APPENDIX F

GROUNDWATER DEPENDENT ECOSYSTEMS AND SURFACE WATER TECHNICAL MEMORANDUM

14 September 2021

TECHNICAL MEMORANDUM

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Subject: **Groundwater Dependent Ecosystems and Surface Water – Groundwater Interaction Program Update**
Zone 7 Water Agency Alternative Groundwater Sustainability Plan
(EKI C00065.00)

EKI Environment & Water, Inc. (EKI) is pleased to present to Zone 7 Water Agency (Zone 7) a memorandum documenting the update the groundwater dependent ecosystems (GDEs) and surface water – groundwater interaction program within the Livermore Valley Groundwater Basin (Basin) as part of Zone 7's 2022 Alternative Groundwater Sustainability Plan (Alt GSP or Plan) Update.

Pursuant to our approved scope of work, EKI's work efforts included: (1) identification of GDEs and other areas of potential interconnected surface water (ICSW), (2) evaluation of the need for and identification of new monitoring locations, (3) assessment of groundwater demands from GDEs, (4) development of sustainability criteria (i.e., Measurable Objectives [MOs] and Minimum Thresholds [MTs]) for Depletion of Interconnected Surface Water.

A final version of this memorandum is anticipated to be included as an attachment to the 2022 Alt GSP and/or to inform selected chapters of the Plan.

1. UPDATE TO GROUNDWATER DEPENDENT ECOSYSTEMS AND INTERCONNECTED SURFACE WATER PROGRAM

The following section describes the process used to update the GDE and ICSW program.

1.1. Identification of Groundwater Dependent Ecosystems

EKI (supported by Stillwater Sciences [Stillwater]) performed a preliminary identification of likely GDEs within the Basin based on the available data and tools, field and aerial photo surveys, and analysis conducted in general accordance with the process laid out in The Nature Conservancy (TNC) guidance[1]. A summary of the work effort is presented below and in **Attachments A and B**.

1.1.1. Preliminary Screening

Based on the available data, EKI conducted a preliminary screening to identify potential GDE areas in the Basin as described below.

Data Sources

Primary data sources that were incorporated into the screening analyses or otherwise supported the GDE field investigation and identification include the following:

- GDE information from the California Department of Water Resources' (DWR) Natural Communities Commonly Associated with Groundwater (NCCAG) dataset and TNC guidance documents[2,3,4];
- GDE health indices from the TNC GDE Pulse tool[5], including the Normalized Derived Moisture Index (NDMI) and the Normalized Derived Vegetation Index (NDVI), which indicate the vegetation moisture and vegetation greenness, respectively;
- Additional resources regarding the presence of GDEs in the Basin provided by Zone 7, including GDE geospatial data and Sycamore alluvial woodland data;
- United States Geological Survey (USGS) ground surface elevation data;
- Well information, including locations and well construction details as provided by Zone 7; and
- Groundwater elevation and depth to water data provided by Zone 7.

Depth to Groundwater Analysis

The NCCAG dataset identifies land areas by vegetation or wetland categories that potentially indicate the presence of GDEs, as shown on **Figure 1**. The NCCAG dataset also assigns the potential GDEs a polygon number. An additional GDE area (i.e., the Springtown Alkali Sink[6]) was not identified in the NCCAG dataset, but was included in this analysis and on **Figure 1** for completeness.

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[1] Rohde et al., 2018. *Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans.* The Nature Conservancy. Dated January 2018.

[2] Ibid.

[3] Klausmeyer et al., *GDE Pulse: Taking the Pulse of Groundwater Dependent Ecosystems with Satellite Data*. The Nature Conservancy. Dated January 2019.

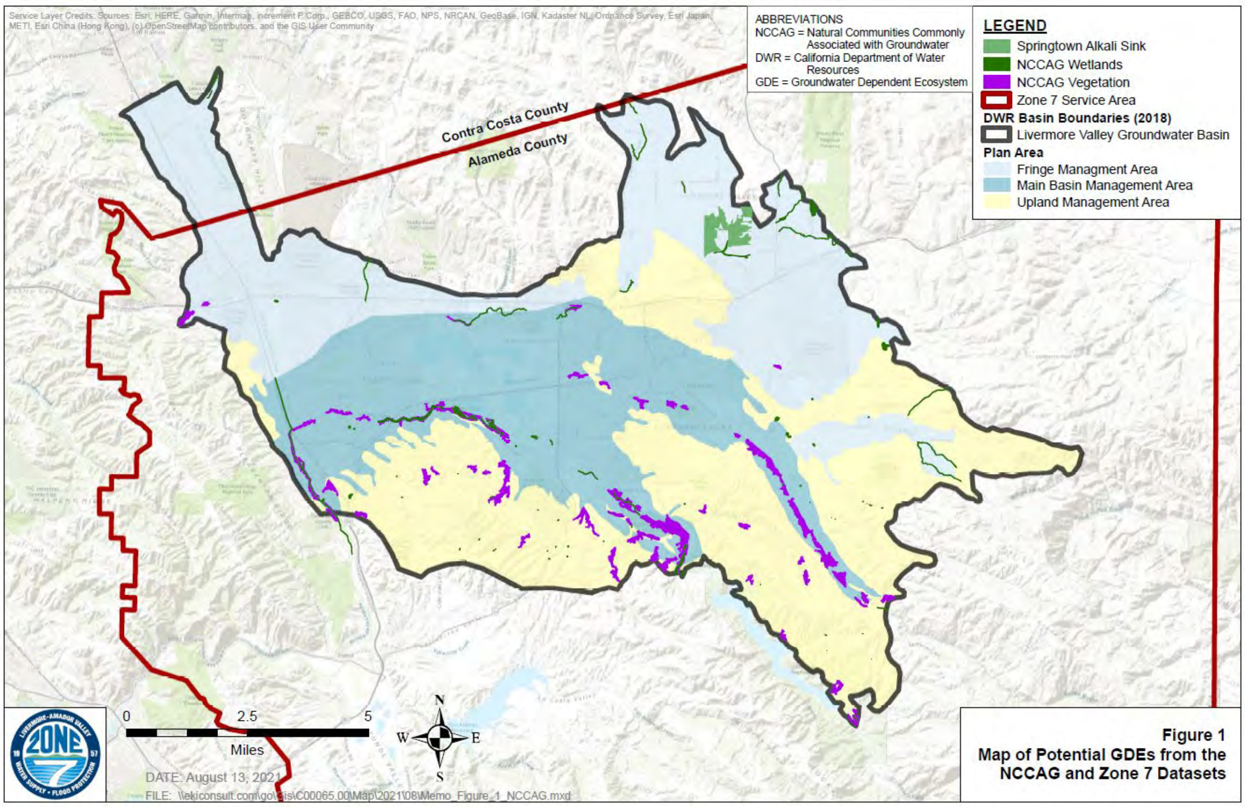
[4] TNC, 2019. *Identifying GDEs Under SGMA: Best Practices for using the NC Dataset*. The Nature Conservancy. Dated July 2019.

[5] https://gde.codefornature.org/#/methodology; The GDE Pulse interactive map developed by The Nature Conservancy provides users easy access to satellite data to view long term temporal trends of vegetation metrics. These vegetation metrics serve as an indicator of vegetation health for GDEs. In addition, the GDE Pulse web app provides long-term temporal trends of groundwater depth and regional precipitation data. This provides users with a platform to infer relationships between groundwater levels, precipitation, and GDE vegetation metrics to monitor and sustainably manage groundwater and GDEs.

[6] The 2016 Alt GSP identified the Springtown Alkali Sink as a GDE in Section 2.1.4.

Based on review of the NCCAG dataset, the maximum rooting depth of various plant species associated with potential GDEs within the Basin is approximately 30 feet below ground surface (ft bgs).[7] As such, if the minimum depth to groundwater between 2015 and 2020 in the vicinity of the mapped potential GDEs was greater than 30 ft bgs,[8] it is unlikely that the mapped vegetation or wetland areas in the NCCAG dataset were accessing the principal aquifer[9] as their source of supply. Rather, these mapped vegetative communities are likely supplied by a surface water, perched groundwater, or other source (e.g., runoff or a man-made water feature) and are therefore not GDEs in the context of SGMA.

Figure 1. Map of Potential GDEs from the NCCAG and Zone 7 Datasets



To further clarify whether the mapped vegetative communities from the NCCAG and Zone 7 datasets are likely GDEs that are dependent on the principal aquifer, the depth to groundwater for each potential GDE polygon (and the area of the Springtown Alkali Sink) was estimated by comparing the potential max GDE rooting depth (30 ft bgs) to the measured depth to groundwater from nearby Upper Aquifer wells within the Basin. Upper Aquifer wells within a one-kilometer (km) radius of the mapped potential GDEs were

[7] https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes/

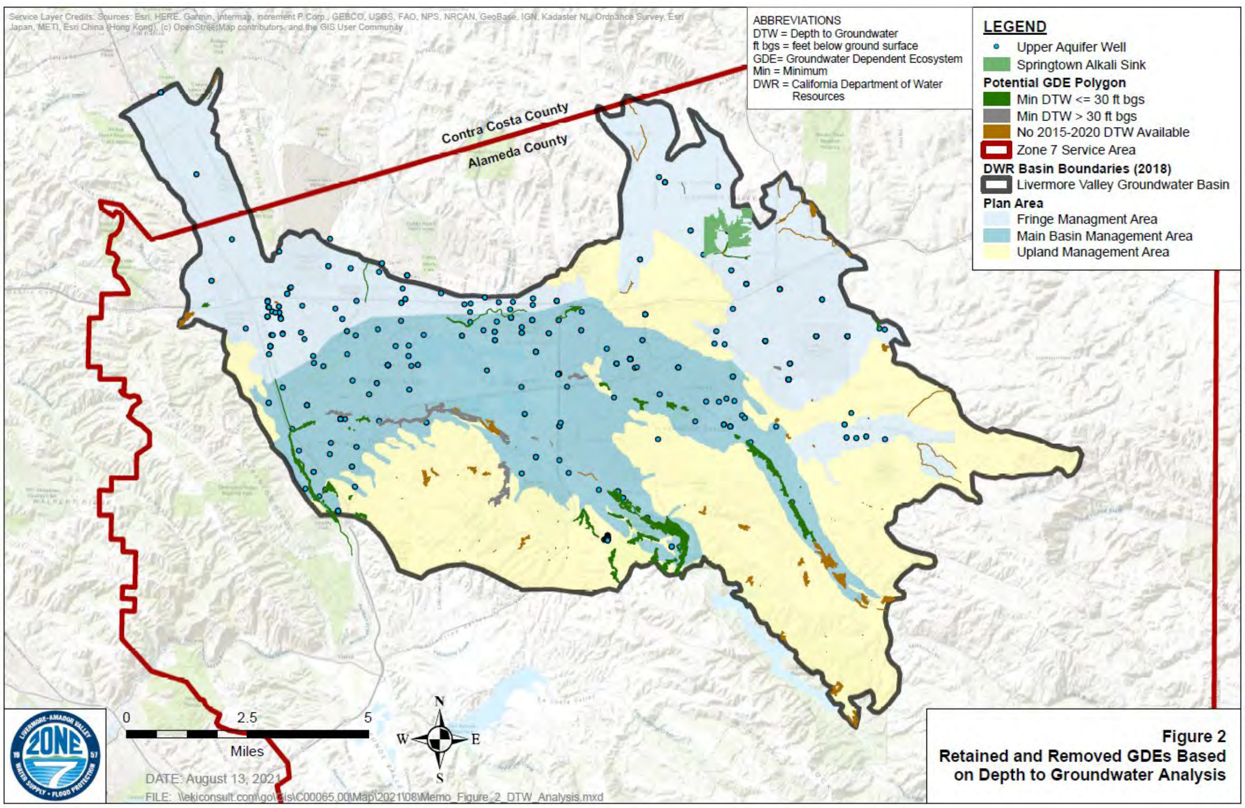
[8] Since the Plan is not required to address undesirable results that occurred before, and have not been corrected by January 1, 2015 (Water Code Section 10727.2 (b)(4)), 2015 is selected as the start of the analysis timeframe.

[9] Per § 351.(aa), "Principal aquifers" refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. The Main Basin includes a single principal aquifer that includes two hydraulically connect zones with varying degrees of connectivity: the Upper Aquifer and Lower Aquifer.

assumed to be representative of groundwater conditions within those areas[10]. The locations of Upper Aquifer wells within the Basin that were used to evaluate shallow groundwater conditions are shown on **Figure 2.** If multiple wells were within one km of a GDE polygon, the minimum depth to groundwater between 2015 and 2020 from these wells was calculated.

If the minimum depth to water between 2015 and 2020 was greater than 30 ft bgs, then that respective GDE polygon was determined to likely not be a GDE that was dependent on the principal aquifer and was "removed" from further consideration. If the minimum depth to groundwater between 2015 and 2020 was less than 30 ft bgs or if no proximate groundwater data were available, the potential GDE polygon was preliminarily "retained" for further review. The retained and removed GDE polygons are shown on **Figure 2.**

Figure 2. Retained and Removed GDEs Based on Depth to Groundwater Analysis



Application of the TNC GDE Pulse Tool Methodology

The TNC GDE Pulse tool provides time series data for two remote sensing indices that are used to monitor a vegetation's health: (1) the Normalized Derived Moisture Index (NDMI), and (2) the Normalized Derived Vegetation Index (NDVI), which indicate the vegetation moisture and vegetation greenness, respectively. Higher NDMI and NDVI values are associated with "healthier" vegetation. In the TNC GDE Pulse tool the

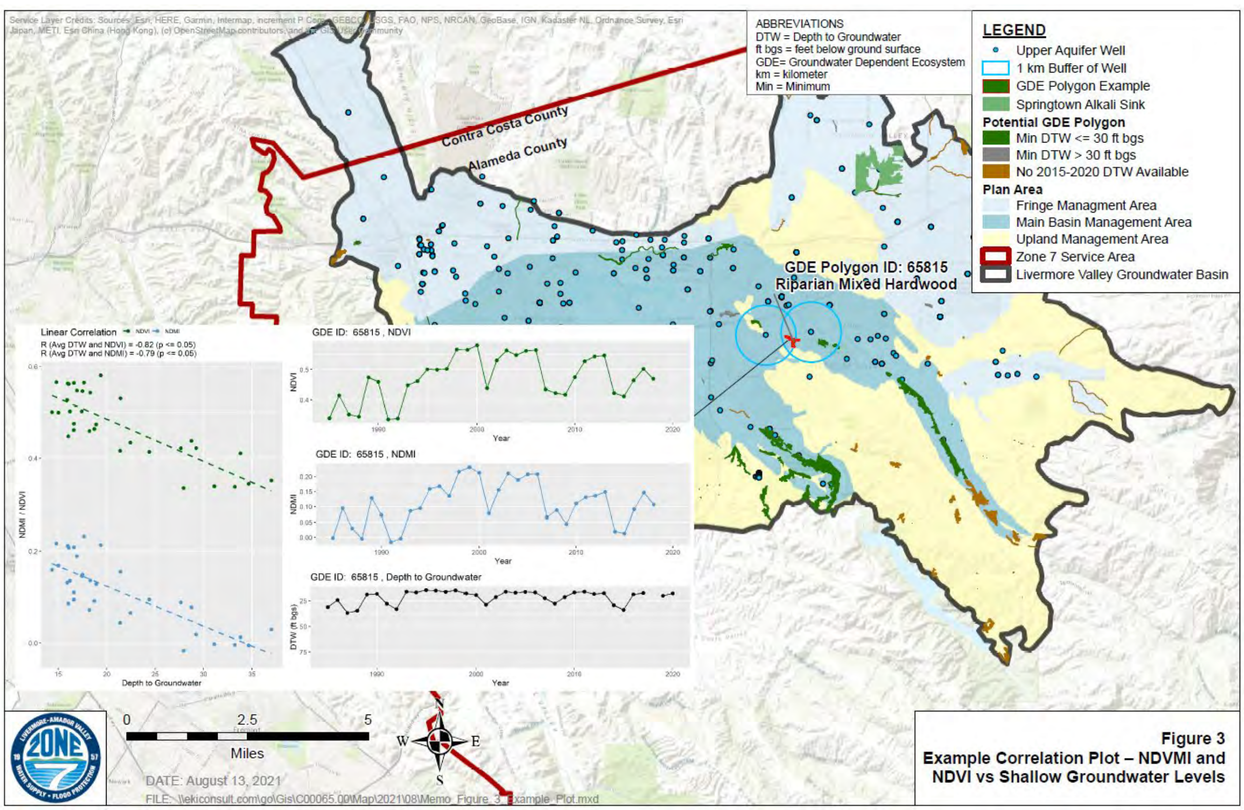
[10] Klausmeyer et al., *GDE Pulse: Taking the Pulse of Groundwater Dependent Ecosystems with Satellite Data*. The Nature Conservancy. Dated January 2019.

NDMI and NDVI data are indexed to the same GDE polygon numbers included in the NCCAG dataset[11].

The premise of the TNC GDE Pulse tool is that, since the NDMI and NDVI indices can quantify changes in the rates and patterns of vegetation growth and moisture levels in plants over time, the relationship between these two indices and the depth to shallow groundwater can be evaluated to examine whether these measures of GDE "health" have a relationship to shallow groundwater conditions. Since limited depth to groundwater data are provided in the TNC GDE Pulse tool, depth to groundwater data provided by Zone 7 were used to supplement this analysis.

Time series data of these two indices and the nearby (i.e., within one km) depth to groundwater data were plotted for each retained GDE polygon, as shown on **Figure 3** and **Attachment A**. A linear correlation between the two indices and the local depth to groundwater data was then evaluated for each polygon. A negative correlation would mean that, when the depths to groundwater increase, the NDMI and NDVI indices decrease, indicating that the GDEs are less healthy when conditions are such that local groundwater elevations decrease, and vice versa.

Figure 3. Example Correlation Plot – NDMI and NDVI vs Shallow Groundwater Levels

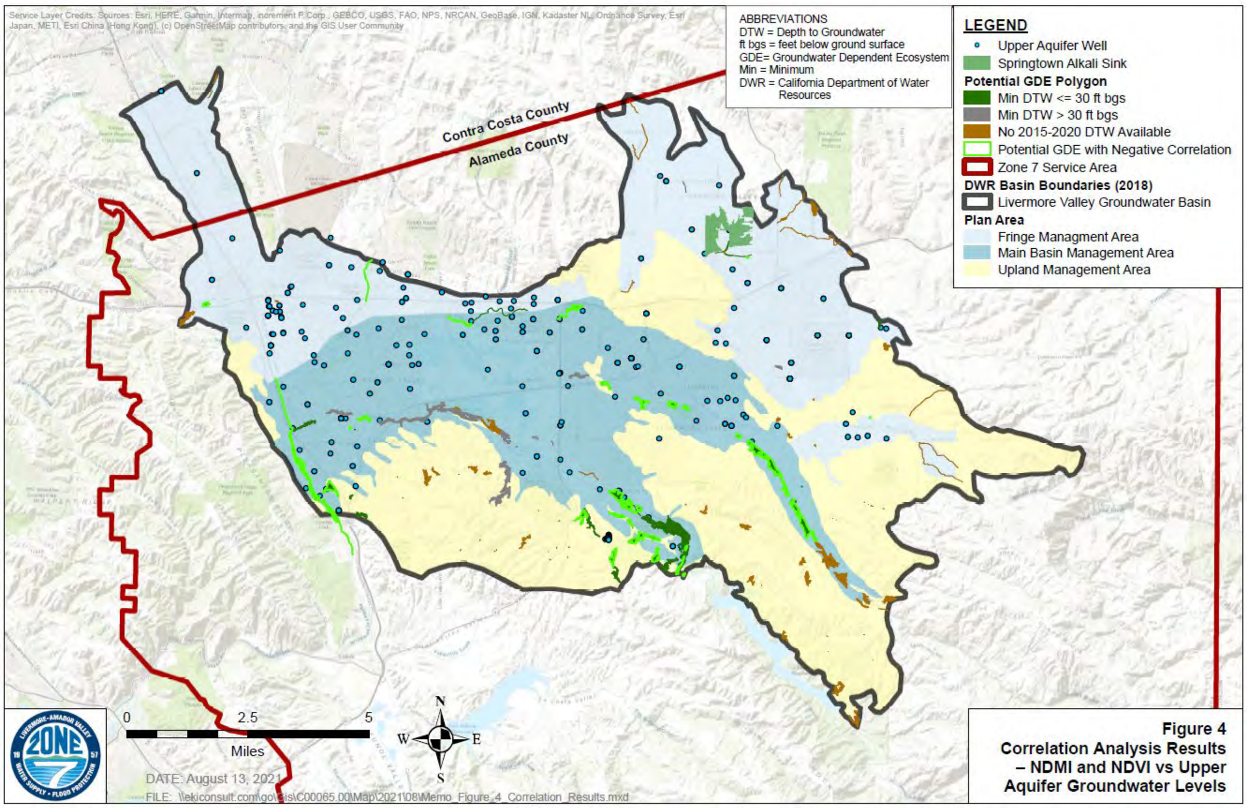


Among the preliminarily retained GDEs (i.e., those GDE polygons where the minimum depth to groundwater in the Upper Aquifer between 2015 and 2020 was less than 30 ft bgs), 84% exhibited a negative correlation between NDMI and depth to groundwater, and 71% exhibited a negative correlation

[11] There are no TNC GDE Pulse data for Springtown Alkali Sink, so the analysis of groundwater level trends and the NDMI and NDVI indices could not be conducted for this GDE.

between NDVI and depth to groundwater. For the purpose of this analysis, correlation with a p-value that is less or equal to 0.05 is considered to be significant. Among the potential GDEs that have negative correlations, 46% of them have a significant correlation between NDMI and depth to groundwater, and 38% of them have a significant correlation between NDVI and depth to groundwater. The potential GDE areas that exhibited negative correlations for both NDMI and NDVI are shown on **Figure 4**. These data indicate that one factor impacting vegetative health in the retained GDE area could be the depth to groundwater.

Figure 4. Correlation Analysis Results – NDMI and NDVI vs Upper Aquifer Groundwater Levels



It should be noted, however, that correlation is not the same as causation and a negative correlation does not necessarily confirm the presence of a GDE that would be impacted by changes in Upper Aquifer groundwater levels. Rather, what this analysis confirms is that GDEs are objectively less healthy when conditions are such that local groundwater elevations decrease, and vice versa. However, significant uncertainties remain. For example, the Overburden layer extent in the Fringe Management Area is uncertain, and therefore while vegetation along the Tassajara Creek and near Dublin (northeastern portion of the Basin) are retained as potential GDEs, they may be disconnected from the underlying Upper Aquifer and any apparent correlation would be meaningless.

1.1.2. <u>Field Investigation & Verification</u>

As described in **Attachment B**, Stillwater Sciences integrated the aforementioned screening analysis and other available local data to conduct a refined mapping of the potential GDEs within the Basin, including: the Classification and Assessment with Landsat of Visible Ecology Groupings (CalVeg) dataset; Urban Creeks Council (UCC) 2014 CalVeg update for third-order and higher channels; Aerial Information Systems

(AIS) Springtown Alkali Sink Preserve Wetlands Mapping; and Sycamore Alluvial Woodland Tree Survey in Arroyo Mocho and Arroyo Valley. Man-made open water areas (e.g., the Chain of Lakes and golf course ponds) were removed from the refined vegetation map. As part of the ecological inventory, special-status species and sensitive natural communities that are potentially associated with GDEs in the Basin were also identified using regional and local databases.[12]

On 31 March 2021, Stillwater conducted field studies and surveyed aerial photography to verify the presence of GDEs at 12 unique sites throughout the Basin (Sites A through L as shown on **Figure 5**). These sites included areas where there were: (1) apparent "gaps" in the potential GDE map shown on **Figure 1** (i.e., where vegetation similar to GDEs occurred immediately upstream and downstream of the mapped site but was not identified as a GDE); (2) where the riparian vegetation was mapped along stream channels (i.e., where the mapped GDEs are potentially supported by surface water, not groundwater); and (3) where the mapped GDEs are underlain by thick clay layers (i.e., where perched groundwater, not the principal aquifer, could be the source). Additionally, Stillwater scientists assessed potential GDEs at sites where groundwater data are sparse (e.g., near Sycamore Park and Springtown). Likely groundwater dependence of these sites was determined by assessing various local water sources and the width of the riparian zone. Where riparian zones were narrow and relatively sparse, other water sources likely support the vegetation. Where existing vegetation and wetland areas extend beyond a narrow strip along the channel, groundwater dependence was considered likely.[13]

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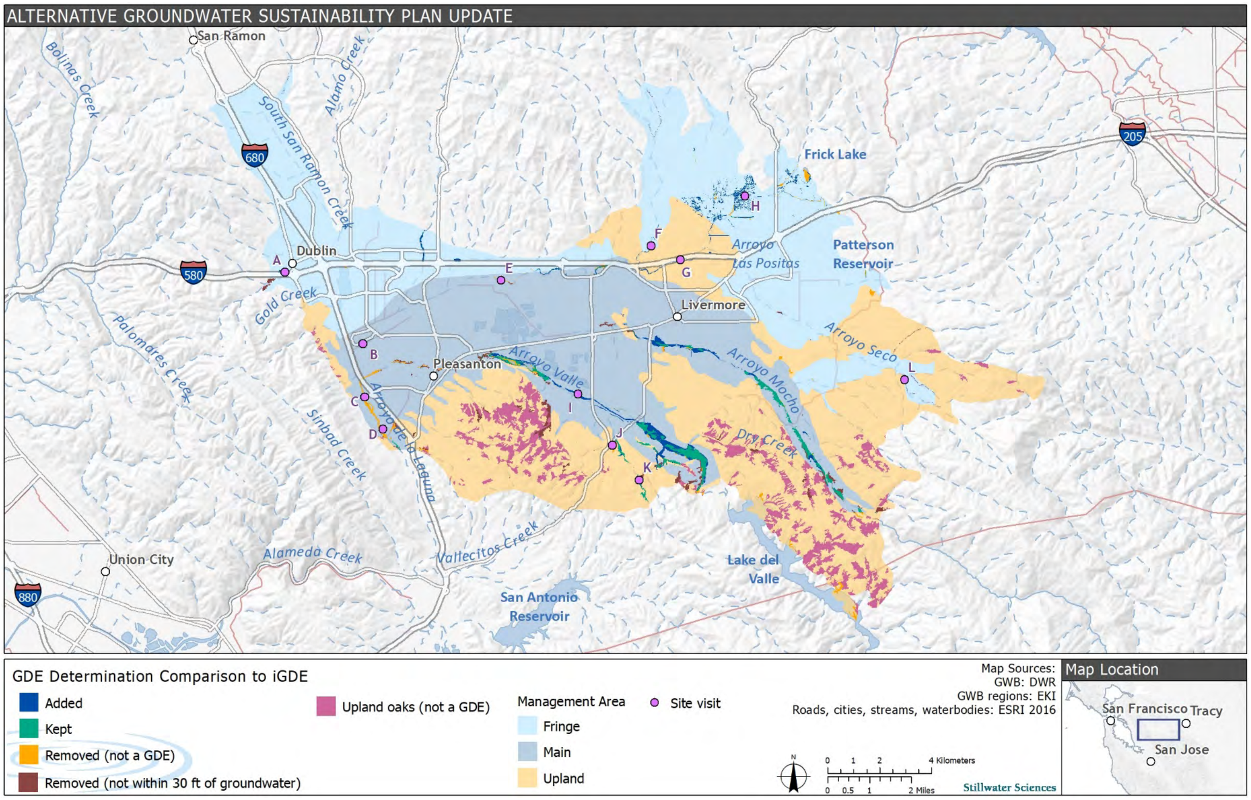
[12] Databases used by Stillwater to identify special-status species include: (1) California Natural Diversity Database, (2) California Native Plant Society (CNPS) Manual of California Vegetation, (3) eBird, and (4) TNC freshwater species lists generated from the California Freshwater Species Database (CAFSD).

[13] Stillwater 2021, Technical Memorandum: Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin, dated 17 May 2021.

Figure 5. Comparison of the Likely GDE Map (Figure 6) with the NCCAG Dataset (Figure 1)



Based on the totality of the above analysis, a final determination was made on the presence of likely GDEs within the Basin. The primary differences in GDE mapping relative to the initial NCCAG map of potential GDEs are summarized below and shown on **Figure 5**:

- Additional GDEs were identified in the northeast portion of the Basin where the AIS mapping occurred (Site H, **Figure 5**).
- Potential GDEs mapped in the NCCAG dataset that occur adjacent to man-made open water features along Chain of Lakes (in the Arroyo Valle corridor) and near the City of Dublin were removed.
- Some further changes in GDE mapping reflect differences between the UCC update to the CalVeg map along Arroyo Mocho and Arroyo Valle. In particular, the width of the riparian vegetation along both streams increased in places, as seen in **Figure 5**.
- The reclassification of vegetation near Lake Boris on Arroyo Valle (downstream of Site I, **Figure 5**) reduced the extent of GDEs downstream of the lake.
- The vegetation was removed along Arroyo de la Laguna and west of Pleasanton (Sites B, C, and D, **Figure 5**) after conducting field investigations. These sites occur above a thick clay layer (known colloquially as the Overburden layer) that precludes connection to the principal aquifer. Observations during the field visit suggested that the riparian vegetation at Sites B, C, and D was likely dependent on surface water rather than groundwater due to the relatively narrow riparian zone.

- The potential GDE community near Site L was also removed since the very sparse riparian vegetation suggested the area was not connected to groundwater.
- Wetlands mapped within man-made lakes and ponds (e.g., Frick Lake in the eastern part of the basin) were also removed.[14]

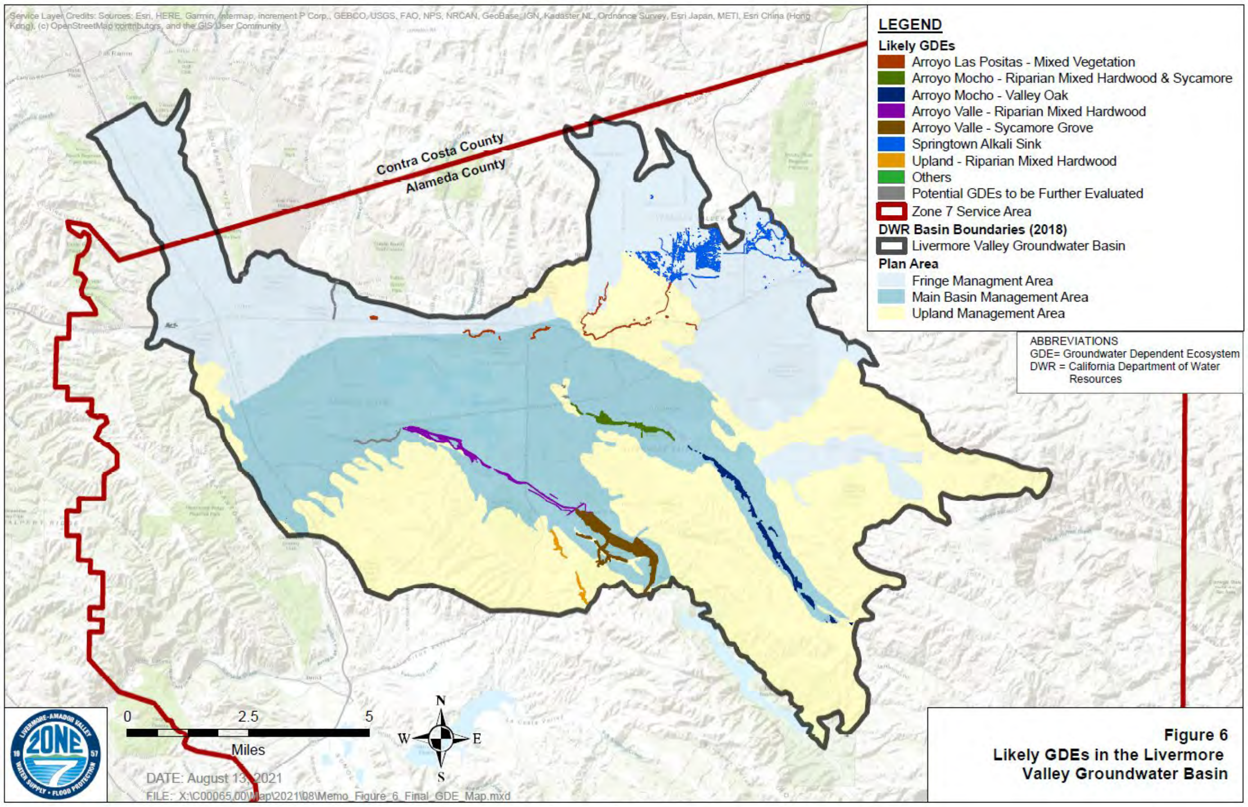
The final likely GDE map is presented on **Figure 6**. Likely GDEs are grouped and named based on their location and major vegetation types, as shown on **Figure 6** and in **Table 1.** However, significant uncertainties remain. For example, the Overburden layer extent in the Fringe Management Area is uncertain, and therefore while vegetation along the Tassajara Creek and near Dublin (northeastern portion of the Basin) are retained as potential GDEs, they may be disconnected from the Upper Aquifer. Other areas retained as potential GDEs include areas of non-native vegetation (such as Eucalyptus trees) or that are adjacent to shallow bedrock outcrops in the center of the Basin (e.g., the "Oak Knoll" area). These GDE areas have been preliminarily retained, but will be further evaluated through monitoring and periodic visual inspections as discussed in **Section 2** below.

Table 1. GDE Region and Major Vegetative Composition

Management Area	Likely GDE Name	Acreages
Main Basin Management Area	Arroyo Valle – Riparian Mixed Hardwood	137
	Arroyo Valle – Sycamore Grove	343
	Arroyo Mocho – Riparian Mixed Hardwood & Sycamore	94
	Arroyo Mocho – Valley Oak	178
Fringe Management Area	Springtown Alkali Sink	173
	Arroyo Las Positas – Mixed Vegetation	56
Upland Management Area	Upland – Riparian Mixed Hardwood	35
Basin-Wide	Potential GDEs to be Further Evaluated	37
	Total Acreages	1,052

[14] Ibid.

Figure 6. Likely GDEs in the Livermore Valley Groundwater Basin



In total, the Basin includes approximately 1,052 acres of likely GDEs, approximately 2% of the total Basin area. The Main Basin Management Area contains approximately 69% of the total likely GDE area, the Fringe Management Area contains approximately 20%, and the Upland Management Area contains the remaining 11% of the likely GDEs. The most prevalent vegetation communities across all likely GDE units are the riparian mixed hardwood alliance and California sycamore alliance, which respectively comprise 40% and 30% of the likely GDE areas in the Basin and are located almost entirely in the Main Basin Management Area. The Alkaline mixed grasses and forbs alliance comprises 10% of total likely GDE area and is located almost entirely in the Fringe Management Area.[15]

The Basin includes United States Fish and Wildlife Service (USFWS) designated critical habitat for four federally listed species: the Alameda whipsnake, California red-legged frog, California tiger salamander, and vernal pool fairy shrimp. As described in **Attachment B**, of the designated critical habitat, most of the habitat for the vernal pool fairy shrimp is co-located with mapped GDEs, but this species relies on vernal pools, which are dependent on rainfall, rather than groundwater and is therefore unlikely to be groundwater dependent. Most of the critical habitat for California red-legged frogs and Alameda whipsnake occurs outside of the defined GDEs, with approximately two acres of their critical habitat overlapping with a riparian GDE at the upstream end of Arroyo Mocho.[16] Zone 7 adheres to the East

[15] Ibid.
[16] Ibid.

Alameda County Conservation Strategy (EACCS) that was developed to preserve endangered species by developing a shared vision for long term habitat protection.[17]

As described in **Attachment B**, 22 special-status plants occur within the Basin, including Alkali milk-vetch, Heartscale, Brittlescale, Livermore tarplant, and Jepson's coyote-thistle. Of these, 12 plant types were likely dependent upon groundwater, four were possibly dependent on groundwater, one was unlikely to be groundwater dependent, and five were not groundwater dependent. All 12 special-status plants likely dependent on groundwater occurred in the Fringe Management Area, and three of the 12 occurred in the Upland Management Area. The likely groundwater dependent special-status plants in the Fringe Management Area mostly were observed in or around the Springtown Alkali Sink.[18]

Thirty-one special-status terrestrial and aquatic wildlife species were identified as having the potential to occur within the Basin, including the Crotch bumble bee, Southwestern pond turtle, and American peregrine falcon. Of these, 14 were potentially groundwater dependent species: two amphibian species, two reptile species, seven bird species, and three mammal species. Additional information on these groundwater dependent species, including regulatory status and habitat associations, is provided in **Attachment B**. Ten of the groundwater dependent special status species are likely to occur in the Main Basin Management Area, eight of the groundwater-dependent special status species are likely to occur in the Fringe Management Area, and 13 of the groundwater-dependent special status species are likely to occur in the Upland Management Area.[19]

1.2. Identification of Interconnected Surface Water Locations

EKI performed various statistical and geospatial analyses to identify locations in the Basin where surface water bodies (e.g., streams) are likely interconnected to shallow groundwater. A summary of this work effort is presented below and in **Attachments C and D**.

1.2.1. Preliminary Screening

Information regarding the locations of streams within the Basin was provided by Zone 7 and are shown on **Figure 7**. EKI conducted a preliminary screening of potential ICSW locations as further described below.

Data Sources

The primary data sources that were incorporated into the analyses include the following:

- Stream mapping provided by Zone 7;
- Stream daily flow data and gauge height between 2015 and 2020 provided by Zone 7;
- Stream recharge rates shapefile provided by Zone 7 based on synoptic surveys;
- Groundwater elevation and depth to water data provided by Zone 7;
- Stream cross sections provided by Zone 7; and

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[17] EACCS website, http://eastalco-conservation.org/about.html.

[18] Stillwater 2021, Technical Memorandum: Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin, dated 17 May 2021.

[19] Ibid.

- Guidance document from Environmental Defense Fund (EDF),[20] USGS,[21] and UC Berkeley.[22]

Physical and Operational Exemptions

Artificial stream sections (i.e., those that have been channelized and lined with concrete) were excluded from the depth to groundwater analysis discussed below that was used to identify potential ICSW. Similarly, stream sections that overlie the Overburden layer were excluded. The Overburden layer consists of a thick, continuous surficial lens of clay reaching up to 70 feet thickness that precludes connection to the Upper Aquifer, and mainly exists in the Main Basin Management Area and extends from the north central portion of the Basin to the western edge of the Basin.

Although in its comment letter the DWR identified the Chain of Lakes (COL) as a potential ICSW feature, as stated in the 2016 Alt GSP, "Ongoing mining and reclamation are changing to some degree the connection between upper and lower aquifers and surface water, as some areas are capped or filled (thus reducing connection), and as excavation of wet pits effectively creates surface water ponds. However, no GDEs exist in the mining area and the surface water pits are not identified for specific beneficial uses in the Basin Plan. Releases of water for recharge along the arroyos have resulted in dry season flows in the arroyos; however, these are flows are relatively warm and not equivalent to cool pre-mining flows that could support some native species." Therefore, COL is also excluded from ICSW consideration.

Depth to Groundwater Analysis

The relationship between groundwater and surface water largely depends upon the depth to groundwater relative to the streambed depth. For groundwater to be interconnected with a stream channel, the depth to groundwater in the vicinity of the stream must be less than the streambed depth. Conversely, for surface water to seep to groundwater, which indicates disconnectivity between surface water and groundwater, the depth to groundwater in the vicinity of the stream must be deeper than the streambed depth.

Based on review of the stream cross section profiles provided by Zone 7, the maximum streambed depth of the streams within the Basin is approximately 30 feet. As such, if the minimum depth to groundwater between 2015 and 2020 in the vicinity of the stream sections is more than 30 ft bgs, it is unlikely that the mapped stream sections are interconnected with groundwater. Conversely, if the depth to groundwater is less than 30 ft bgs along the stream sections, the groundwater and stream sections are likely to be interconnected. Upper Aquifer groundwater elevation rasters between 2015 and 2020 were provided by Zone 7, and the depth to groundwater rasters were generated by subtracting the groundwater elevation rasters from the ground surface elevation raster. Depth to groundwater estimates in the vicinity of the mapped streams were made at 500 foot intervals along the length of the mapped streams.

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[20] EDF, 2018. *Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act*, dated August 2018.

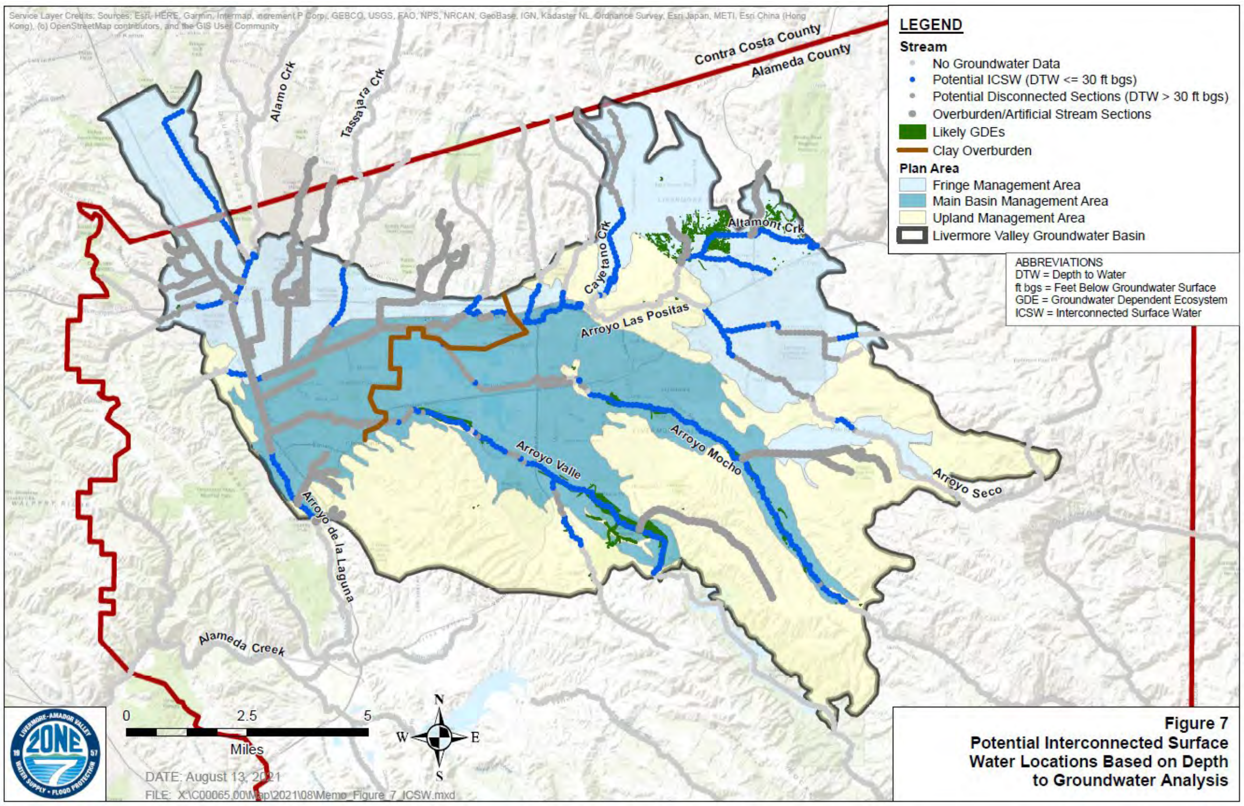
[21] Winter et al., 1998. *Ground Water and Surface Water: A Single Resource*. USGS. Dated 1998.

[22] Cantor et al., 2018. *Navigating Groundwater-Surface Water Interactions under the Sustainable Groundwater Management Act*. Center for Law, Energy & the Environment, UC Berkeley School of Law. Dated March 2018.

Additionally, Zone 7 has conducted synoptic surveys to identify the reaches of major streams in the Basin and whether they are gaining or losing, and what the respective rates are, as shown on Figure 2-4 of the 2016 Alt GSP (**Attachment C**).

Based on the above data and analysis, locations of potential ICSW locations are shown on **Figure 7**.

Figure 7. Potential Interconnected Surface Water Locations Based on Depth to Groundwater Analysis



Correlation Analysis

SGMA requires that the sustainability criteria of the ICSW Sustainability Indicator be developed based on the "…rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water..."[23] Alternatively, groundwater levels can be used as a proxy.[24]

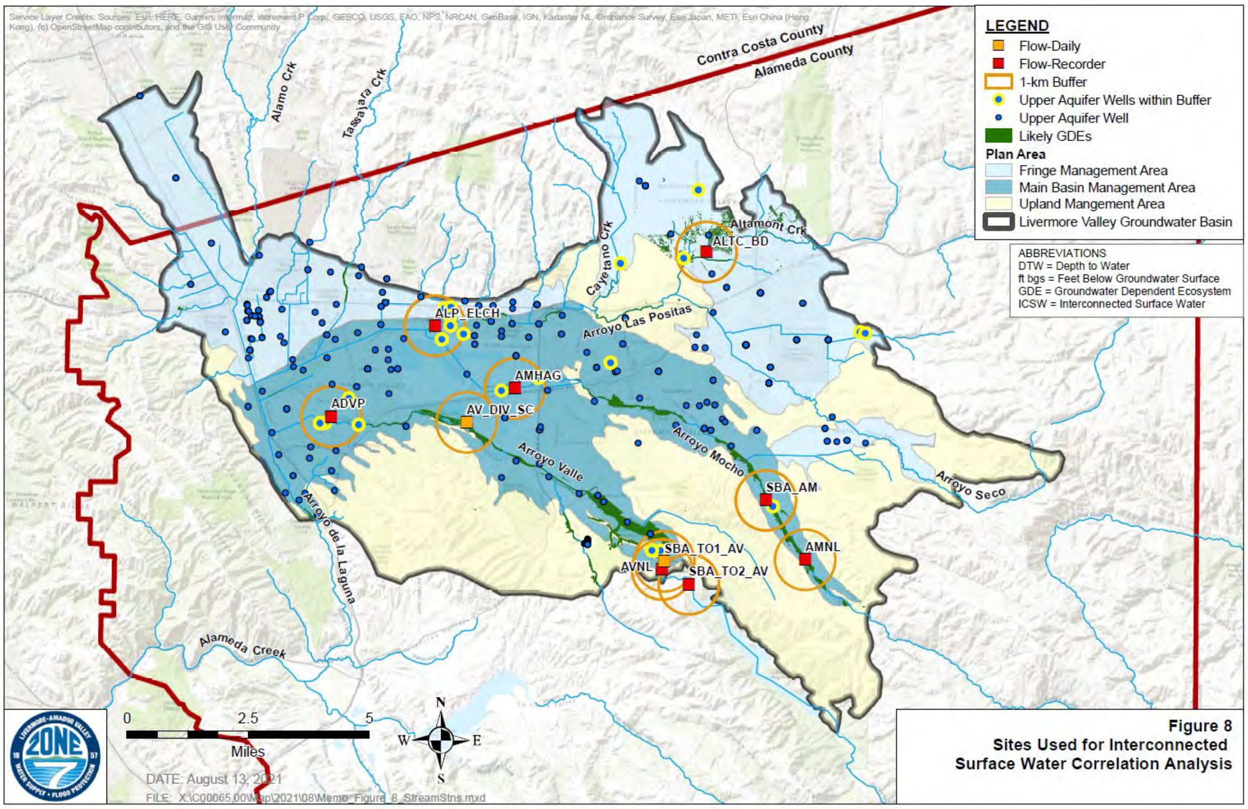
Based on the above, the potential correlation between Upper Aquifer groundwater elevation and streamflow data, including gauge height and flow rate, were evaluated to examine whether the portions of the streams that were identified as likely ICSW have a quantifiable relationship to the principal aquifer. Stream gauging stations along potential ICSW sections and near likely GDEs (from **Figure 7** and

[23] § 354.28(b)(6)

[24] § 354.28(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence

Attachment C) were selected for the correlation analysis, as shown on **Figure 8**. Zone 7 provided daily flow data and gauge height between 2015 and 2020 for the selected stations.

Figure 8. Sites Used for Interconnected Surface Water Correlation Analysis

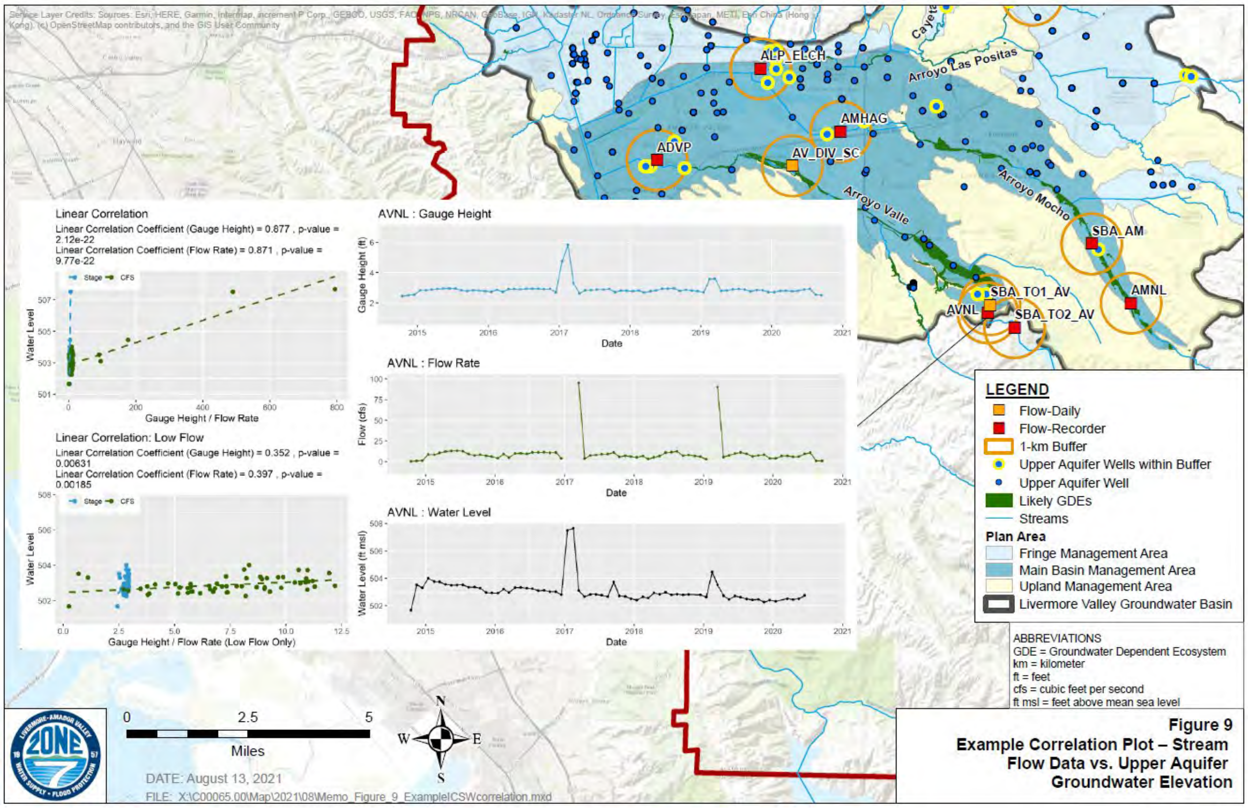


Upper Aquifer wells within a one km radius of the selected stream gauging stations were assumed to be representative of groundwater conditions in vicinity of the stations. If multiple wells were associated with (i.e., within one km of) a stream gauging station, average groundwater elevations from these wells were calculated. The Upper Aquifer wells within the one km buffer of each selected stream gauging station are shown on **Figure 8**. Since most of the groundwater elevations were measured monthly, monthly average flow data and gauge height were calculated.

Time series data of the gauge height and flow rate were plotted for each stream gauging station, as shown on **Figure 9** and in **Attachment D**. A linear correlation between the stream flow data (gauge height and flow rate) and the local groundwater elevation was then evaluated for each station. A positive correlation would mean that, when the gauge height or flow rate increases, the groundwater elevation also increases, indicating that there is potential interconnectivity between the stream and groundwater, and vice versa.

As part of its active management of the Basin, Zone 7 imports surface water from the State Water Project (SWP) through the South Bay Aqueduct (SBA) for treatment, storage, and groundwater recharge. Since the streams within the Basin are also used for artificial recharge, correlation between low flow, which better represents the natural streamflow conditions, and Upper Aquifer groundwater elevation was also performed. Low flow data for each stream gauging station were obtained by removing the gauge height and flow rate data that fell outside of the 90th percentile[25]. The low flow correlation result for each stream gauging station is also shown on **Figure 9** and in **Attachment D**.

Figure 9. Example Correlation Plot – Stream Flow Data vs. Upper Aquifer Groundwater Elevation



Among the selected stream gauging stations (i.e., stations located along potential ICSW and near likely GDEs), only the AVNL station exhibited statistically significant positive correlations between streamflow data (gauge height and flow rate) and groundwater elevation data.[26] The ADVP station also showed a low but statistically significant positive correlation for low flow conditions only. Groundwater elevation measurements from the wells located close to the other stream gauging stations are generally collected biannually, and thus there is insufficient groundwater elevation data to support statistically significant correlation between groundwater levels and monthly average stream flow data. This data gap is addressed further under **Section 2**.

For the AVNL station, the correlation using all stream flow data has a larger correlation coefficient and smaller p-value than those for the correlation using low flow data only (i.e., for all stream flow data, correlation coefficients and p-values are 0.88 and 2.1e-22 for gauge height, 0.87 and 9.8e-22 for flow rate; for low flow data, the correlation coefficients and p-values are 0.35 and 0.006 for gauge height, 0.40 and 0.002 for flow rate). The AVNL station is located along Arroyo Valle and near the location where imported

[25] Ratio of high flow events to low flow events is approximately 1:9 in most of the stream stations, and therefore 90th percentile is used as a threshold to retain low flow data.

[26] For the purpose of this analysis, correlation with a p-value that is less or equal to 0.05 is considered to be significant.

SWP water is released into the stream. Nearby likely GDEs (Sycamore Grove located in the southeastern portion of the Basin) have been documented to rely on the released imported water for artificial recharge,[27] which is also reflected in the higher correlation for all flow data (i.e., during active Zone 7 recharge operations).

Additionally, cross-correlation was performed for the AVNL station data to examine whether a time lag exists between the stream flow data and shallow groundwater elevations.[28] The cross-correlation result shows that maximum correlation is reached when time lag equals zero months and the correlation is significant, which indicates that limited time lag exists between the stream flow data and groundwater elevations for the AVNL station.

