NDVI analysis.
- Field surveys of live/dead Mesquite trees at the specific NDVI analysis sites could be performed once every three years to validate the interpretations derived from NDVI and air photo analyses.

A programmatic approach to prioritizing and performing these activities could be accomplished through the development of a “Monitoring Work Plan for the BS Mesquite Bosque.” We recognize that it is not economically feasible for Watermaster to implement all elements of such a workplan without supplemental funding from grants and/or academic or other partnerships. Having a comprehensive monitoring workplan would serve as a useful document for seeking funding through grants and partnerships and would be a logical next step for the Watermaster.

Evaluation and Use of the BVHM

The BVHM includes functionality to simulate ET_{gw} as part of the water budget of the groundwater basin. For example, the BVHM estimated about 9,000 afy of ET_{gw} in the late 1940s before the onset of significant pumping, which progressively declined to about 331 afy of ET_{gw} in WY 2022, presumably due to the pumping-induced overdraft of the Basin and the associated decline in groundwater levels. This functionality of the BVHM could be evaluated against what is currently known about the BS Mesquite Bosque, which could lead to recommendations to update the BVHM and improve its ability to estimate the water budget of the Basin, including the 5-year redeterminations of the Sustainable Yield. The BVHM could also be used to predict future changes in groundwater levels beneath the BS Mesquite Bosque and ET_{gw} during the SGMA planning horizon (through 2070) under various assumptions for future pumping and climate.

Adaptive Management Framework

Since its inception in 2020, the Borrego Springs Watermaster has been implementing groundwater management actions to slow and eventually halt groundwater-level declines in the Basin, which should be beneficial to the BS Mesquite Bosque, if and where it is still a GDE. The main management action is the Rampdown of groundwater pumping to the Sustainable Yield of the Basin by 2040. Currently, the pumpers in the Basin have reduced pumping to rates that are significantly ahead of the prescribed Rampdown schedule.

If it were demonstrated through the monitoring/modeling studies recommended above that the declining groundwater levels caused by the Rampdown through 2040 would cause (or is causing) significant and unreasonable degradation of the BS Mesquite Bosque, then adaptive management options could include:

- Acceleration of the Rampdown schedule
- Reduction of the Sustainable Yield
- A shift in the location of groundwater pumping away from the BS Mesquite Bosque
- A mitigation program to provide an alternative water source for the BS Mesquite Bosque

As stated above, not enough information and understanding is currently available to warrant these actions at this time.

To validate this management approach for the BS Mesquite Bosque as a potential GDE, the Watermaster should prepare a memorandum that describes:

- The history and current understanding of the BS Mesquite Bosque as a potential GDE.
- The Watermaster's current management program to achieve sustainability (e.g., pumping Rampdown, stabilization of groundwater levels, implementation of monitoring programs, etc.).
- Any monitoring and/or modeling efforts proposed for the BS Mesquite Bosque area.
- SGMA statutory and regulatory provisions governing sustainable groundwater management, including consideration of potential GDEs.

The memorandum should be prepared by Watermaster legal counsel to evaluate whether the Watermaster's management and monitoring programs satisfy SGMA requirements regarding potential GDEs.