1.3. GDE and ICSW Program Update

Based on the above analyses and field investigation, the Basin includes approximately 1,052 acres of likely GDEs, which encompass approximately 2% of the total Basin area. The most prevalent vegetation communities across all likely GDE units are the riparian mixed hardwood alliance, California sycamore alliance, and the Alkaline mixed grasses and forbs alliance. Most of the likely GDEs are located along the Arroyo Valle and Arroyo Mocho creeks in the Main Basin Management Area and around Altamont Creek in the Fringe Management Area.

Likely ICSW sections have also been identified along several reaches of the major surface water features within the Basin, including Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, and Altamont Creek. Unsurprisingly, most of the areas where potential ICSW sections occur also support likely GDEs, as these stream corridors consistently encounter some of the shallowest groundwater elevations observed within the Basin, see **Figure 7**.

Where sufficient data and ICSW conditions exist, groundwater levels in the Upper Aquifer can be correlated to ICSW conditions and GDE locations. As such, Upper Aquifer wells and the selected stream gauging stations can serve as the representative monitoring sites for purposes of SGMA implementation, and sustainability criteria that are protective of both GDEs and ICSW can be developed using groundwater levels as a proxy.

2. GDE AND ICSW MONITORING NETWORK

This section describes the existing and proposed Monitoring Network for areas of the Basin that have likely GDEs and/or ICSW reaches. As mentioned above, the locations of likely GDE communities within the Basin are largely coincident with the presence of ICSW reaches, given that both GDEs and ICSW are supported by shallow local groundwater conditions. As such, the proposed ICSW Monitoring Network presented in this section is designed to provide a “dual benefit” of: (1) assessing ongoing surface water - shallow groundwater connectivity within ICSW reaches, as well as (2) supporting monitoring of groundwater conditions that are one of the factors that can contribute to the health of nearby GDE communities.

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[27] Zone 7, 2009. Phase 2 Technical Report: Sycamore Grove Recovery Program, Sycamore Grove Park, Livermore, California, dated December 2009.

[28] Cross-correlation is a measurement that tracks the movements of two or more sets of time series data relative to one another.

2.1. Existing Monitoring Locations

Zone 7 has about 240 program wells for the groundwater elevation monitoring program in order to track groundwater levels and flow, identify short- and long-term trends, estimate subsurface flow between Management Areas, and support water budget and storage analyses.[29] Among the 240 program wells, about 110 wells are Upper Aquifer wells, as shown on **Figure 10**. The program wells are measured at least biannually. Water level measurements are also taken monthly in several wells to track performance of recharge and pumping operations and groundwater conditions. Figure 2-17 and Appendix C-1 of the 2016 Alt GSP show the location and well construction information of the program wells. Two wells (2S2E34E001 and 2S2E27P002) are currently used for monitoring of Springtown Alkali Sink, which is one of the likely GDE areas (see **Table 1** and **Figure 6**).

Zone 7 monitors also streamflow within the Basin and has a stream monitoring program that includes 15 stream gauging stations that record flow data at 15-minute intervals. Figure 4-2 and Table 4-3 of the 2016 Alt GSP show the location and detail of the stations.

In addition to the existing network, as part of the development of the 2022 Plan, Zone 7 has identified and secured access to additional well sites. Several of these new wells have been identified as candidates for the ICSW Monitoring Network; selected others will become program wells.

2.2. Proposed ICSW Monitoring Network

The objective of a SGMA Representative Monitoring Network is to collect sufficient data for the correct assessment of the Sustainability Indicators relevant to the Basin, and the impacts to the beneficial uses and users of groundwater.[30] The proposed SGMA Representative Monitoring Network for Depletions of Interconnected Surface Water (RMN-ICSW) is therefore comprised of selected Upper Aquifer program wells, new wells, and stream gauging stations along the ICSW reaches and near the likely GDEs identified in **Section 1.1.2**.

In developing the RMW-ICSW, the EDF guidance, which recommends a monitoring location every four to six miles along an ICSW stream for a "reasonable balance between rigor and practicality" was considered.[31] Upper Aquifer wells with a long period of record and located in close proximity to a stream gauging station were preferentially selected and a higher density of monitoring wells was selected in some likely ICSW reaches to sufficiently cover nearby likely GDEs within the Basin.

Figure 10 shows the RMN-ICSW, including both representative monitoring wells and representative stream gauging stations. **Table 2** shows the monitoring network details, including the nearby likely GDEs, nearby stream gauging stations, monitoring methods, monitoring frequency, and well construction information. In total 14 wells and 10 stream gauging stations have been selected as part of the RMN-ICSW, where data will be collected manually every month, semi-annually, or using data loggers every 15 minutes, depending on the site.[32] These data will be evaluated annually to assess the correlation between

[29] Zone 7, 2016. Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin, dated December 2016.

[30] Pursuant to § 354.32

[31] Hall et al., 2018. *Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act. Environmental Defense Fund.* Dated 2018.

[32] Two of the wells (3S1E16P005 and 3S2E30D002) currently have data loggers installed.

shallow groundwater levels and GDE health and ICSW flow rates to confirm that groundwater levels can serve as an appropriate proxy for purposes of developing and applying sustainability criteria. Monitoring frequency will be re-evaluated if groundwater levels decline below their Minimum Thresholds (MT) in the RMN-ICSW monitoring wells.

In addition to monitoring the proposed RMN-ICSW, Zone 7 plans to perform periodic visual inspections to monitor the health of likely GDEs and ICSW conditions. Visual inspections will be either examination of areal images or field investigation, or a combination thereof. Bi-annual or monthly monitoring of the remaining Upper Aquifer program wells will also continue, which will provide additional data and perspective on shallow aquifer conditions within the Basin.

Figure 10. Proposed Representative Monitoring Network for Depletions of Interconnected Surface Water

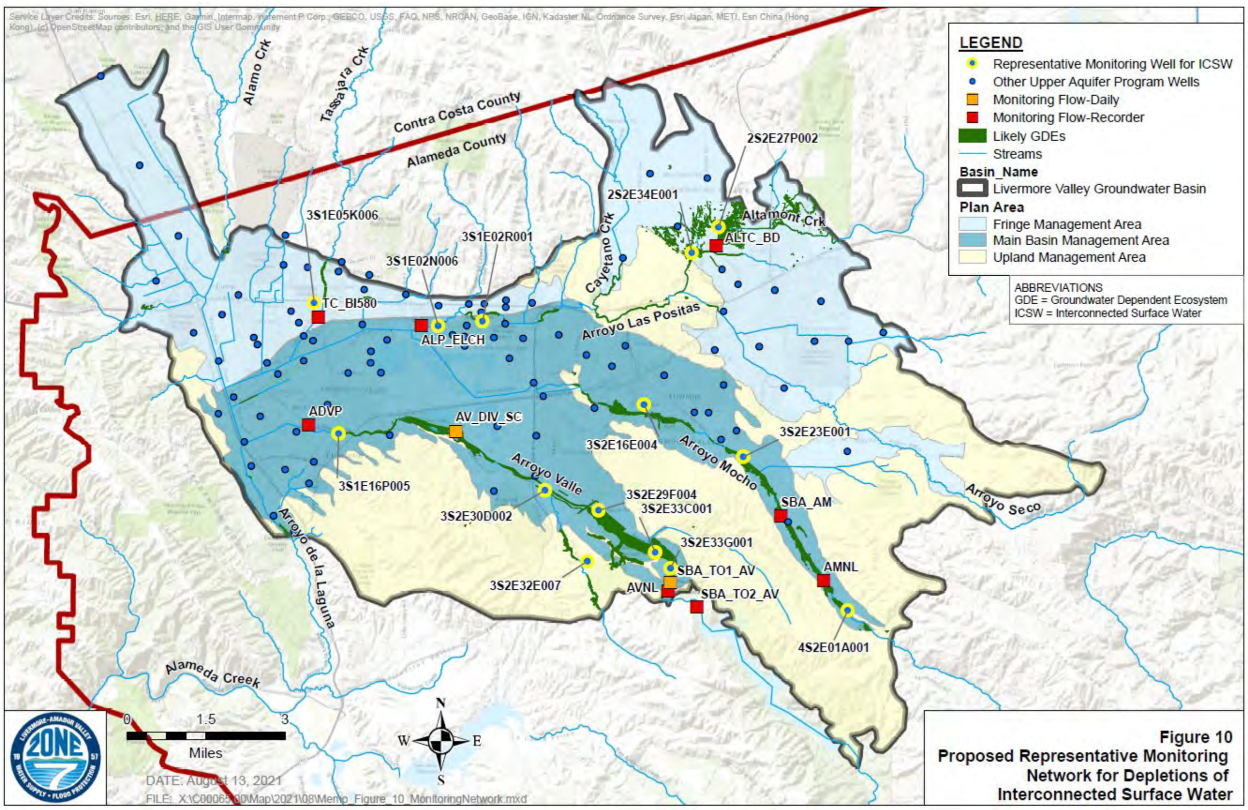

Table 2. Proposed Representative Monitoring Network for Depletions of Interconnected Surface Water Details

Well Name	Well Type	Nearby GDE	Nearby ICSW	Nearby Stream Station (<=1km)	Monitoring Method	Monitoring Frequency	RP Elev (ft msl)	Top Perf (ft bgs)	Bot Perf (ft bgs)	Well Depth (ft bgs)
2S2E27P002	Program Well	Springtown Alkali Sink	Altamont Creek	ALTC_BD	Collect Manually	SemiAnnual	505.43	35	63	68
2S2E34E001	Program Well	Springtown Alkali Sink	Altamont Creek	ALTC_BD	Collect Manually	SemiAnnual	499.73	40	45	49
3S1E05K006	Program Well	TC-Riparian Mixed Hardwood	Tassajara Creek	TC_BI580	Collect Manually	SemiAnnual	346.05	40	70	75
3S2E30D002	Program Well	AV-Riparian Mixed Hardwood	Arroyo Valle	--	Logger (existing)	15 Minutes	431.6	24	39	44
3S1E16P005	Program Well	AV-Riparian Mixed Hardwood	Arroyo Valle	ADVP	Logger (existing)	15 Minutes	354.51	64	69	75
3S2E33G001	Program Well	AV-Sycamore Grove	Arroyo Valle	AVNL, SBA_TO1_AV, SBA_TO2_AV	Collect Manually	Monthly	511.52	9	14	17
3S2E29F004	Program Well	AV-Sycamore Grove	Arroyo Valle	--	Collect Manually	Monthly	457.50	26	31	36
3S2E33C001	New Program Well (Monitoring)	AV-Sycamore Grove	Arroyo Valle	--	Collect Manually	SemiAnnual	493.23	5	20	20
3S1E02R001	Program Well	ALP-Mixed Vegetation	Arroyo Las Positas	--	Collect Manually	SemiAnnual	376.29	21	26	33
3S1E02N006	Program Well	ALP-Mixed Vegetation	Arroyo Las Positas	ALP_ELCH	Collect Manually	SemiAnnual	366.14	40	55	55
3S2E16E004	Program Well	AM-Riparian Mixed Hardwood & Sycamore	Arroyo Mocho	--	Collect Manually	SemiAnnual	506.26	35	40	45
3S2E23E001	Program Well	AM-Valley Oak	Arroyo Mocho	--	Logger (to be added)	15 Minutes	613.36	20	35	40
4S2E01A001	New Program Well (Ag)	AM-Valley Oak	Arroyo Mocho	AMNL	Collect Manually	SemiAnnual	819.76	45	130	150
3S2E32E007	Program Well	Upland-Riparian Mixed Hardwood	Vineyard Creek	--	Collect Manually	SemiAnnual	610.94	19	34	37

Table 2. Proposed Representative Monitoring Network for Depletions of Interconnected Surface Water (Cont.)

Station ID	Measures	Nearby GDE	Nearby ICSW	Flow Frequency	Gauge Height	Flow Rate
ALTC_BD	Streamflow	Springtown Alkali Sink	Altamont Creek	15 Min	x	x
ALP_ELCH	Streamflow	ALP-Mixed Vegetation	Arroyo Las Positas	15 Min	x	x
ADVP	Streamflow	AV-Riparian Mixed Hardwood	Arroyo Valle	15 Min	x	x
AV_DIV_SC	Diversion From AV	AV-Riparian Mixed Hardwood	Arroyo Valle	Daily	-	x
AVNL	Streamflow	AV-Sycamore Grove	Arroyo Valle	15 Min	x	x
SBA_TO1_AV	Release into AV	AV-Sycamore Grove	Arroyo Valle	15 Min	-	x
SBA_TO2_AV	Release into AV	AV-Sycamore Grove	Arroyo Valle	15 Min	-	x
SBA_AM	Release into AM	AM-Valley Oak	Arroyo Mocho	15 Min	-	x
AMNL	Streamflow	AM-Valley Oak	Arroyo Mocho	15 Min	x	x
TC_BI580	Streamflow	Tassajara Creek - Riparian Mixed Hardwood	Tassajara Creek	15 Min	x	x

2.3. Data Gap Filling Activities

Zone 7 uses Arroyo Valle and Arroyo Mocho for artificial recharge of the Basin using imported SWP water. Currently two representative monitoring wells, 3S2E30D002 and 3S1E16P005 along Arroyo Valle, have automatic dataloggers installed that collect data at 15-minute intervals. In addition, to better evaluate the relationship between the Upper Aquifer groundwater elevations and the stream flow data collected along the Arroyo Mocho, Zone 7 plans to install dataloggers in well 3S2E23E001.

Additional analyses that may help further characterize the degree of connectivity between stream reaches and the underlying principal aquifer system include installation of additional data loggers, pumping tests, geophysical investigations, and tracer studies within potential ICSW reaches and nearby GDE communities. Zone 7 will evaluate these data gap filling activities prior to the 2027 Alt GSP update.

3. GROUNDWATER DEPENDENT ECOSYSTEM DEMANDS

Quantifying groundwater consumptive use from GDEs can be estimated using a soil moisture balance model. Evapotranspiration (ET) uptake from groundwater occurs when the saturated groundwater table is accessible by the root zone of a GDE or is within a small enough depth below the root zone such that groundwater can be accessed via capillary rise. As part of this work effort, EKI has utilized DWR's Integrated Water Flow Model Demand Calculator (IDC) soil moisture balance model to provide initial estimates of ET uptake from groundwater for the GDE communities identified in the above analyses. The IDC employs the "Root Water Uptake" package to simulate shallow groundwater uptake by GDE communities to meet ET demands[33]. In its current form, the Zone 7 IDC model explicitly simulates shallow groundwater uptake from the five largest and most contiguous GDE communities identified in the Basin, including:

- Arroyo Valle - Riparian Mixed Hardwood
- Arroyo Valle - Sycamore Grove
- Arroyo Mocho - Riparian Mixed Hardwood & Sycamore
- Arroyo Mocho - Valley Oak
- Springtown Alkali Sink

These GDE communities collectively comprise approximately 925 acres, or roughly 90% of the total mapped GDE areas within the Basin.

Based on IDC model outputs for DWR Water Years 2011 – 2020, approximately 2,900 acre-feet per year (AFY) of shallow groundwater are consumed by GDE communities to help meet ET demands, equating to approximately 3.0 AF/acre. This represents roughly 70% of the total potential ET demand estimated for GDEs within the Basin (~4.3 AFY/acre) [34]. Given the considerable uncertainties in soil properties, shallow groundwater availability, and plant-specific groundwater uptake rates embedded in this calculation, a

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[33] Dogrul, E.C., Kadir, T.N. (DWR). 2020*. IWFM Demand Calculator, IDC-2015. Theoretical Documentation and User's Manual.*

[34] Based on local CIMIS station reference evapotranspiration (ETo) data and monthly riparian/native vegetation ET coefficients provided by DWR's Cal-SIMETAW model for the Livermore study area.

more reasonable range of average GDE groundwater demands within the Basin is likely somewhere between 2,000 AFY (~2 AFY/acre) and 4,000 AFY (~4 AFY/acre).

4. SUSTAINABLE MANAGEMENT CRITERIA

The SGMA legislation defines a "Sustainability Goal" as "the existence and implementation of one or more groundwater sustainability plans [GSPs] that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield".[35] The SGMA requires Groundwater Sustainability Agencies (GSAs) to develop and implement GSPs to meet the Sustainability Goal[36] and defines terms related to achievement of the Sustainability Goal, including:

- Measurable Objective (MO) – "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin";[37]
- Minimum Threshold (MT) – "a numeric value for each sustainability indicator used to define undesirable results";[38] and
- Interim Milestone (IM) – "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan".[39]

Collectively, the Sustainability Goal, IMs, MOs, and MTs are referred to herein as Sustainable Management Criteria (SMCs).

This section describes the proposed SMCs for Depletions of Interconnected Surface Water, including the Undesirable Results (URs), MOs and MTs for areas of the Basin that have confirmed GDEs and/or ICSW. These SMCs were developed in consideration of the California Water Code (CWC) §10727.2(b)(4) which states that the Plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015. It is further noted that the GSP Emergency Regulations (23-CCR § 354.28(c)) state that the SMCs for a given Sustainability Indicator can be set by using groundwater levels as a proxy, which is the approach utilized herein.

4.1. Undesirable Results

Undesirable Results are defined in the SGMA as "when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin". For Depletions of Interconnected Surface water, SGMA defines an UR as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water".[40]

[35] CWC § 10721(u)
[36] CWC § 10727(a)
[37] 23 CCR § 351(s)
[38] 23 CCR § 351(t)
[39] 23 CCR § 351(q)
[40] CWC § 10721(x) (6)

As shown in **Attachment E**, based on information provided by TNC,[41] the area-weighted average change in the size of the GDE areas between 2014 and 2018 within the Basin was approximately 40% (i.e., the mapped GDE area in 2014 was 40% smaller than the GDE areas mapped in 2018).[42] Based on this change in GDE area analysis, a 40% reduction in GDE area is within the historical range of GDE area fluctuation under recently-observed, post-SGMA hydrologic conditions.

As such, the URs for Depletions of ICSW would be experienced in the Basin when groundwater extractions in the Basin cause significant and unreasonable depletions of hydrologically connected surface water, such that beneficial uses and users of the surface water (including the likely GDEs and protected species) are significantly and unreasonably harmed. Specifically, a significant and unreasonable negative effect would be experienced if the health of the GDE areas in the Basin are adversely impacted by mechanisms that can be directly attributed to pumping-related lowering of groundwater levels over time, rather than effects of natural or climactic processes and/or unfavorable hydrologic conditions or land use changes.

This Undesirable Result definition is preliminary pending the collection of additional data. At this time, as described above, the relationship between ICSW, GDE health and groundwater conditions has not been definitively determined and the ability of Zone 7 to manage the ICSW and GDE areas is limited given the significant other factors that impact their occurrence and health (e.g., climate, hydrology, invasive species, land development, etc.). Furthermore, if groundwater levels in the vicinity of ICSW (and the co-located GDEs) remain too high, Zone 7's ability to actively manage the Basin through recharge operations will be negatively impacted. Consideration of all the above was included as part of the development of the SMCs. Zone 7 will continue to monitor the ICSW and GDE areas and may refine the definition of URs once the information regarding the relationship between the occurrence of ICSW and GDEs and the management of the Basin is better understood.

4.1.1. Potential Causes of Undesirable Results

Depletions of Interconnected Surface Water are generally correlated to Chronic Lowering of Groundwater Levels in a system of ICSW and groundwater. Therefore, the potential causes of URs for the Depletions of Interconnected Surface Water are generally the same as the potential causes for URs due to Chronic Lowering of Groundwater Levels, including increased groundwater pumping and reduced recharge. Additional causes directly related to surface water bodies can also influence depletions including, but not limited to, hydrology, increased diversions, reduced return flows, and water consumption by riparian vegetation. Additional causes related to GDEs can include hydrology, land use changes and the occurrence of invasive species, among other things. Currently there are little to no quantitative data regarding the impacts from these potentially contributing causes to ICSW and GDEs within the Basin.

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[41] Statewide raster data that show NDVI trends are provided by TNC on 30 August 2021. Since NDVI is used to estimate vegetation greenness and provides a proxy for vegetation growth, change in GDE area can be estimated using TNC GDE Pulse raster data that shows the NDVI trends between 2014 and 2018. Moderate to large increases in NDVI trends represent an increase in the GDE area and moderate to large decreases in NDVI trends represent a decrease in the GDE area. Therefore, the change in GDE area can be estimated by subtracting GDE area with decreasing NDVI trends from GDE area with increasing NDVI trends.

[42] Since the Plan is not required to address undesirable results that occurred before, and have not been corrected by January 1, 2015 (Water Code Section 10727.2 (b)(4)), 2014 is selected as the start of the analysis timeframe. 2018 is selected as the end of the analysis timeframe since it is a recent wet year when GDE conditions might be above average.

4.1.2. Criteria Used to Define Undesirable Results

Per Section 354.26(b)(2) of the GSP Emergency Regulations, the description of Undesirable Results must include a quantitative description of the combination of MT exceedances that constitute an UR. The MTs for Depletions of Interconnected Surface Water are described below in **Section 4.2.1**.

Based on application of the MTs at the Representative Monitoring Network for Interconnected Surface Water (RMN-ICSW) and the significant and unreasonable negative effect discussed above, URs will be experienced if and when Depletions of Interconnected Surface Water occur as a result of unsustainable groundwater extraction such that groundwater levels decline below their MTs in the Representative Monitoring Sites (RMSs) for more than two consecutive non-drought years.

This UR criteria is preliminary pending the collection of additional data. At this time, as described above, the relationship between ICSW, GDE health and groundwater conditions has not been definitively determined and the ability of Zone 7 to manage the ICSW and GDE areas is limited given the significant other factors that impact their occurrence and health (e.g., climate, hydrology, invasive species, land development, etc.). Furthermore, if groundwater levels in the vicinity of ICSW (and the co-located GDEs) remain too high, Zone 7's ability to actively manage the Basin through recharge operations will be negatively impacted. Consideration of all the above was included as part of the development of the SMCs. Zone 7 will continue to monitor the ICSW and GDE areas and may refine the criteria used to determine URs once the data gaps are filled, additional information are gathered and the relationship between the occurrence of ICSW and GDEs and the management of the Basin is better understood.

4.1.3. Potential Effects of Undesirable Results

Potential effects of URs for Depletion of Interconnected Surface Water may include impacts to environmental users, such as likely GDEs, critical habitat for federally listed species, special-status plants, and special-status terrestrial and aquatic wildlife species, as discussed in **Section 1.1.2**. Furthermore, there may be reduced surface water flows to support downstream or in-stream uses. Conversely, if groundwater levels in the vicinity of ICSW (and the co-located GDEs) remain too high, Zone 7's ability to actively manage the Basin through recharge operations will be negatively impacted. Consideration of all the above was included as part of the development of the SMCs.

4.2. Minimum Threshold, Measurable Objective, and Interim Milestones Development

The sections below discussed the development of MOs, IMs, and MTs for Depletions of Interconnected Surface Water.

The GSP Emergency Regulations (23 CCR 354.28(c)) state that the MT for Depletions of Interconnected Surface Water "shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial users of the surface water and may lead to undesirable results". Based on the analysis presented in **Sections 1.1** and **1.2**, where sufficient data are available and ICSW conditions exist, a reasonable correlation exists between groundwater levels in the monitoring wells included in the RMW-ICSW. As such, for the purposes of developing SMCs, water levels in those monitoring wells are used as a proxy for developing the MTs.

4.2.1. Minimum Threshold

MTs are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause URs for that indicator or for other indicators by proxy. This section describes the MTs that have been developed to avoid URs related to the of Depletions of Interconnected Surface Water in the Basin.

Water levels are considered reasonably effective (and the best available) criteria because they can be utilized to help maintain conditions and instream flows that support environmental water users and, in the case of Zone 7, Basin recharge operations. A composite map of historic lows observed in the Upper Aquifer, as shown on Figure 3-1 of the Alt GSP, has been prepared by Zone 7. For several decades, Zone 7 has operated the Basin to maintain water levels above historic low levels throughout the Main Basin Management Area [without causing URs].[43] Water levels outside of the Main Basin Management Area have not fluctuated significantly over time, and no areas of significant downward trends [or areas with URs] have been identified.[44]

Generally consistent with the definition used for the MT for the Chronic Lowering of Groundwater Levels, the MT for the Depletions of Interconnected Surface Water is defined as the historic low water level at the wells included in the RMN-ICSW. The resultant MTs for the RMN-ICSW within the Basin are shown in **Table 3**. Where historical water level measurements are not available, estimated values at the RMWs are sourced from the groundwater elevation rasters developed by Zone 7 as discussed in **Section 1.2.1**. **Attachment F** shows the hydrograph and SMC for the Depletions of Interconnected Surface Water for each RMW-ICSW.

Currently there are no significant quantitative data representing negative impacts from the contributing causes identified in **Section 4.1.1** to ICSW and GDEs within the Basin. Therefore, historical groundwater conditions are concluded to be sufficient to sustain ICSW and GDEs within the Basin.

As discussed above, the 10 stream stations located along the potential ICSW within the Basin (as shown in **Table 1**) that are included in the RMN-ICSW will record either flow rates and/or gauge heights. These data, combined with water level measurements from the monitoring wells in the RMN-ICSW, will better quantify relationships between measured changes in groundwater levels and surface water flows that can help ensure that these MTs are protective and will allow for refinement of the SMC approach over time.

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[43] Zone 7, 2016. Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin, dated December 2016.

[44] Ibid.

Table 3. Sustainable Management Criteria for Depletions of Interconnected Surface Water

Well Name	Minimum Thresholds (ft msl)	Interim Milestones (ft msl)			Measurable Objectives (ft msl)
		IM-5	*IM-10*	*IM-15*	
2S2E27P002	501.0	501.0	501.0	501.0	501.0
2S2E34E001	491.2	492.1	492.4	492.7	493.0
3S1E05K006	326.0	328.2	328.2	328.2	328.2
3S2E30D002	401.0	403.8	404.7	405.6	406.5
3S1E16P005	285.2	285.2	285.2	285.2	285.2
3S2E33G001	501.0	501.1	501.2	501.2	501.3
3S2E29F004	437.8	441.2	442.3	443.5	444.6
3S2E33C001	482.1	484.2	484.8	485.5	486.2
3S1E02R001	345.3	349.4	350.8	352.2	353.6
3S1E02N006	331.5	333.9	333.9	333.9	333.9
3S2E16E004	466.9	466.9	466.9	466.9	467.0
3S2E23E001	595.4	595.4	595.4	595.4	595.4
4S2E01A001	781.2 (a)	781.2 (a)	781.2 (a)	781.2 (a)	781.2 (a)
3S2E32E007	591.4	591.4	591.4	591.4	591.4

Notes:

(a) RMW 4S2E01A001 is a new well and there are insufficient water level data to establish an MT, MO, and IM based on historical water levels. As such, initial MT, MO, and IM for these RMW are based on the minimum water level values sourced from 2014 to 2020 groundwater elevation rasters developed by Zone 7 for the Basin.

4.2.2. Measurable Objective and Interim Milestones

MO Determination

As described in the Sustainable Management Criteria BMP document, "Measurable Objectives should be set such that there is a reasonable margin of operation flexibility (or 'margin of safety'), between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities".[45]

The MOs for Depletion of Interconnected Surface Water were similarly developed based on measured groundwater levels in the monitoring wells included in the RMN-ICSW. Specifically, the MOs are equal to the minimum water levels measured between 2014 and 2020 at each RMN-ICSW, which represents the recent groundwater conditions that are protective of ICSW and GDEs following the adoption of SGMA. Where water level measurements between 2014 and 2020 are not available, estimated values at the RMWs are sourced from the groundwater elevation rasters developed by Zone 7 as discussed in **Section**

[45] DWR, 2017. Best Management Practices for the Sustainable Management of Groundwater, dated November 2017.

1.2.1. The hydrographs and SMCs for the Depletions of Interconnected Surface Water at each RMW-ICSW are shown in **Attachment F**.

Based on the defined MOs and MTs (**Table 3**), Zone 7 considers there to be a sufficient Margin of Operational Flexibility at each RMN-ICSW. Data collected regularly from the RMN-ICSW will better quantify relationships between measured changes in groundwater levels, surface water flows and GDE areas that can help ensure that these MOs are protective and will allow for refinement of the SMC approach over time.

IM Determination

Interim Milestones for Depletion of Interconnected Surface Water are defined herein based on a trajectory for groundwater levels informed by the groundwater level trends since 2015, MOs, and MTs. If the RMN-ICSWs have decreasing groundwater level trends since 2015, the IM for the first 5-year period is set as the average between MOs and MTs, and the IMs for the following three 5-year periods are set as groundwater elevations that are linearly interpolated between IM for the first 5-year period and the MO. This trajectory allows for and assumes a continuation of current groundwater level trends for the first 5-year period, and recovery towards the MOs over the following three 5-year periods. Conversely, if the RMN-ICSWs have increasing groundwater level trends since 2015, the subsequent IMs are all equal to the MOs. The IMs are presented in **Table 3** and the methodology used to develop them is shown in **Table 4**.

Table 4. Interim Milestone Trajectory for Depletion of Interconnected Surface Water

Calendar Year	Interim Milestone for Depletion of Interconnected Surface Water	Basis for Interim Milestone
2022	Not applicable	Not applicable
2027	IM-5	½ * (MO_{GWL}+ MT_{GWL})
2032	IM-10	$IM\text{-}5_{GWL}$ + 1/3 * (MO_{GWL}-$IM\text{-}5_{GWL}$)
2037	IM-15	$IM\text{-}5_{GWL}$ + 2/3 * (MO_{GWL}-$IM\text{-}5_{GWL}$)
2045	MO	MO_{GWL}

Where:

IM-5, IM-10, and IM-15 are the IM for Depletion of Interconnected Surface Water after 5 years, 10 years and 15 years respectively; and

MO and MT are the MO and MT for Depletion of Interconnected Surface Water defined previously.

ATTACHMENTS

Attachment A: Time Series Data and Correlation Plots by GDE Polygon

Attachment B: Technical Memorandum from Stillwater: Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin

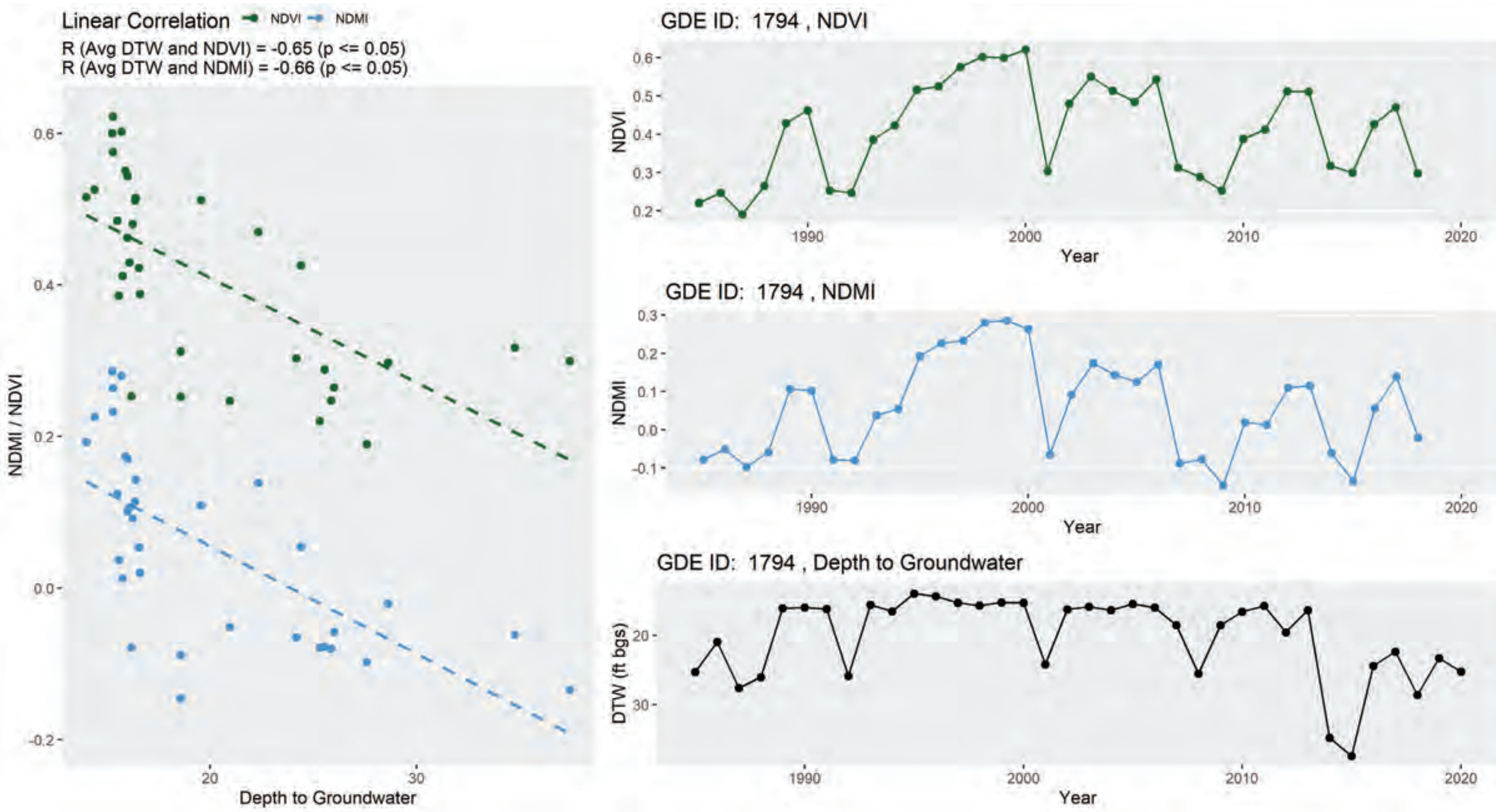
Attachment C: Surface Water Bodies and Monitoring Sites

Attachment D: Time Series Data and Correlation Plots by Stream Station

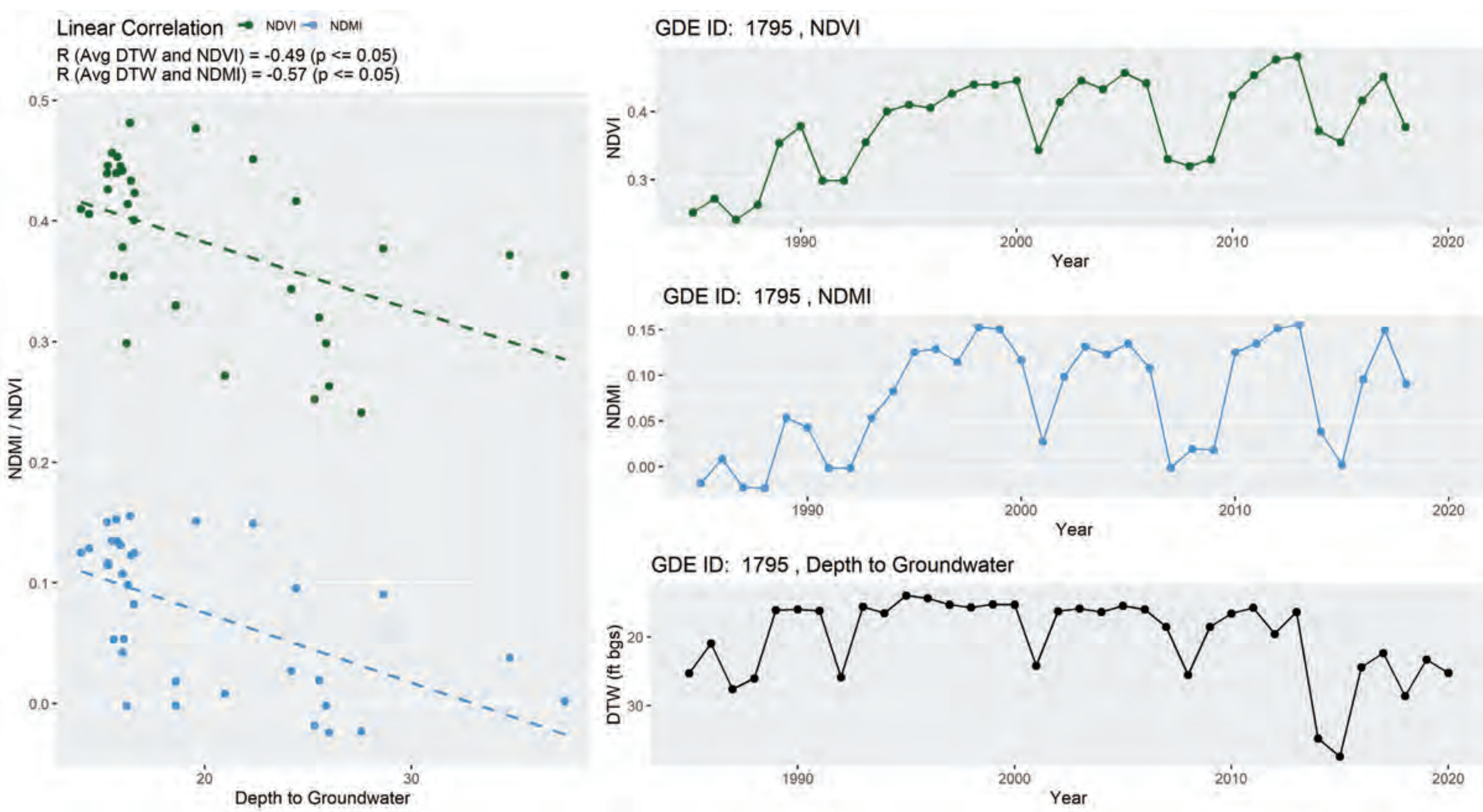
Attachment E: Change in GDE Area Analysis

Attachment F: Water Levels and SMC Plots by RMW-ICSW

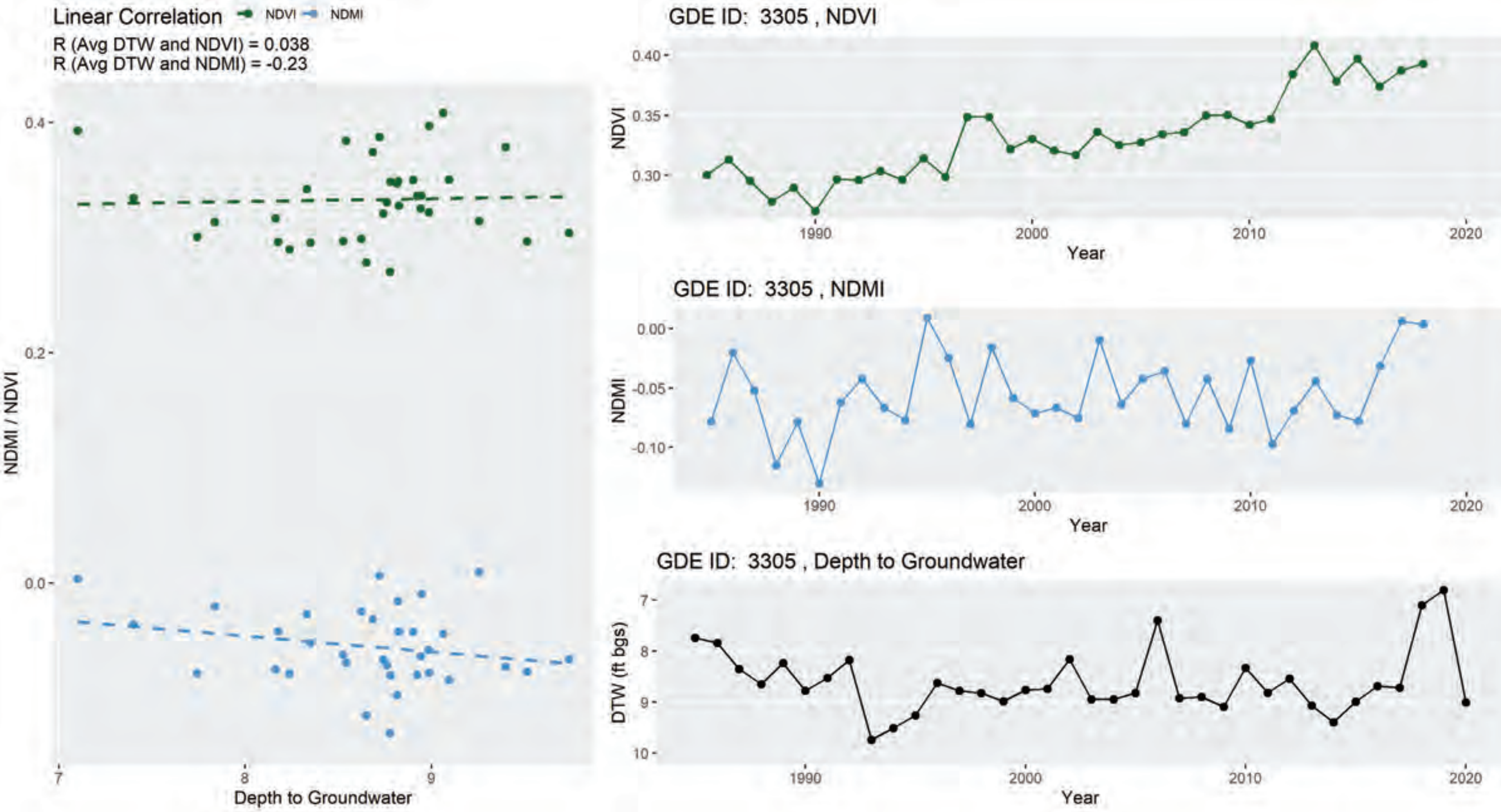
Attachment A: Time Series Data and Correlation Plots by GDE Polygon

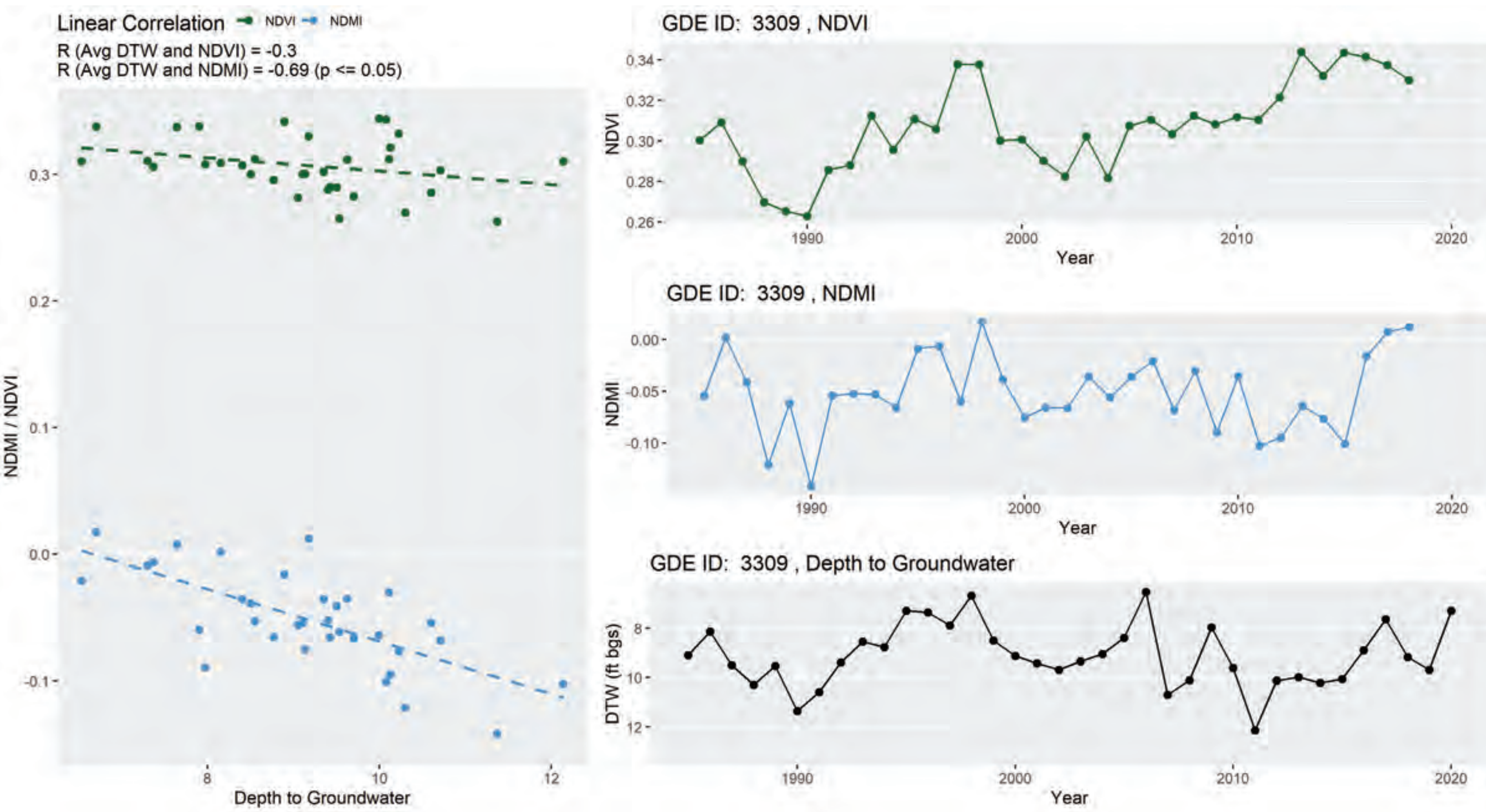


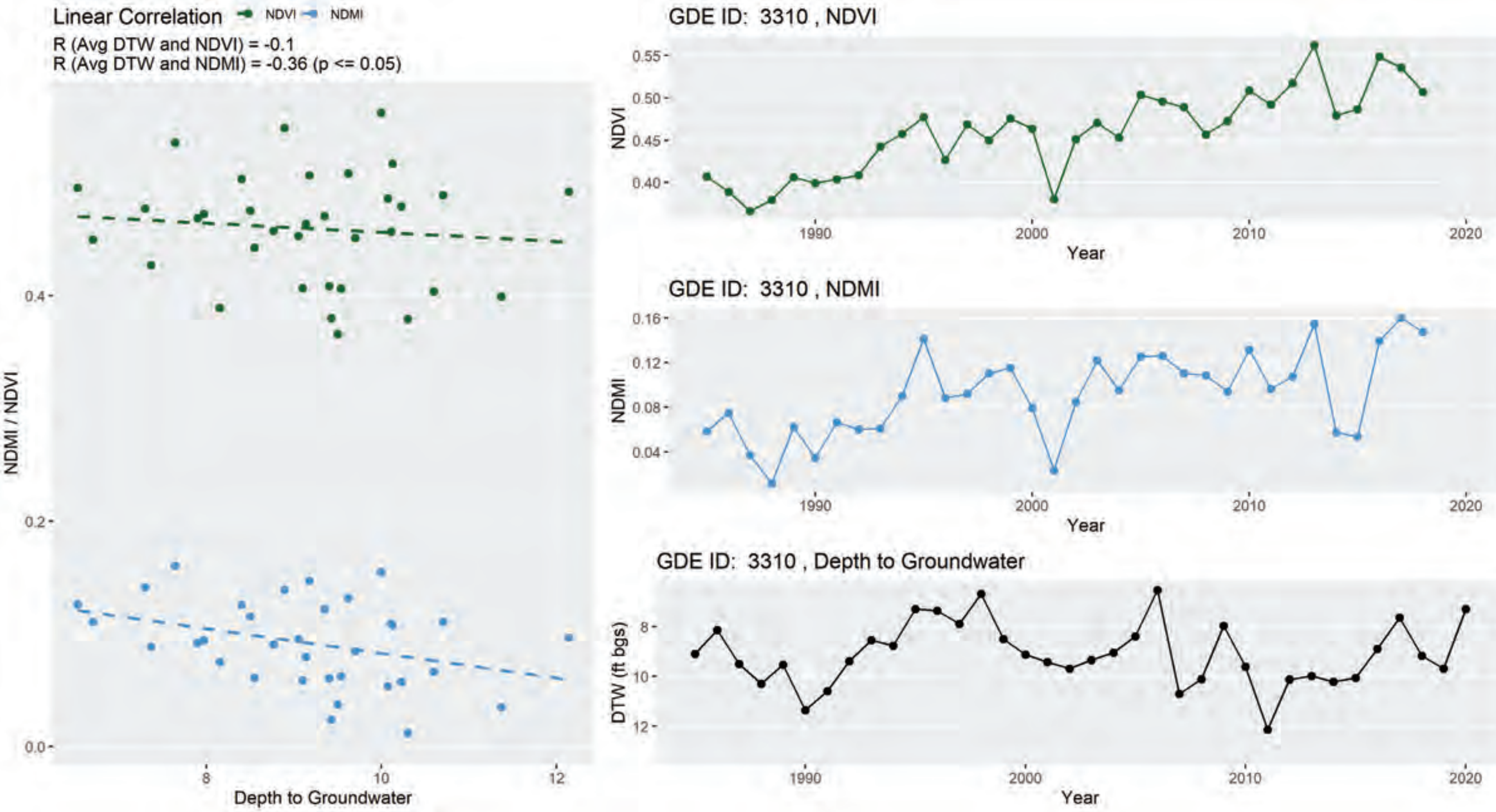
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.65 (p <= 0.05)
R (Avg DTW and NDMI) = -0.66 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 1794 , NDVI
NDVI
Year
GDE ID: 1794 , NDMI
NDMI
Year
GDE ID: 1794 , Depth to Groundwater
DTW (ft bgs)
Year

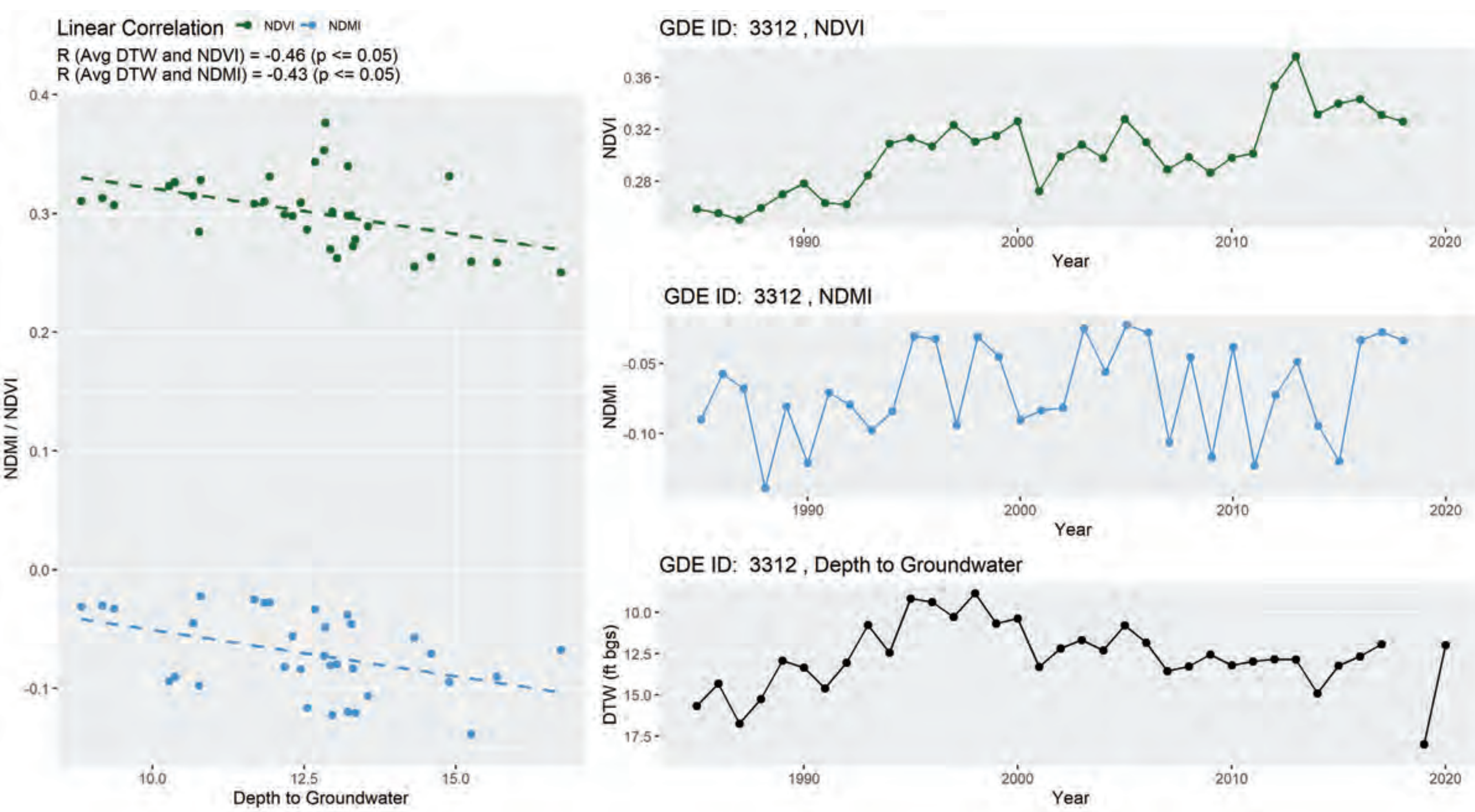


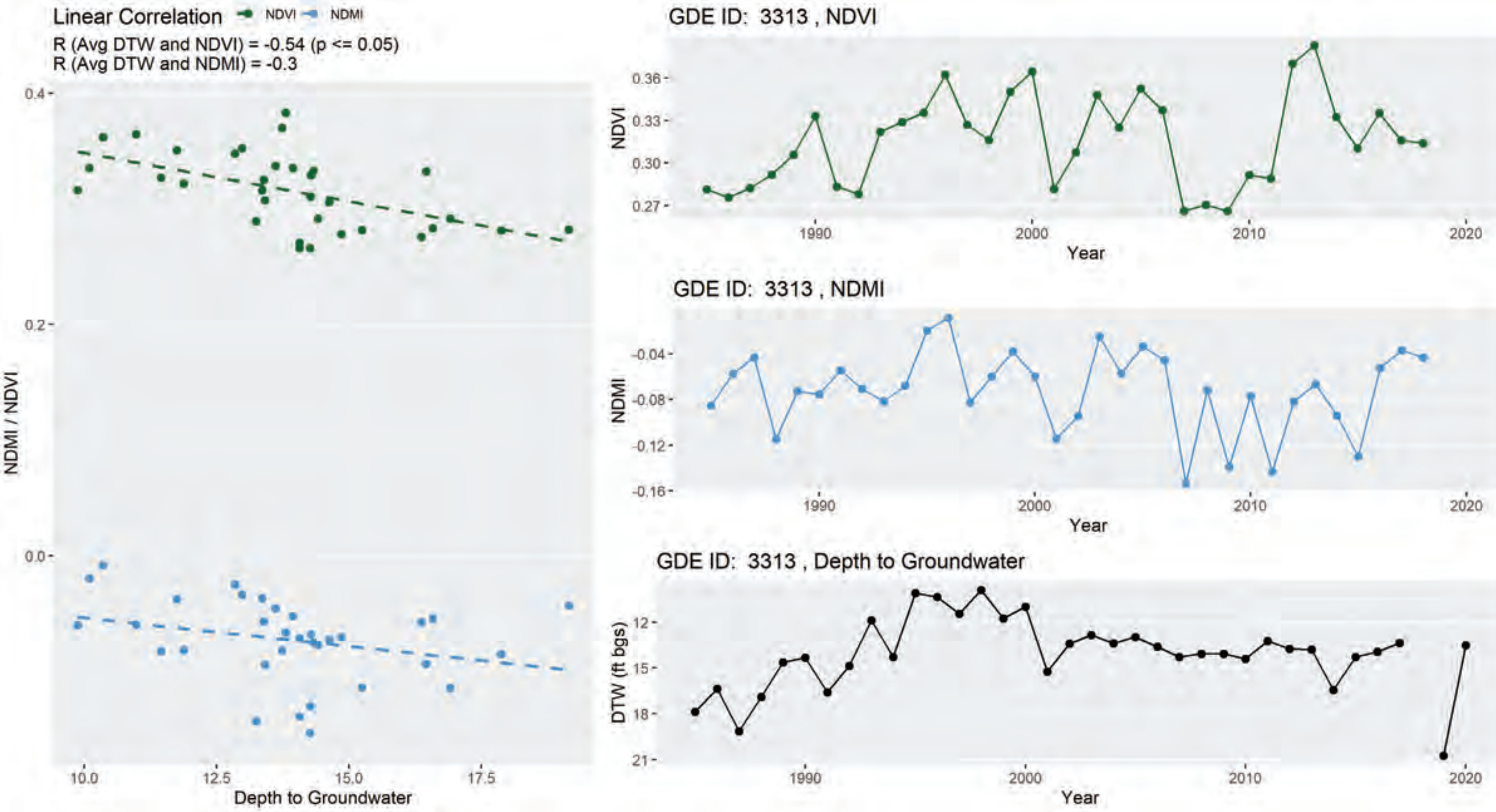
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.49 (p <= 0.05)
R (Avg DTW and NDMI) = -0.57 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 1795 , NDVI
NDVI
Year
GDE ID: 1795 , NDMI
NDMI
Year
GDE ID: 1795 , Depth to Groundwater
DTW (ft bgs)
Year

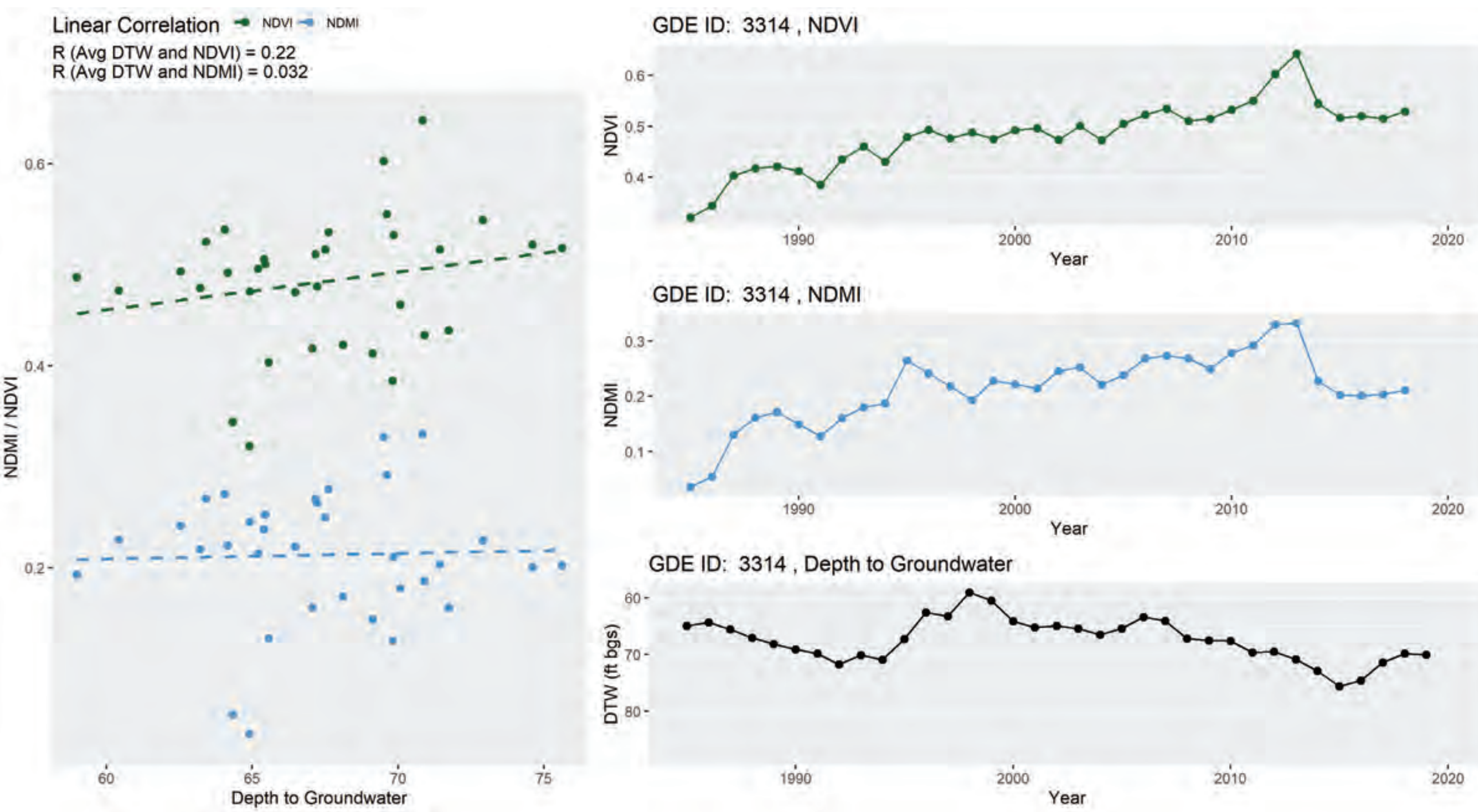

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.038
R (Avg DTW and NDMI) = -0.23
NDMI / NDVI
Depth to Groundwater
GDE ID: 3305 , NDVI
NDVI
Year
GDE ID: 3305 , NDMI
NDMI
Year
GDE ID: 3305 , Depth to Groundwater
DTW (ft bgs)
Year

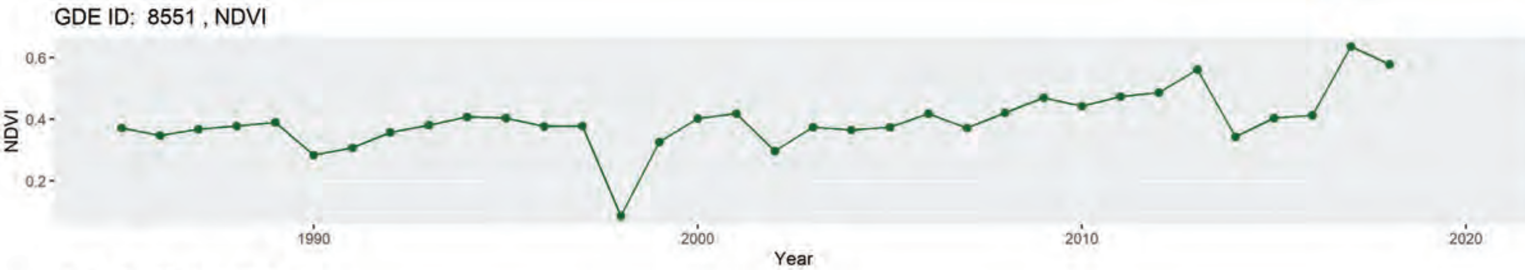

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.3
R (Avg DTW and NDMI) = -0.69 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 3309 , NDVI
NDVI
Year
GDE ID: 3309 , NDMI
NDMI
Year
GDE ID: 3309 , Depth to Groundwater
DTW (ft bgs)
Year

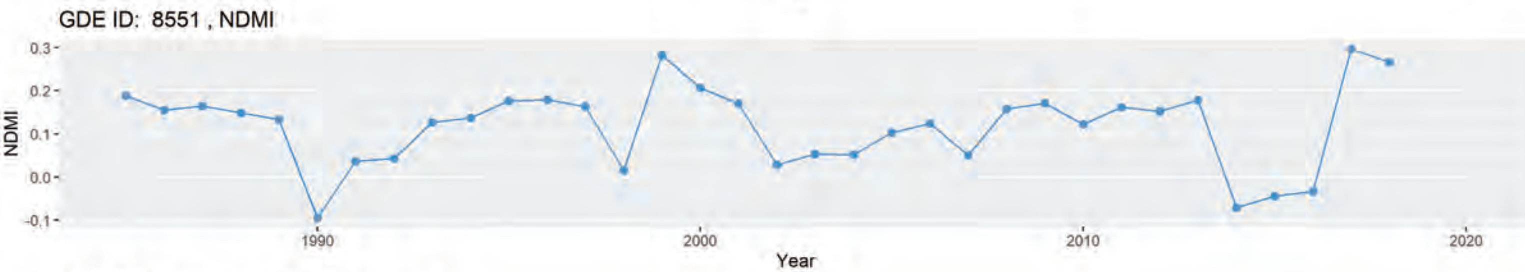

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.1
R (Avg DTW and NDMI) = -0.36 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 3310 , NDVI
NDVI
Year
GDE ID: 3310 , NDMI
NDMI
Year
GDE ID: 3310 , Depth to Groundwater
DTW (ft bgs)
Year

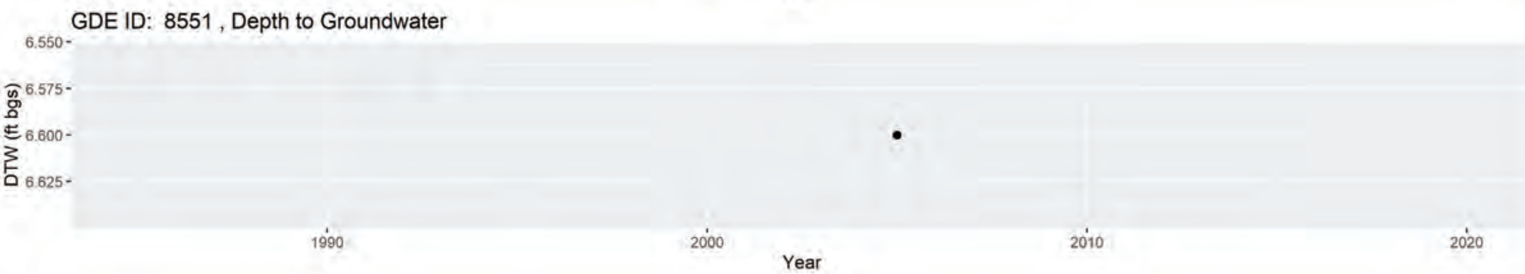

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.46 (p <= 0.05)
R (Avg DTW and NDMI) = -0.43 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 3312 , NDVI
NDVI
Year
GDE ID: 3312 , NDMI
NDMI
Year
GDE ID: 3312 , Depth to Groundwater
DTW (ft bgs)
Year

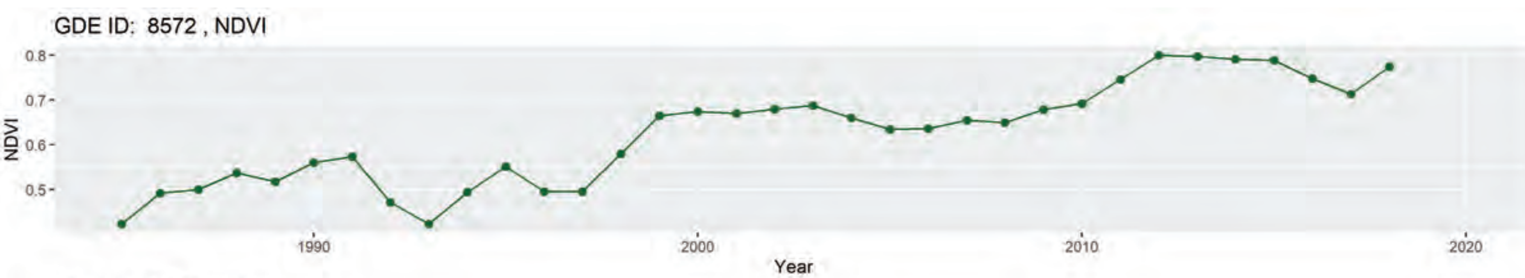

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.54 (p <= 0.05)
R (Avg DTW and NDMI) = -0.3
NDMI / NDVI
Depth to Groundwater
GDE ID: 3313 , NDVI
NDVI
Year
GDE ID: 3313 , NDMI
NDMI
Year
GDE ID: 3313 , Depth to Groundwater
DTW (ft bgs)
Year

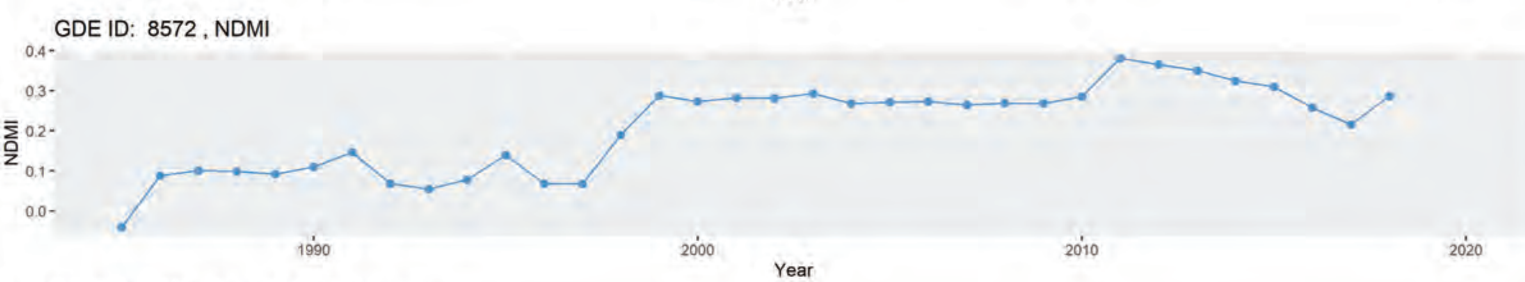

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.22
R (Avg DTW and NDMI) = 0.032
NDMI / NDVI
Depth to Groundwater
GDE ID: 3314 , NDVI
NDVI
Year
GDE ID: 3314 , NDMI
NDMI
Year
GDE ID: 3314 , Depth to Groundwater
DTW (ft bgs)
Year

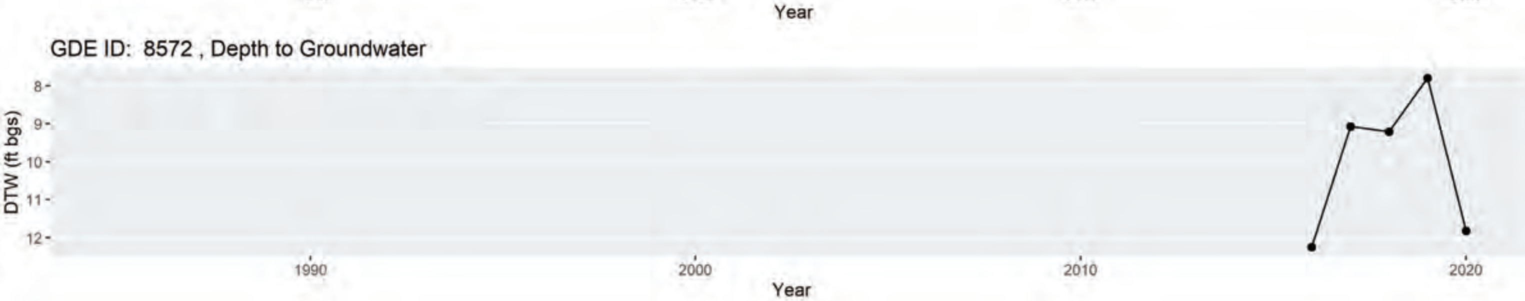

GDE ID: 8551 , NDVI
NDVI
0.6
0.4
0.2
1990
2000
2010
2020
Year

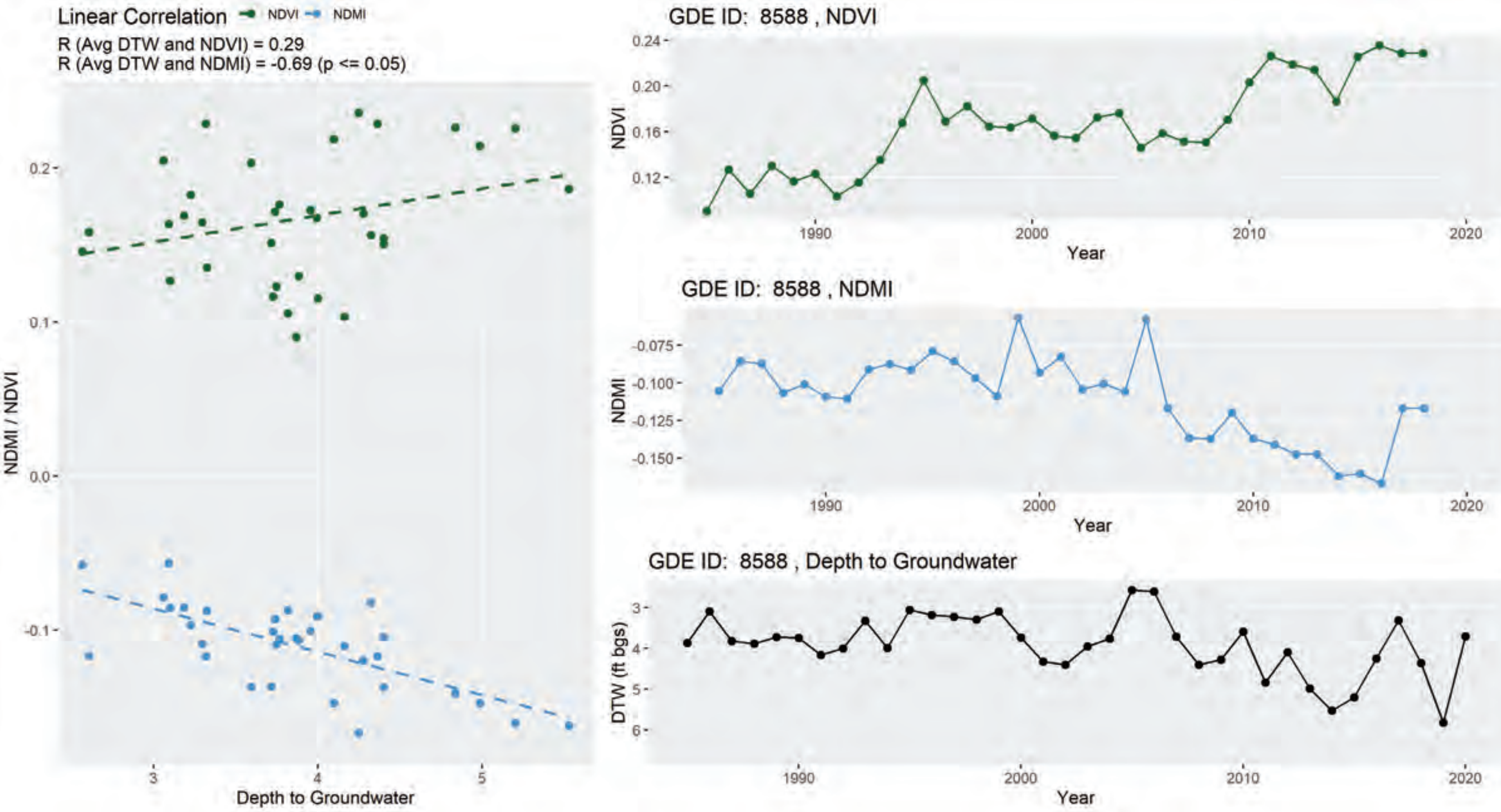

GDE ID: 8551 , NDMI
NDMI
0.3
0.2
0.1
0.0
-0.1
1990
2000
2010
2020
Year

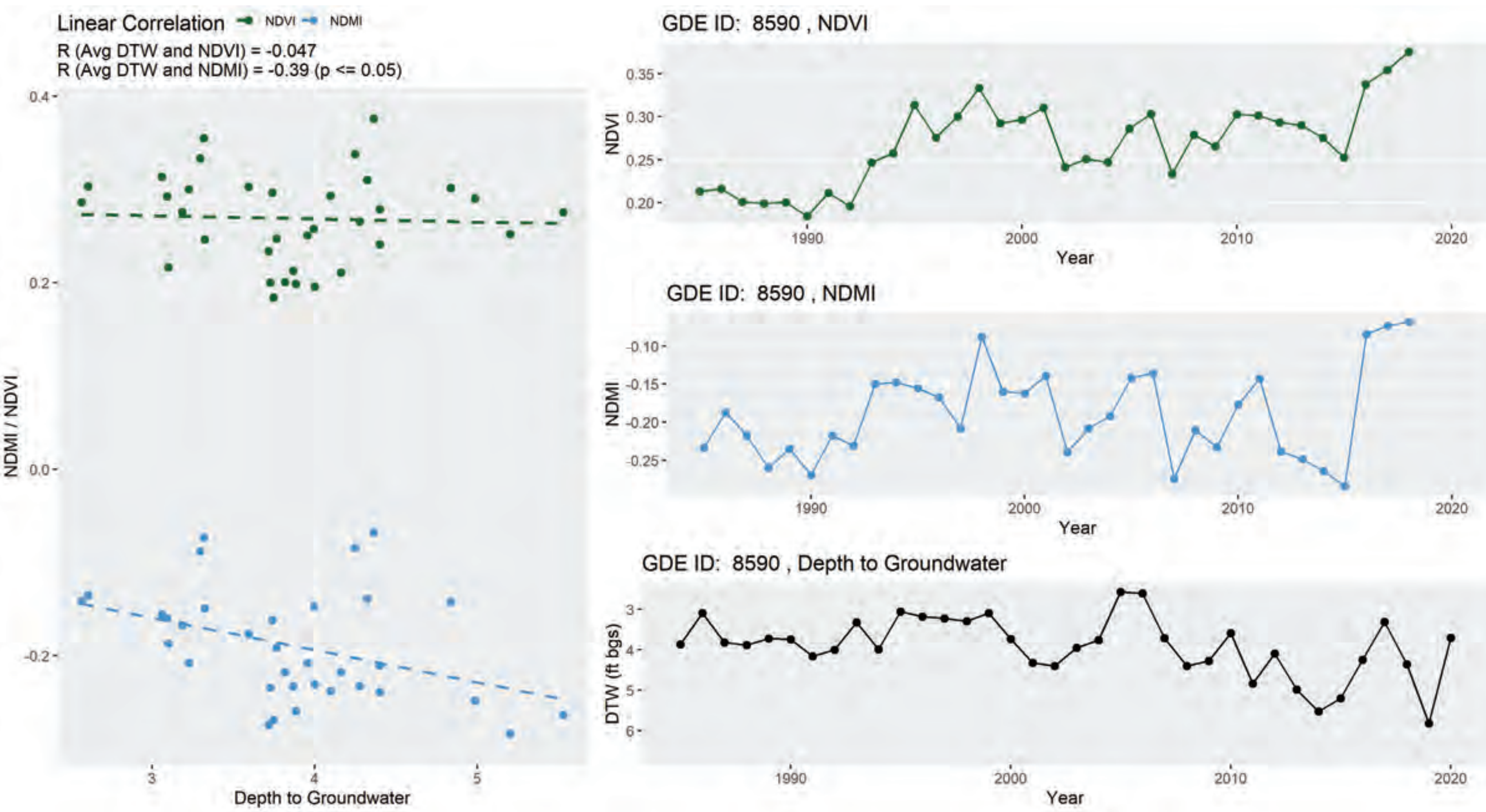

GDE ID: 8551 , Depth to Groundwater
DTW (ft bgs)
6.550
6.575
6.600
6.625
1990
2000
2010
2020
Year

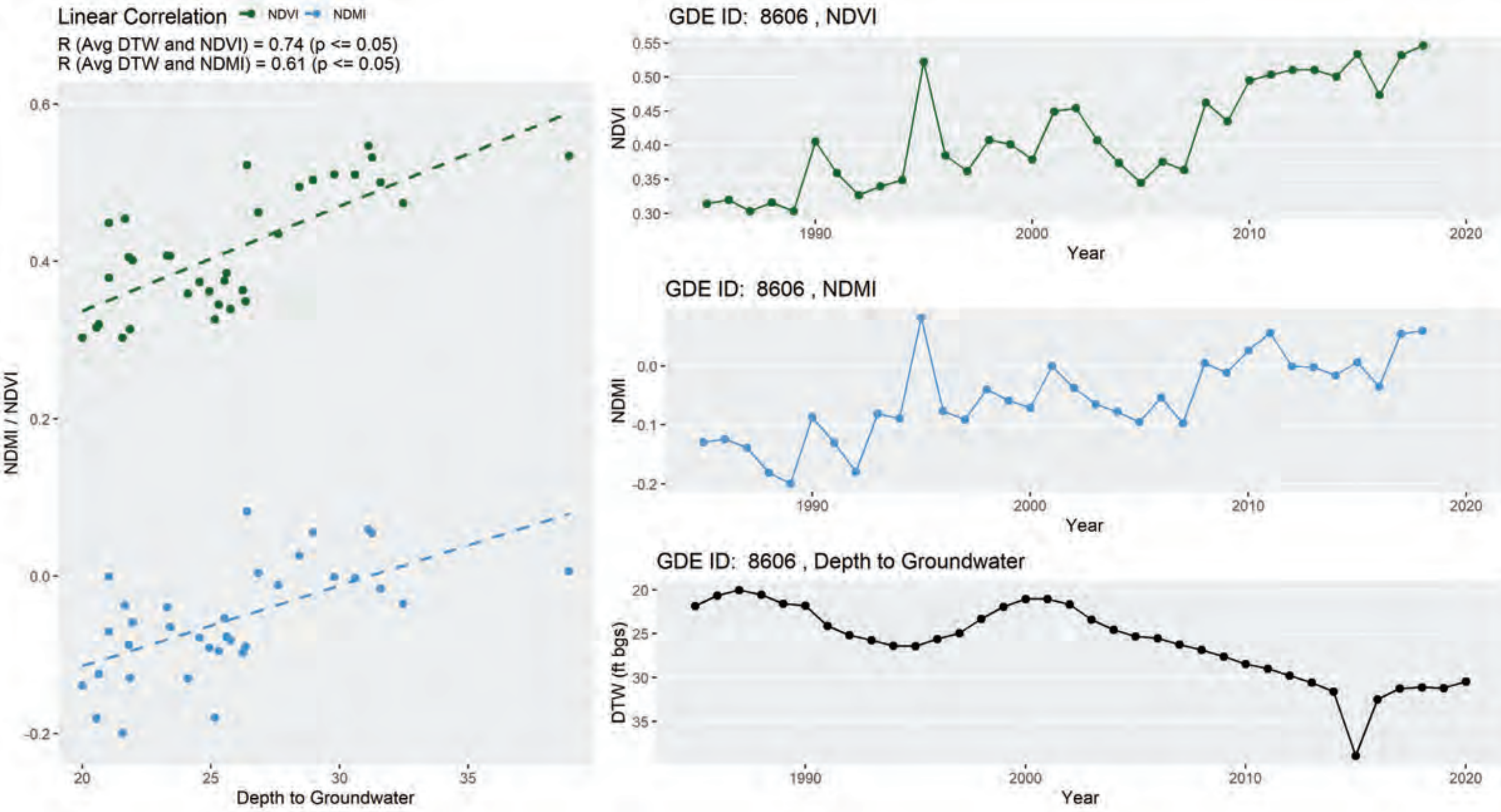

GDE ID: 8572 , NDVI
NDVI
0.8
0.7
0.6
0.5
1990
2000
2010
2020
Year

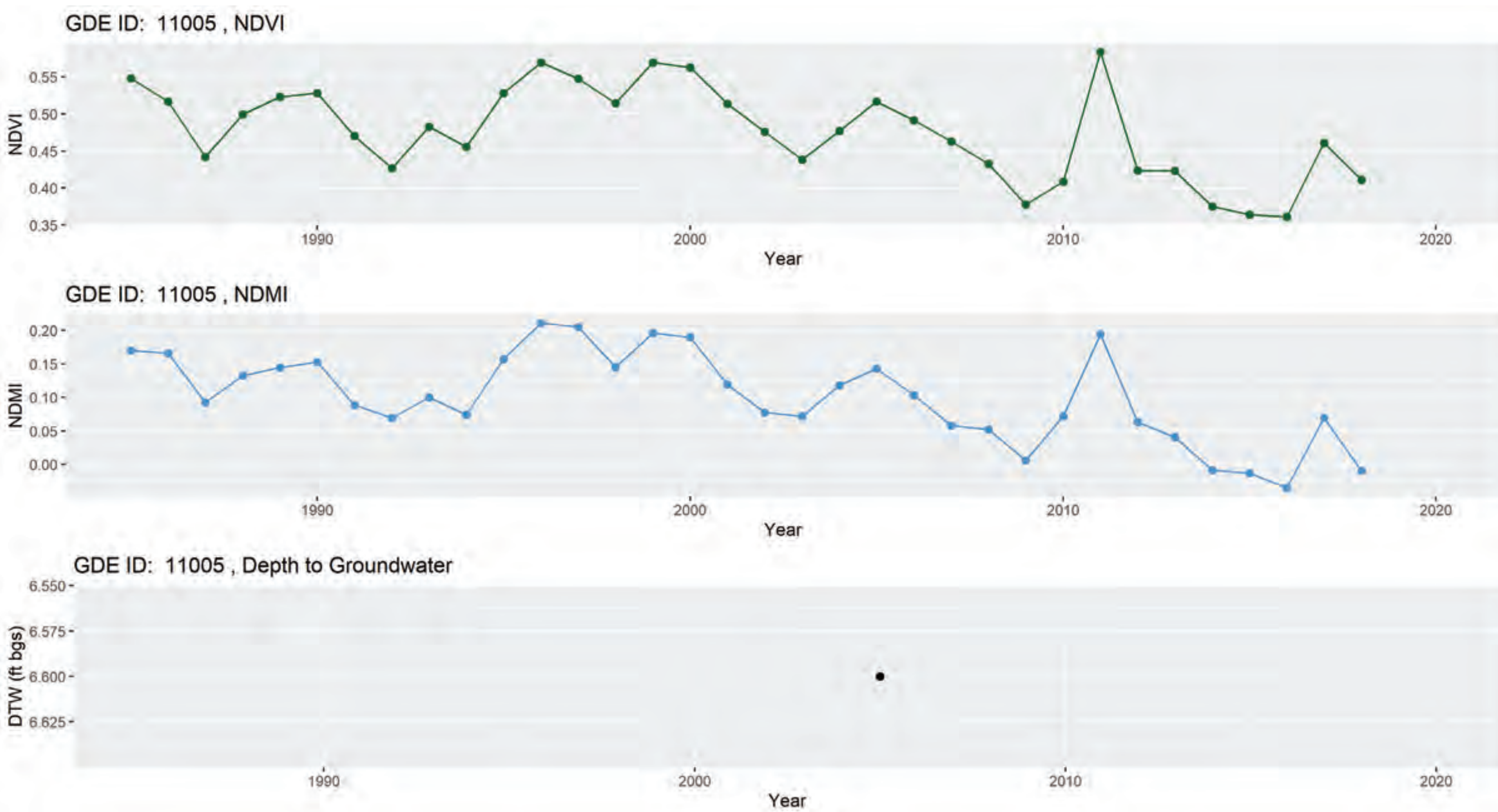

GDE ID: 8572 , NDMI
NDMI
0.4
0.3
0.2
0.1
0.0
1990
2000
2010
2020
Year

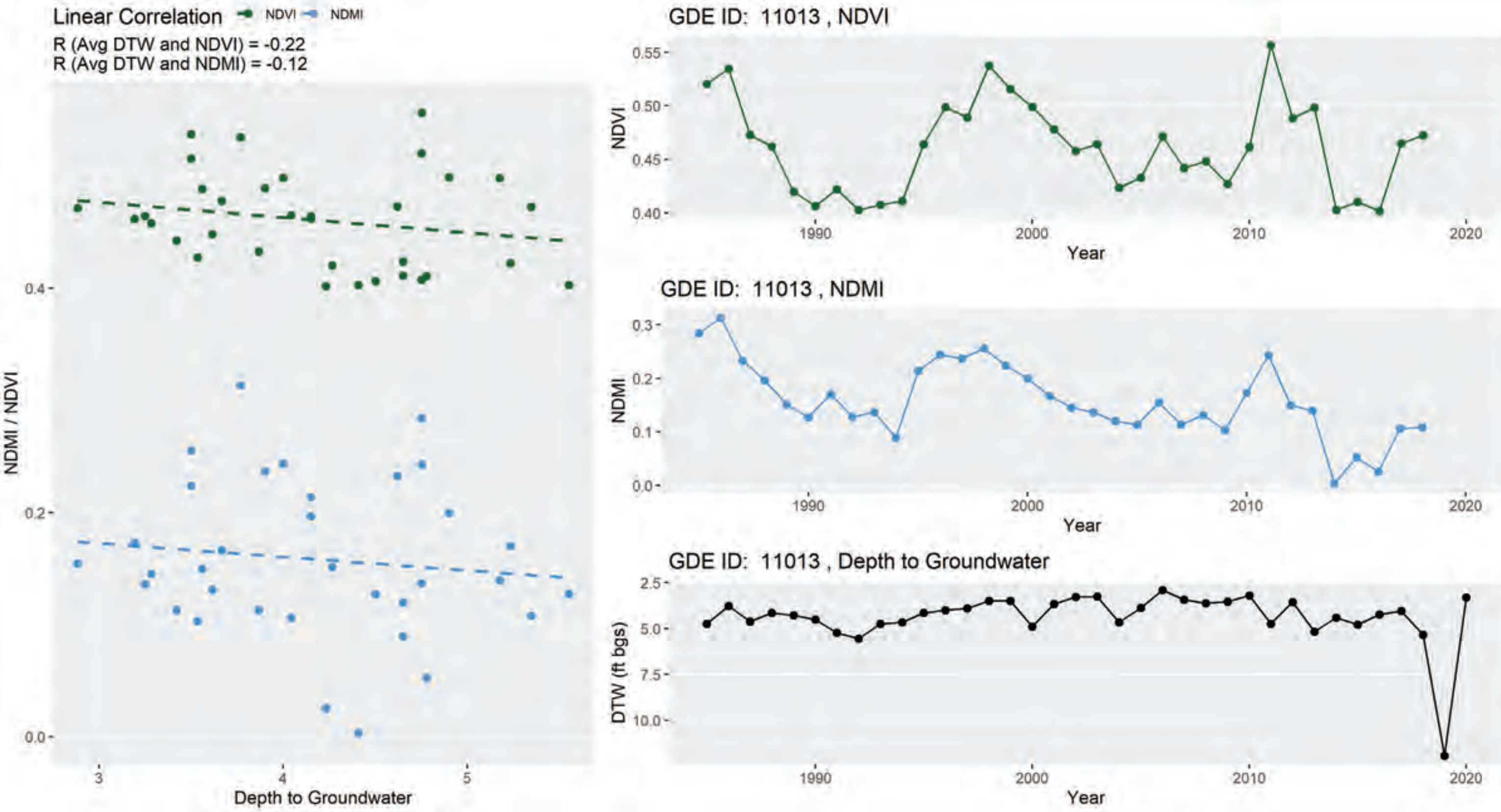

GDE ID: 8572 , Depth to Groundwater
DTW (ft bgs)
8
9
10
11
12
1990
2000
2010
2020
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.29
R (Avg DTW and NDMI) = -0.69 (p <= 0.05)
NDMI / NDVI
0.2
0.1
0.0
-0.1
3
4
5
Depth to Groundwater
GDE ID: 8588 , NDVI
NDVI
0.24
0.20
0.16
0.12
1990
2000
2010
2020
Year
GDE ID: 8588 , NDMI
NDMI
-0.075
-0.100
-0.125
-0.150
1990
2000
2010
2020
Year
GDE ID: 8588 , Depth to Groundwater
DTW (ft bgs)
3
4
5
6
1990
2000
2010
2020
Year

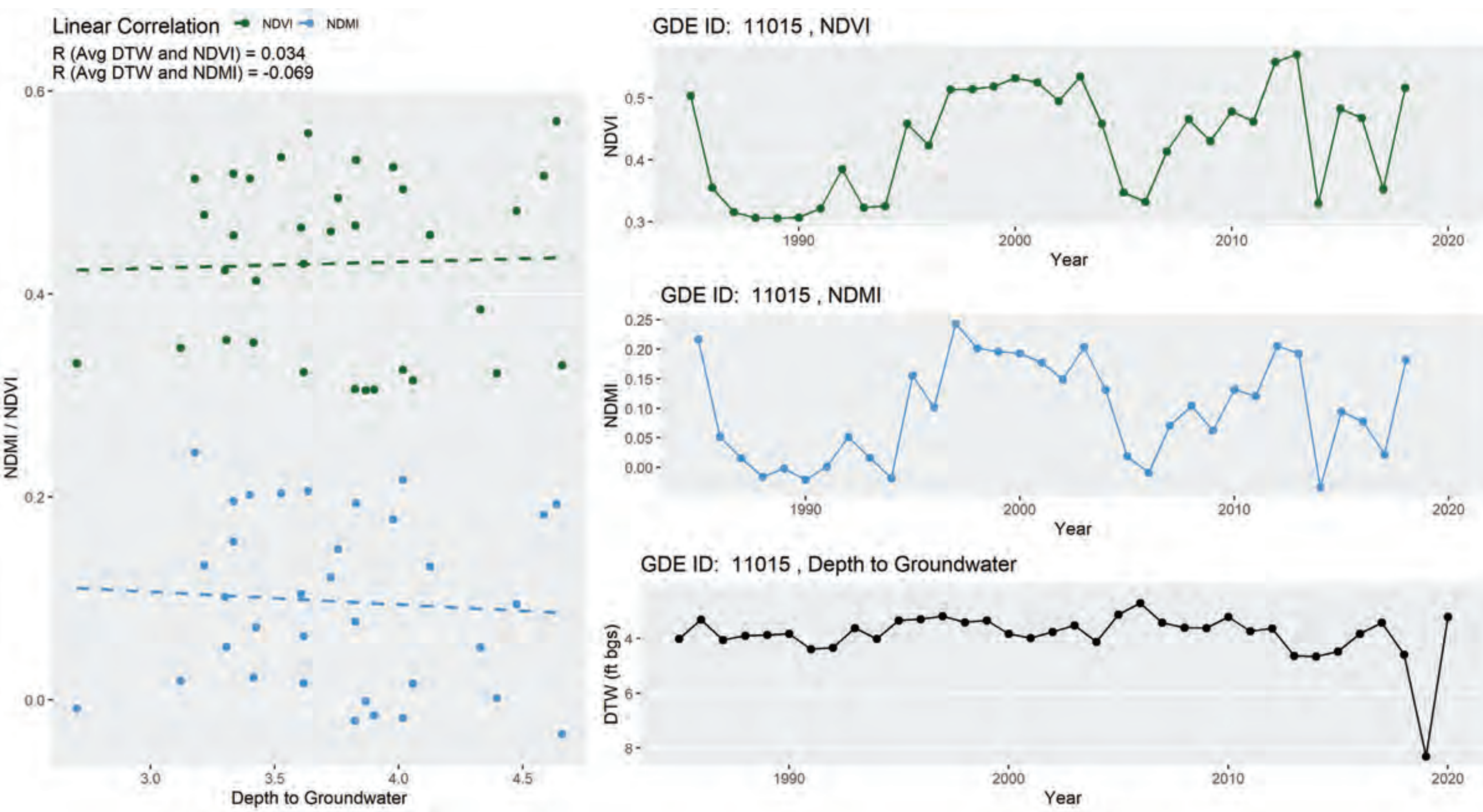

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.047
R (Avg DTW and NDMI) = -0.39 (p <= 0.05)
NDMI / NDVI
0.4
0.2
0.0
-0.2
3
4
5
Depth to Groundwater
GDE ID: 8590 , NDVI
NDVI
0.35
0.30
0.25
0.20
1990
2000
2010
2020
Year
GDE ID: 8590 , NDMI
NDMI
-0.10
-0.15
-0.20
-0.25
1990
2000
2010
2020
Year
GDE ID: 8590 , Depth to Groundwater
DTW (ft bgs)
3
4
5
6
1990
2000
2010
2020
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.74 (p <= 0.05)
R (Avg DTW and NDMI) = 0.61 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 8606 , NDVI
NDVI
Year
GDE ID: 8606 , NDMI
NDMI
Year
GDE ID: 8606 , Depth to Groundwater
DTW (ft bgs)
Year

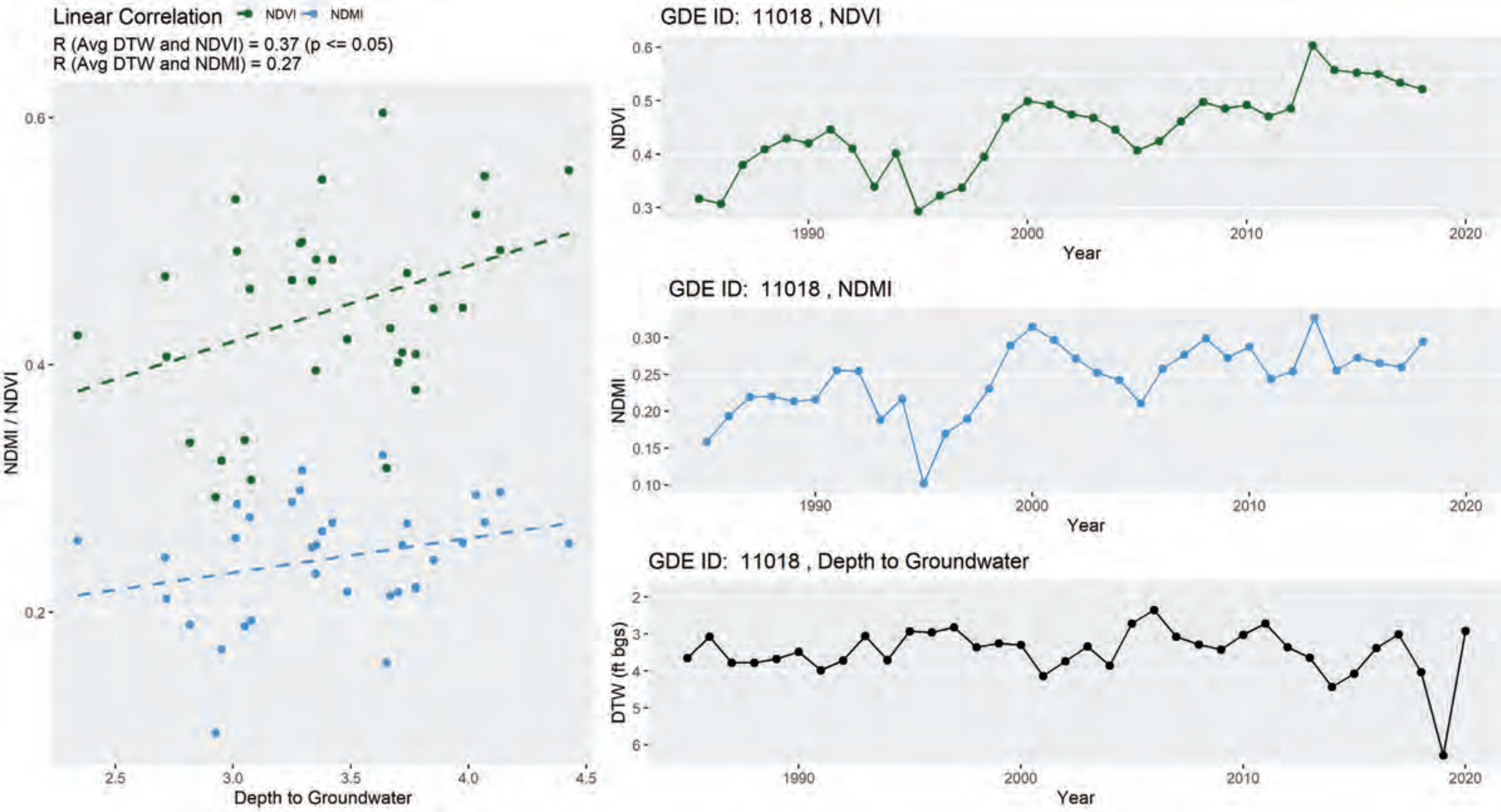

GDE ID: 11005 , NDVI
NDVI
Year
GDE ID: 11005 , NDMI
NDMI
Year
GDE ID: 11005 , Depth to Groundwater
DTW (ft bgs)
Year



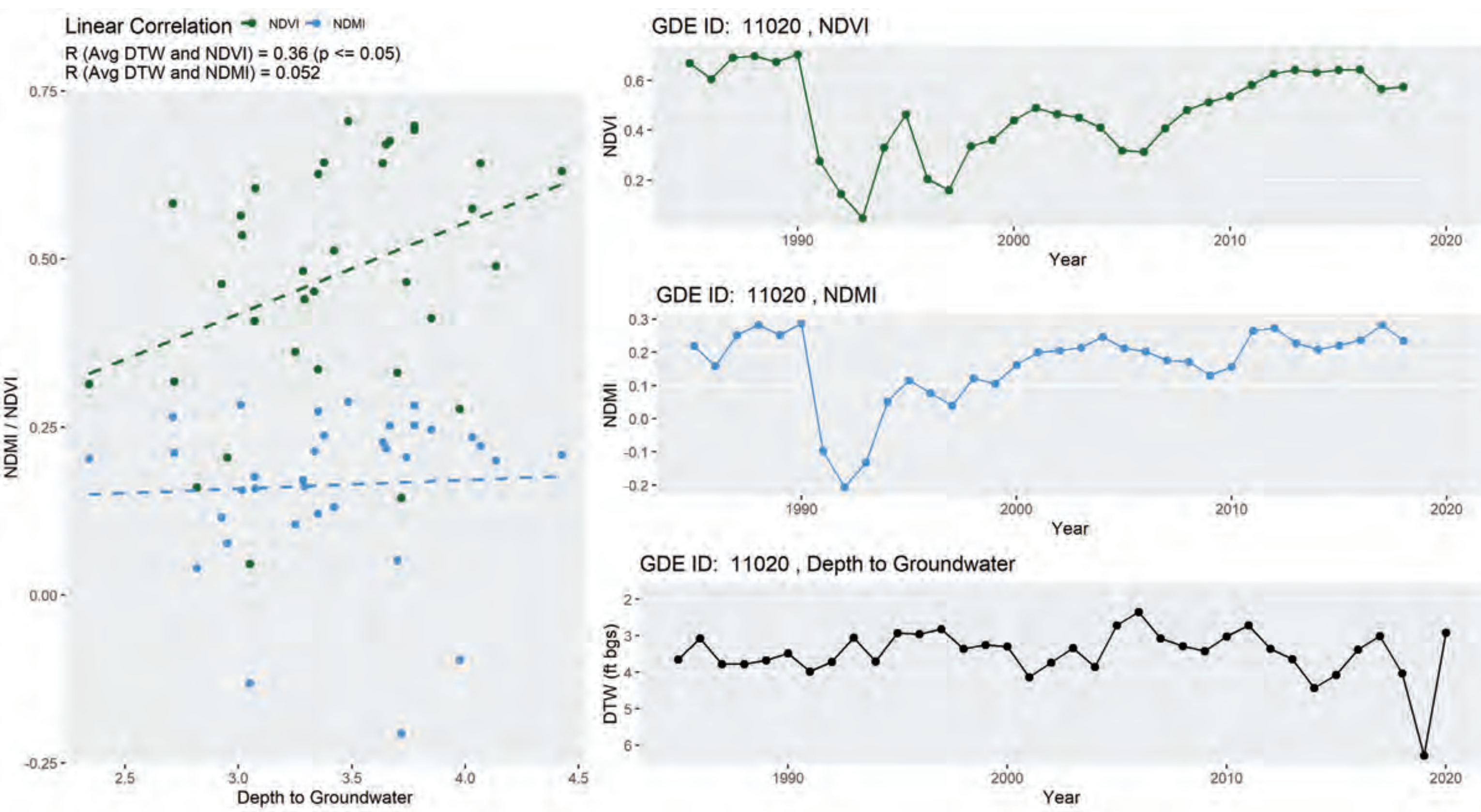
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.22
R (Avg DTW and NDMI) = -0.12
NDMI / NDVI
Depth to Groundwater
GDE ID: 11013 , NDVI
NDVI
Year
GDE ID: 11013 , NDMI
NDMI
Year
GDE ID: 11013 , Depth to Groundwater
DTW (ft bgs)
Year



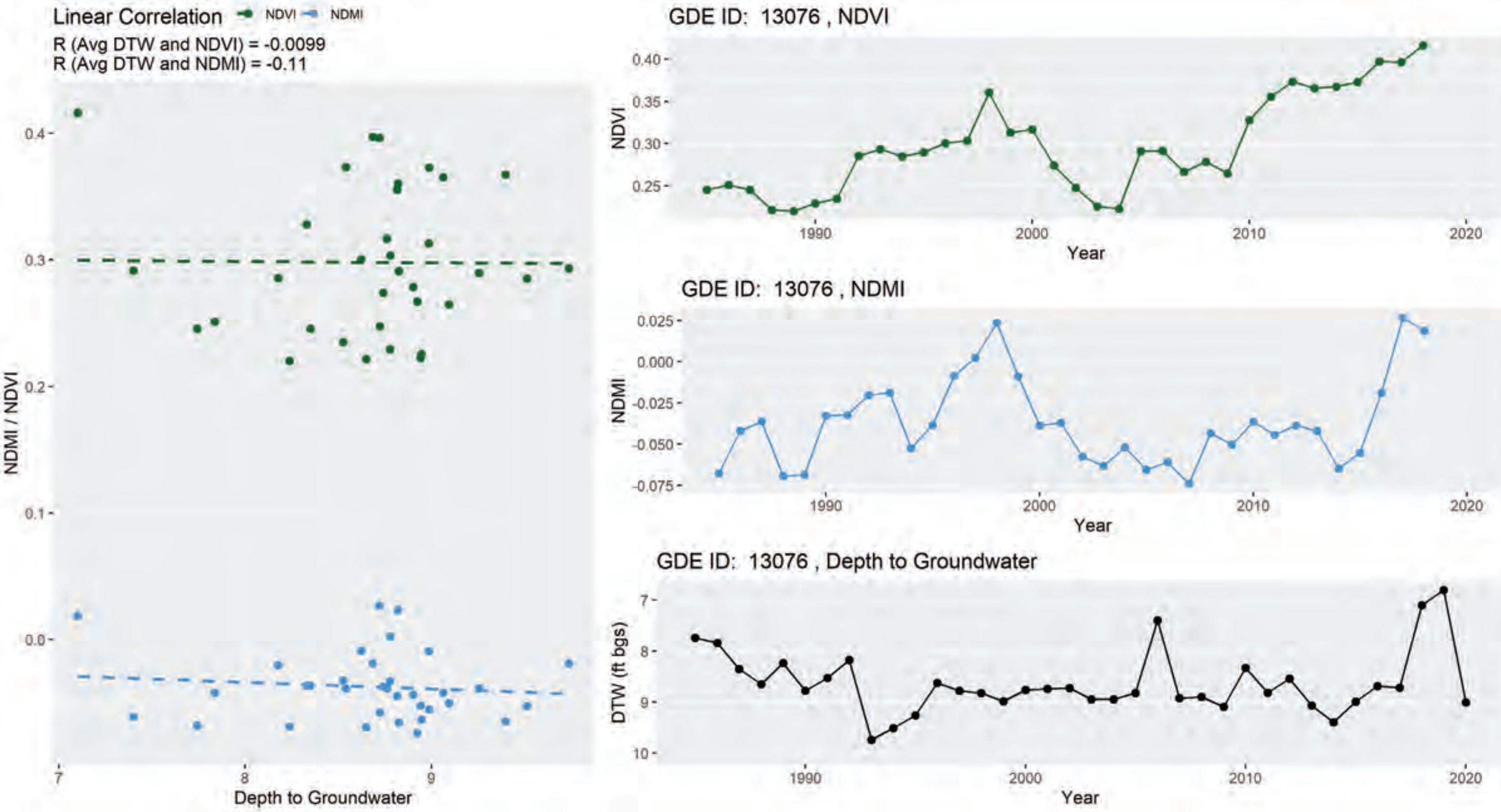
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.034
R (Avg DTW and NDMI) = -0.069
NDMI / NDVI
Depth to Groundwater
GDE ID: 11015 , NDVI
NDVI
Year
GDE ID: 11015 , NDMI
NDMI
Year
GDE ID: 11015 , Depth to Groundwater
DTW (ft bgs)
Year

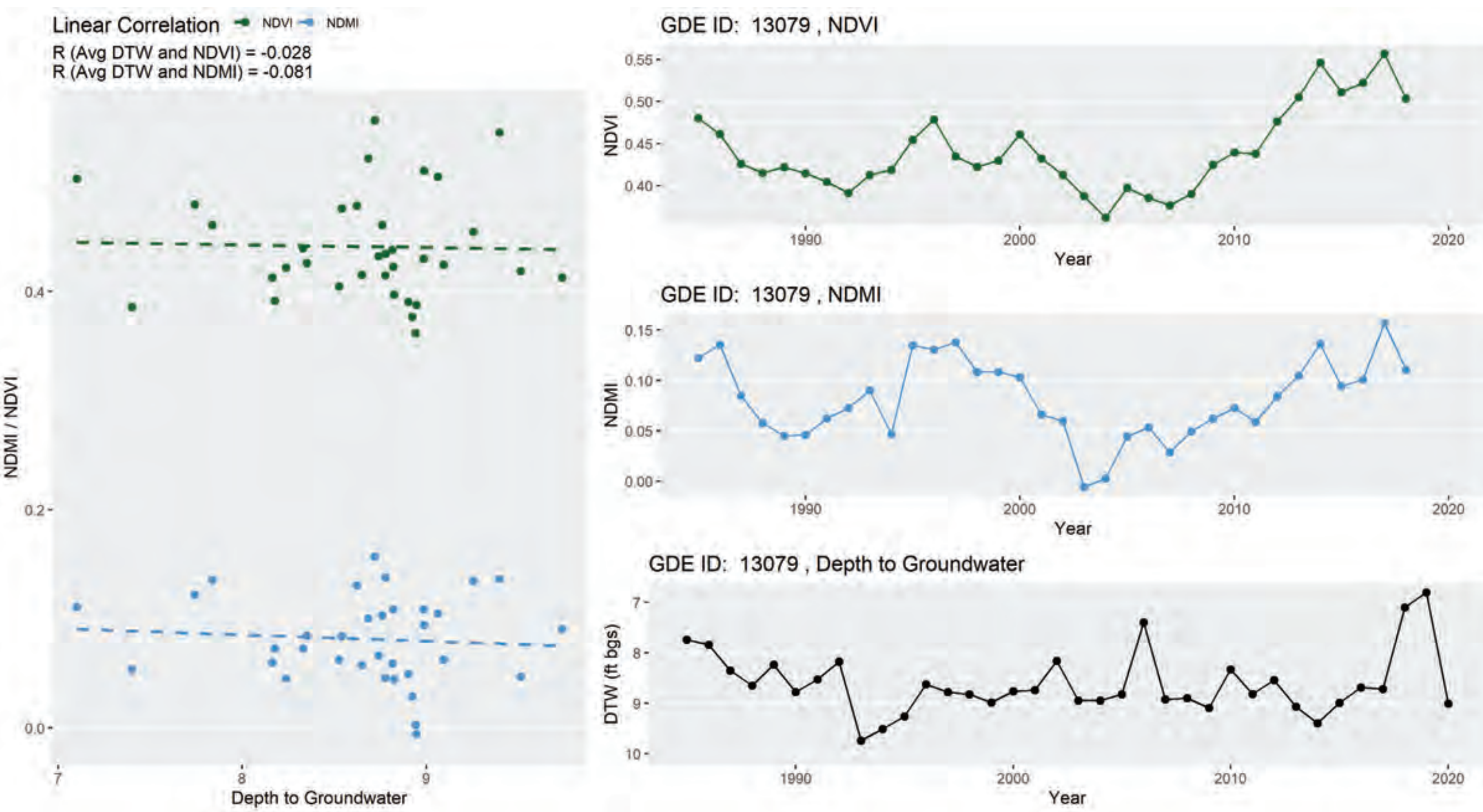


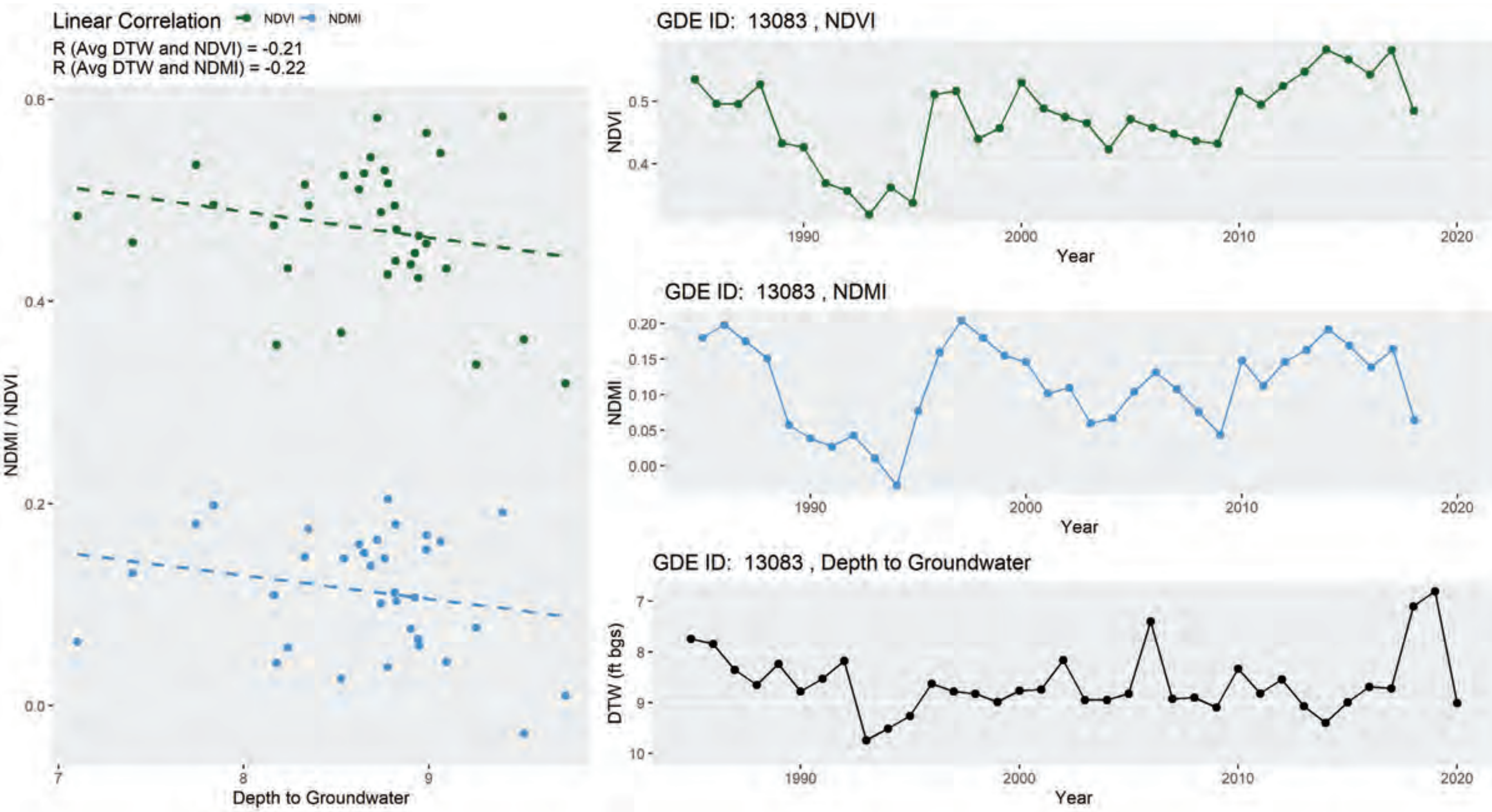
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.37 (p <= 0.05)
R (Avg DTW and NDMI) = 0.27
NDMI / NDVI
Depth to Groundwater
GDE ID: 11018 , NDVI
NDVI
Year
GDE ID: 11018 , NDMI
NDMI
Year
GDE ID: 11018 , Depth to Groundwater
DTW (ft bgs)
Year

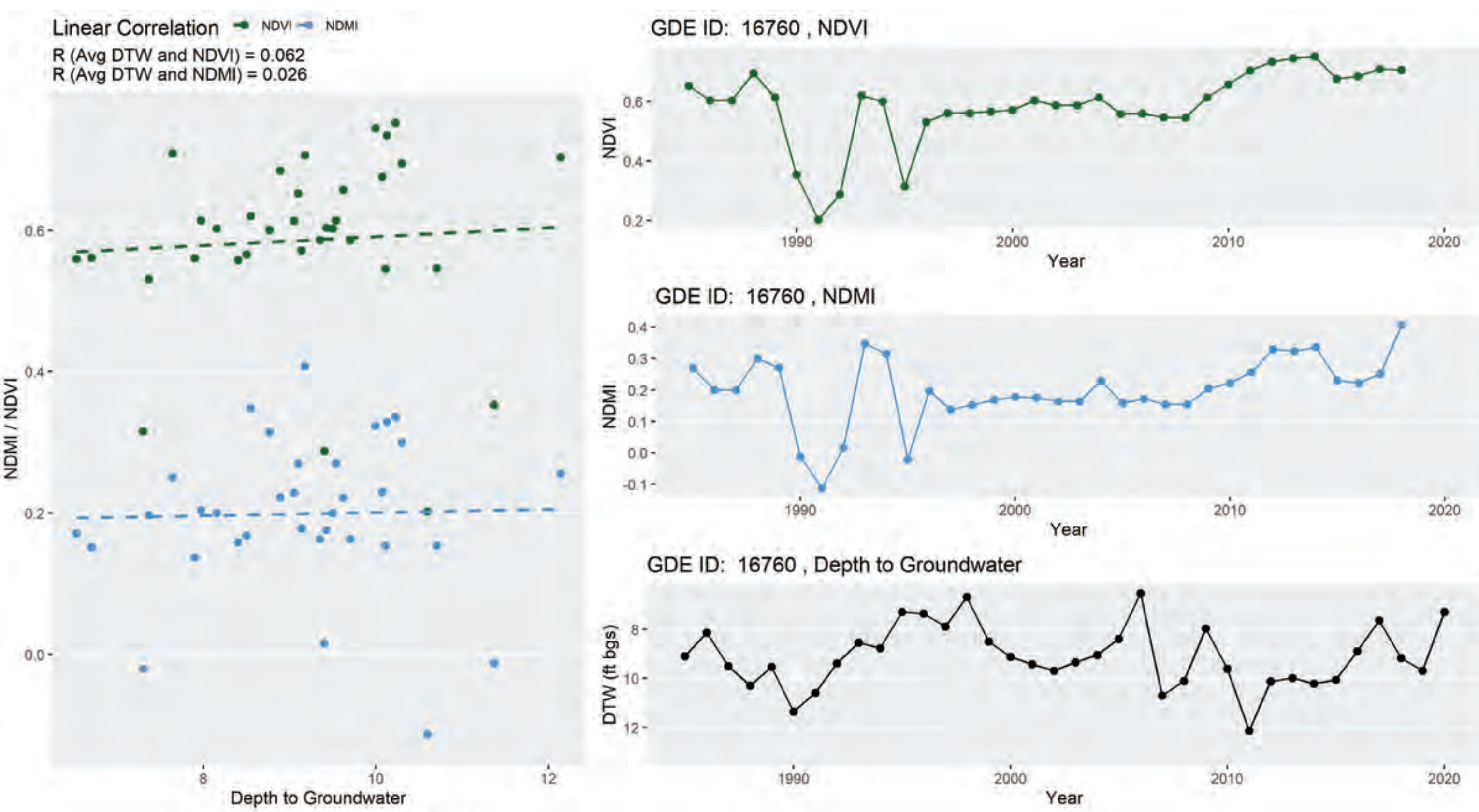


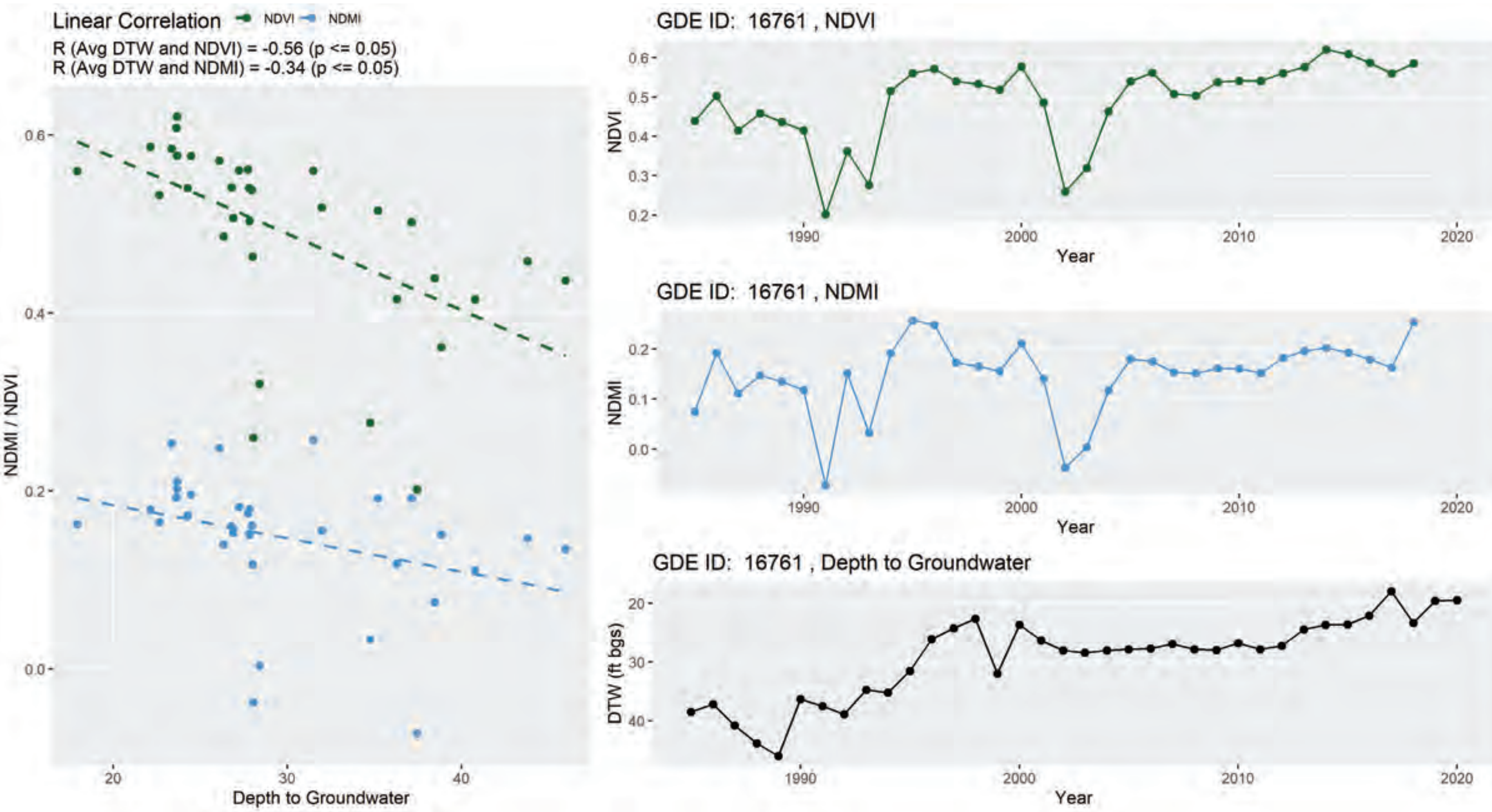
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.36 (p <= 0.05)
R (Avg DTW and NDMI) = 0.052
NDMI / NDVI
Depth to Groundwater
GDE ID: 11020 , NDVI
NDVI
Year
GDE ID: 11020 , NDMI
NDMI
Year
GDE ID: 11020 , Depth to Groundwater
DTW (ft bgs)
Year

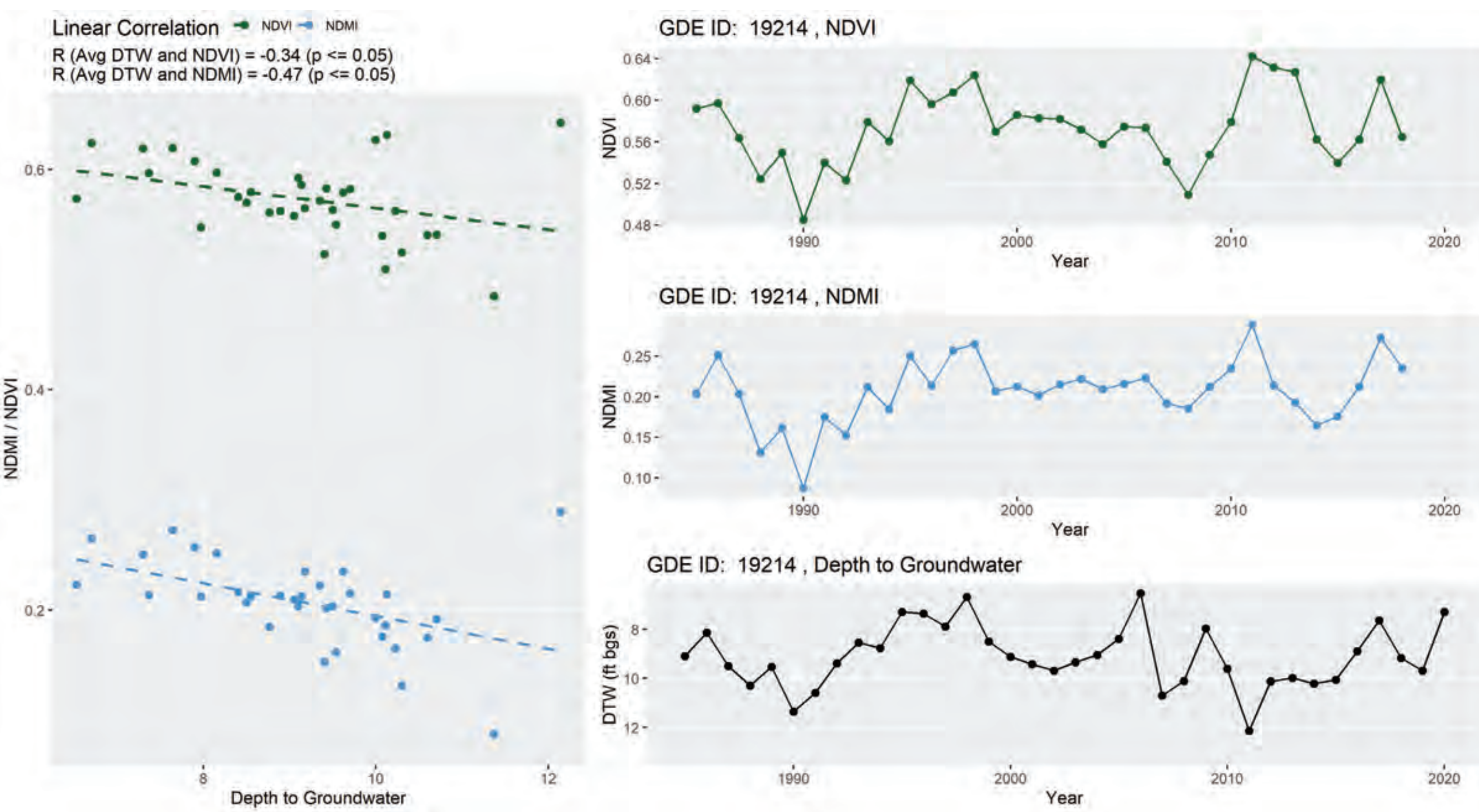

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.0099
R (Avg DTW and NDMI) = -0.11
NDMI / NDVI
Depth to Groundwater
GDE ID: 13076 , NDVI
NDVI
Year
GDE ID: 13076 , NDMI
NDMI
Year
GDE ID: 13076 , Depth to Groundwater
DTW (ft bgs)
Year

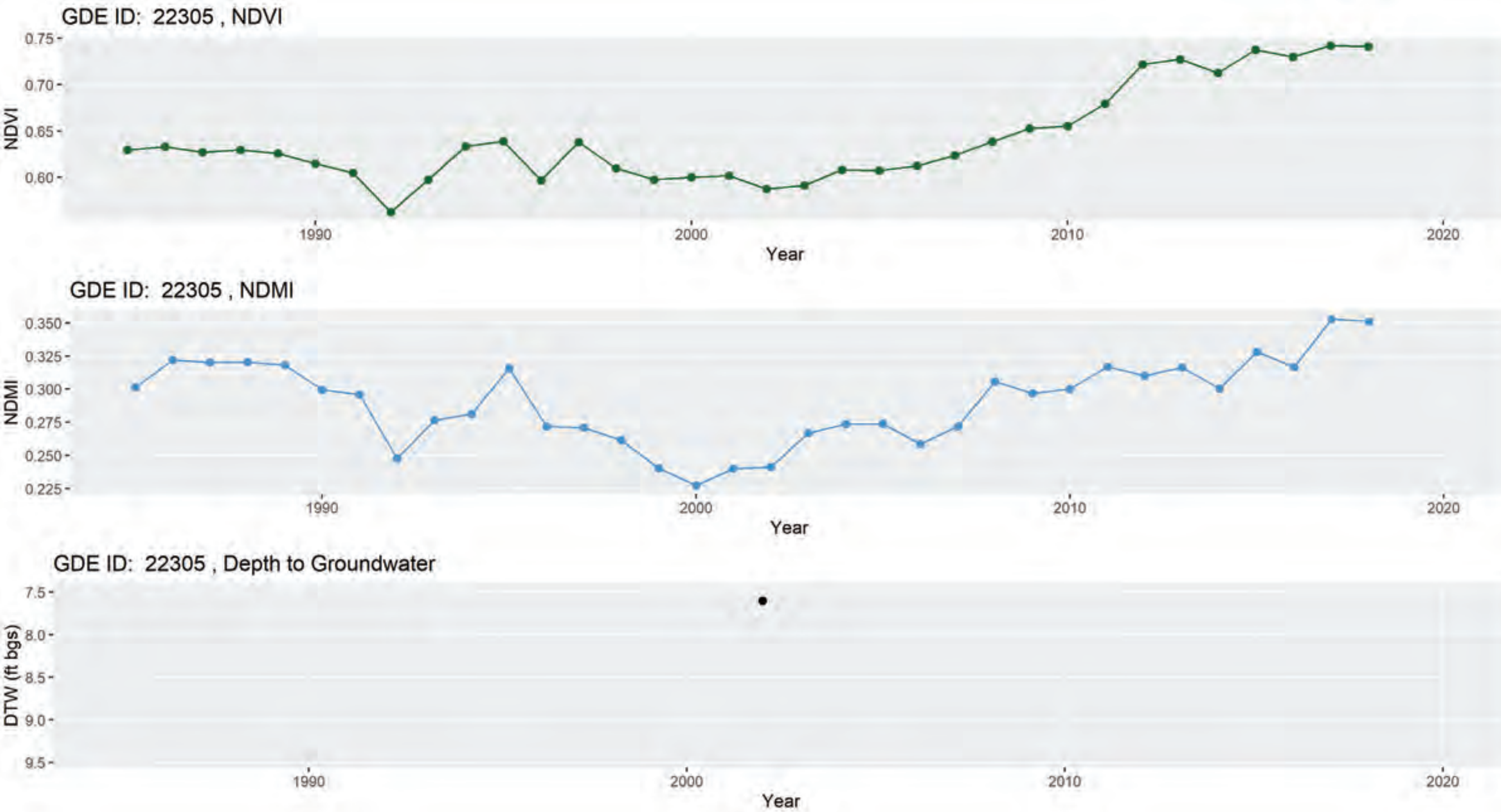

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.028
R (Avg DTW and NDMI) = -0.081
NDMI / NDVI
Depth to Groundwater
GDE ID: 13079 , NDVI
NDVI
Year
GDE ID: 13079 , NDMI
NDMI
Year
GDE ID: 13079 , Depth to Groundwater
DTW (ft bgs)
Year

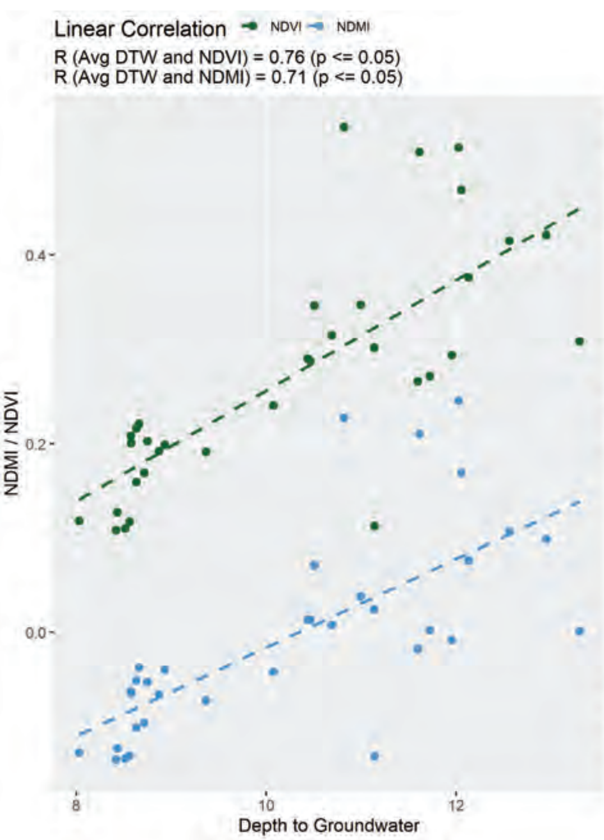

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.21
R (Avg DTW and NDMI) = -0.22
NDMI / NDVI
Depth to Groundwater
GDE ID: 13083 , NDVI
NDVI
Year
GDE ID: 13083 , NDMI
NDMI
Year
GDE ID: 13083 , Depth to Groundwater
DTW (ft bgs)
Year

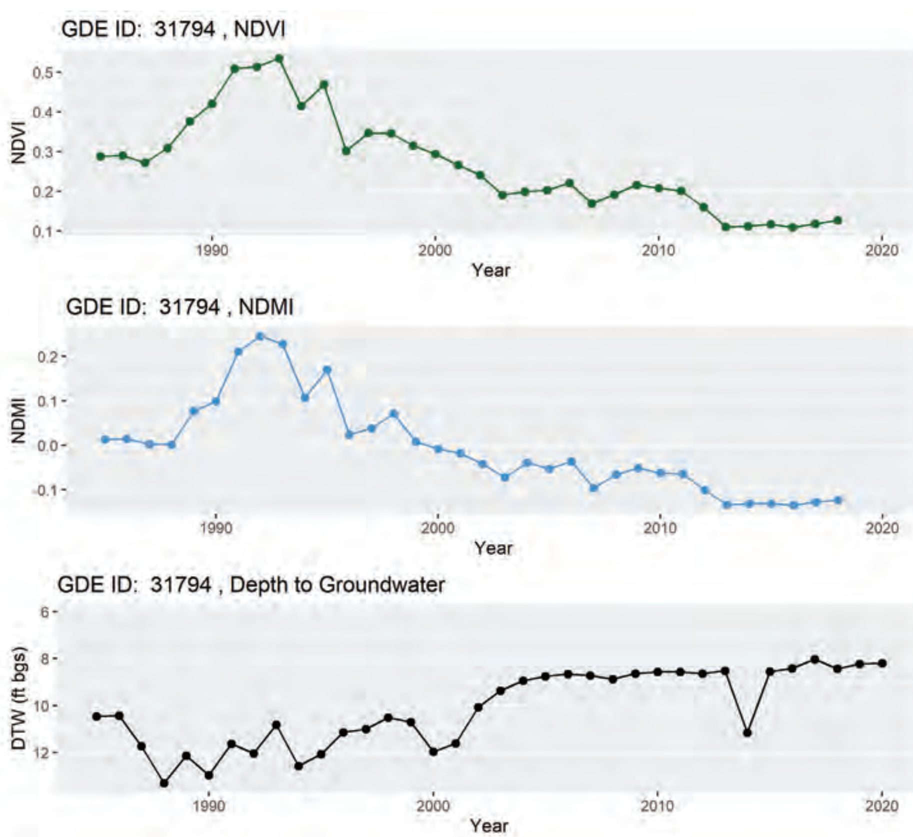

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.062
R (Avg DTW and NDMI) = 0.026
NDMI / NDVI
Depth to Groundwater
GDE ID: 16760 , NDVI
NDVI
Year
GDE ID: 16760 , NDMI
NDMI
Year
GDE ID: 16760 , Depth to Groundwater
DTW (ft bgs)
Year

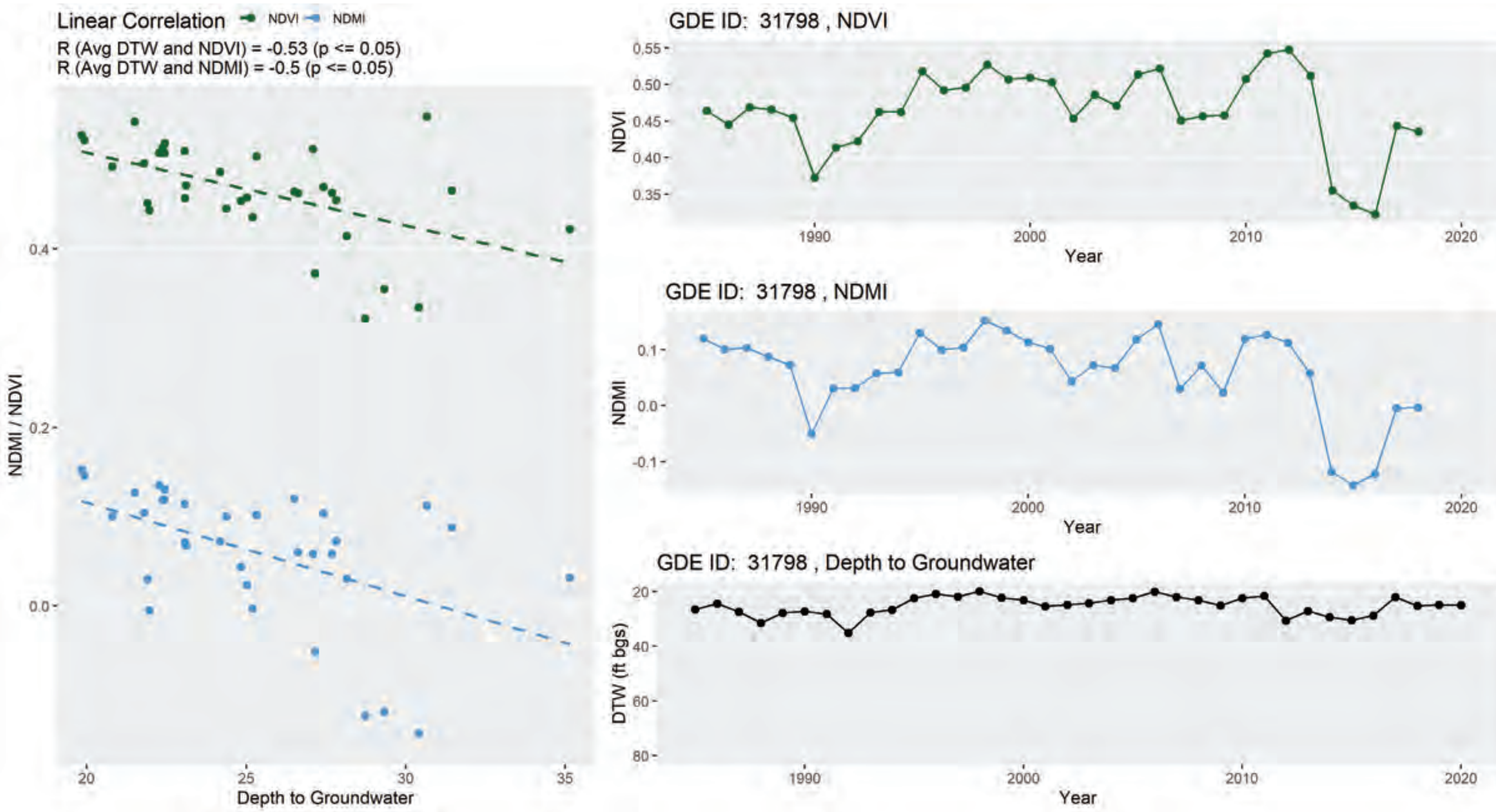

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.56 (p <= 0.05)
R (Avg DTW and NDMI) = -0.34 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 16761 , NDVI
NDVI
Year
GDE ID: 16761 , NDMI
NDMI
Year
GDE ID: 16761 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.34 (p <= 0.05)
R (Avg DTW and NDMI) = -0.47 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 19214 , NDVI
NDVI
Year
GDE ID: 19214 , NDMI
NDMI
Year
GDE ID: 19214 , Depth to Groundwater
DTW (ft bgs)
Year

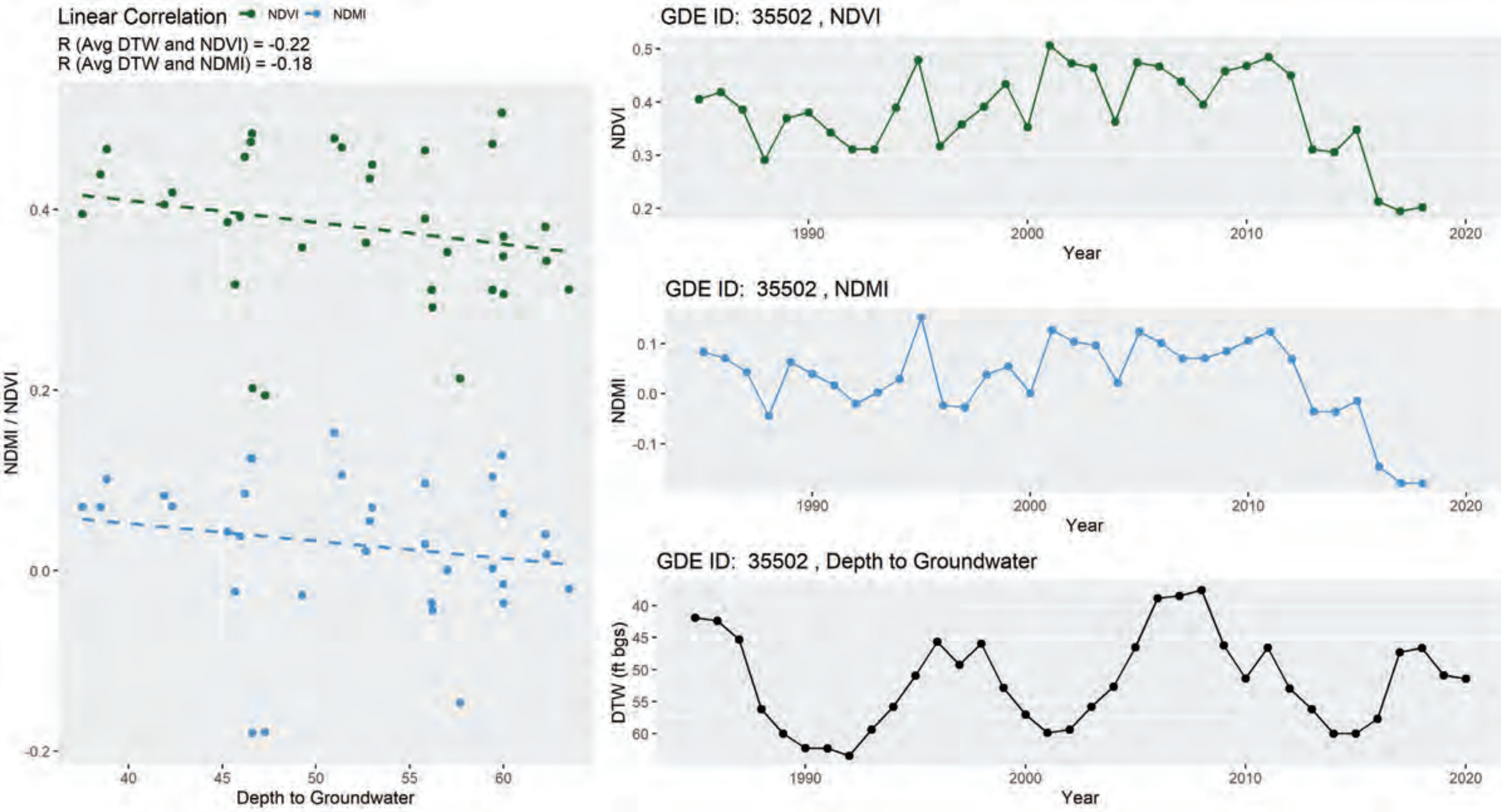

GDE ID: 22305 , NDVI
NDVI
Year
GDE ID: 22305 , NDMI
NDMI
Year
GDE ID: 22305 , Depth to Groundwater
DTW (ft bgs)
Year

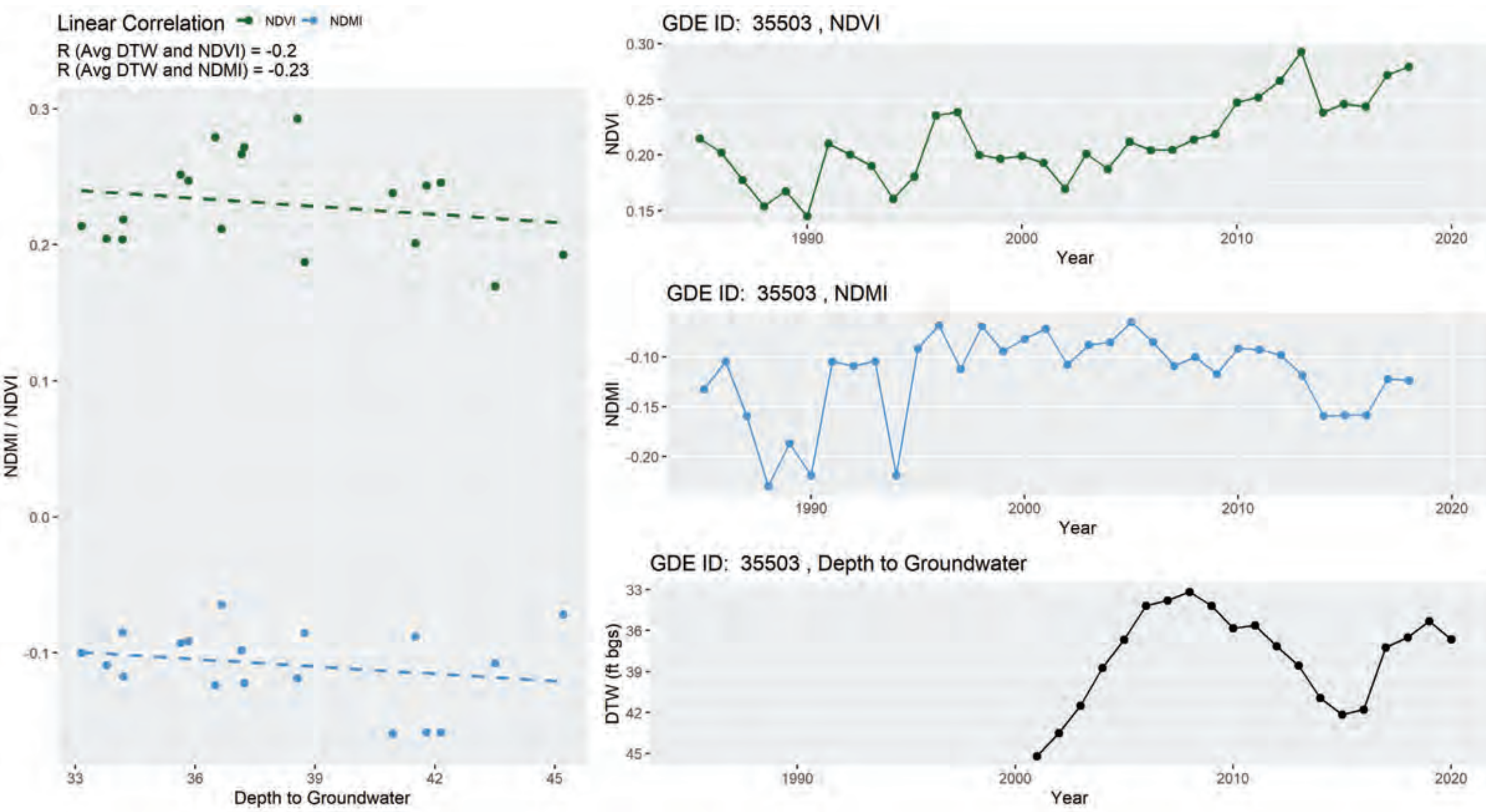

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.76 (p <= 0.05)
R (Avg DTW and NDMI) = 0.71 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater

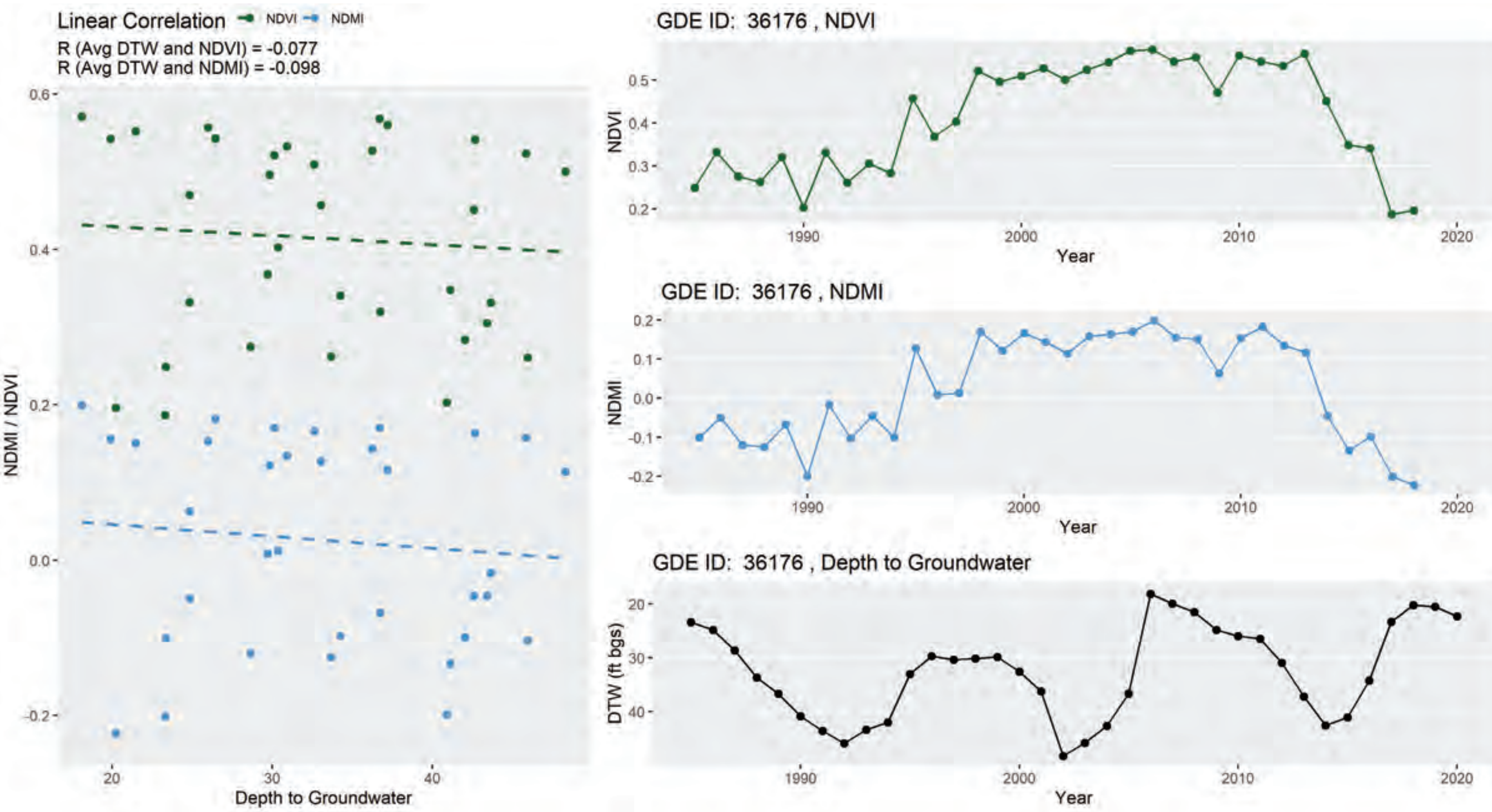

GDE ID: 31794 , NDVI
NDVI
Year
GDE ID: 31794 , NDMI
NDMI
Year
GDE ID: 31794 , Depth to Groundwater
DTW (ft bgs)
Year

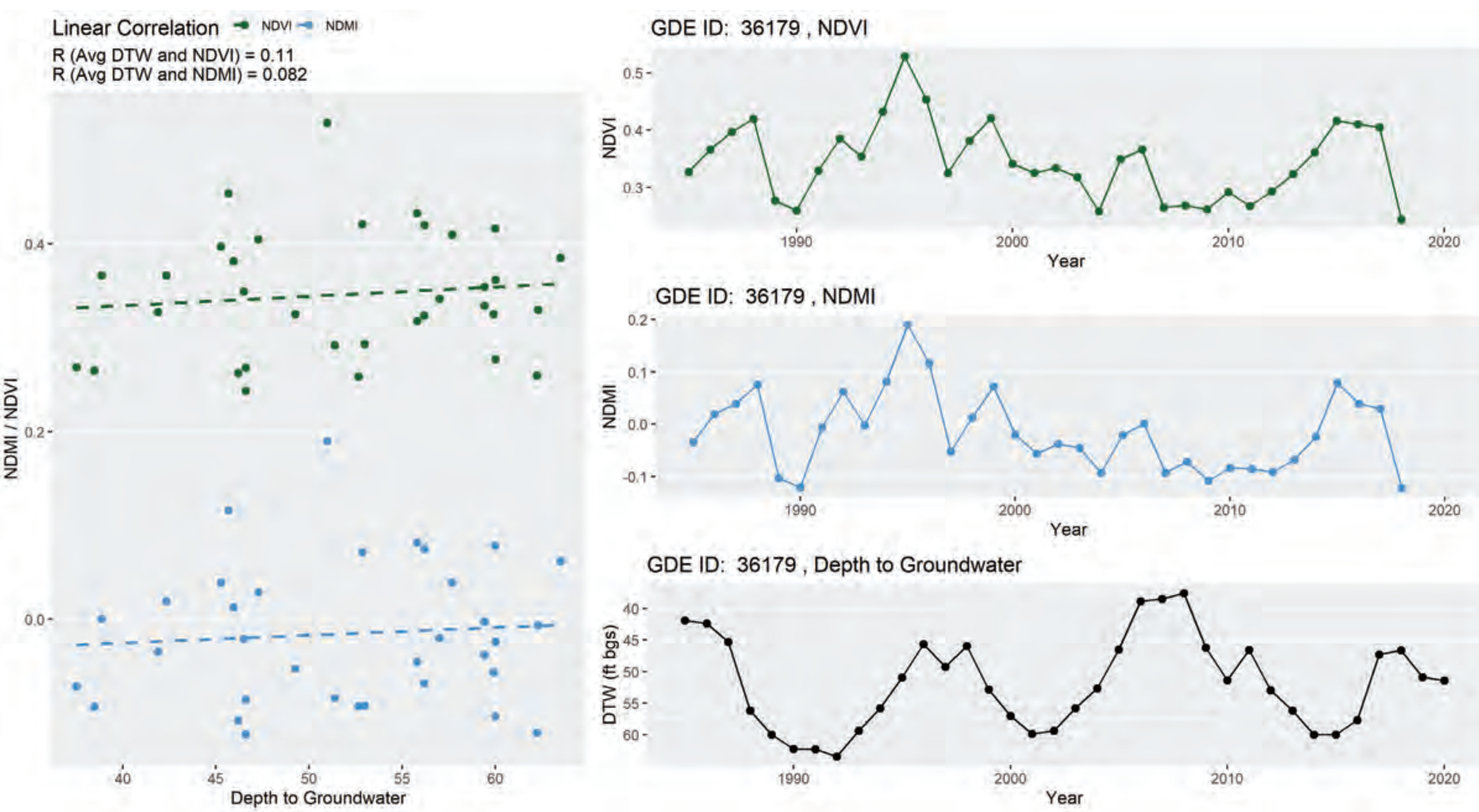

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.53 (p <= 0.05)
R (Avg DTW and NDMI) = -0.5 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 31798 , NDVI
NDVI
Year
GDE ID: 31798 , NDMI
NDMI
Year
GDE ID: 31798 , Depth to Groundwater
DTW (ft bgs)
Year

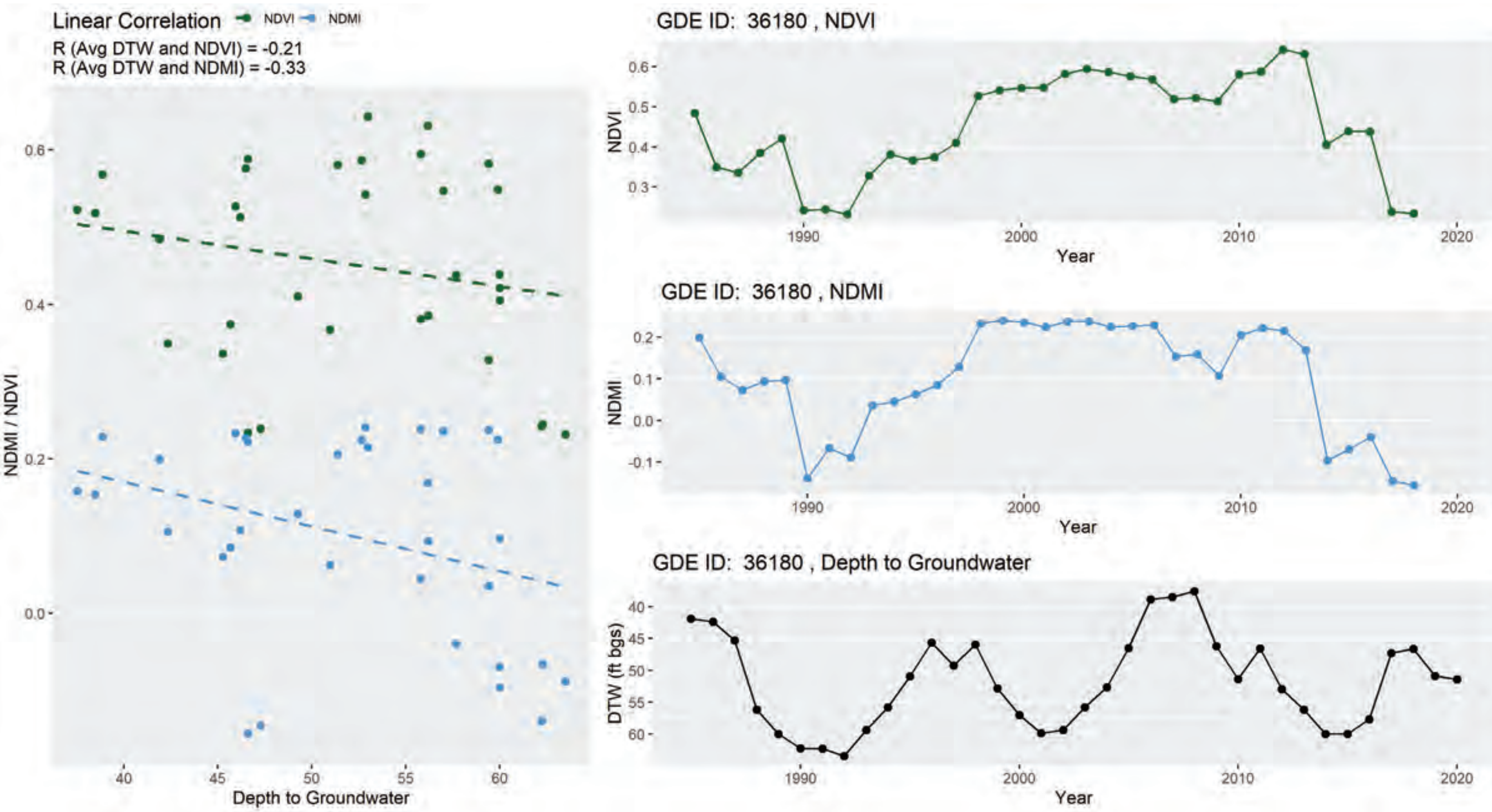

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.19
R (Avg DTW and NDMI) = -0.079
NDMI / NDVI
Depth to Groundwater
GDE ID: 31801 , NDVI
NDVI
Year
GDE ID: 31801 , NDMI
NDMI
Year
GDE ID: 31801 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.22
R (Avg DTW and NDMI) = -0.18
NDMI / NDVI
Depth to Groundwater
GDE ID: 35502 , NDVI
NDVI
Year
GDE ID: 35502 , NDMI
NDMI
Year
GDE ID: 35502 , Depth to Groundwater
DTW (ft bgs)
Year

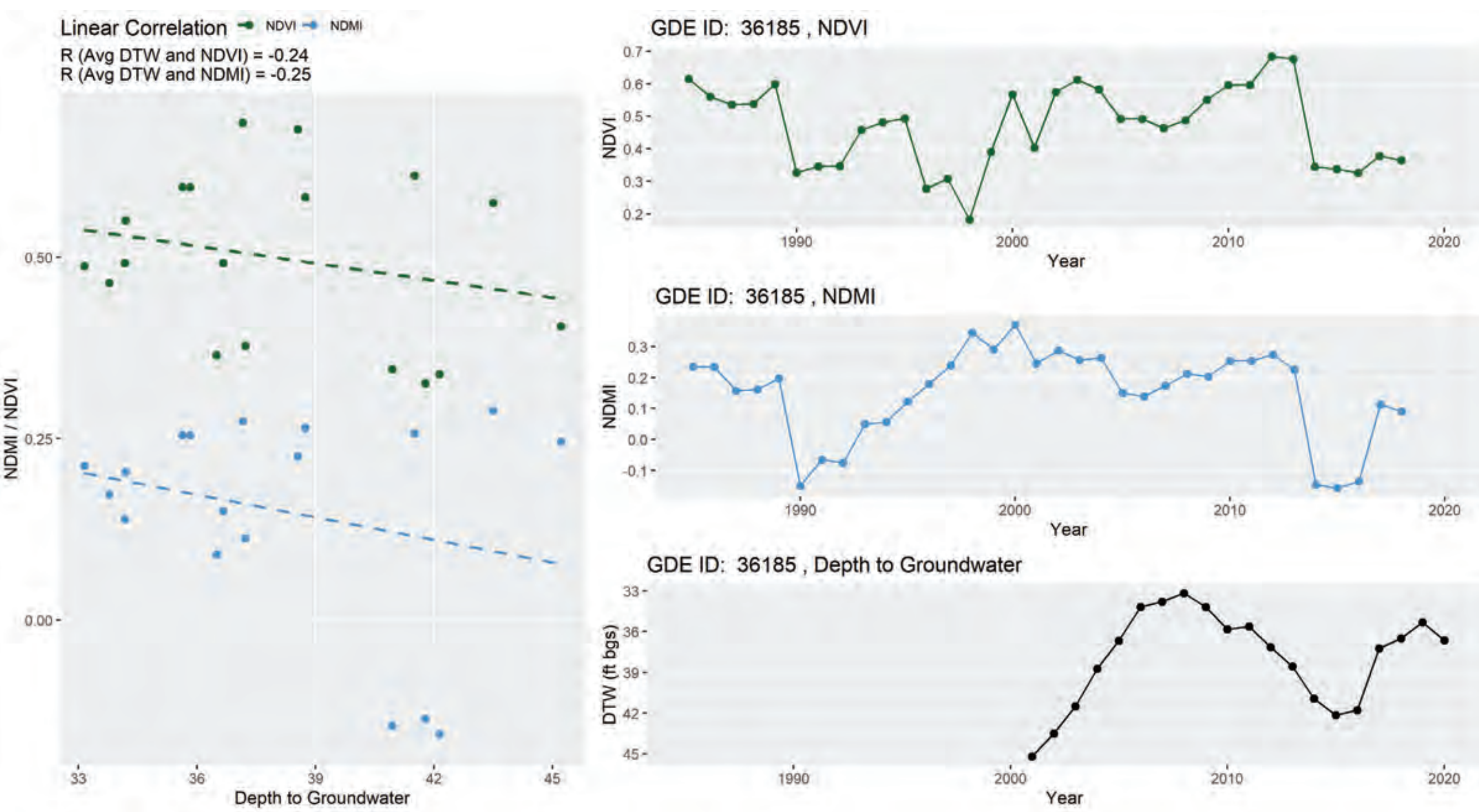

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.2
R (Avg DTW and NDMI) = -0.23
NDMI / NDVI
Depth to Groundwater
GDE ID: 35503 , NDVI
NDVI
Year
GDE ID: 35503 , NDMI
NDMI
Year
GDE ID: 35503 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.077
R (Avg DTW and NDMI) = -0.098
NDMI / NDVI
Depth to Groundwater
GDE ID: 36176 , NDVI
NDVI
Year
GDE ID: 36176 , NDMI
NDMI
Year
GDE ID: 36176 , Depth to Groundwater
DTW (ft bgs)
Year

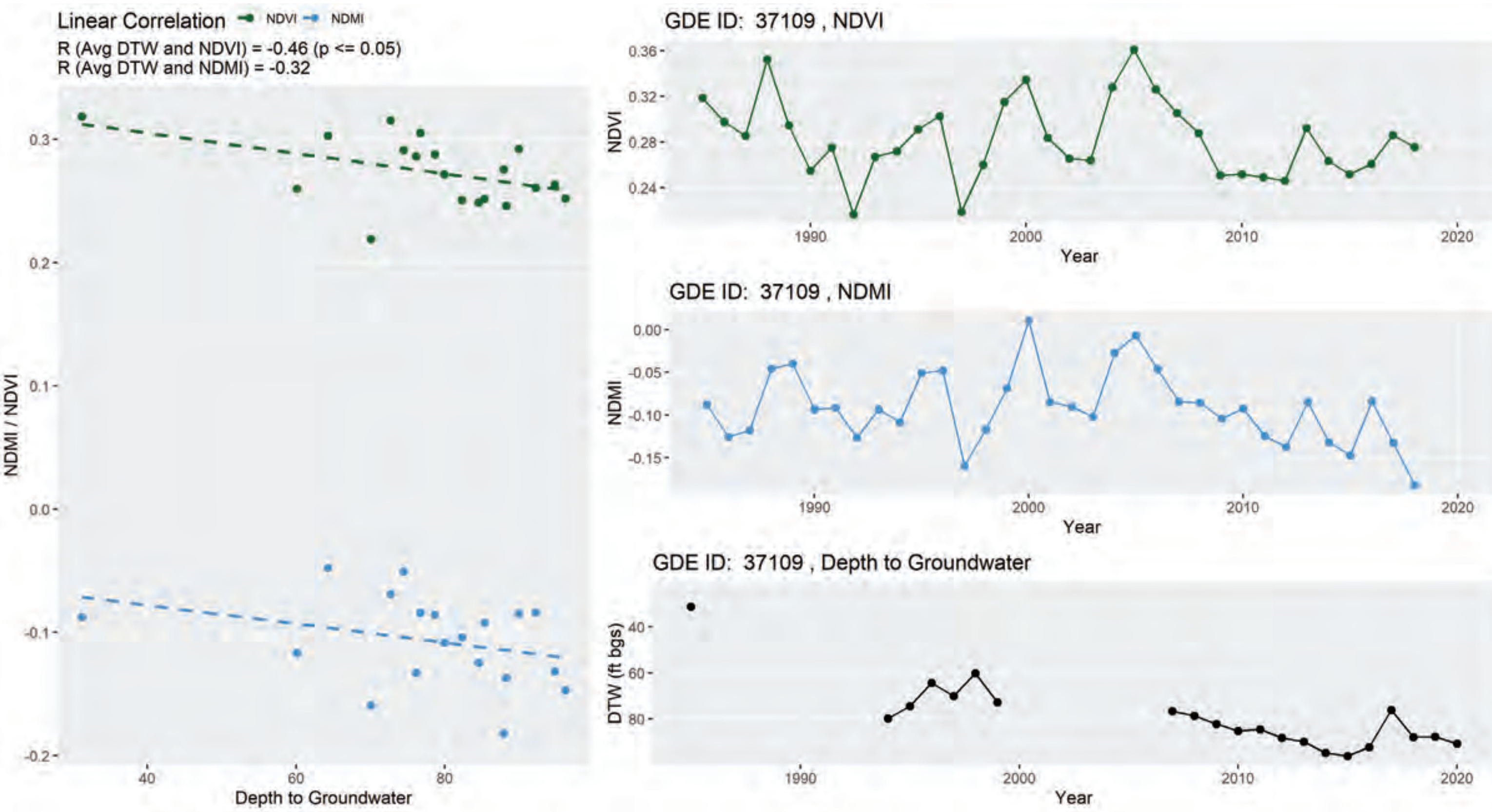

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.11
R (Avg DTW and NDMI) = 0.082
NDMI / NDVI
Depth to Groundwater
GDE ID: 36179 , NDVI
NDVI
Year
GDE ID: 36179 , NDMI
NDMI
Year
GDE ID: 36179 , Depth to Groundwater
DTW (ft bgs)
Year



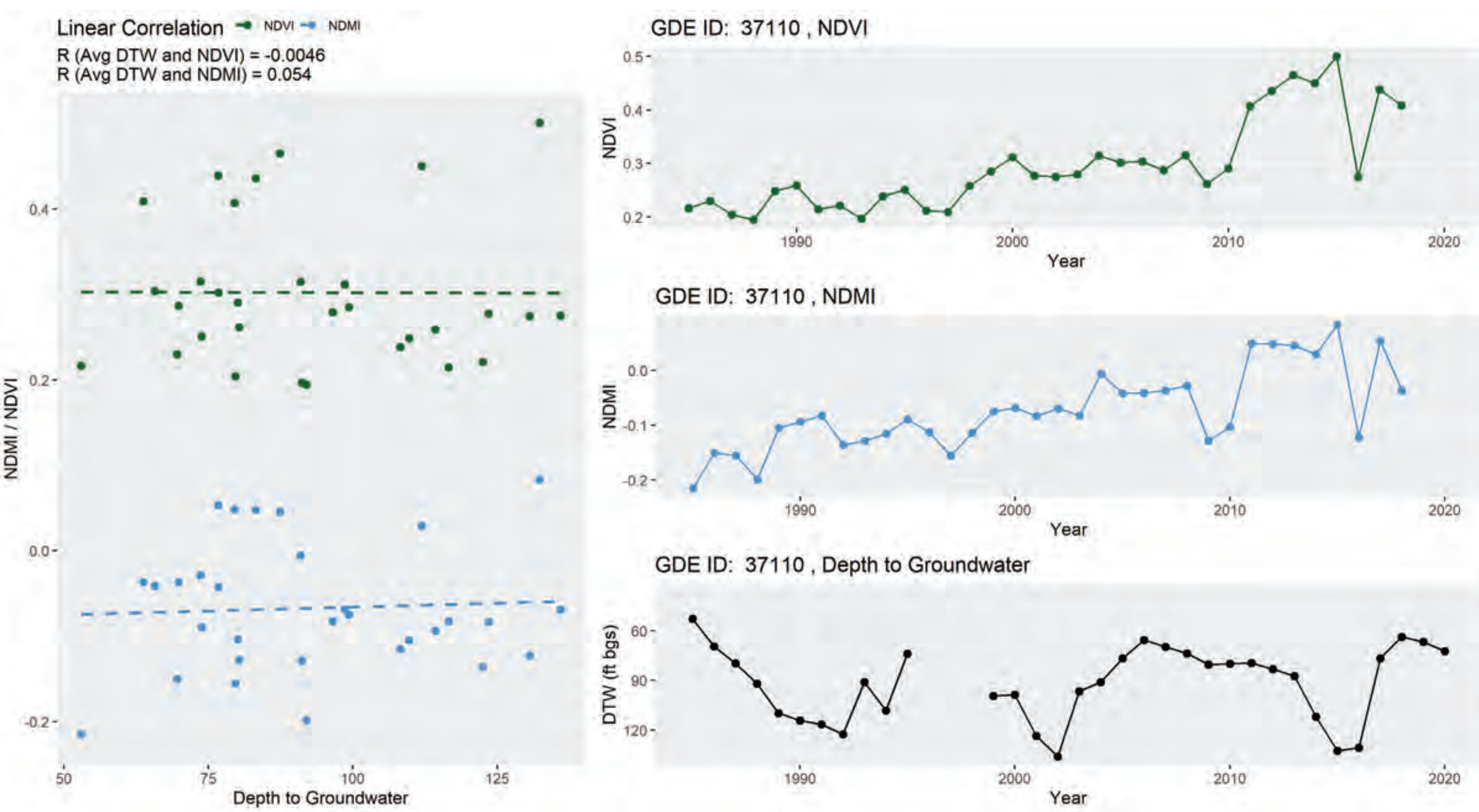
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.21
R (Avg DTW and NDMI) = -0.33
NDMI / NDVI
Depth to Groundwater
GDE ID: 36180 , NDVI
NDVI
Year
GDE ID: 36180 , NDMI
NDMI
Year
GDE ID: 36180 , Depth to Groundwater
DTW (ft bgs)
Year



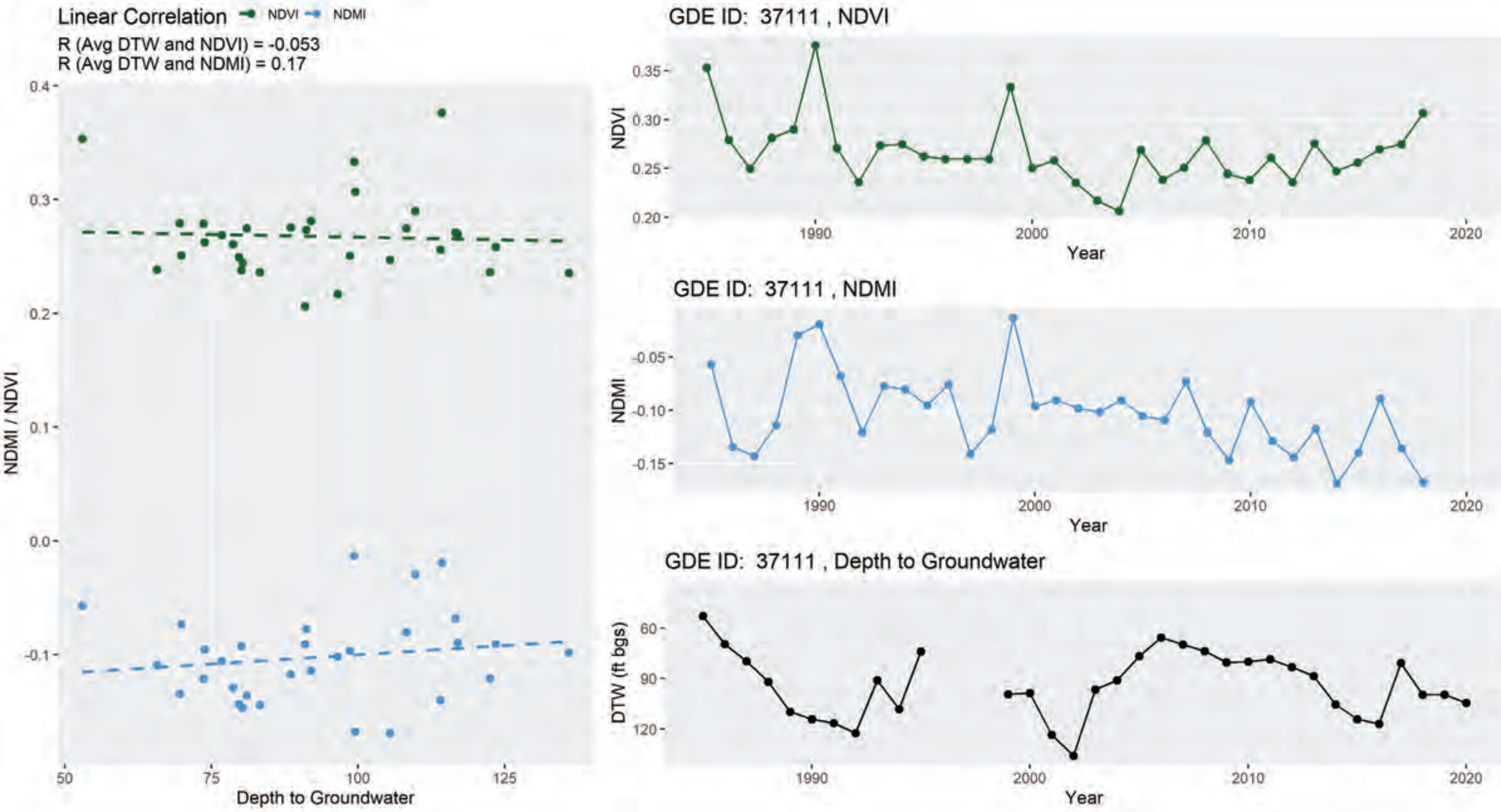
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.24
R (Avg DTW and NDMI) = -0.25
NDMI / NDVI
Depth to Groundwater
GDE ID: 36185 , NDVI
NDVI
Year
GDE ID: 36185 , NDMI
NDMI
Year
GDE ID: 36185 , Depth to Groundwater
DTW (ft bgs)
Year

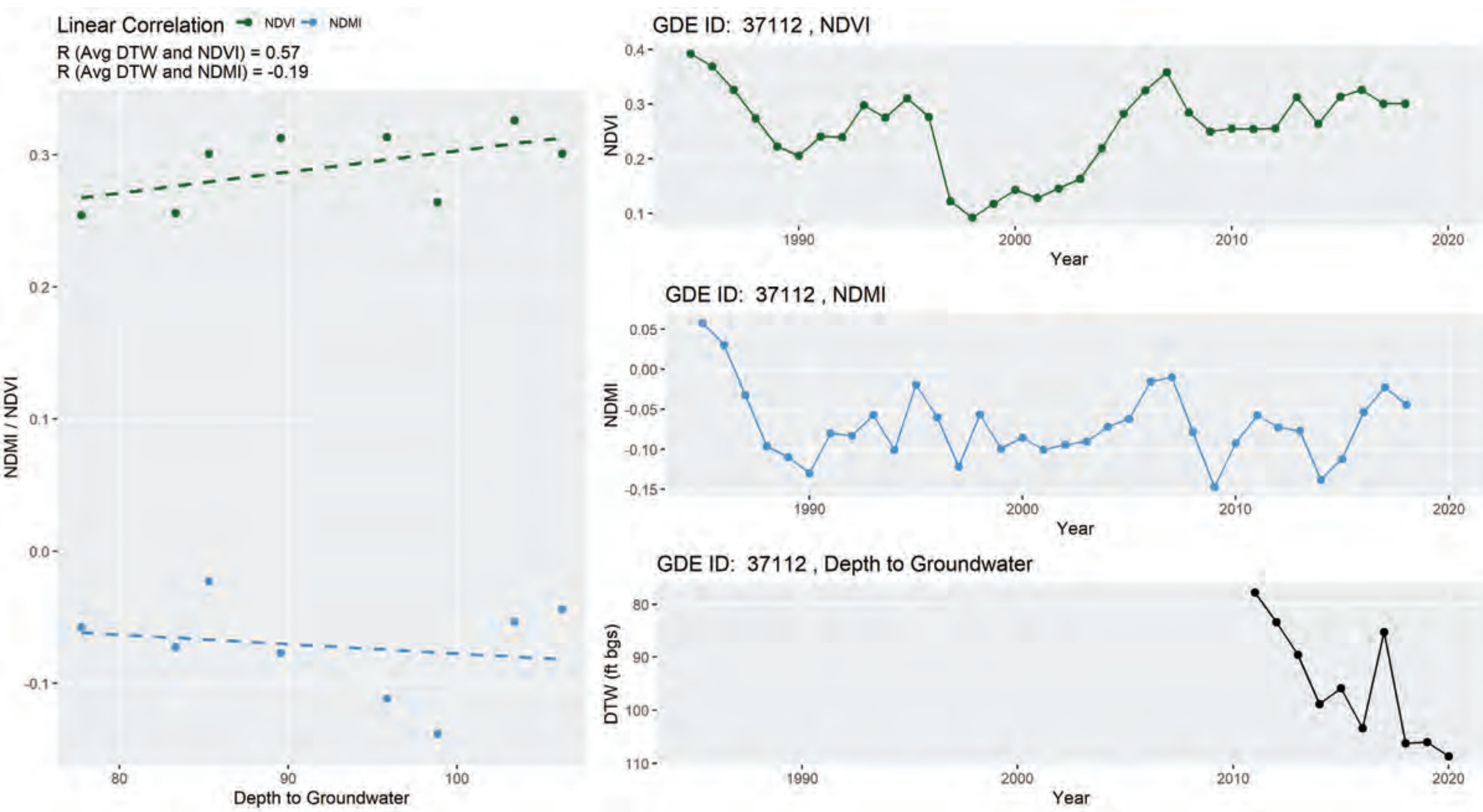


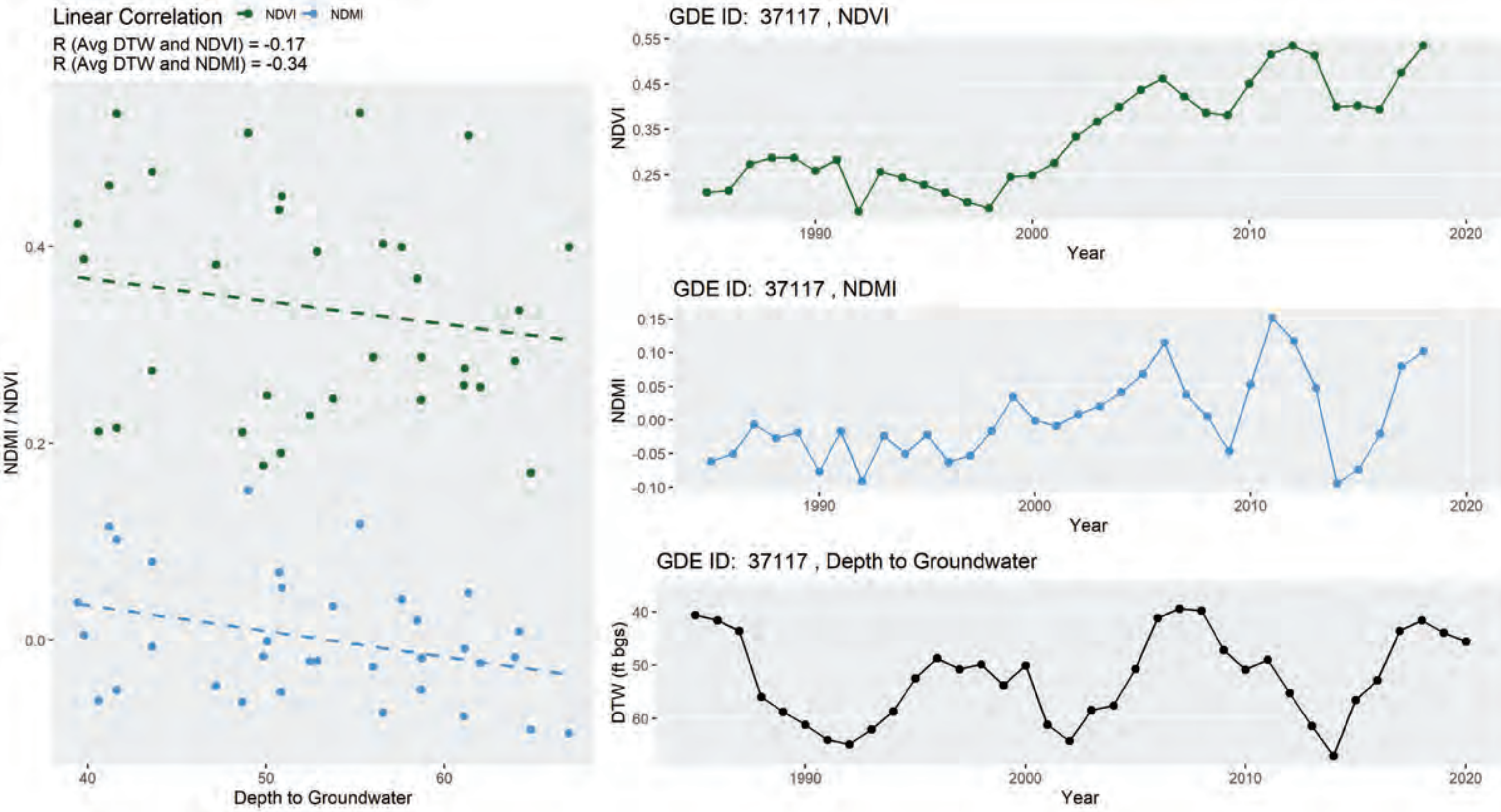
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.46 (p <= 0.05)
R (Avg DTW and NDMI) = -0.32
NDMI / NDVI
Depth to Groundwater
GDE ID: 37109 , NDVI
NDVI
Year
GDE ID: 37109 , NDMI
NDMI
Year
GDE ID: 37109 , Depth to Groundwater
DTW (ft bgs)
Year

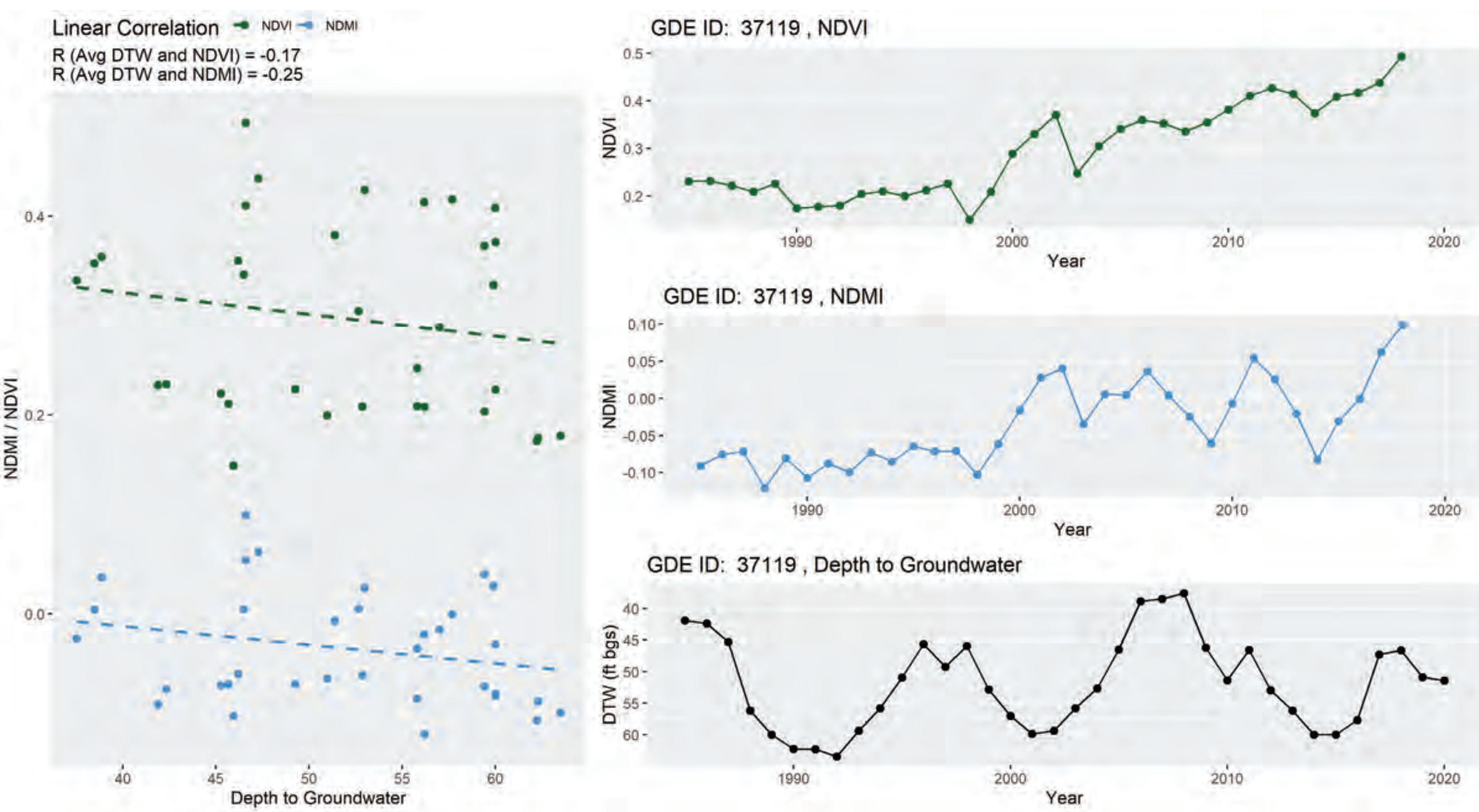


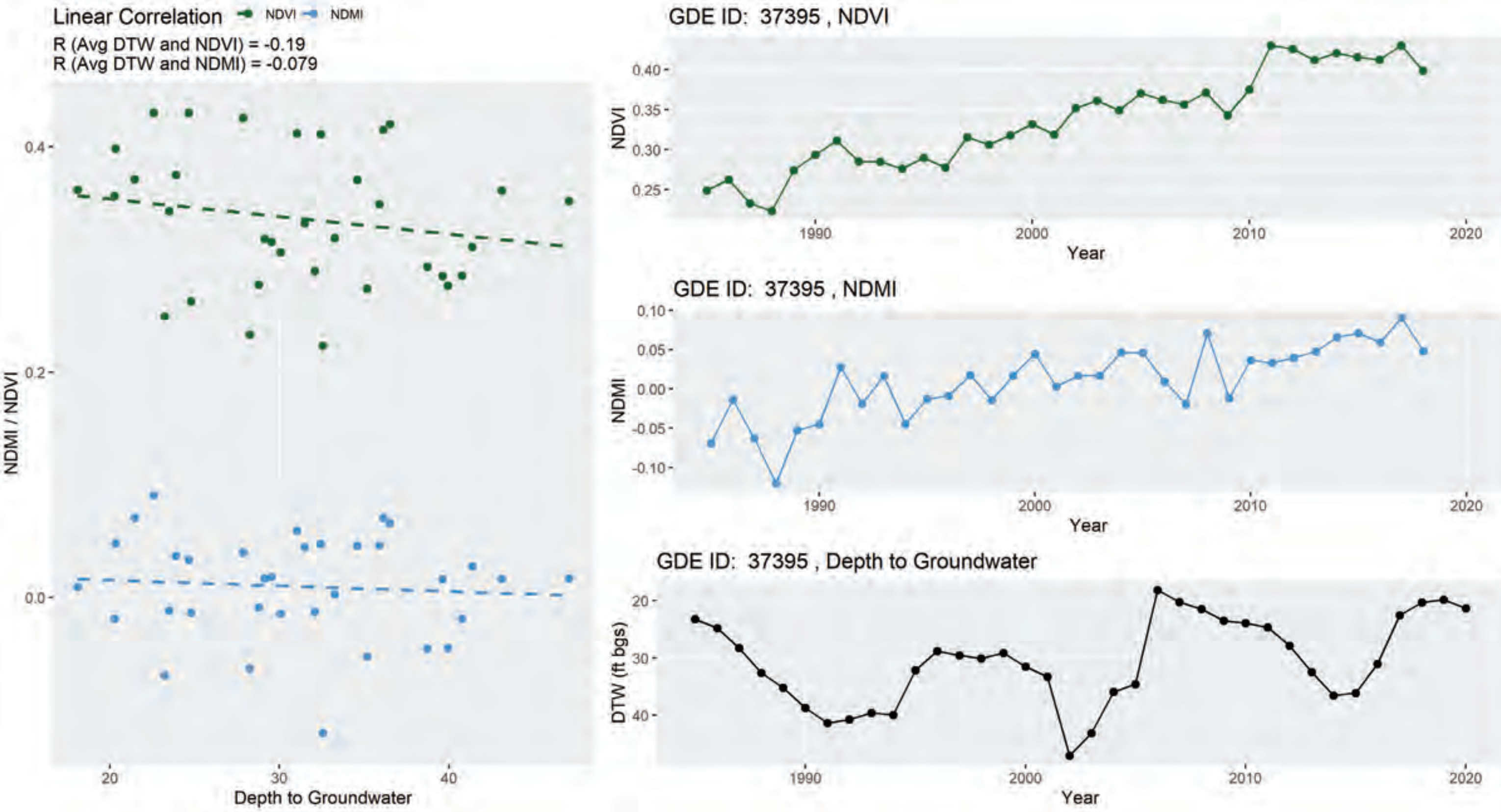
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.0046
R (Avg DTW and NDMI) = 0.054
NDMI / NDVI
Depth to Groundwater
GDE ID: 37110 , NDVI
NDVI
Year
GDE ID: 37110 , NDMI
NDMI
Year
GDE ID: 37110 , Depth to Groundwater
DTW (ft bgs)
Year

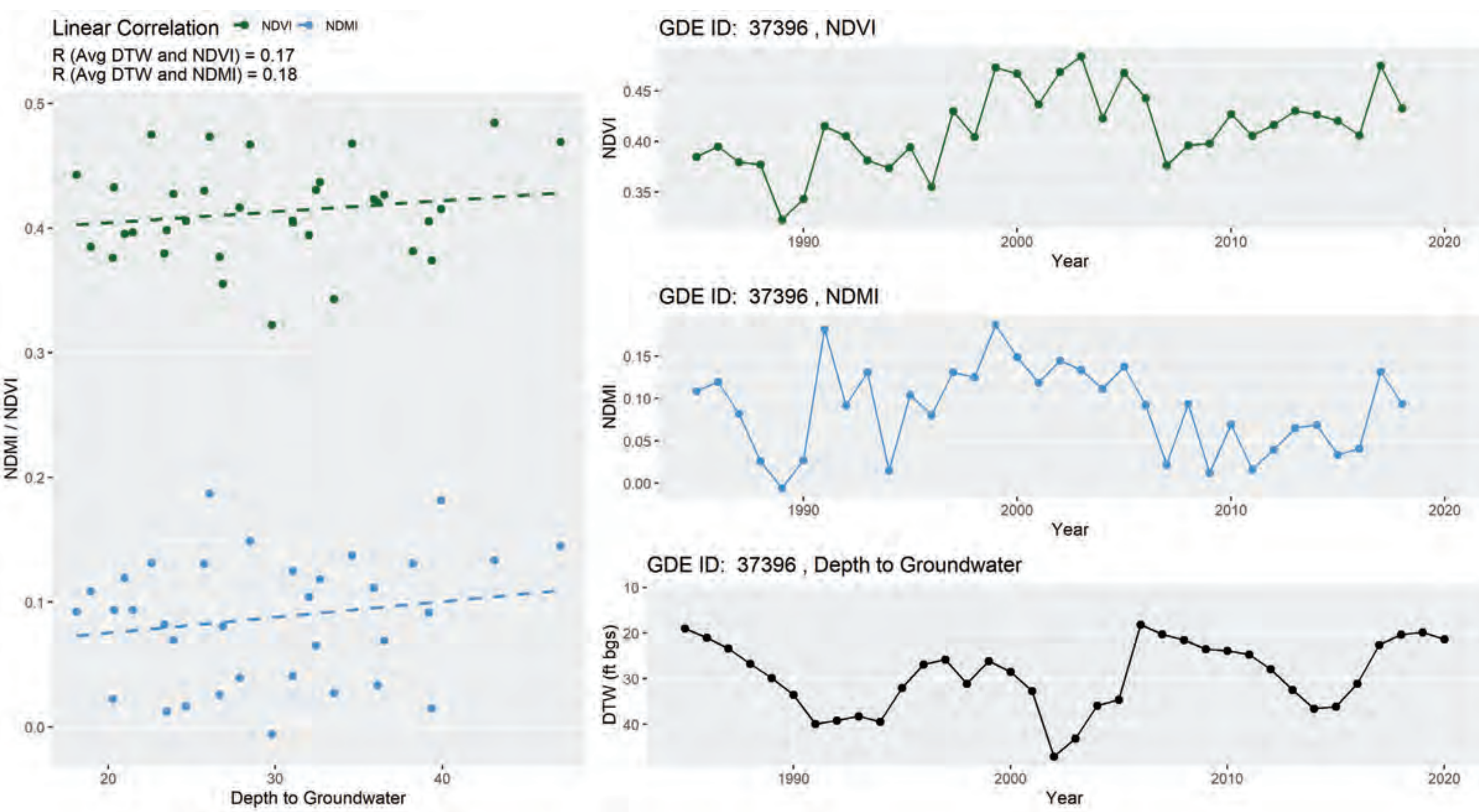

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.053
R (Avg DTW and NDMI) = 0.17
NDMI / NDVI
Depth to Groundwater
GDE ID: 37111 , NDVI
NDVI
Year
GDE ID: 37111 , NDMI
NDMI
Year
GDE ID: 37111 , Depth to Groundwater
DTW (ft bgs)
Year

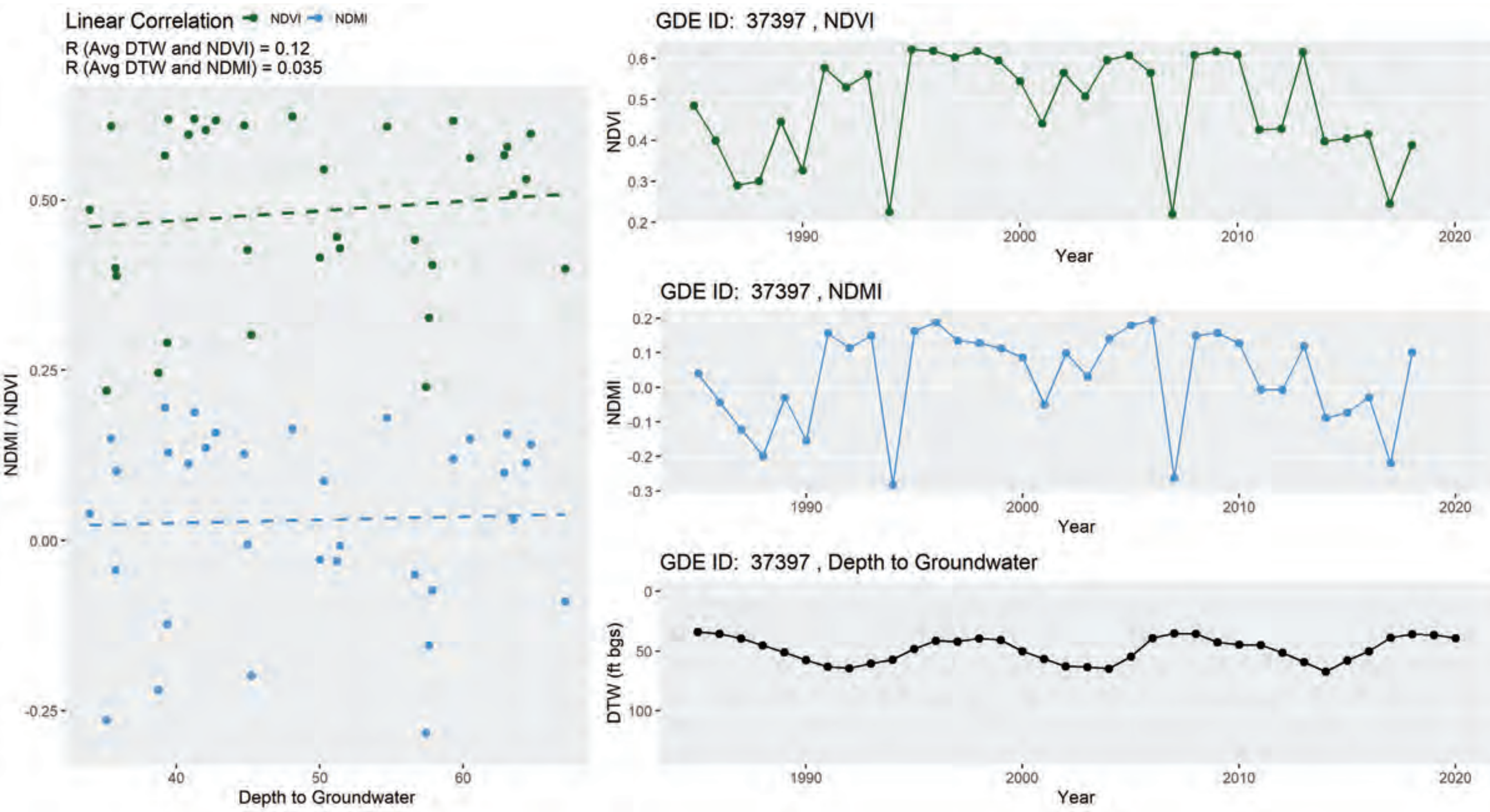

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.57
R (Avg DTW and NDMI) = -0.19
NDMI / NDVI
Depth to Groundwater
GDE ID: 37112 , NDVI
NDVI
Year
GDE ID: 37112 , NDMI
NDMI
Year
GDE ID: 37112 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.17
R (Avg DTW and NDMI) = -0.34
NDMI / NDVI
Depth to Groundwater
GDE ID: 37117 , NDVI
NDVI
Year
GDE ID: 37117 , NDMI
NDMI
Year
GDE ID: 37117 , Depth to Groundwater
DTW (ft bgs)
Year

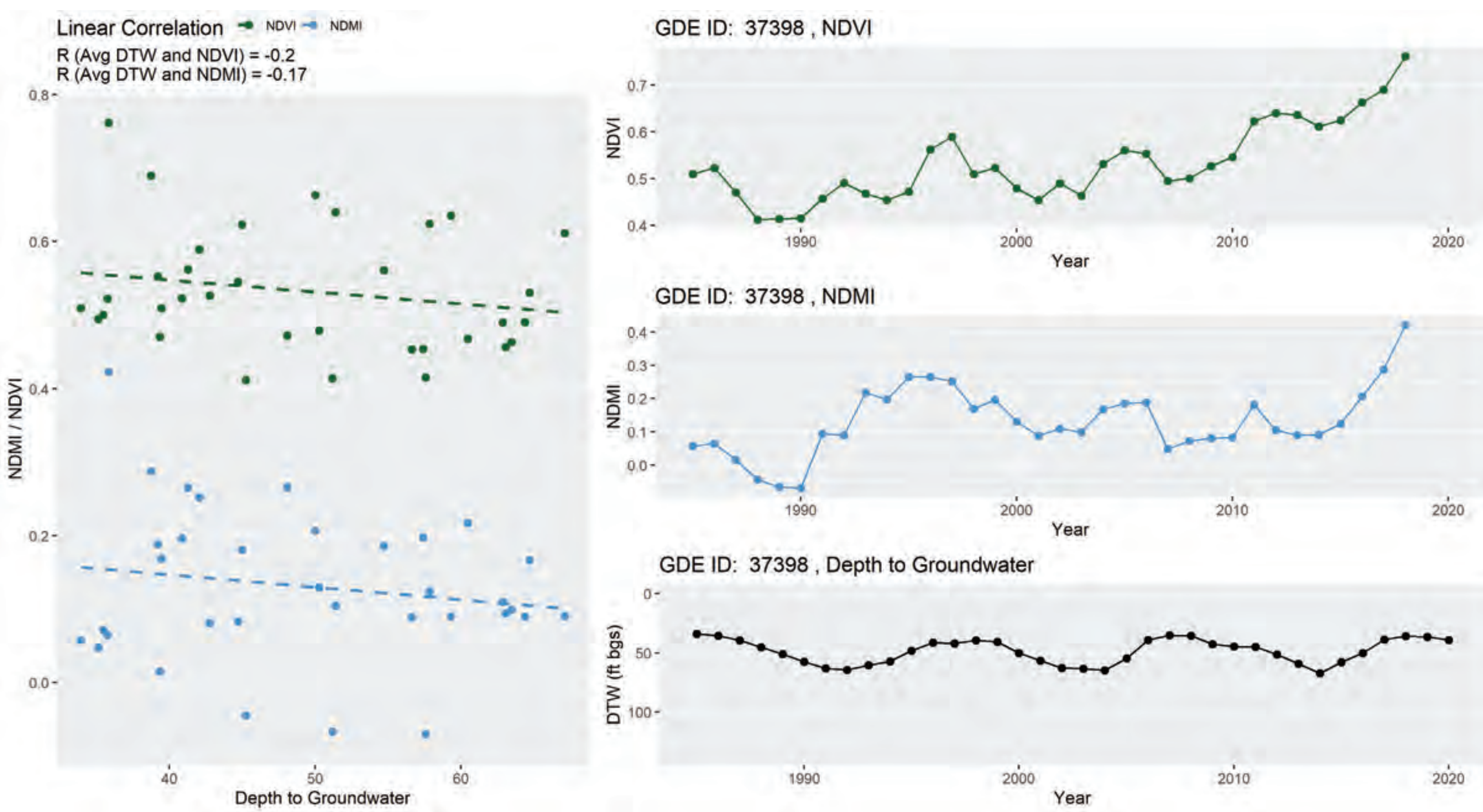

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.17
R (Avg DTW and NDMI) = -0.25
NDMI / NDVI
Depth to Groundwater
GDE ID: 37119 , NDVI
NDVI
Year
GDE ID: 37119 , NDMI
NDMI
Year
GDE ID: 37119 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.19
R (Avg DTW and NDMI) = -0.079
NDMI / NDVI
Depth to Groundwater
GDE ID: 37395 , NDVI
NDVI
Year
GDE ID: 37395 , NDMI
NDMI
Year
GDE ID: 37395 , Depth to Groundwater
DTW (ft bgs)
Year

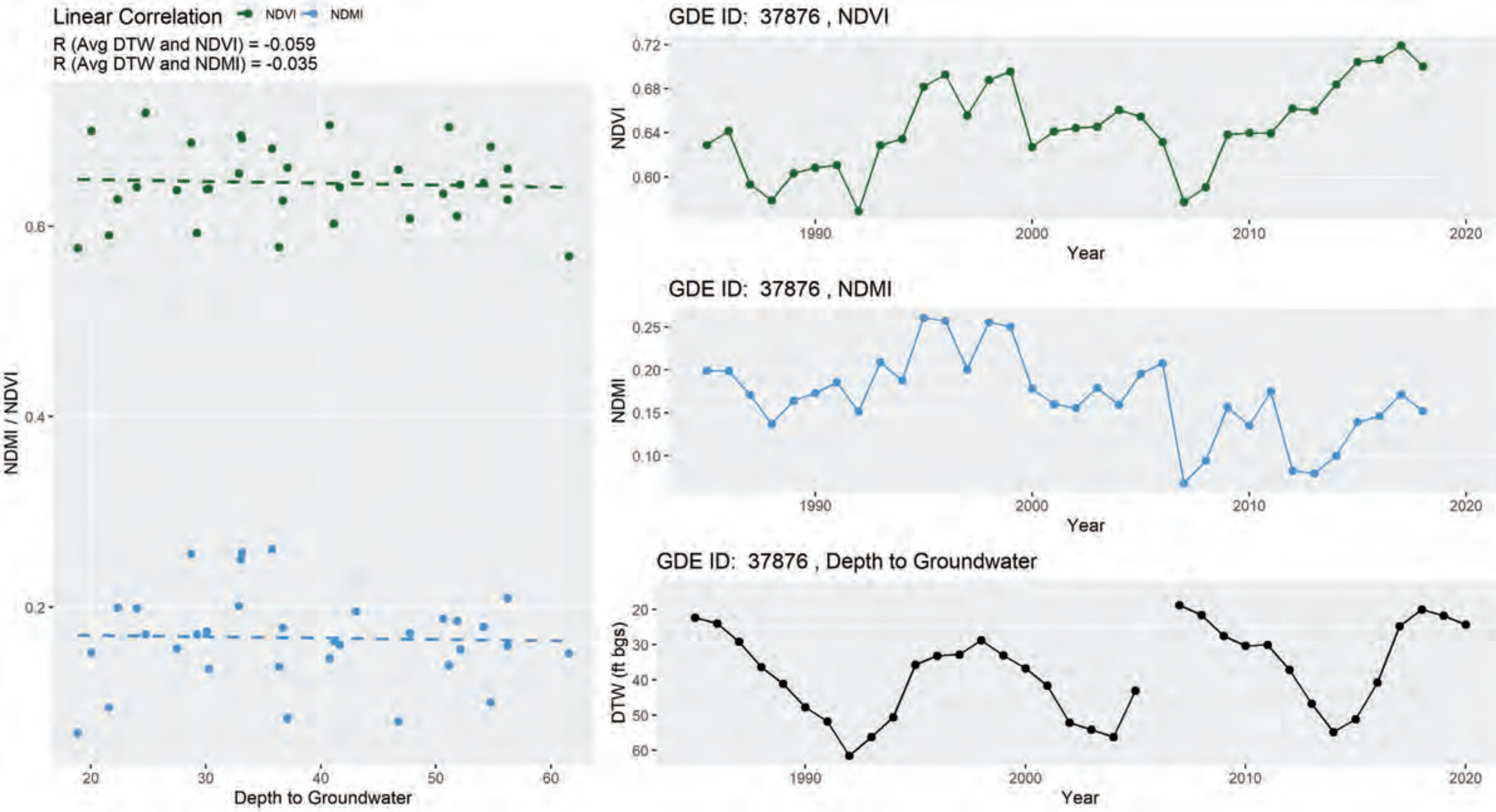

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = 0.17
R (Avg DTW and NDMI) = 0.18
NDMI / NDVI
Depth to Groundwater
GDE ID: 37396 , NDVI
NDVI
Year
GDE ID: 37396 , NDMI
NDMI
Year
GDE ID: 37396 , Depth to Groundwater
DTW (ft bgs)
Year

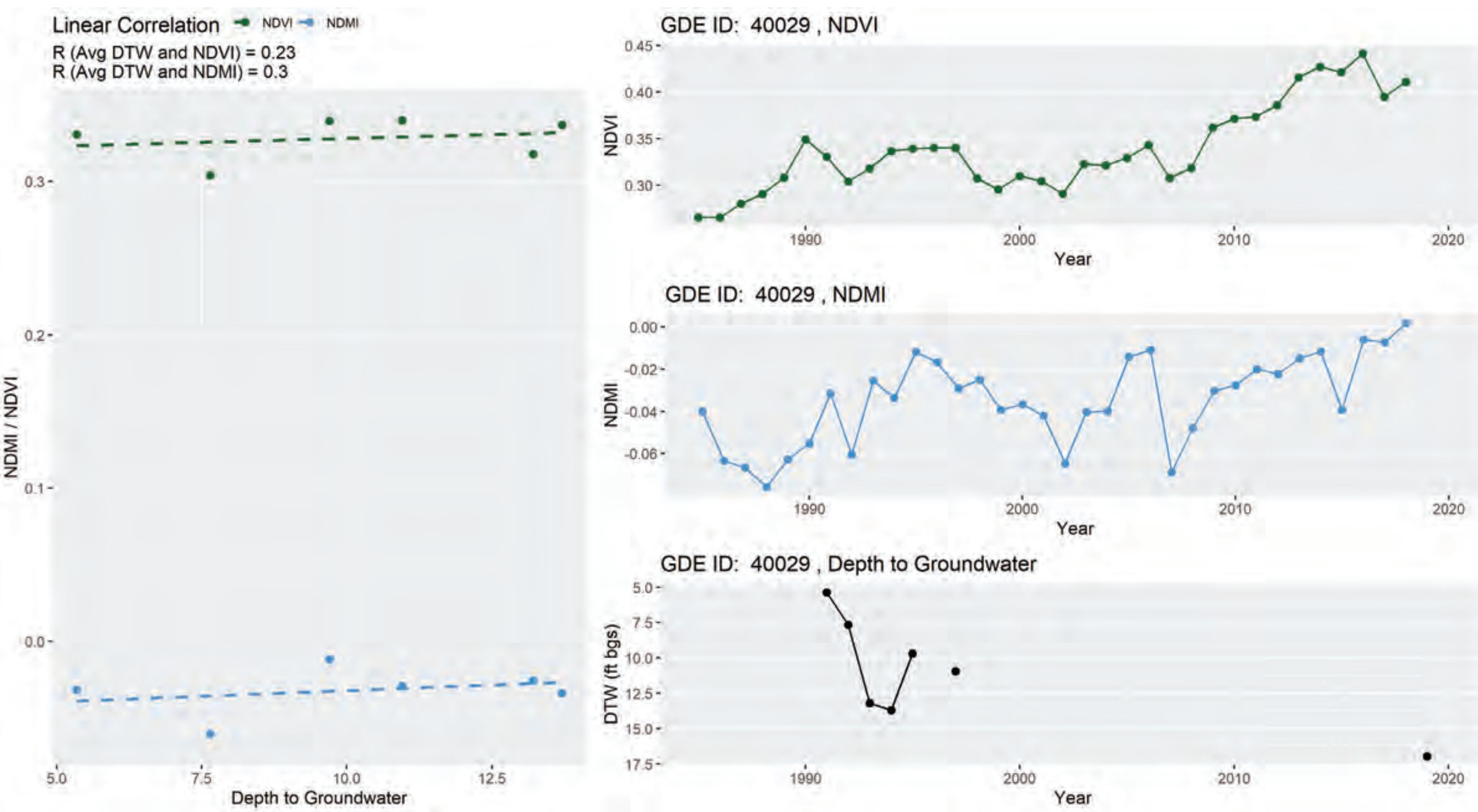


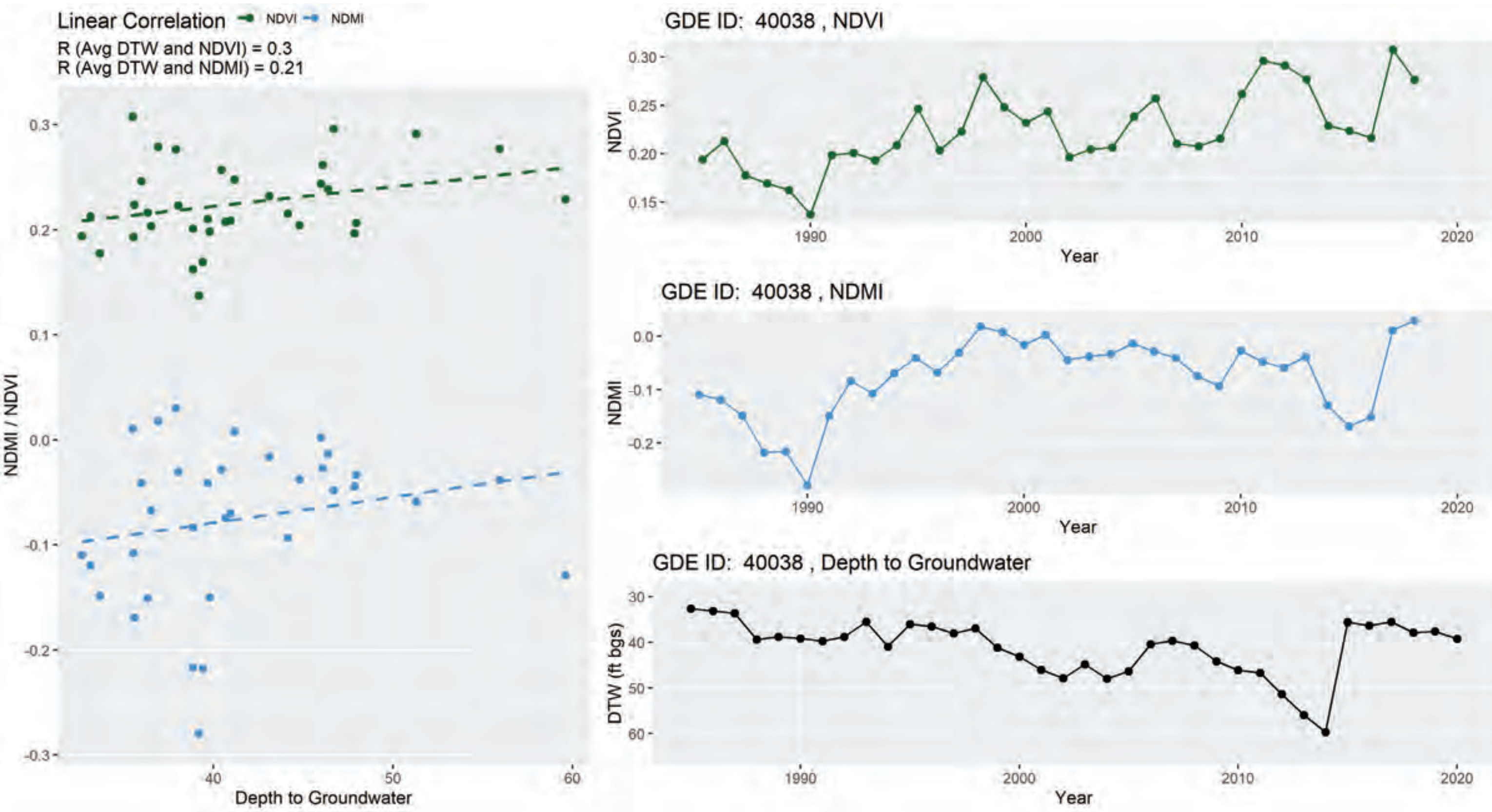
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.12
R (Avg DTW and NDMI) = 0.035
NDMI / NDVI
Depth to Groundwater
GDE ID: 37397 , NDVI
NDVI
Year
GDE ID: 37397 , NDMI
NDMI
Year
GDE ID: 37397 , Depth to Groundwater
DTW (ft bgs)
Year

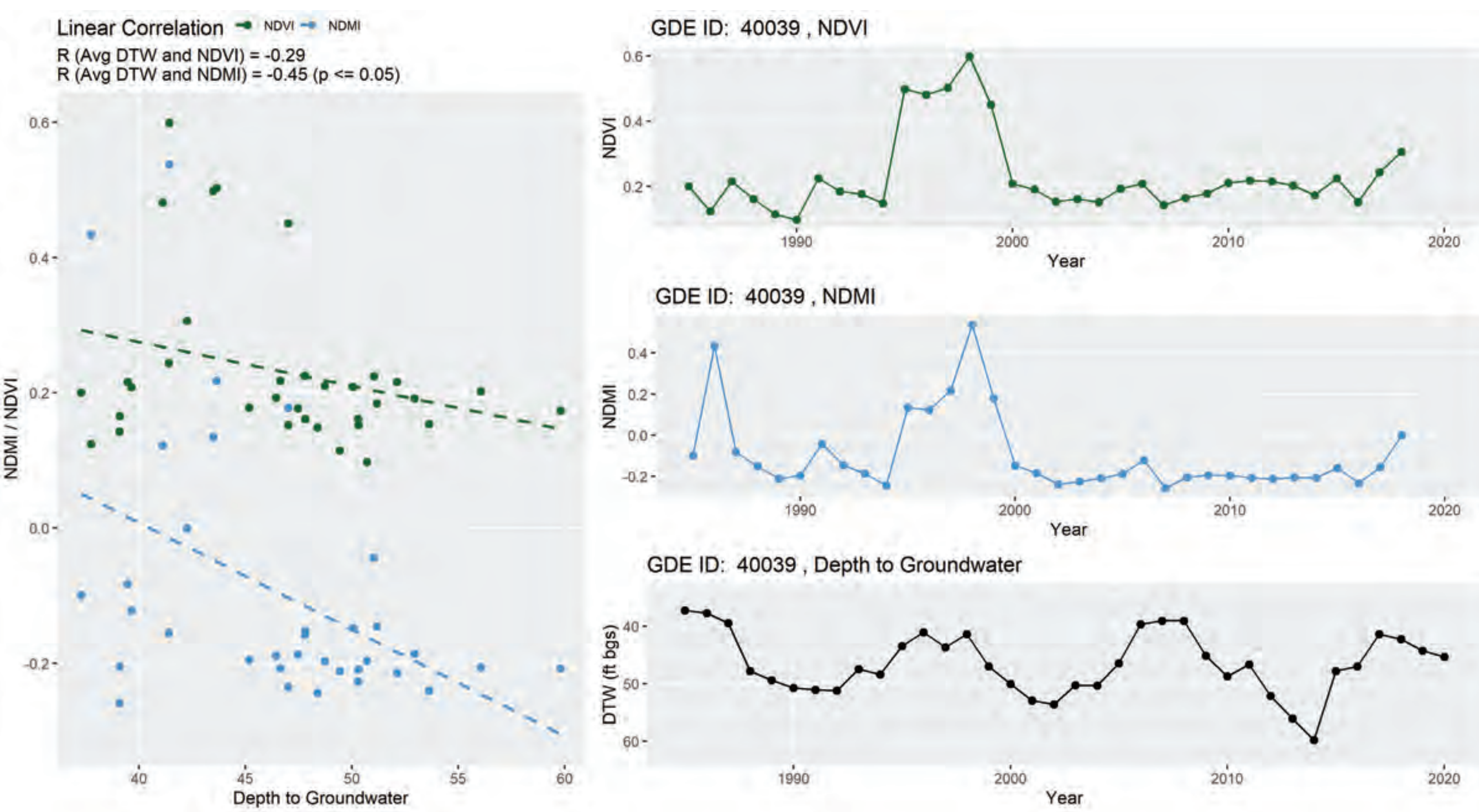


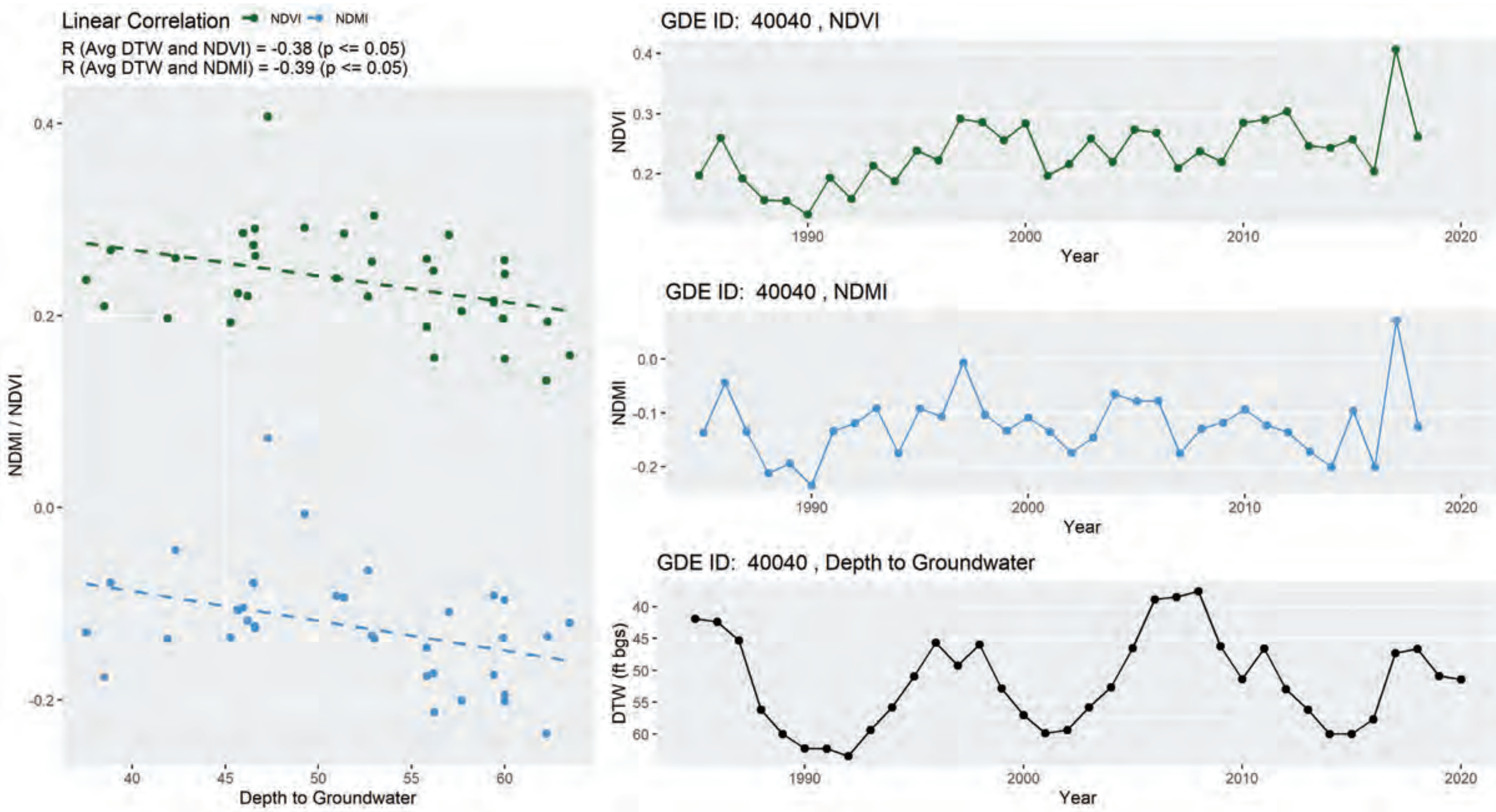
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.2
R (Avg DTW and NDMI) = -0.17
NDMI / NDVI
Depth to Groundwater
GDE ID: 37398 , NDVI
NDVI
Year
GDE ID: 37398 , NDMI
NDMI
Year
GDE ID: 37398 , Depth to Groundwater
DTW (ft bgs)
Year

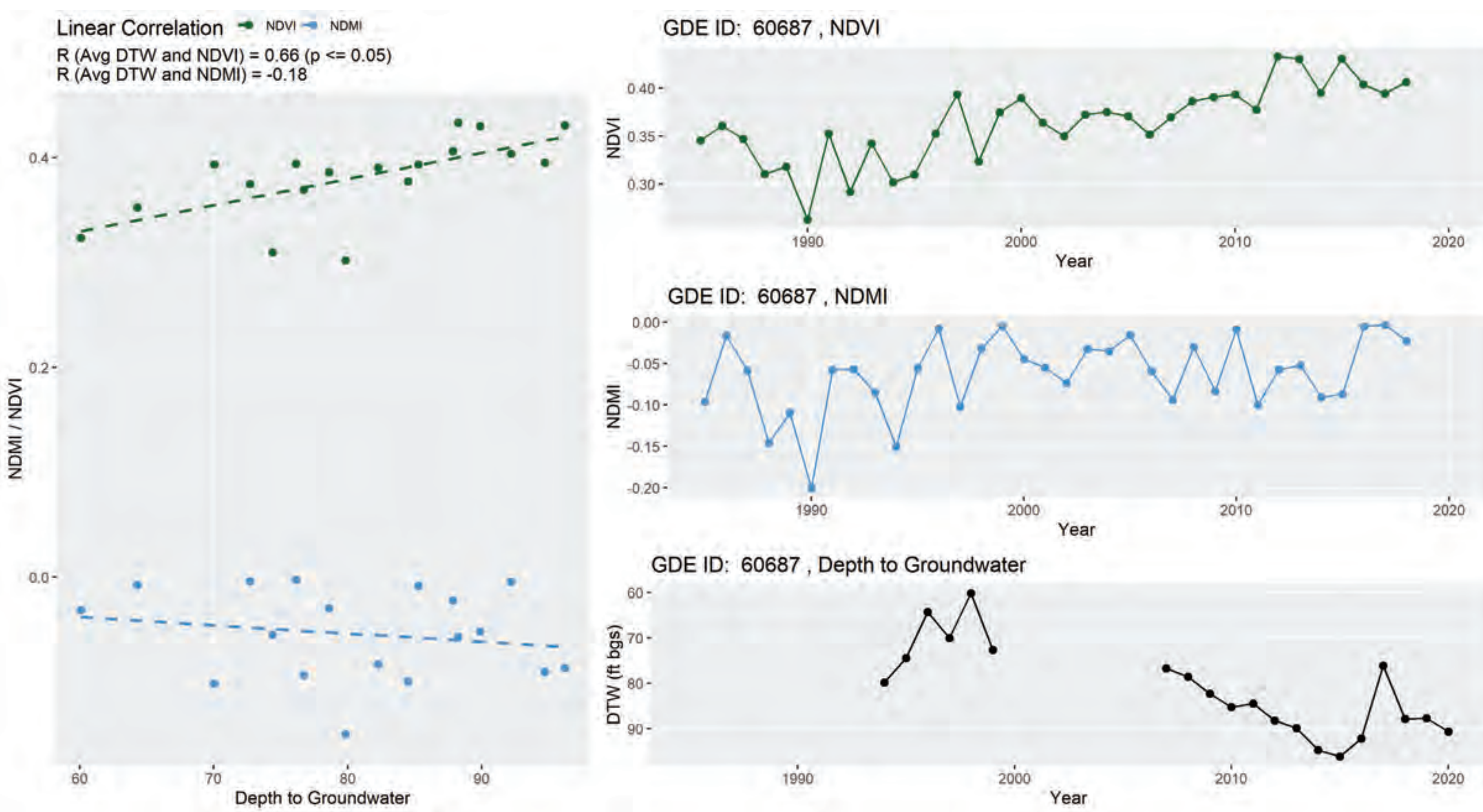

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.059
R (Avg DTW and NDMI) = -0.035
NDMI / NDVI
Depth to Groundwater
GDE ID: 37876 , NDVI
NDVI
Year
GDE ID: 37876 , NDMI
NDMI
Year
GDE ID: 37876 , Depth to Groundwater
DTW (ft bgs)
Year

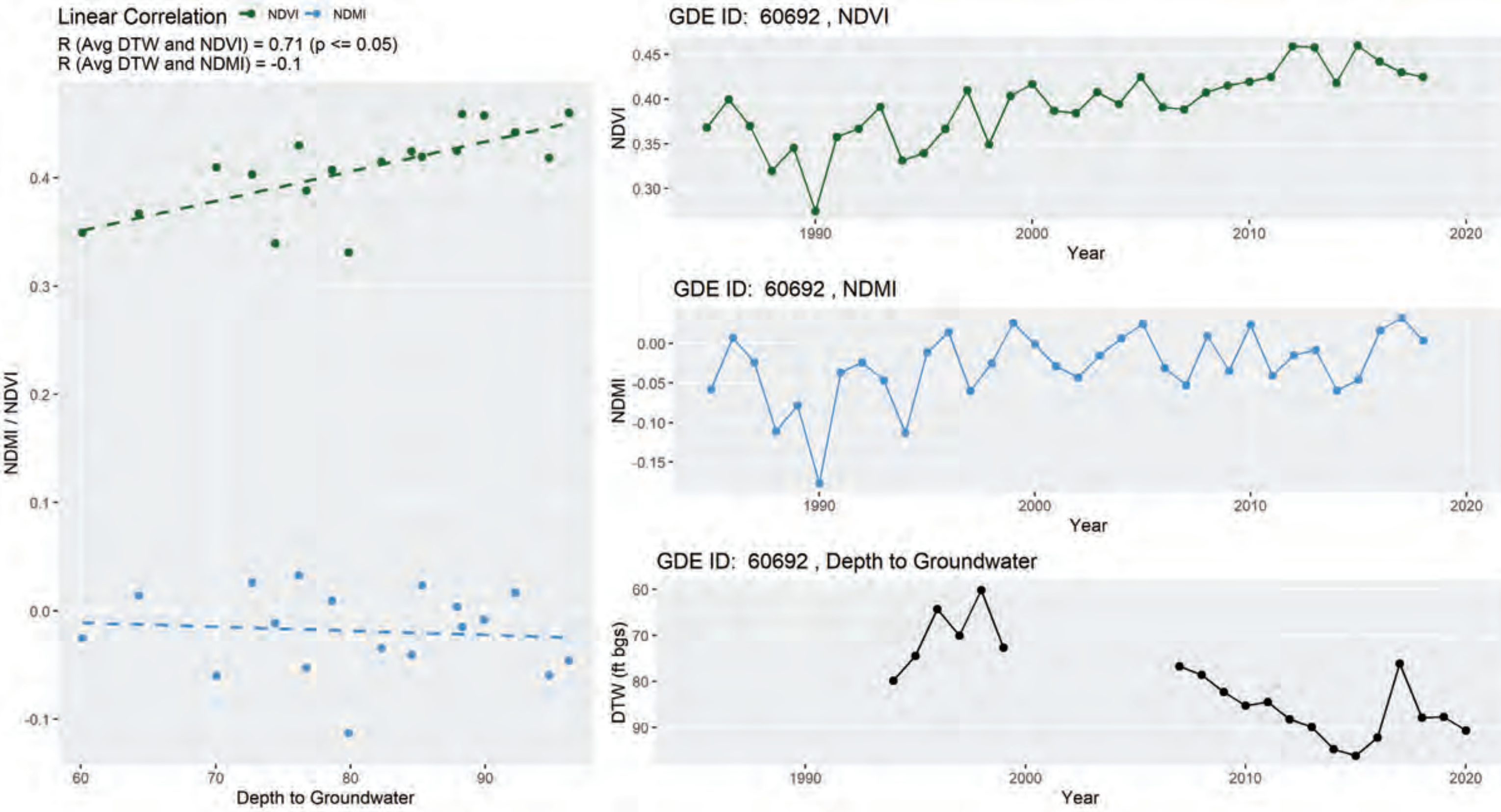

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.23
R (Avg DTW and NDMI) = 0.3
NDMI / NDVI
Depth to Groundwater
GDE ID: 40029 , NDVI
NDVI
Year
GDE ID: 40029 , NDMI
NDMI
Year
GDE ID: 40029 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.3
R (Avg DTW and NDMI) = 0.21
NDMI / NDVI
Depth to Groundwater
GDE ID: 40038 , NDVI
NDVI
Year
GDE ID: 40038 , NDMI
NDMI
Year
GDE ID: 40038 , Depth to Groundwater
DTW (ft bgs)
Year

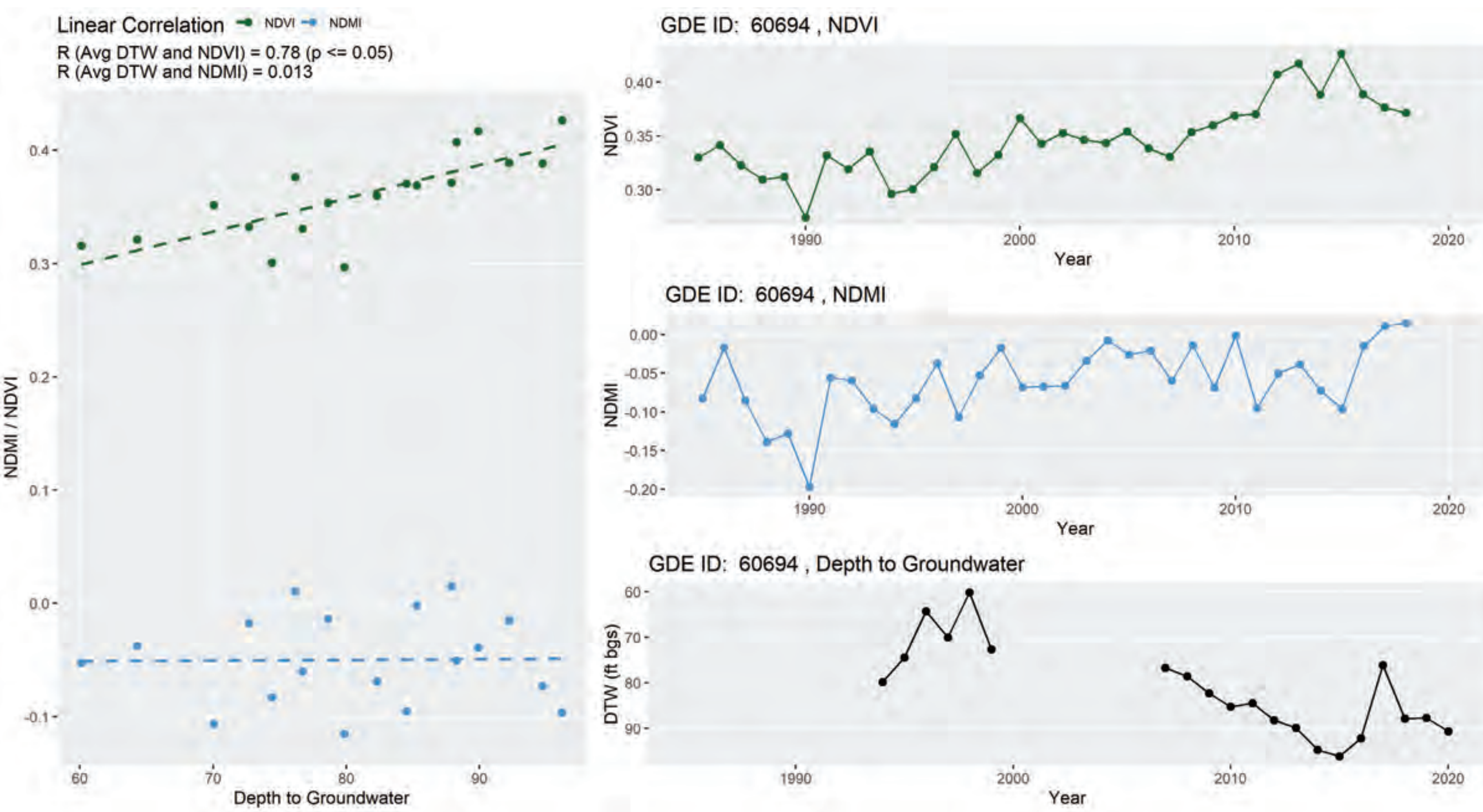

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.29
R (Avg DTW and NDMI) = -0.45 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 40039 , NDVI
NDVI
Year
GDE ID: 40039 , NDMI
NDMI
Year
GDE ID: 40039 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.38 (p <= 0.05)
R (Avg DTW and NDMI) = -0.39 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 40040 , NDVI
NDVI
Year
GDE ID: 40040 , NDMI
NDMI
Year
GDE ID: 40040 , Depth to Groundwater
DTW (ft bgs)
Year

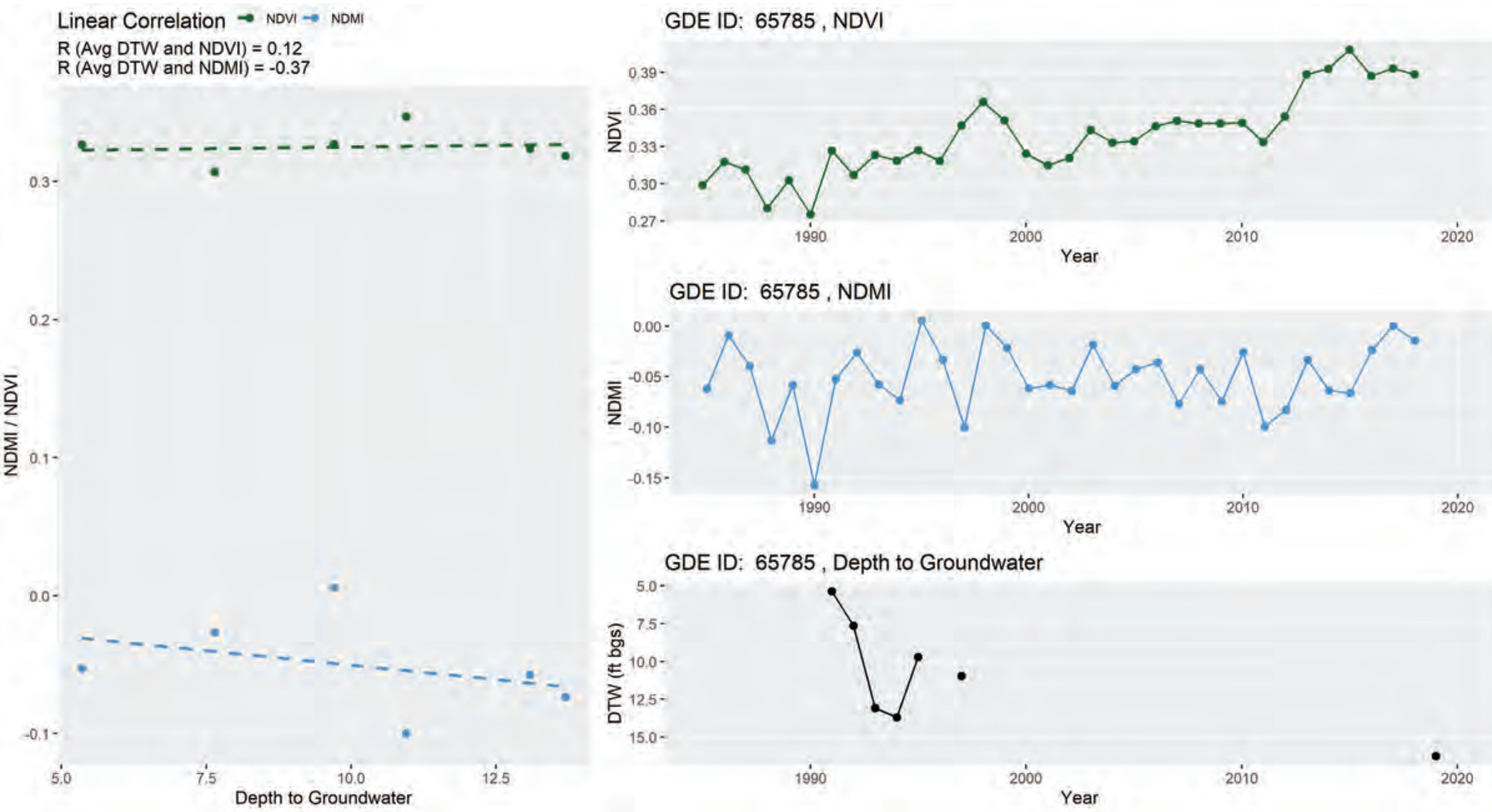

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.66 (p <= 0.05)
R (Avg DTW and NDMI) = -0.18
NDMI / NDVI
Depth to Groundwater
GDE ID: 60687 , NDVI
NDVI
Year
GDE ID: 60687 , NDMI
NDMI
Year
GDE ID: 60687 , Depth to Groundwater
DTW (ft bgs)
Year

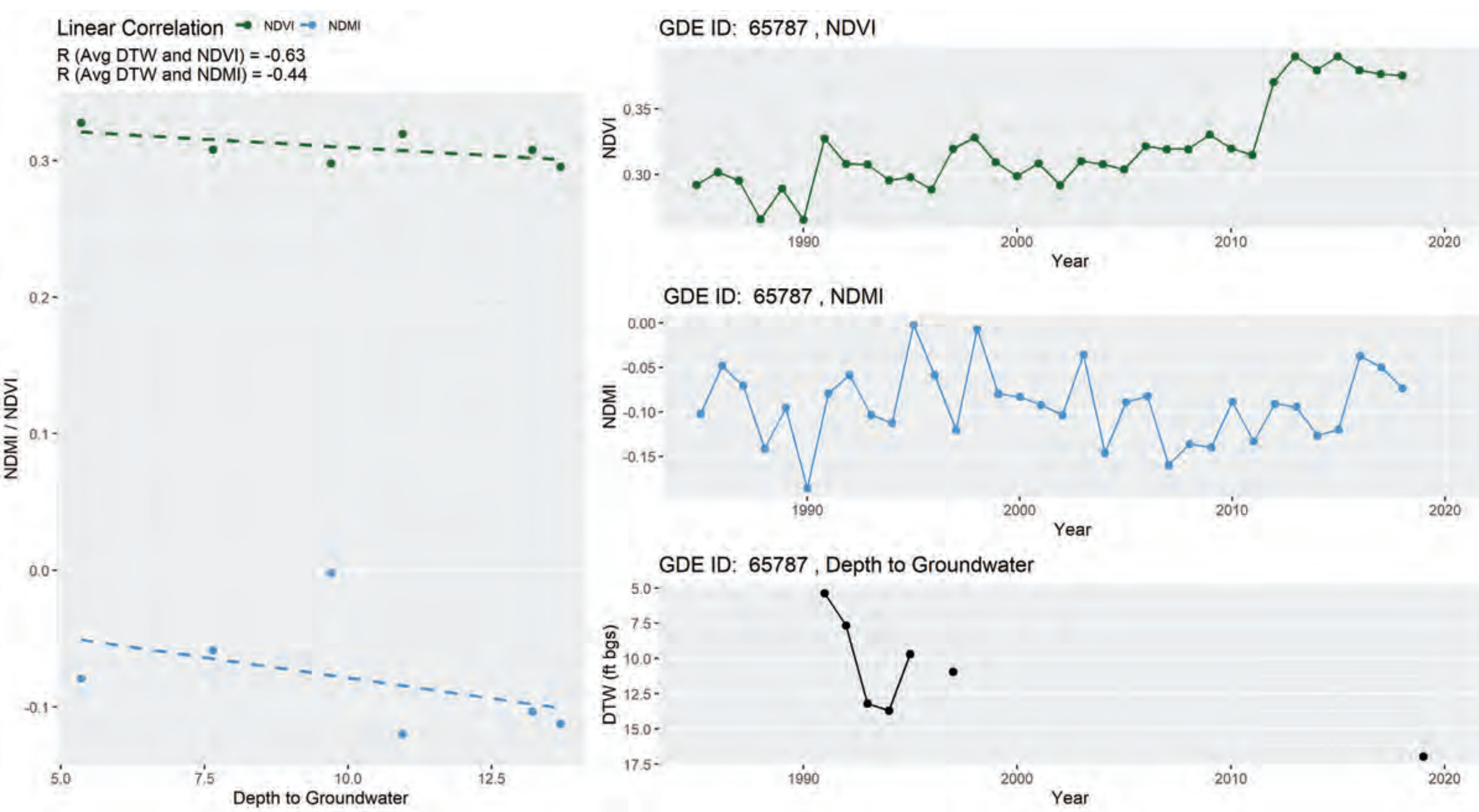


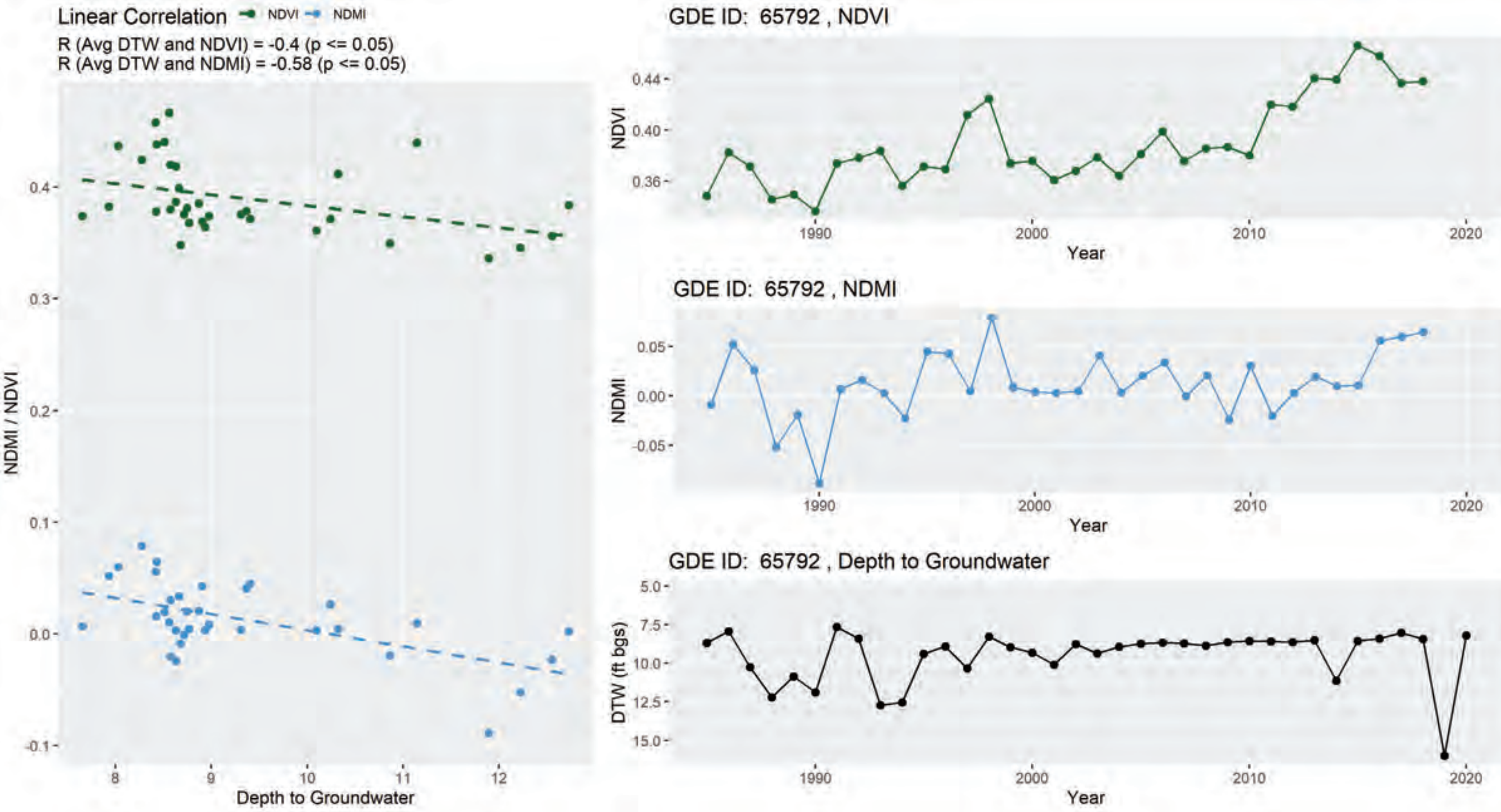
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.71 (p <= 0.05)
R (Avg DTW and NDMI) = -0.1
NDMI / NDVI
Depth to Groundwater
GDE ID: 60692 , NDVI
NDVI
Year
GDE ID: 60692 , NDMI
NDMI
Year
GDE ID: 60692 , Depth to Groundwater
DTW (ft bgs)
Year

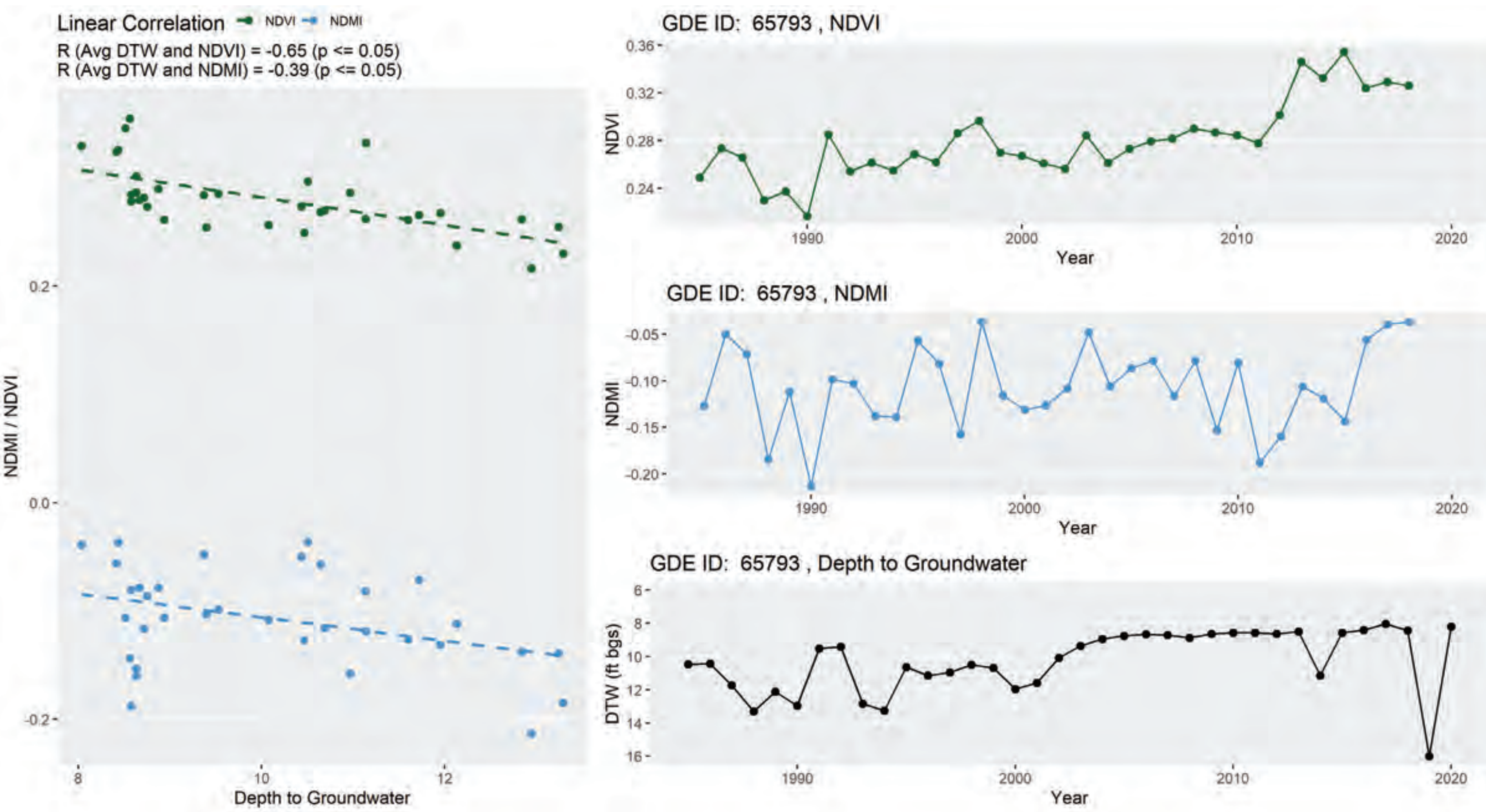


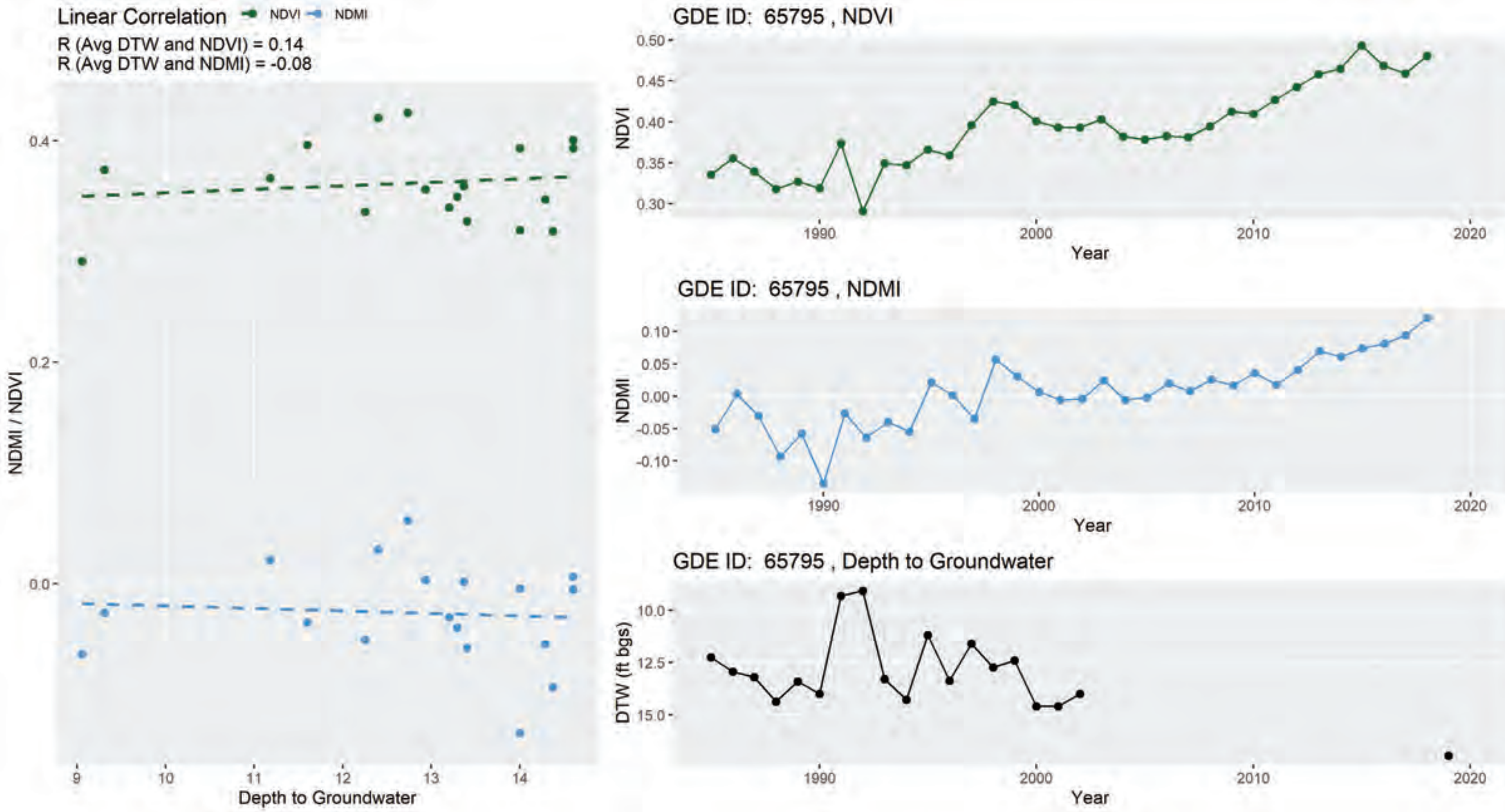
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.78 (p <= 0.05)
R (Avg DTW and NDMI) = 0.013
NDMI / NDVI
Depth to Groundwater
GDE ID: 60694 , NDVI
NDVI
Year
GDE ID: 60694 , NDMI
NDMI
Year
GDE ID: 60694 , Depth to Groundwater
DTW (ft bgs)
Year

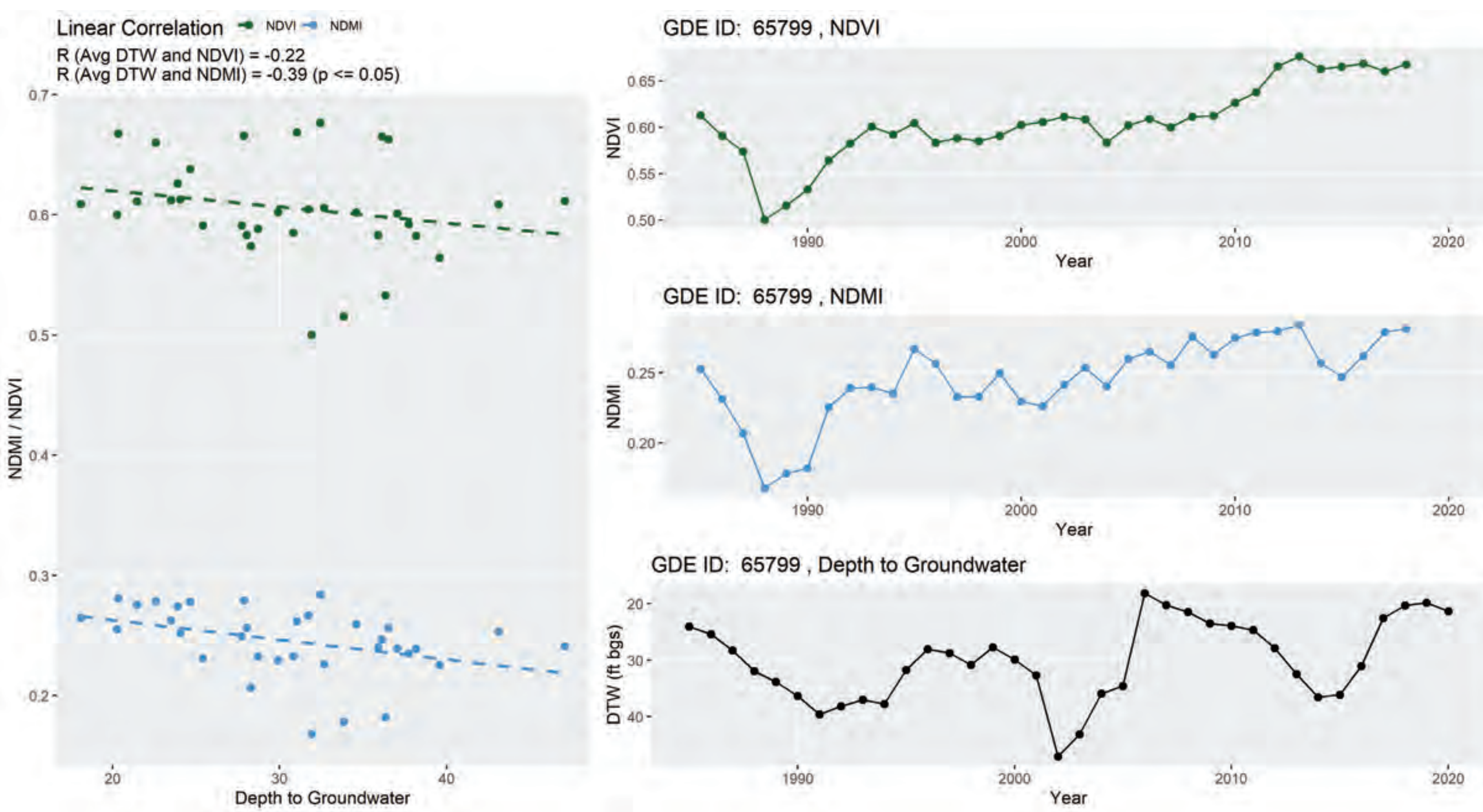

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.12
R (Avg DTW and NDMI) = -0.37
NDMI / NDVI
Depth to Groundwater
GDE ID: 65785 , NDVI
NDVI
Year
GDE ID: 65785 , NDMI
NDMI
Year
GDE ID: 65785 , Depth to Groundwater
DTW (ft bgs)
Year

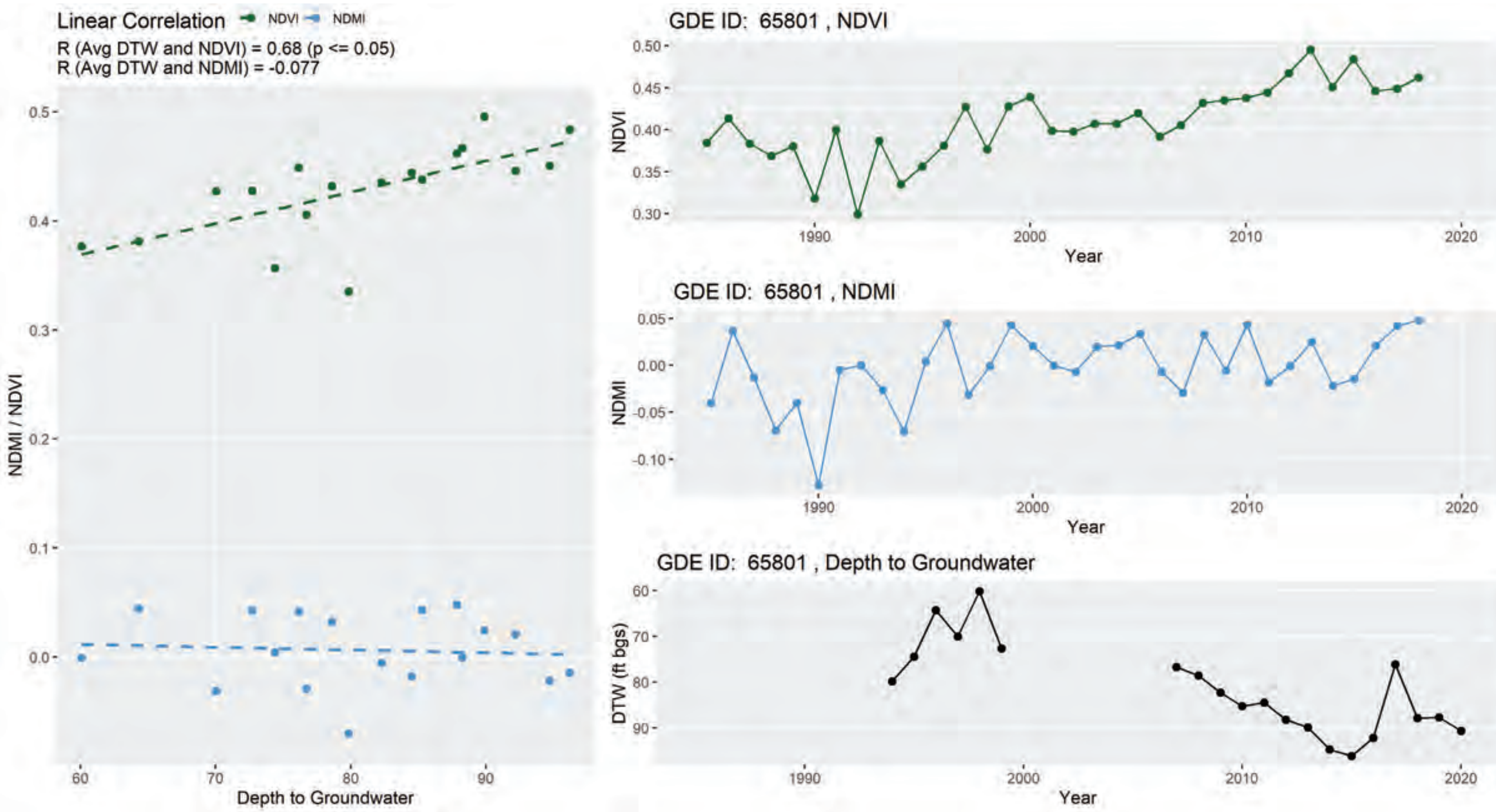

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.63
R (Avg DTW and NDMI) = -0.44
NDMI / NDVI
Depth to Groundwater
GDE ID: 65787 , NDVI
NDVI
Year
GDE ID: 65787 , NDMI
NDMI
Year
GDE ID: 65787 , Depth to Groundwater
DTW (ft bgs)
Year

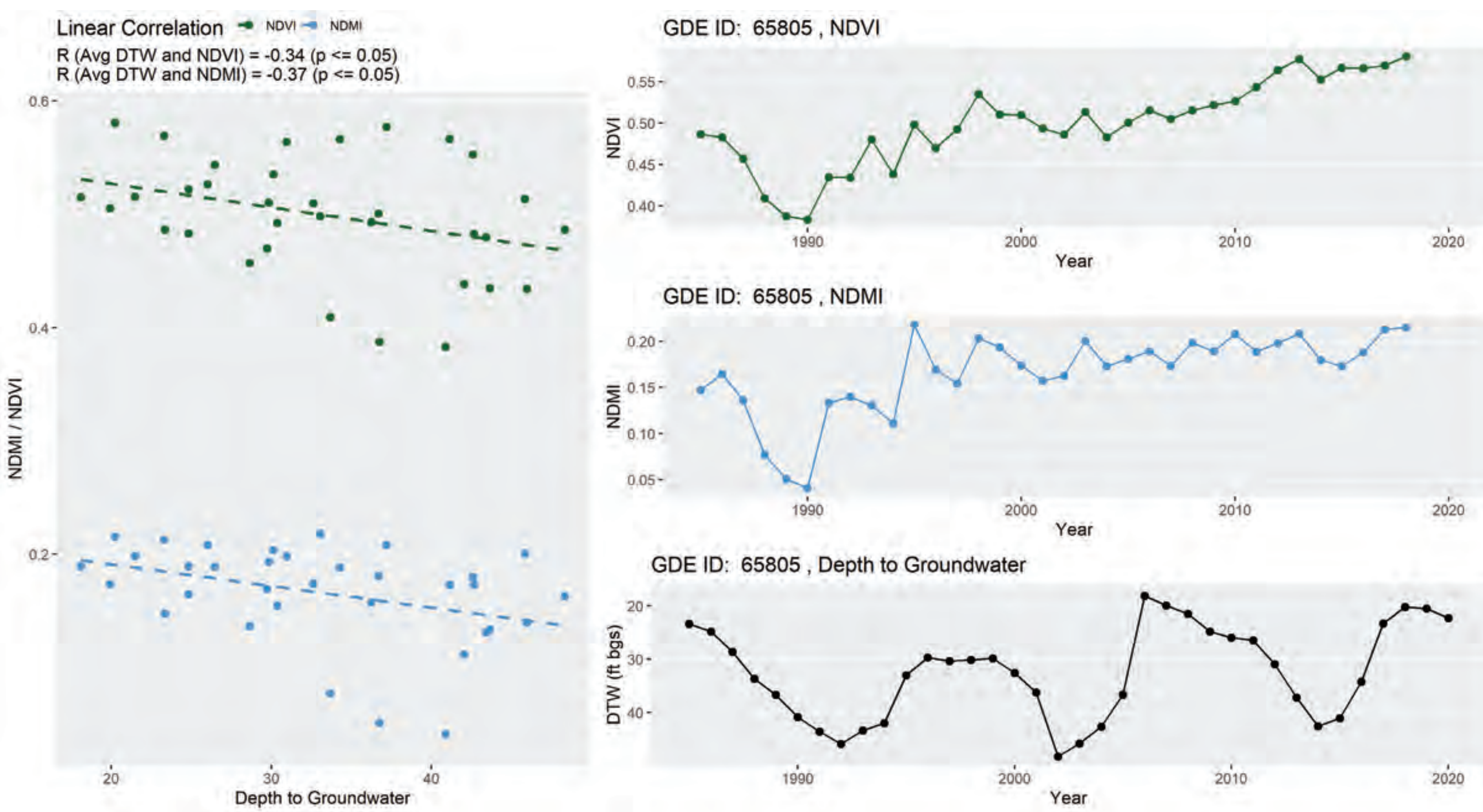

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.4 (p <= 0.05)
R (Avg DTW and NDMI) = -0.58 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65792 , NDVI
NDVI
Year
GDE ID: 65792 , NDMI
NDMI
Year
GDE ID: 65792 , Depth to Groundwater
DTW (ft bgs)
Year

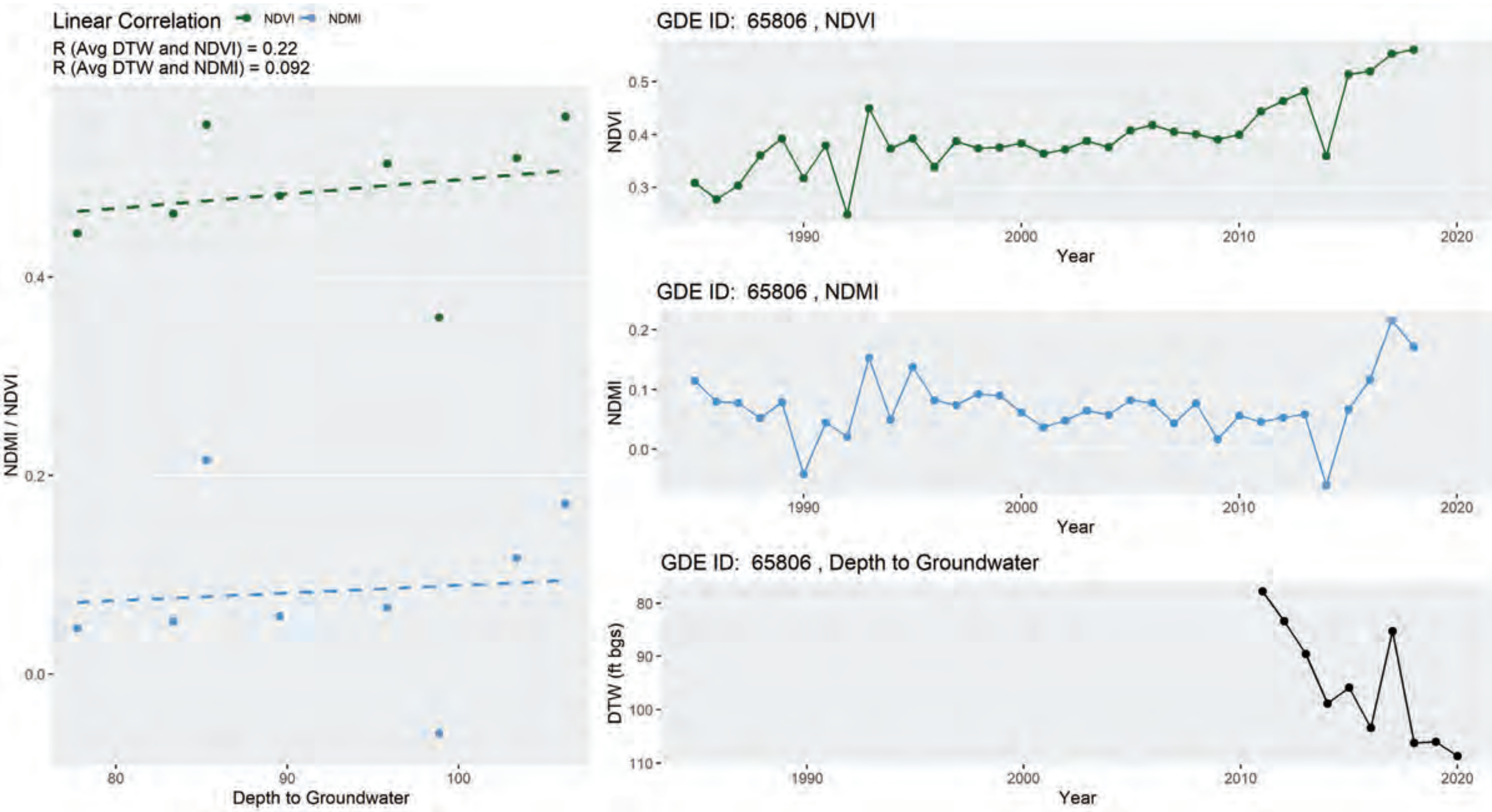

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.65 (p <= 0.05)
R (Avg DTW and NDMI) = -0.39 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65793 , NDVI
NDVI
Year
GDE ID: 65793 , NDMI
NDMI
Year
GDE ID: 65793 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.14
R (Avg DTW and NDMI) = -0.08
NDMI / NDVI
Depth to Groundwater
GDE ID: 65795 , NDVI
NDVI
Year
GDE ID: 65795 , NDMI
NDMI
Year
GDE ID: 65795 , Depth to Groundwater
DTW (ft bgs)
Year

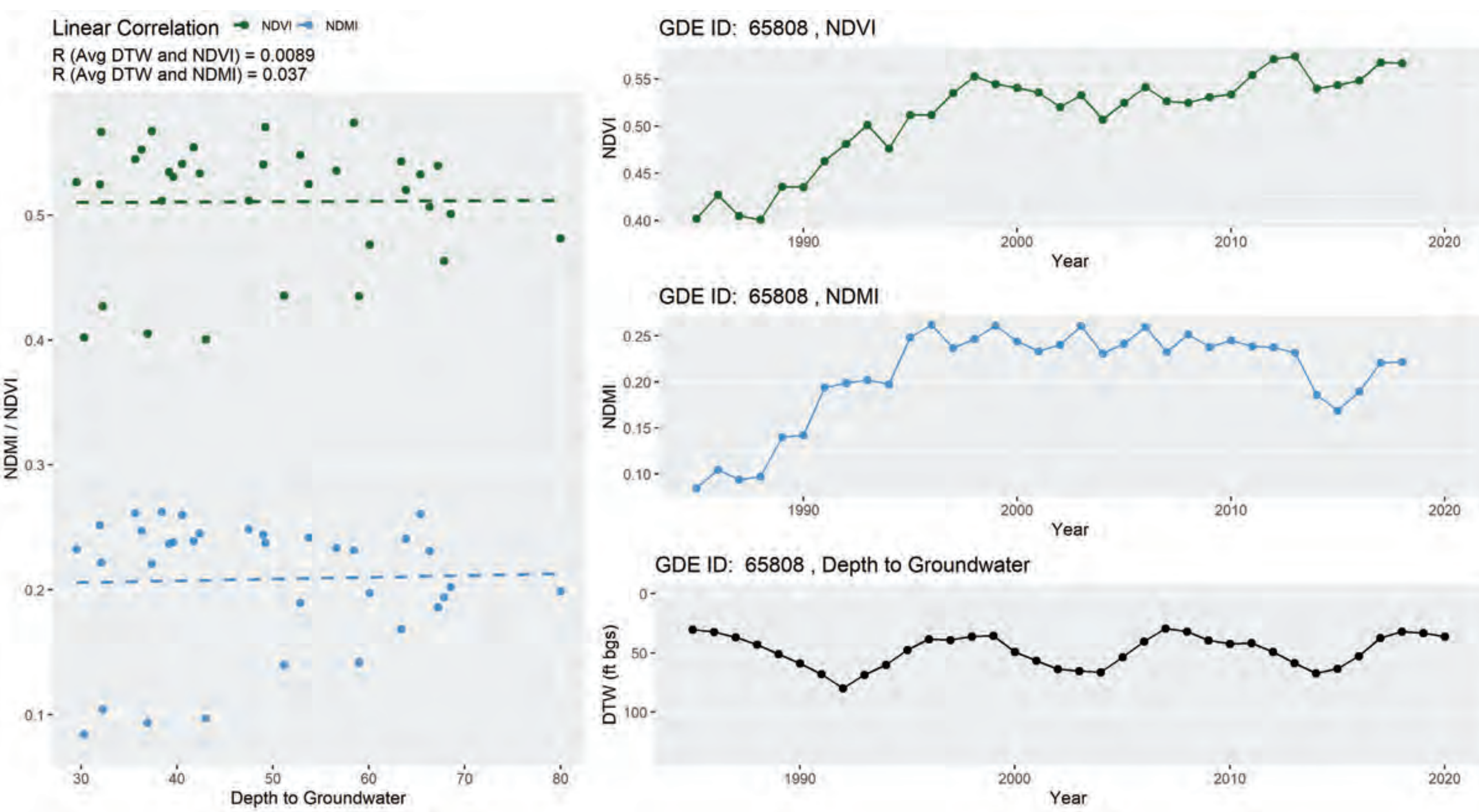

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.22
R (Avg DTW and NDMI) = -0.39 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65799 , NDVI
NDVI
Year
GDE ID: 65799 , NDMI
NDMI
Year
GDE ID: 65799 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.68 (p <= 0.05)
R (Avg DTW and NDMI) = -0.077
NDMI / NDVI
Depth to Groundwater
GDE ID: 65801 , NDVI
NDVI
Year
GDE ID: 65801 , NDMI
NDMI
Year
GDE ID: 65801 , Depth to Groundwater
DTW (ft bgs)
Year

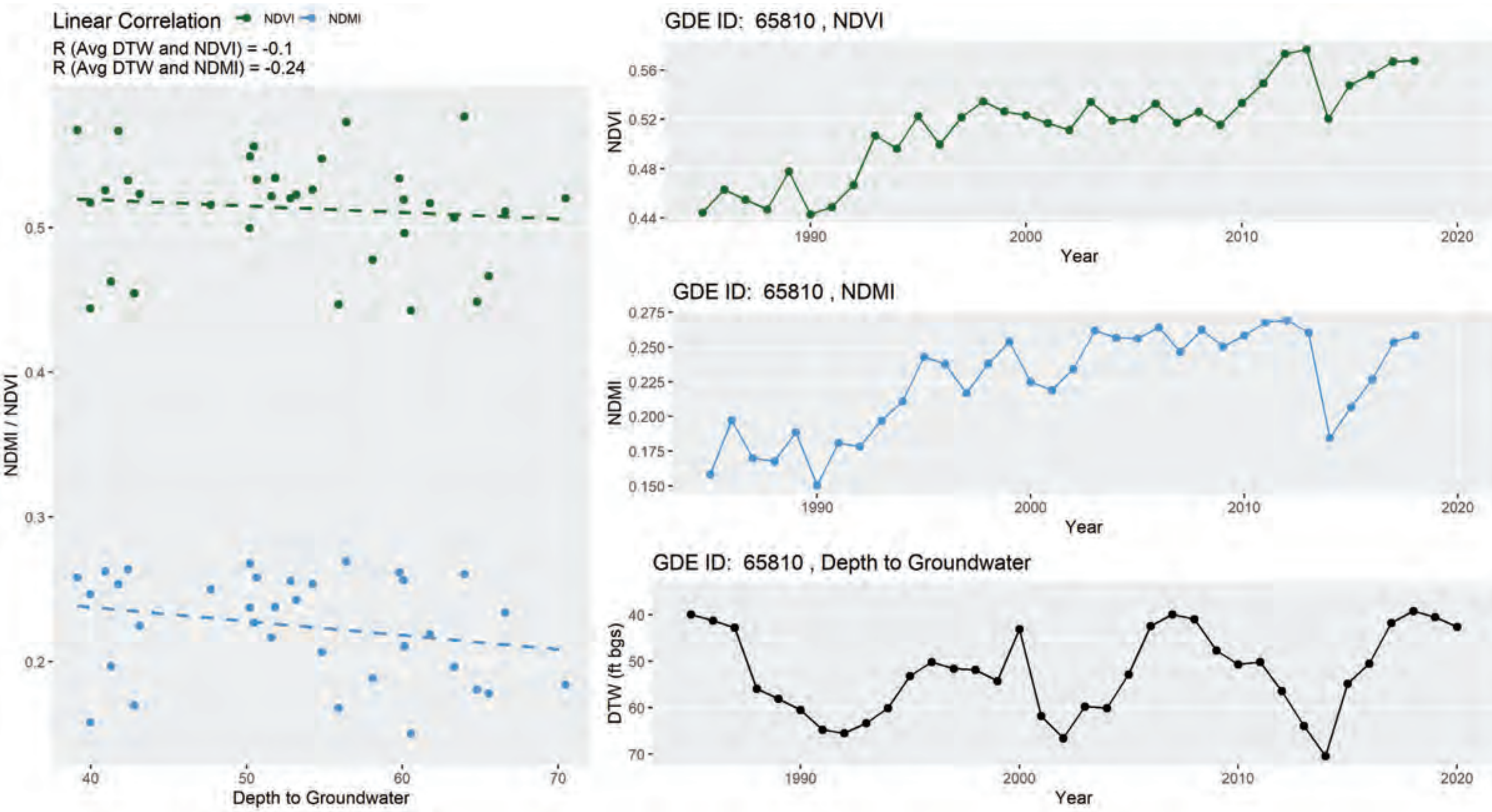

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.34 (p <= 0.05)
R (Avg DTW and NDMI) = -0.37 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65805 , NDVI
NDVI
Year
GDE ID: 65805 , NDMI
NDMI
Year
GDE ID: 65805 , Depth to Groundwater
DTW (ft bgs)
Year

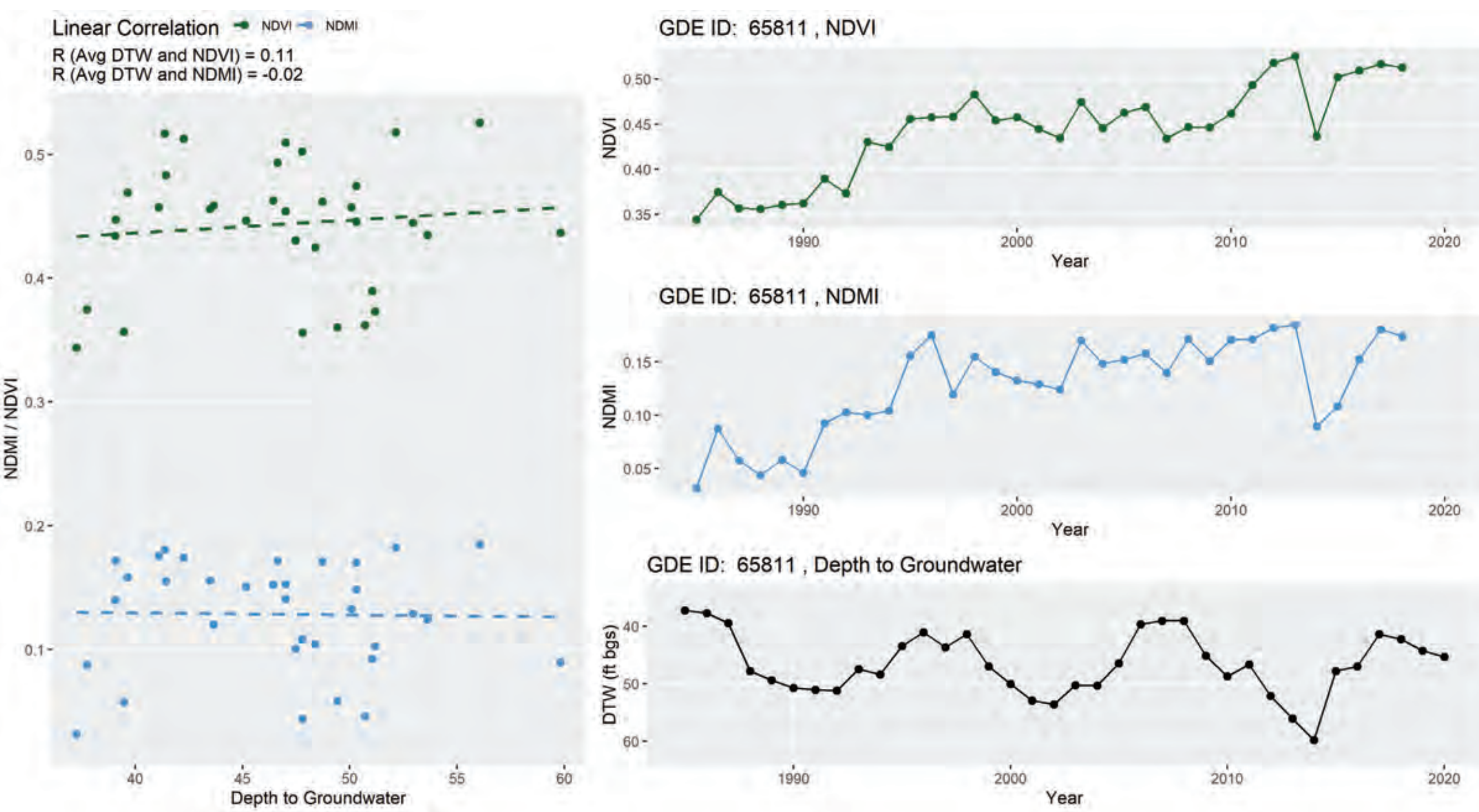


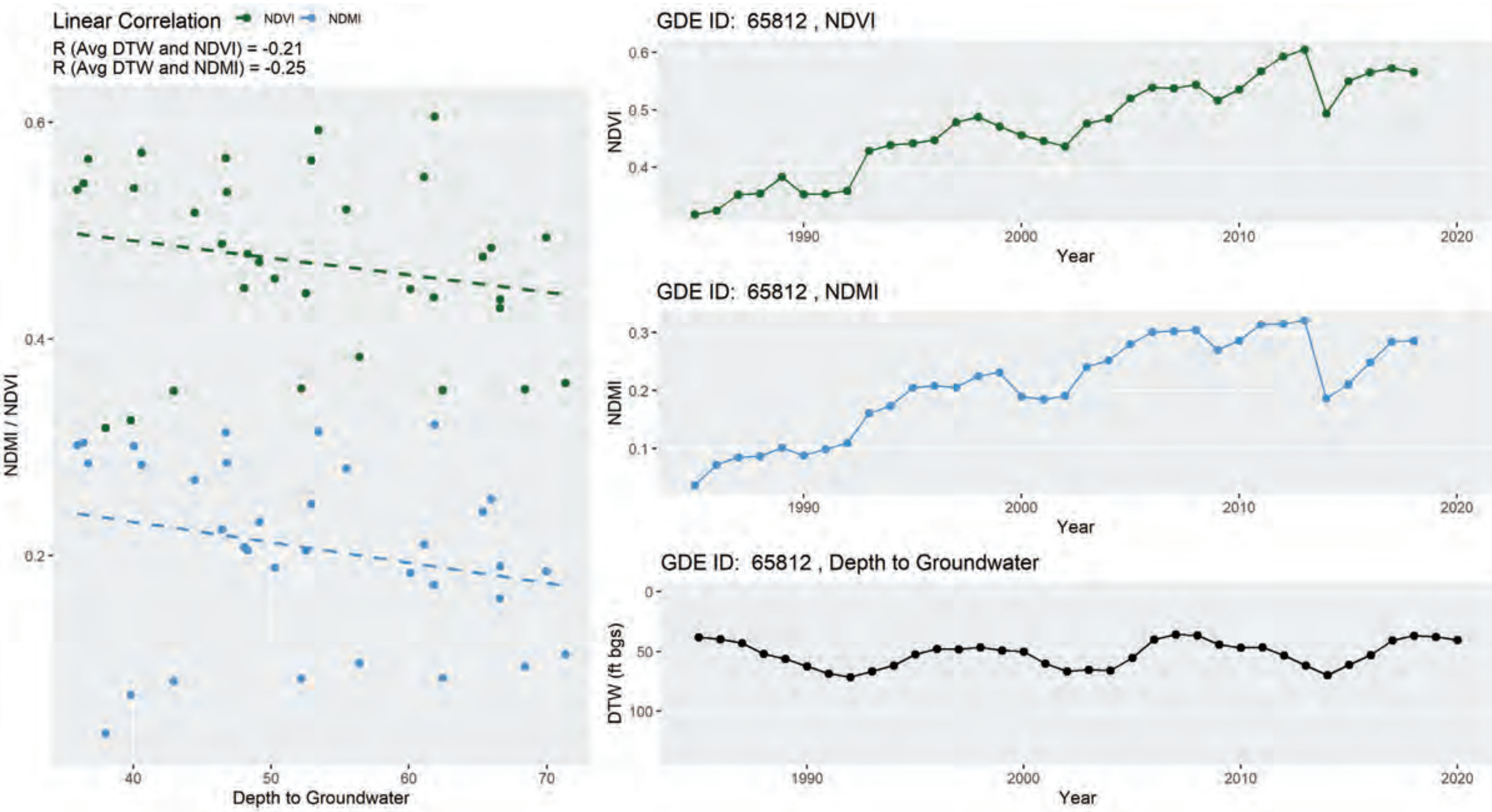
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.22
R (Avg DTW and NDMI) = 0.092
NDMI / NDVI
Depth to Groundwater
GDE ID: 65806 , NDVI
NDVI
Year
GDE ID: 65806 , NDMI
NDMI
Year
GDE ID: 65806 , Depth to Groundwater
DTW (ft bgs)
Year

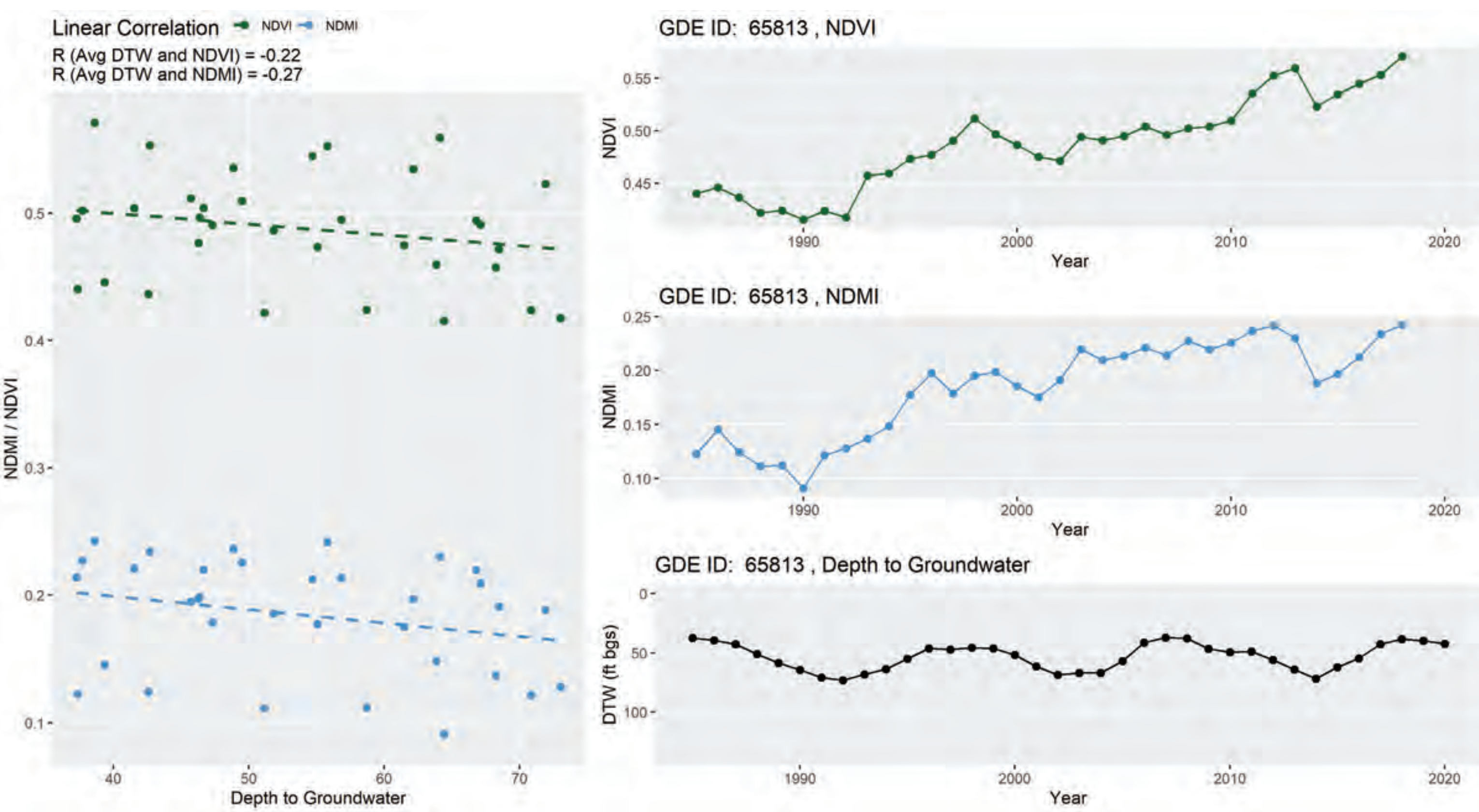


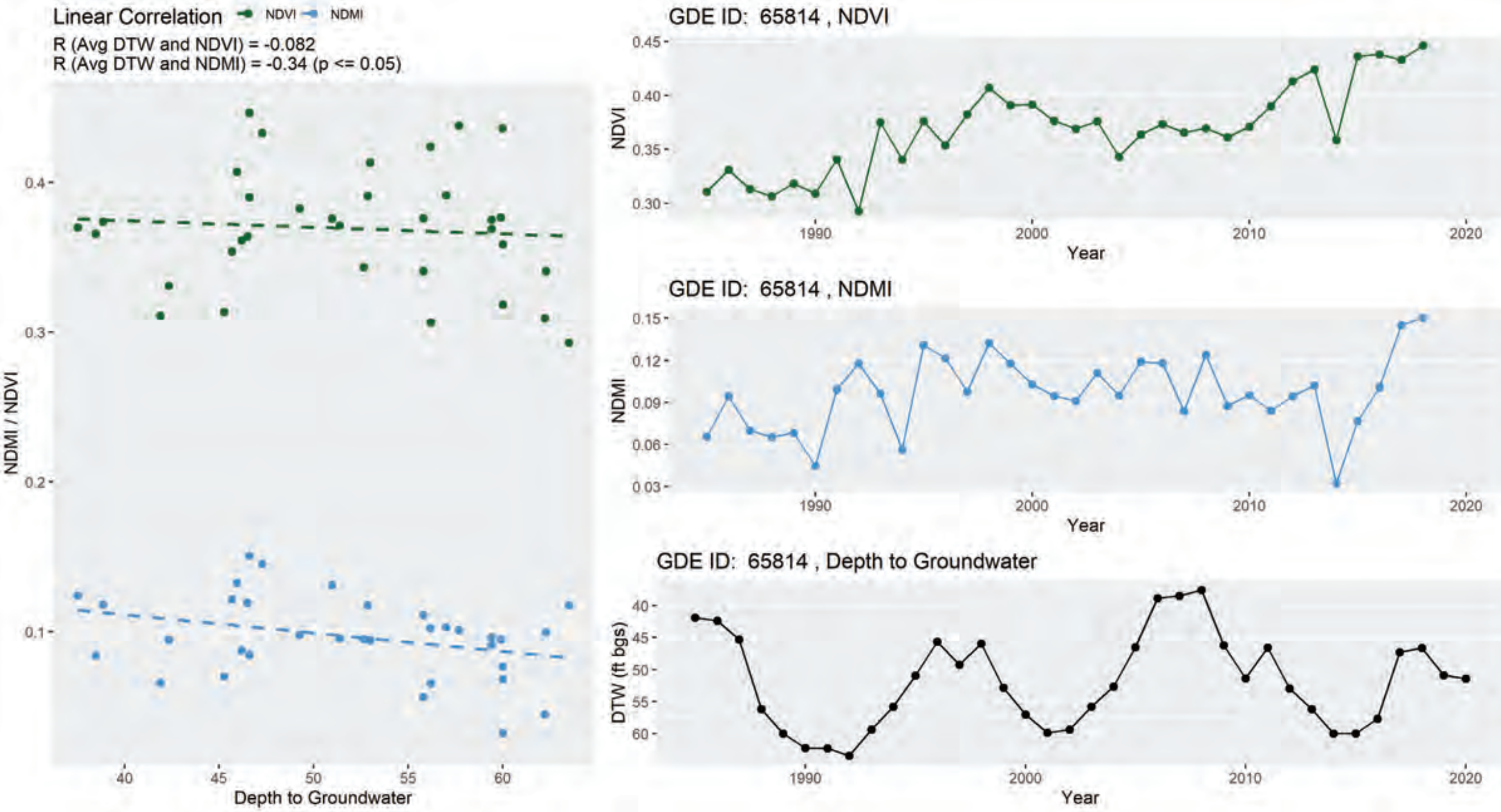
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.0089
R (Avg DTW and NDMI) = 0.037
NDMI / NDVI
Depth to Groundwater
GDE ID: 65808 , NDVI
NDVI
Year
GDE ID: 65808 , NDMI
NDMI
Year
GDE ID: 65808 , Depth to Groundwater
DTW (ft bgs)
Year

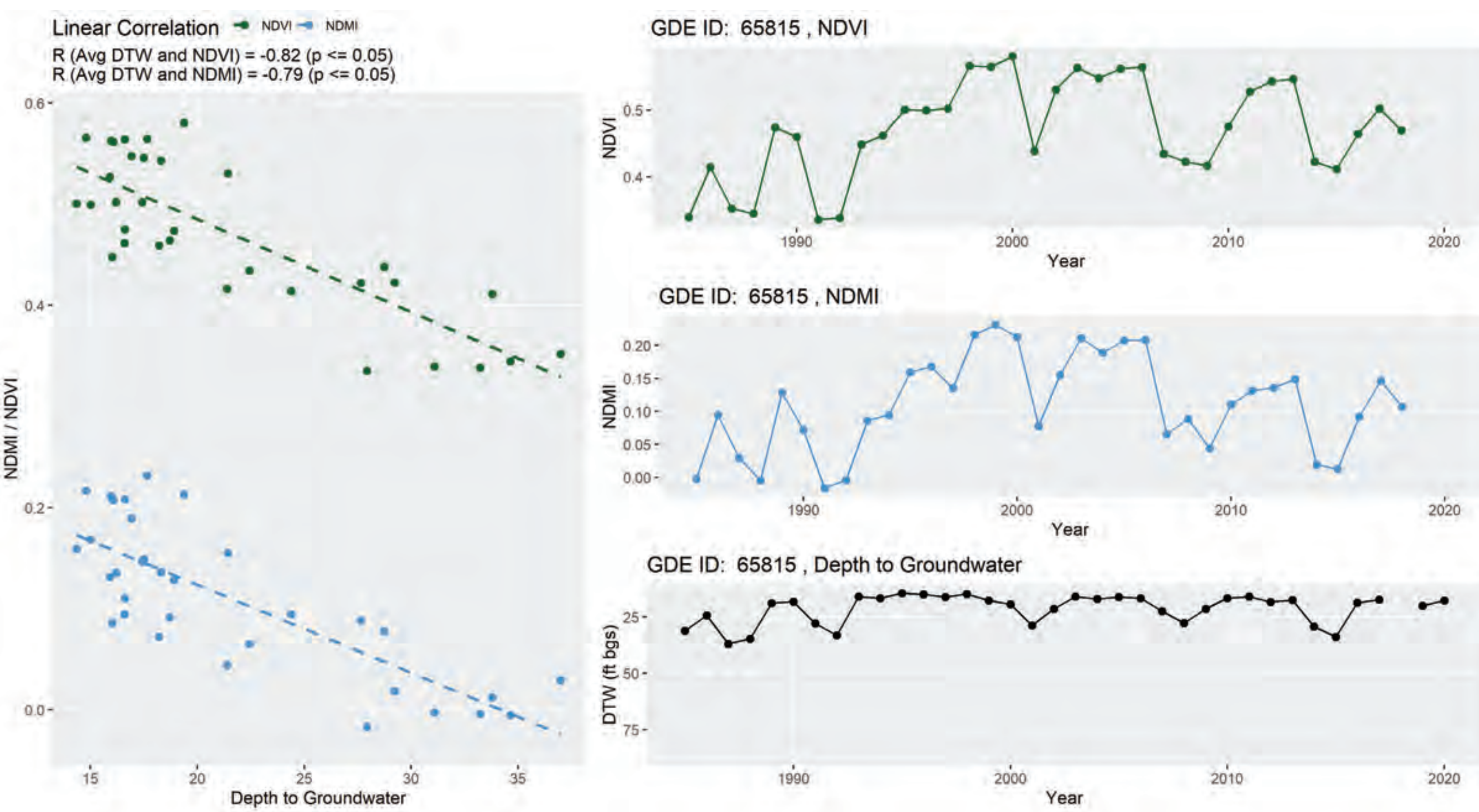

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.1
R (Avg DTW and NDMI) = -0.24
NDMI / NDVI
Depth to Groundwater
GDE ID: 65810 , NDVI
NDVI
Year
GDE ID: 65810 , NDMI
NDMI
Year
GDE ID: 65810 , Depth to Groundwater
DTW (ft bgs)
Year

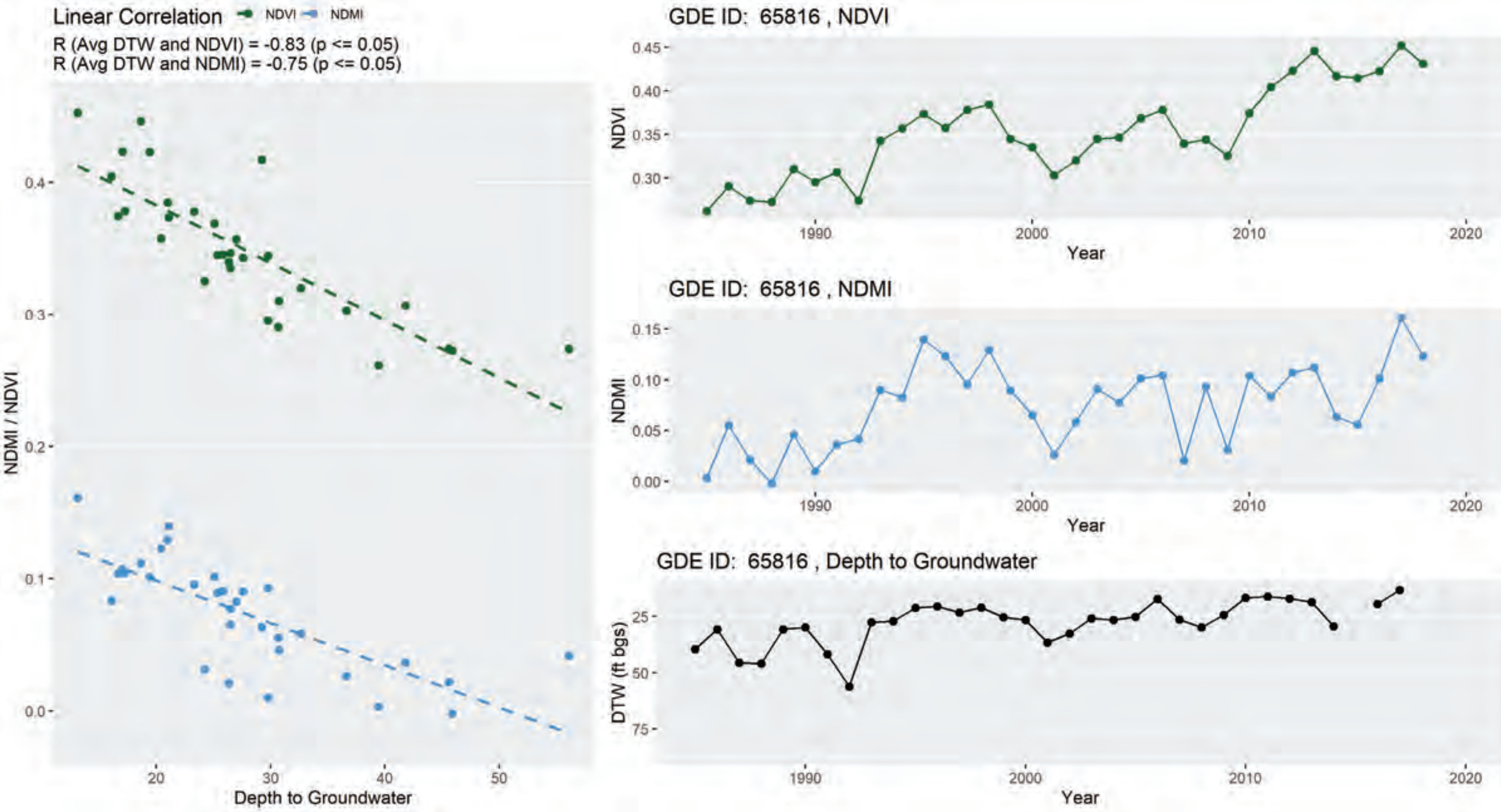

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.11
R (Avg DTW and NDMI) = -0.02
NDMI / NDVI
Depth to Groundwater
GDE ID: 65811 , NDVI
NDVI
Year
GDE ID: 65811 , NDMI
NDMI
Year
GDE ID: 65811 , Depth to Groundwater
DTW (ft bgs)
Year

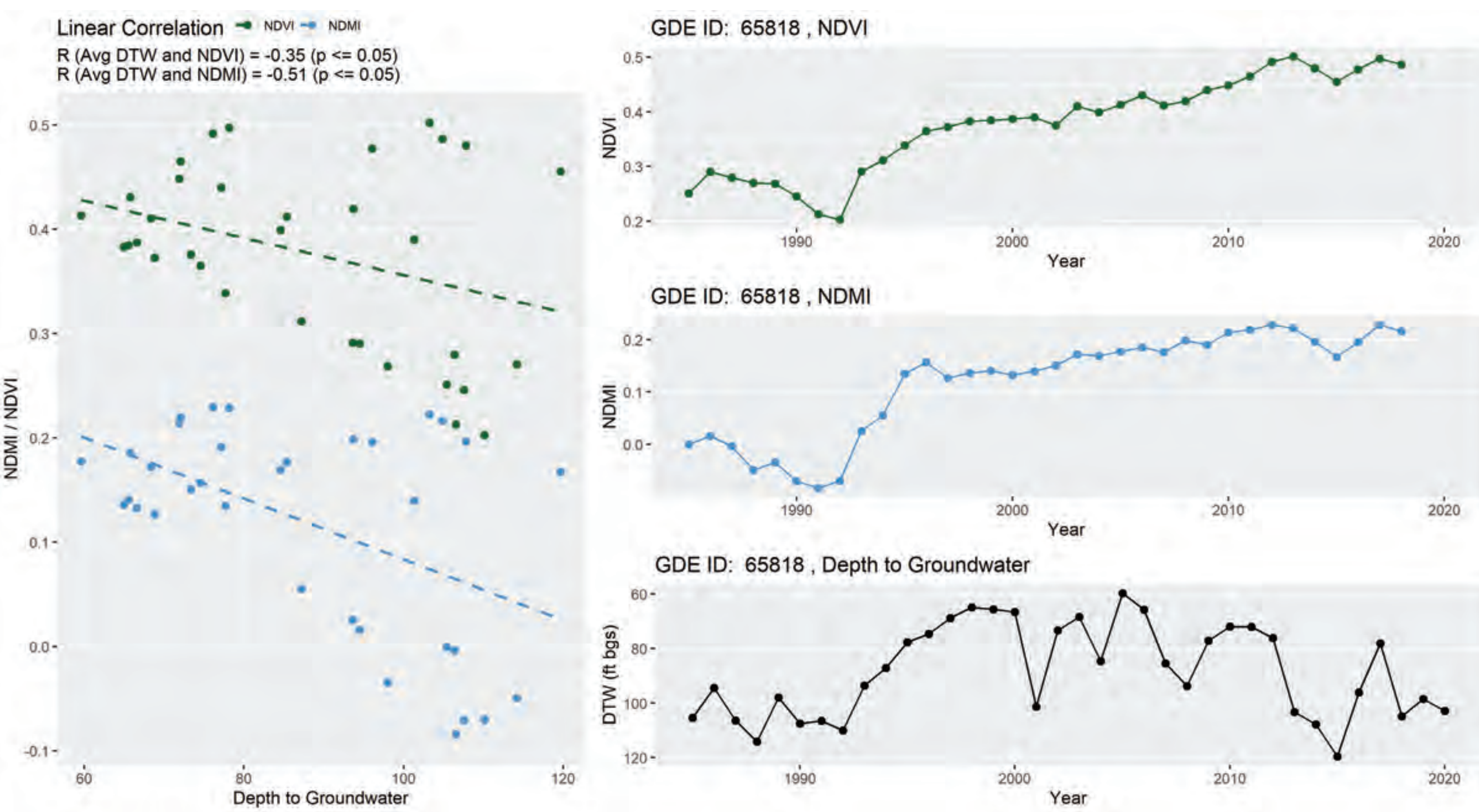

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.21
R (Avg DTW and NDMI) = -0.25
NDMI / NDVI
Depth to Groundwater
GDE ID: 65812 , NDVI
NDVI
Year
GDE ID: 65812 , NDMI
NDMI
Year
GDE ID: 65812 , Depth to Groundwater
DTW (ft bgs)
Year

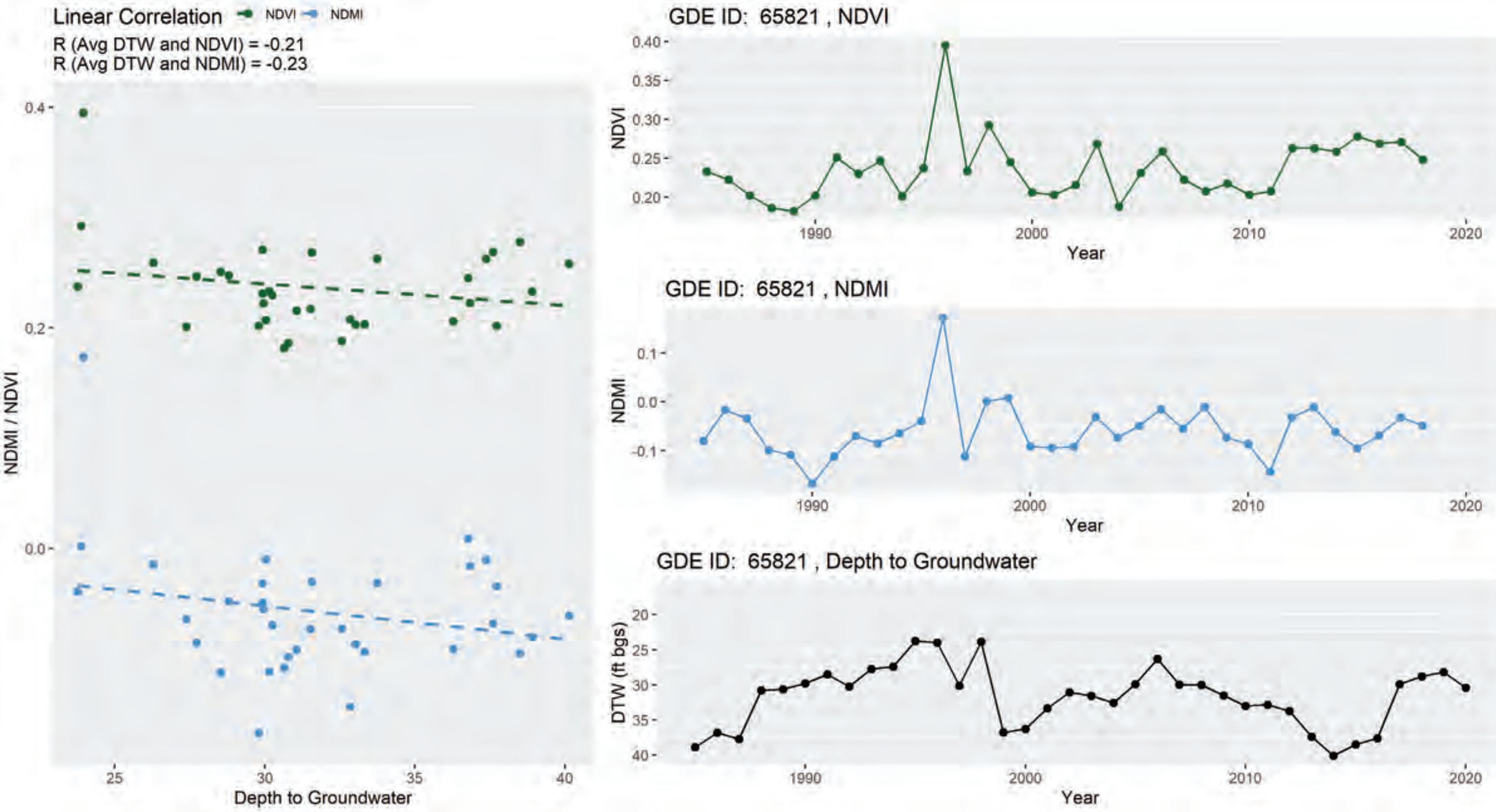

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.22
R (Avg DTW and NDMI) = -0.27
NDMI / NDVI
Depth to Groundwater
GDE ID: 65813 , NDVI
NDVI
Year
GDE ID: 65813 , NDMI
NDMI
Year
GDE ID: 65813 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.082
R (Avg DTW and NDMI) = -0.34 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65814 , NDVI
NDVI
Year
GDE ID: 65814 , NDMI
NDMI
Year
GDE ID: 65814 , Depth to Groundwater
DTW (ft bgs)
Year

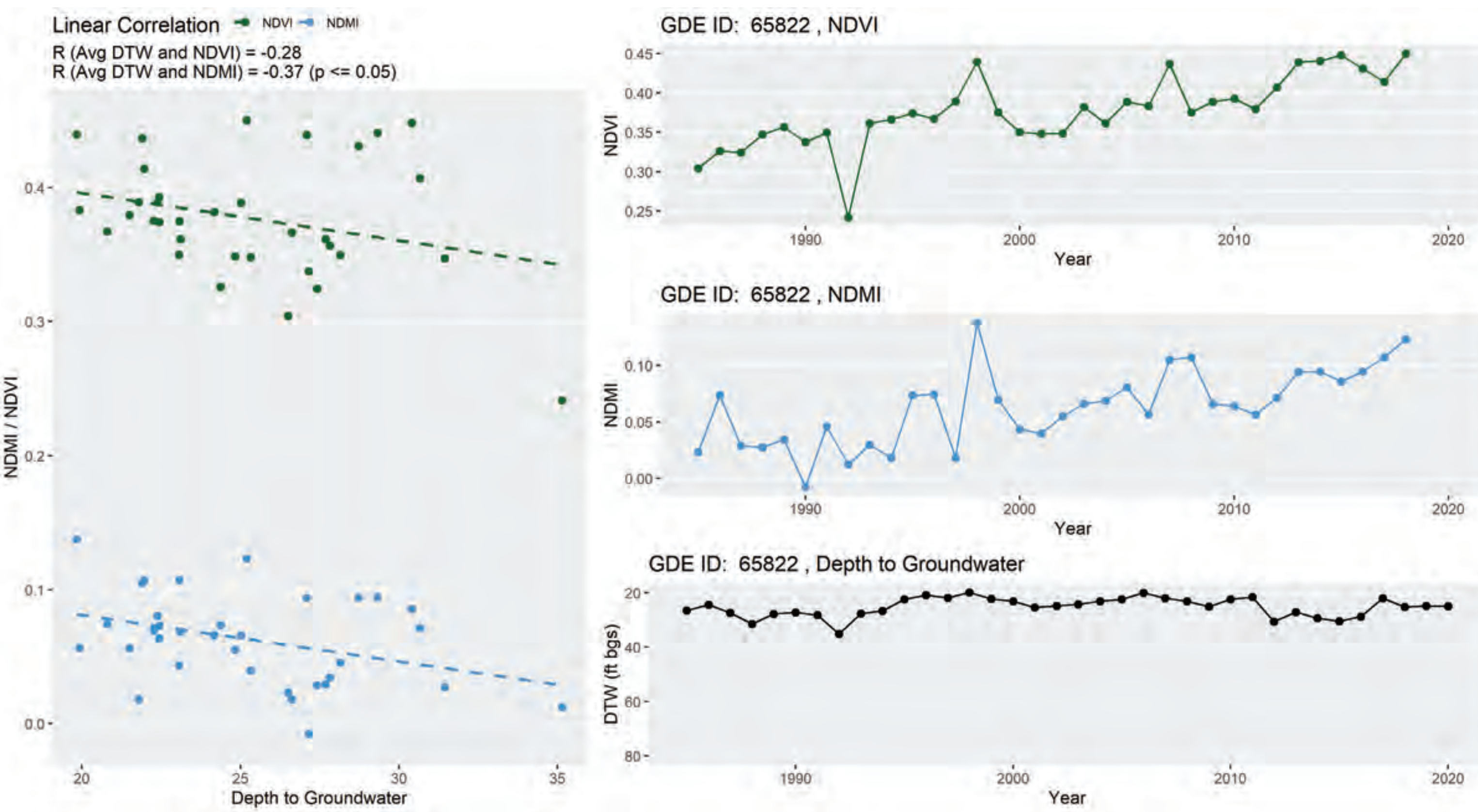

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.82 (p <= 0.05)
R (Avg DTW and NDMI) = -0.79 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65815 , NDVI
NDVI
Year
GDE ID: 65815 , NDMI
NDMI
Year
GDE ID: 65815 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.83 (p <= 0.05)
R (Avg DTW and NDMI) = -0.75 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65816 , NDVI
NDVI
Year
GDE ID: 65816 , NDMI
NDMI
Year
GDE ID: 65816 , Depth to Groundwater
DTW (ft bgs)
Year

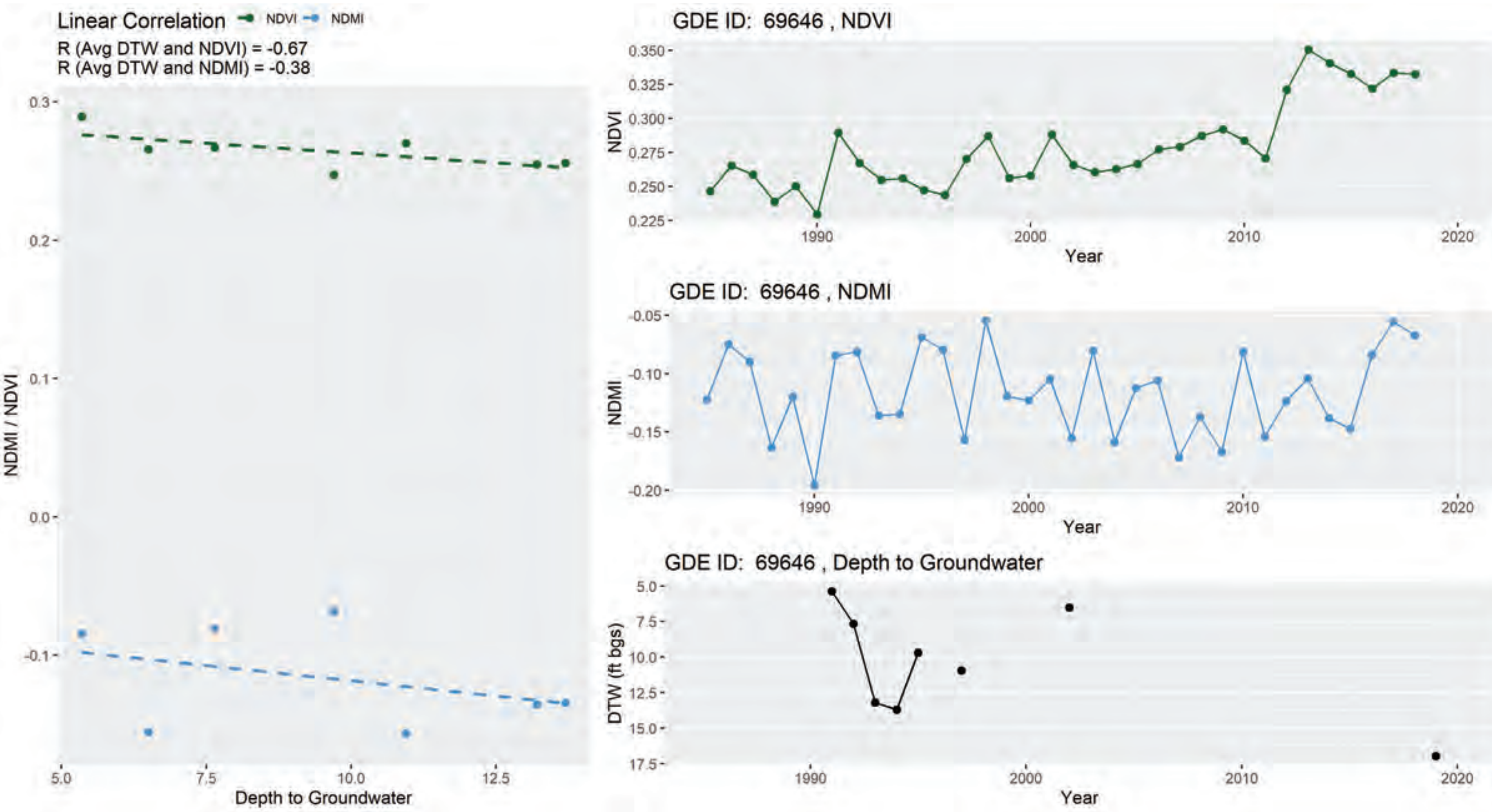

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.35 (p <= 0.05)
R (Avg DTW and NDMI) = -0.51 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65818 , NDVI
NDVI
Year
GDE ID: 65818 , NDMI
NDMI
Year
GDE ID: 65818 , Depth to Groundwater
DTW (ft bgs)
Year

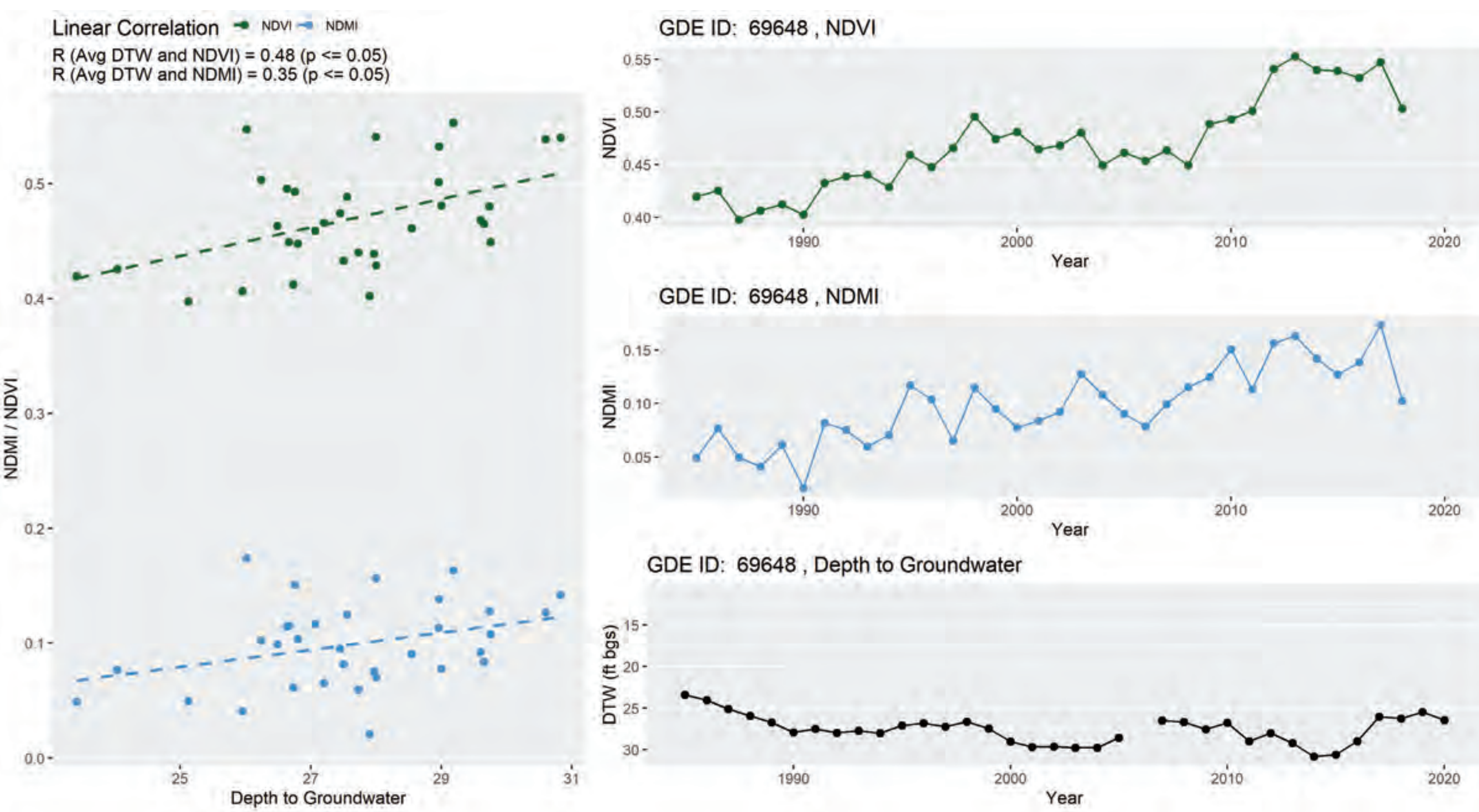


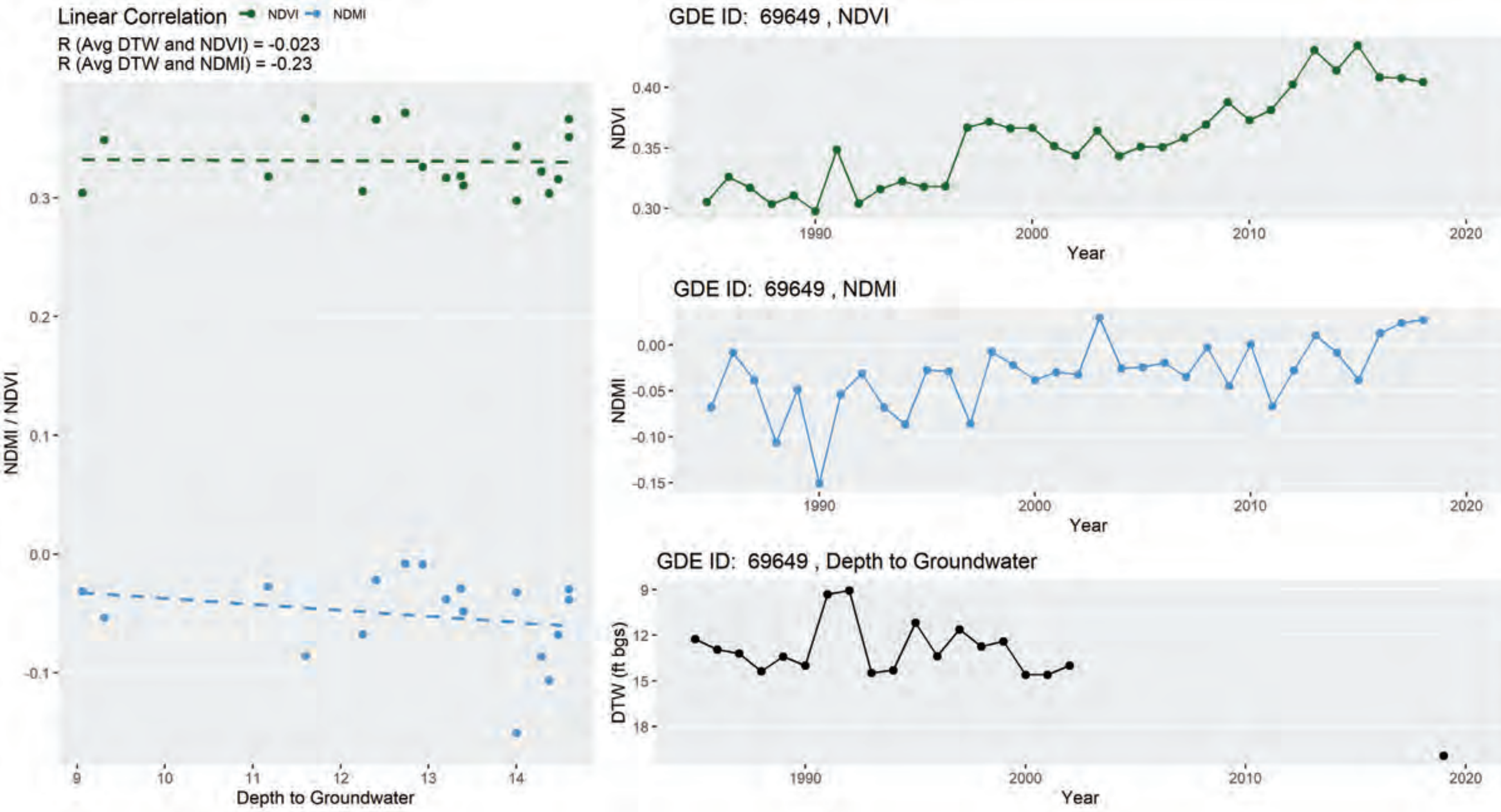
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.21
R (Avg DTW and NDMI) = -0.23
NDMI / NDVI
Depth to Groundwater
GDE ID: 65821 , NDVI
NDVI
Year
GDE ID: 65821 , NDMI
NDMI
Year
GDE ID: 65821 , Depth to Groundwater
DTW (ft bgs)
Year

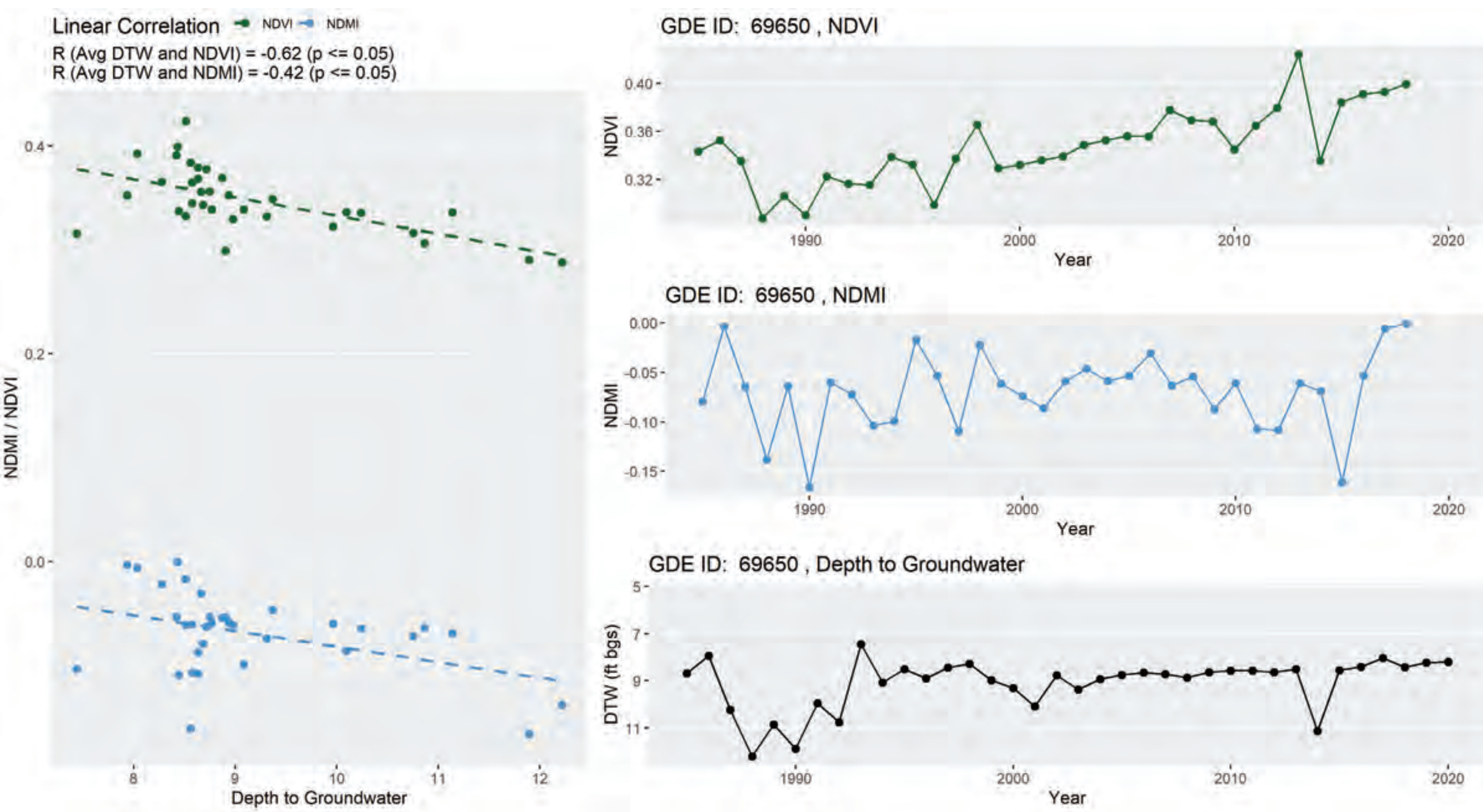


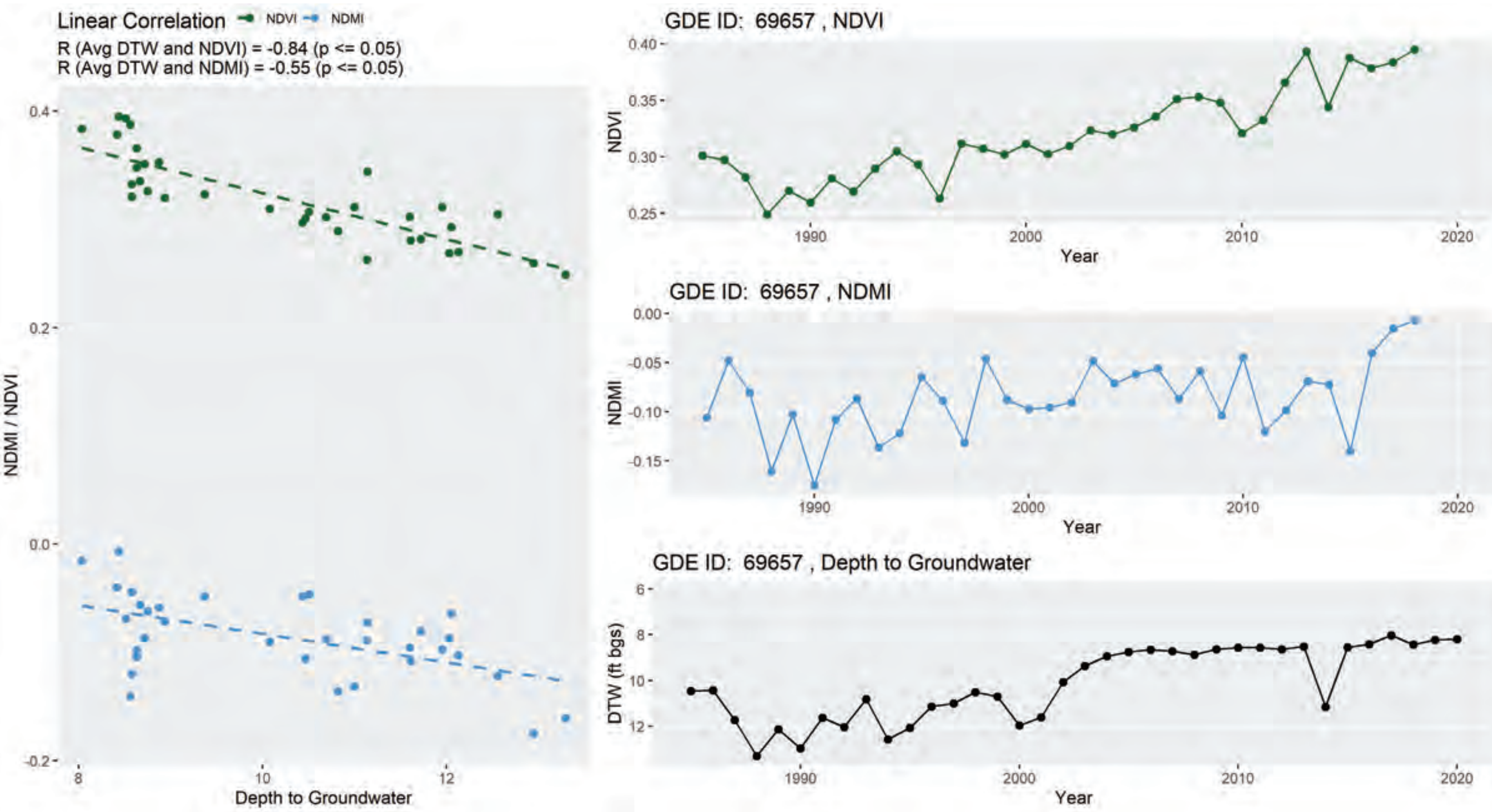
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.28
R (Avg DTW and NDMI) = -0.37 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 65822 , NDVI
NDVI
Year
GDE ID: 65822 , NDMI
NDMI
Year
GDE ID: 65822 , Depth to Groundwater
DTW (ft bgs)
Year

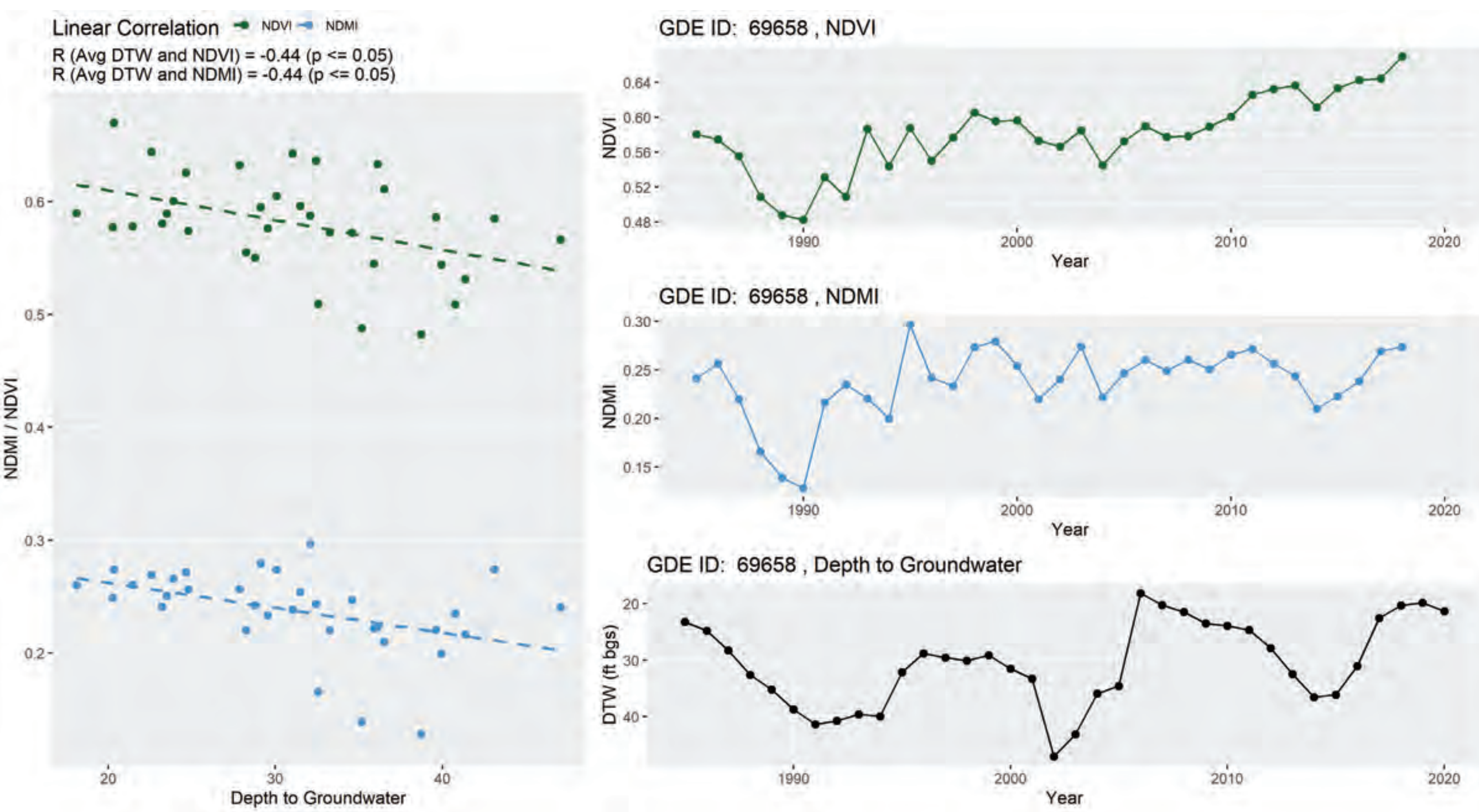

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.67
R (Avg DTW and NDMI) = -0.38
NDMI / NDVI
Depth to Groundwater
GDE ID: 69646 , NDVI
NDVI
Year
GDE ID: 69646 , NDMI
NDMI
Year
GDE ID: 69646 , Depth to Groundwater
DTW (ft bgs)
Year

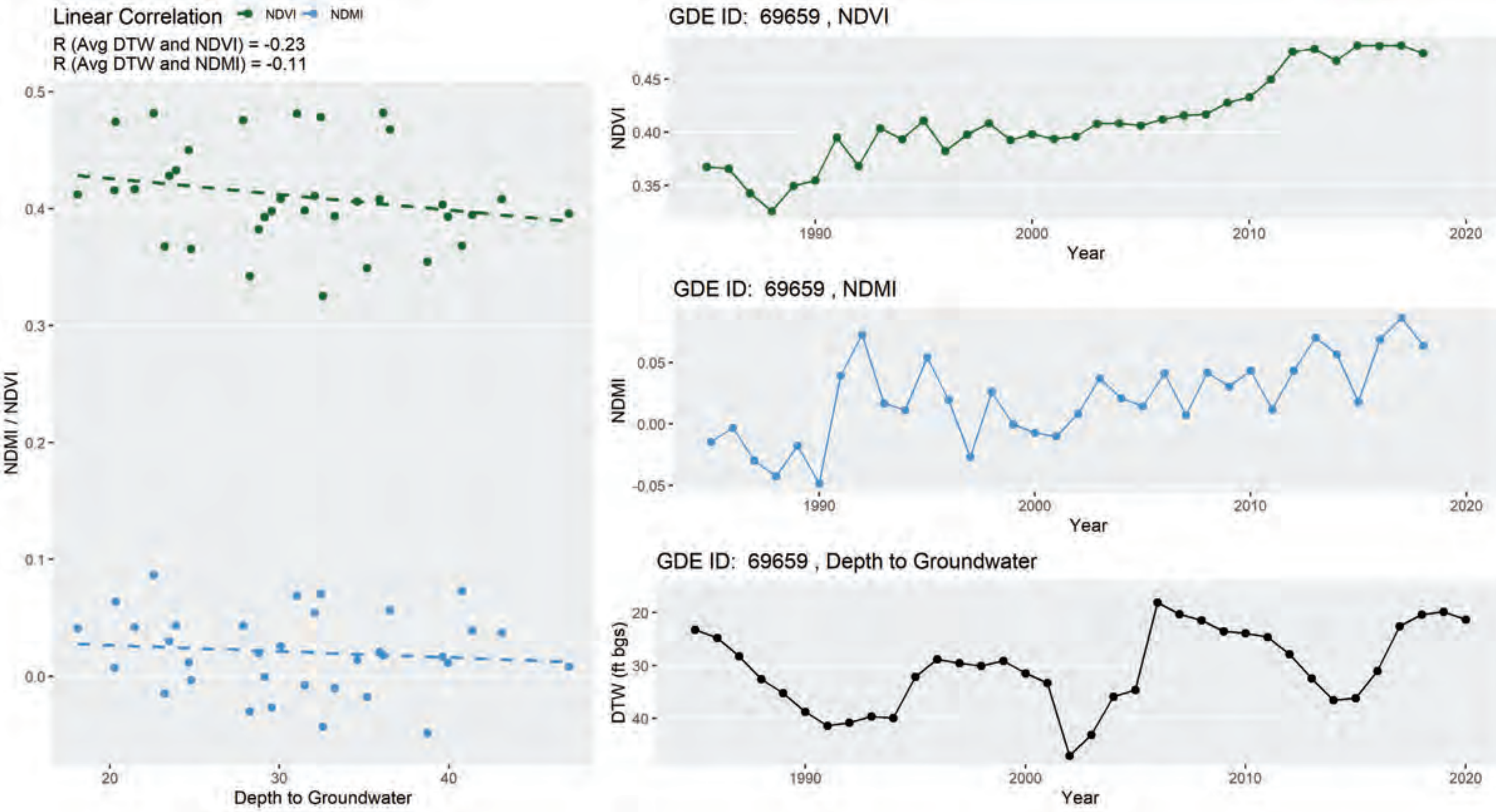

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = 0.48 (p <= 0.05)
R (Avg DTW and NDMI) = 0.35 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 69648 , NDVI
NDVI
Year
GDE ID: 69648 , NDMI
NDMI
Year
GDE ID: 69648 , Depth to Groundwater
DTW (ft bgs)
Year

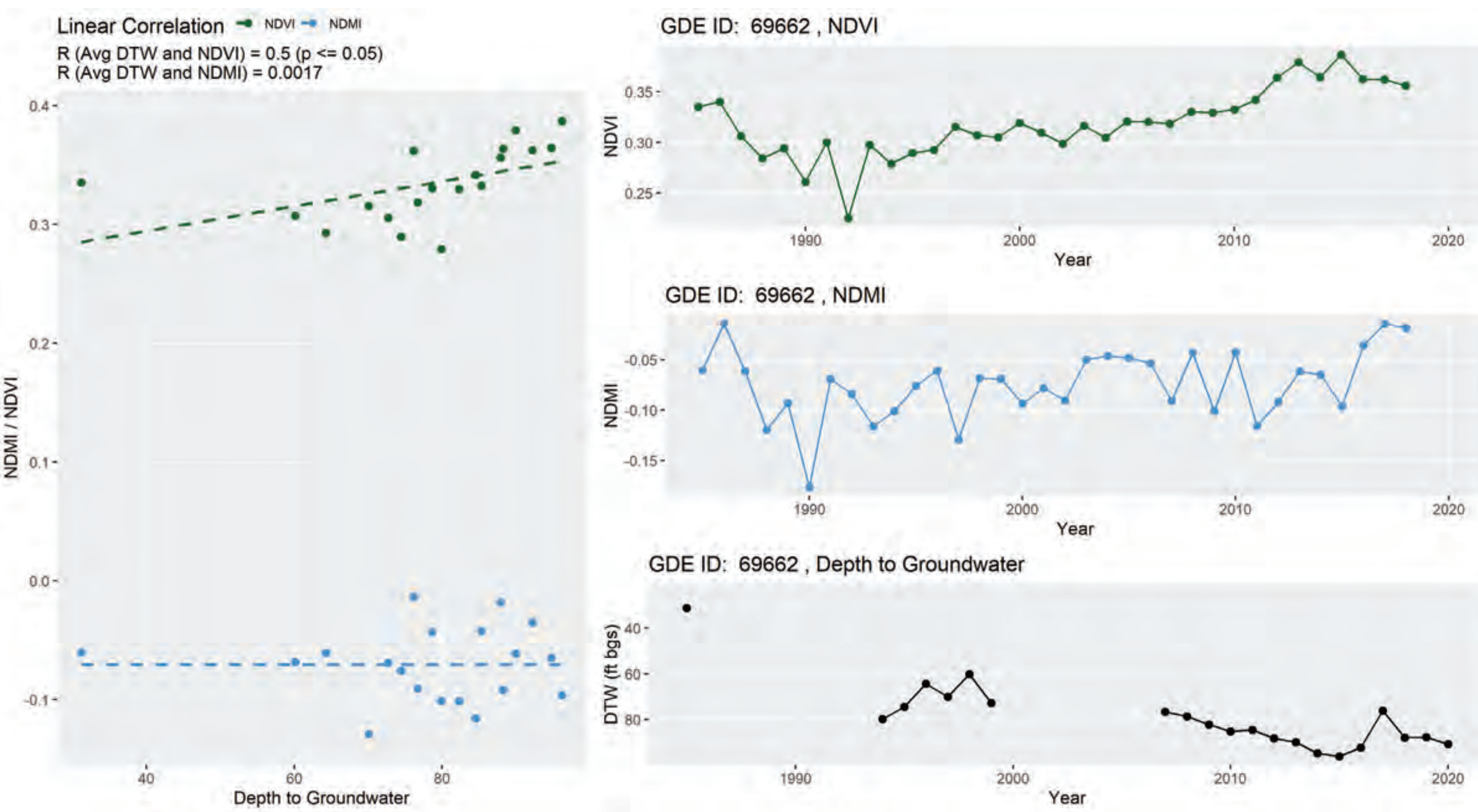

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.023
R (Avg DTW and NDMI) = -0.23
NDMI / NDVI
Depth to Groundwater
GDE ID: 69649 , NDVI
NDVI
Year
GDE ID: 69649 , NDMI
NDMI
Year
GDE ID: 69649 , Depth to Groundwater
DTW (ft bgs)
Year

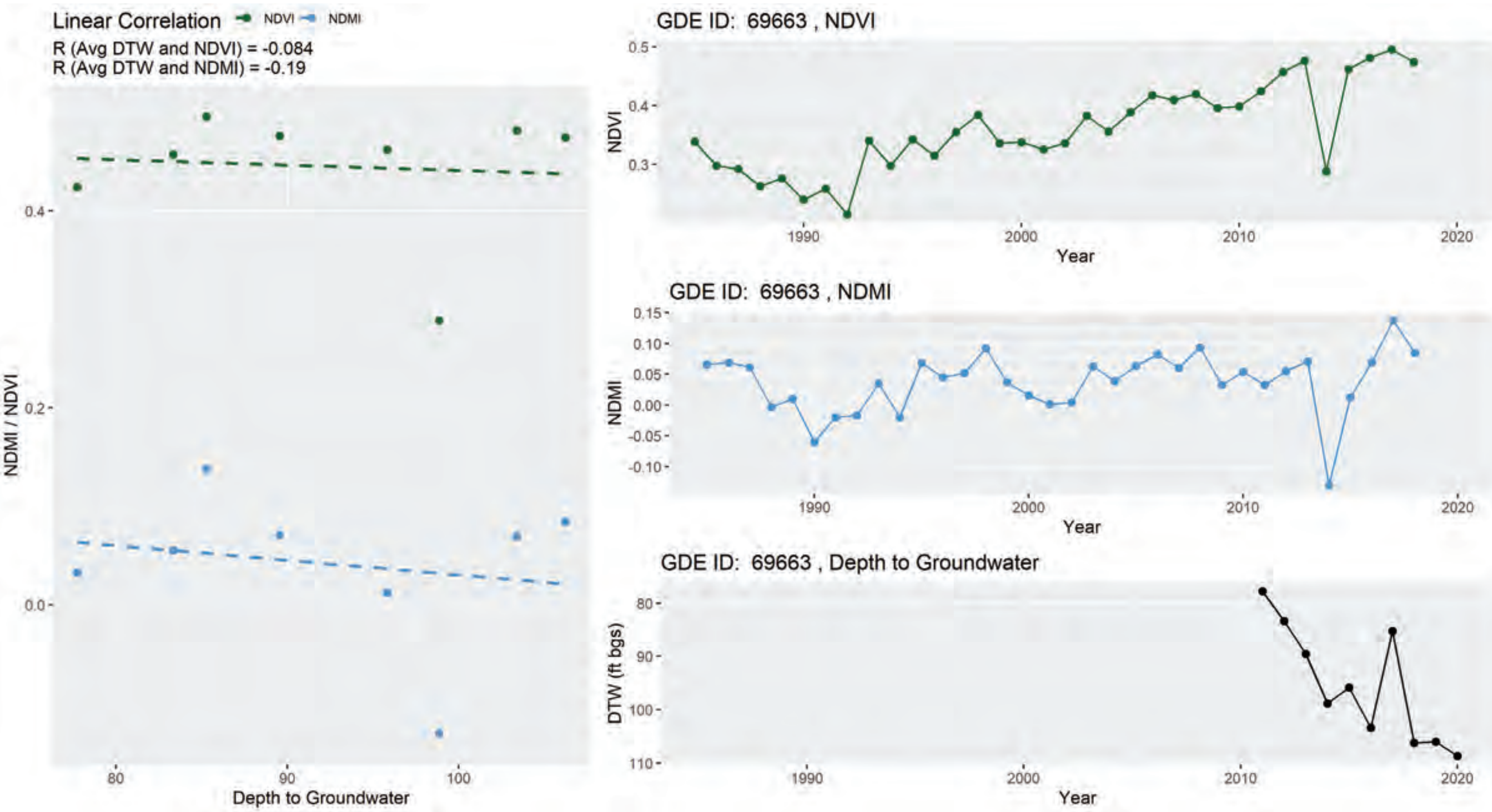

Linear Correlation NDVI NDMI
R (Avg DTW and NDVI) = -0.62 (p <= 0.05)
R (Avg DTW and NDMI) = -0.42 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 69650 , NDVI
NDVI
Year
GDE ID: 69650 , NDMI
NDMI
Year
GDE ID: 69650 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.84 (p <= 0.05)
R (Avg DTW and NDMI) = -0.55 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 69657 , NDVI
NDVI
Year
GDE ID: 69657 , NDMI
NDMI
Year
GDE ID: 69657 , Depth to Groundwater
DTW (ft bgs)
Year

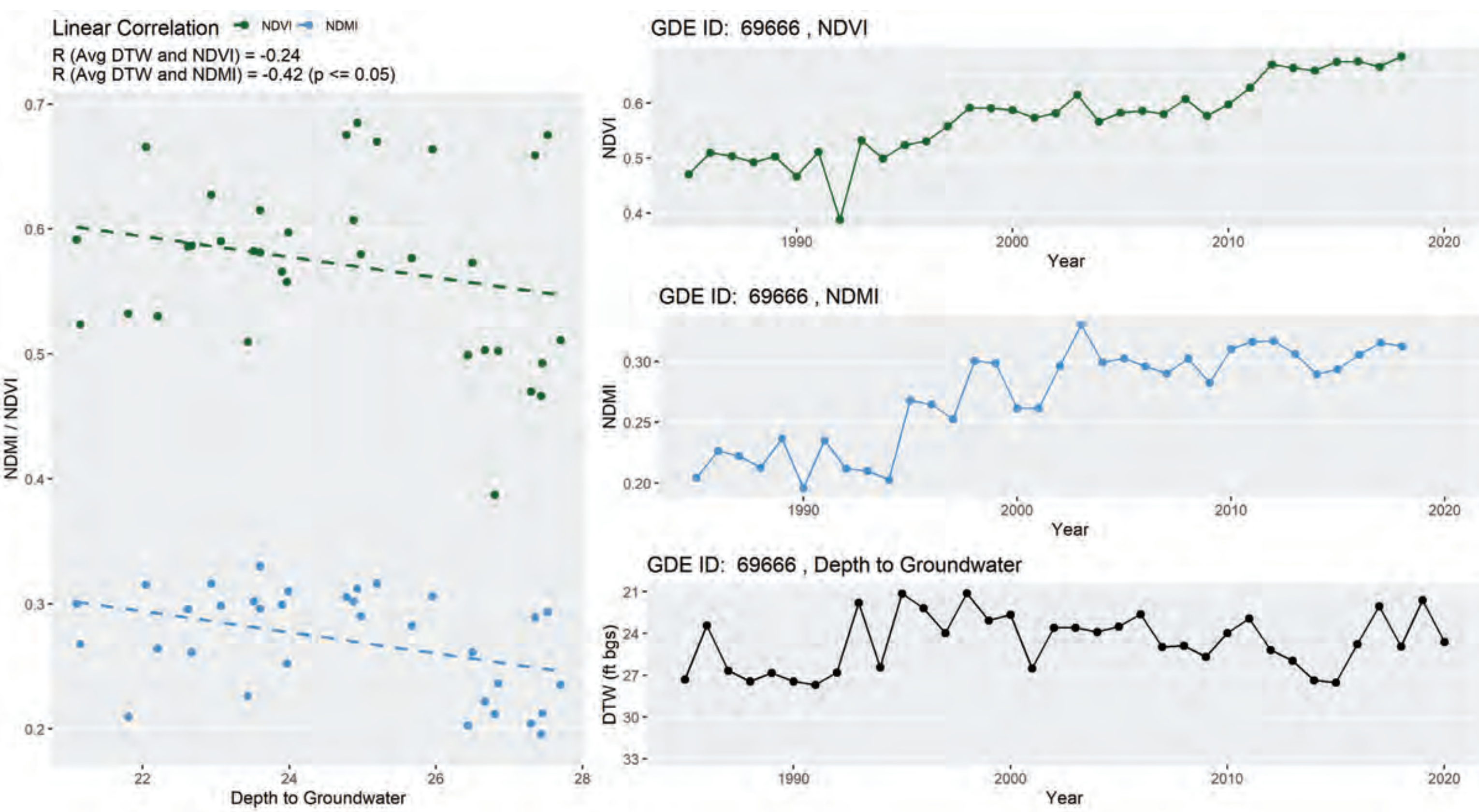

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.44 (p <= 0.05)
R (Avg DTW and NDMI) = -0.44 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 69658 , NDVI
NDVI
Year
GDE ID: 69658 , NDMI
NDMI
Year
GDE ID: 69658 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.23
R (Avg DTW and NDMI) = -0.11
NDMI / NDVI
Depth to Groundwater
GDE ID: 69659 , NDVI
NDVI
Year
GDE ID: 69659 , NDMI
NDMI
Year
GDE ID: 69659 , Depth to Groundwater
DTW (ft bgs)
Year

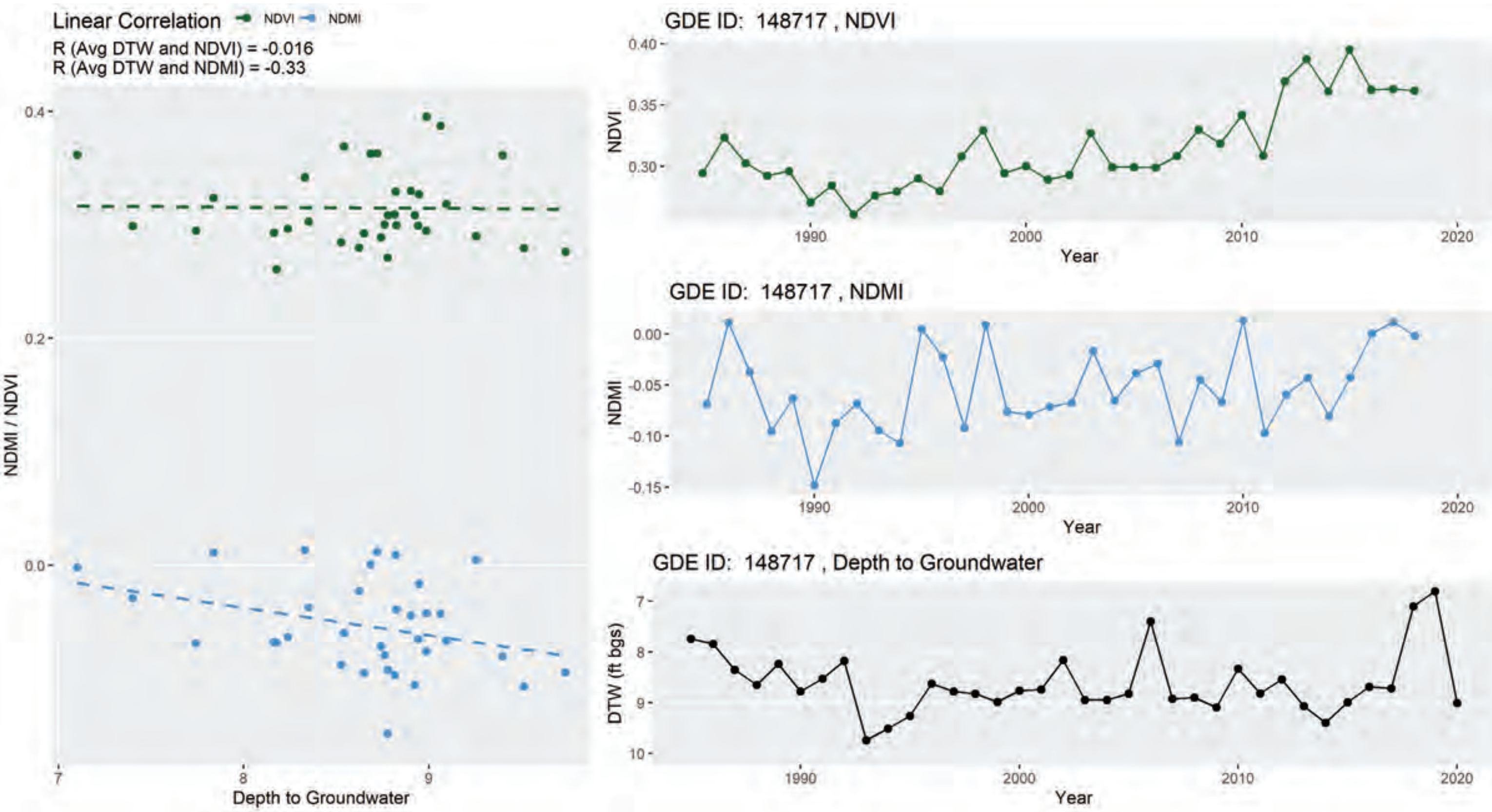

Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.5 (p <= 0.05)
R (Avg DTW and NDMI) = 0.0017
NDMI / NDVI
Depth to Groundwater
GDE ID: 69662 , NDVI
NDVI
Year
GDE ID: 69662 , NDMI
NDMI
Year
GDE ID: 69662 , Depth to Groundwater
DTW (ft bgs)
Year

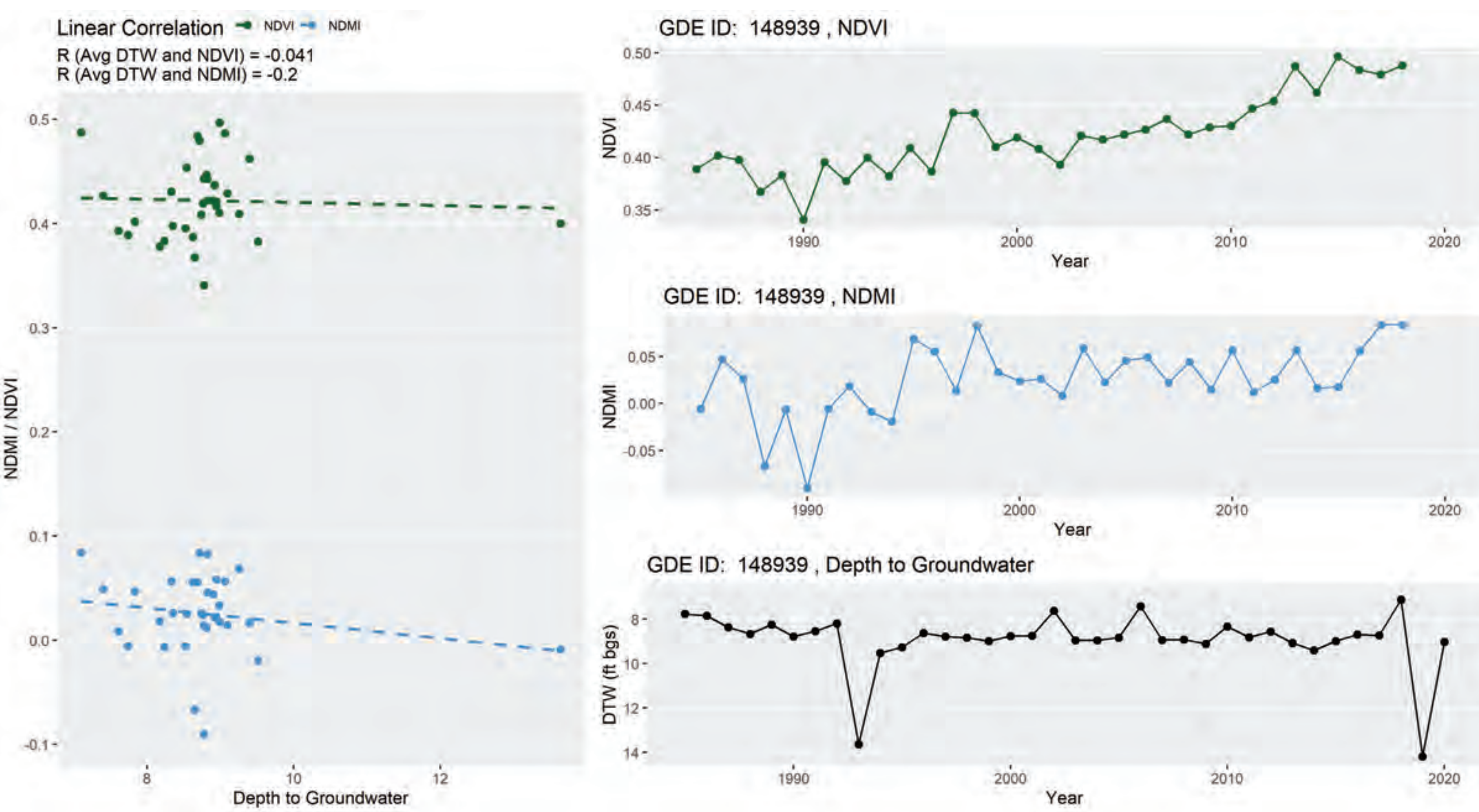


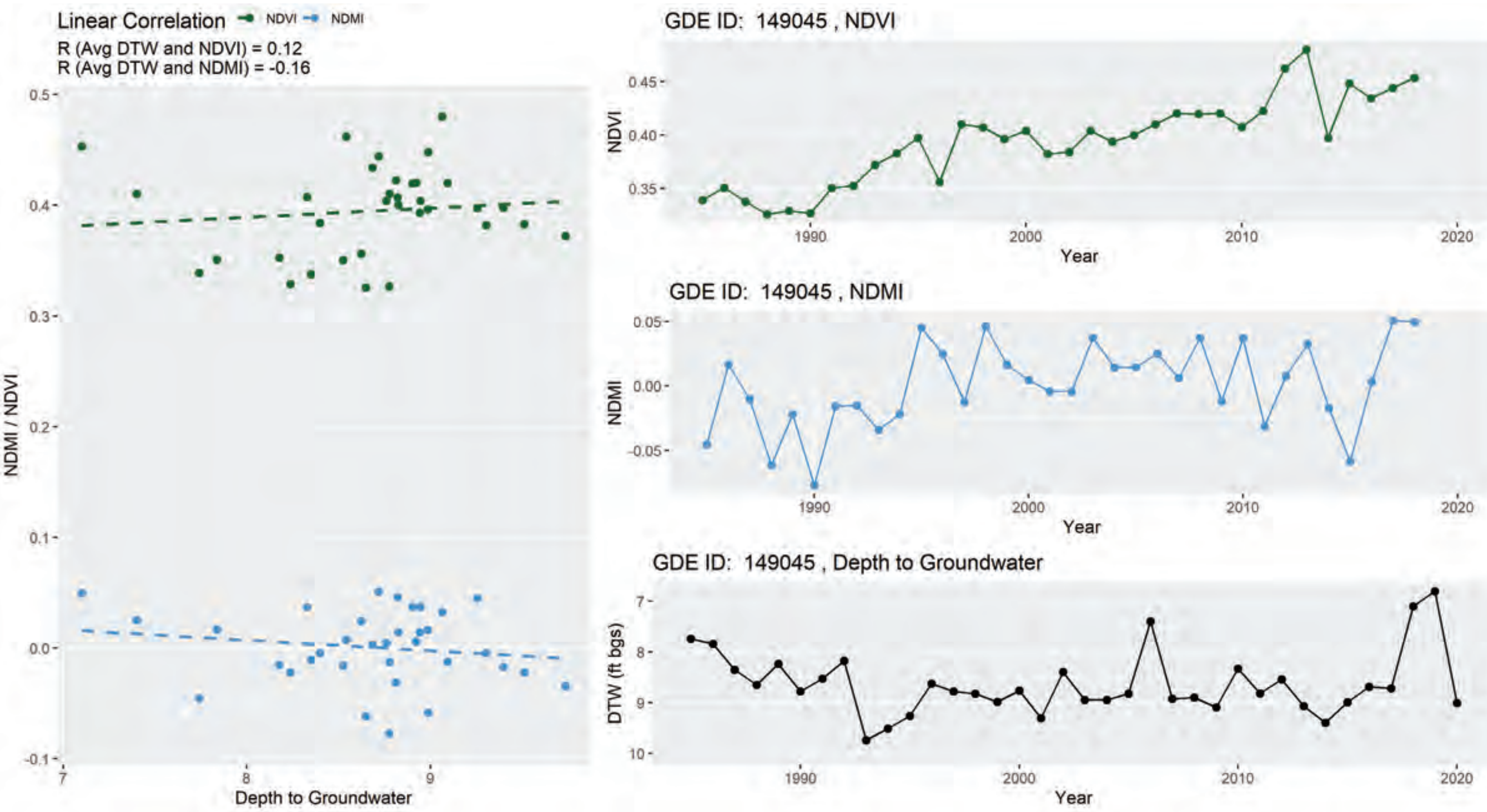
Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.084
R (Avg DTW and NDMI) = -0.19
NDMI / NDVI
Depth to Groundwater
GDE ID: 69663 , NDVI
NDVI
Year
GDE ID: 69663 , NDMI
NDMI
Year
GDE ID: 69663 , Depth to Groundwater
DTW (ft bgs)
Year



Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.24
R (Avg DTW and NDMI) = -0.42 (p <= 0.05)
NDMI / NDVI
Depth to Groundwater
GDE ID: 69666 , NDVI
NDVI
Year
GDE ID: 69666 , NDMI
NDMI
Year
GDE ID: 69666 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.016
R (Avg DTW and NDMI) = -0.33
NDMI / NDVI
Depth to Groundwater
GDE ID: 148717 , NDVI
NDVI
Year
GDE ID: 148717 , NDMI
NDMI
Year
GDE ID: 148717 , Depth to Groundwater
DTW (ft bgs)
Year


Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = -0.041
R (Avg DTW and NDMI) = -0.2
NDMI / NDVI
Depth to Groundwater
GDE ID: 148939 , NDVI
NDVI
Year
GDE ID: 148939 , NDMI
NDMI
Year
GDE ID: 148939 , Depth to Groundwater
DTW (ft bgs)
Year



Linear Correlation
NDVI
NDMI
R (Avg DTW and NDVI) = 0.12
R (Avg DTW and NDMI) = -0.16
NDMI / NDVI
Depth to Groundwater
GDE ID: 149045 , NDVI
NDVI
Year
GDE ID: 149045 , NDMI
NDMI
Year
GDE ID: 149045 , Depth to Groundwater
DTW (ft bgs)
Year

Attachment B: Technical Memorandum from Stillwater: Groundwater Dependent Ecosystems of Livermore Valley Groundwater Basin

DRAFT TECHNICAL MEMORANDUM ◦ MAY 2021

Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin

PREPARED FOR

Zone 7 Water Agency
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PREPARED BY

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Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2021. Groundwater Dependent Ecosystems of the Livermore Valley Groundwater Basin. Prepared by Stillwater Sciences, Berkeley, California for EKI Environment & Water, Inc., Burlingame, California

Cover photo: Riparian vegetation along Arroyo Las Positas, Livermore, CA.

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1 INTRODUCTION

This technical memorandum is anticipated to be included as an attachment to the 2022 Alternative Groundwater Sustainability Plan (Alt GSP) for the Livermore Valley Groundwater Basin. This memorandum identifies groundwater dependent ecosystems (GDEs) in the Livermore Valley Groundwater Basin. The Livermore Valley Groundwater Basin is managed by the Zone 7 Water Agency, which is the exclusive Groundwater Sustainability Agency (GSA) within its boundaries. Under the California Sustainable Groundwater Management Act (SGMA), GSAs are required to identify GDEs and other beneficial uses and users of groundwater and consider impacts to GDEs and beneficial users when developing their GSPs as codified in the California Code of Regulations (CCR) sections 23 CCR § 354.16(g), Water Code § 10723.2(e), and Water Code § 10727.4 (State of California 2021). SGMA defines GDEs as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's (TNC) guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or ecological communities on groundwater for all or a portion of their water needs. Mapping GDEs requires mapping vegetation that can tap groundwater through their root systems, assessing where the depth of groundwater is within the rooting depth of that vegetation, and mapping the extent of surface water that is interconnected with groundwater (Rohde et al. 2018). Once the GDEs are mapped, the occurrence of special-status species can be used to assess the sensitivity of GDEs in the basin.

Based on the 2016 Alternative Groundwater Sustainability Plan (Zone 7 Water Agency 2016), the Livermore Valley Groundwater Basin is divided into three management areas (Figure 1):

- **The Main Basin Management Area** includes the major aquifer in the Livermore Valley Groundwater Basin and is comprised of deep alluvial sediments (Zone 7 Water Agency 2016).
- **The Fringe Management Area** makes up the northern and eastern portions of the Livermore Valley Groundwater Basin and does not provide a large source of groundwater to the basin due to poor water quality and low well yields (Zone 7 Water Agency 2016). The Fringe Management Area contains the Springtown Alkali Sink which supports several special status species and GDEs (Zone 7 Water Agency 2016).
- **The Upland Management Area** primarily makes up the southern portion of the groundwater basin and is underlain by the Livermore Formation, which is not extensively used for groundwater pumping due to poor water yields (Zone 7 Water Agency 2016).

Although groundwater pumping volumes in the Fringe and Upland Management Areas are small, potential GDEs were identified in these areas to provide a baseline inventory of GDEs in the basin and to inform future monitoring efforts rather than to develop sustainable management criteria for the 2022 Alt GSP Update.

This assessment was conducted in coordination with EKI Environment & Water, Inc. (EKI) and the Zone 7 Water Agency, as described below.

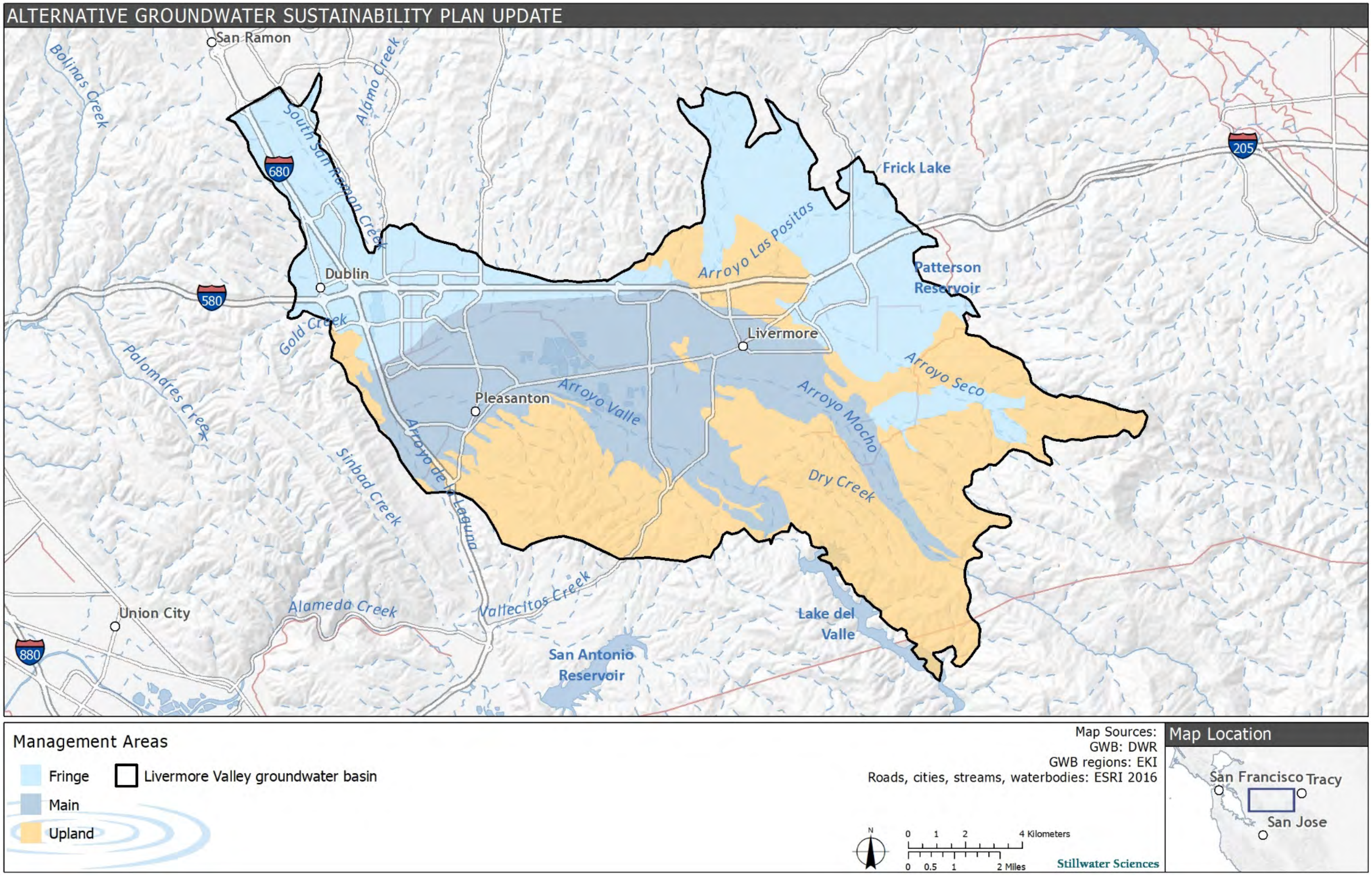

Figure 1. Livermore Valley Groundwater Basin Management Areas.

2 METHODS

2.1 GDE Identification

The procedure used for identifying GDEs is summarized below, and the steps are described in detail in the following sections.

1. **Data sources**: Potential GDEs in the Livermore Valley Groundwater Basin were identified using the California Department of Water Resources' (DWR) indicators of groundwater dependent ecosystems (iGDE) database. The database, which is published online[1] and referred to as the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (Klausmeyer et al. 2018), includes the location and spatial extent of vegetation and wetland natural communities. This database uses statewide vegetation and wetland mapping coupled with information on the potential groundwater dependence of those communities to identify potential GDEs. This map can be refined by including additional or updated vegetation map sources. The vegetation data sources must then be prioritized (based on data resolution, quality and age) to produce an initial vegetation map of the groundwater basin.
2. **Procedure**: Once the maps are assembled, groundwater dependent vegetation communities are identified through a decision tree based on literature review and wetland status (Lichvar et al. 2016) of dominant species.
3. **Refine potential GDE map**: Potential groundwater dependent vegetation communities were initially identified where depths to groundwater were less than 30 feet (ft) anytime between 2015-2020. Where groundwater depth was unknown (e.g., in portions of the Fringe and Upland Management Areas) the vegetation community was not removed. Where potential GDEs did not reflect current conditions, obvious errors in the vegetation mapping (i.e., polygon boundaries) were corrected using aerial imagery. In addition, the potential GDE map incorporated results of a correlation analysis on depth to groundwater and GDE health-indicating indices provided by EKI. The potential GDE maps were further revised based on input from Zone 7 and EKI.
4. **Field visit**: Where the presence of potential GDE communities was uncertain, Stillwater botanists visited several sites to assess groundwater dependence in the field. Updates based on field observations were incorporated into the final GDE assessment.

2.1.1 Data sources

This section includes brief descriptions of the vegetation community data and other information sources used to identify and aggregate potential GDEs into final GDE units. The Indicators of Groundwater Dependent Ecosystems (iGDE) database (Klausmeyer et al. 2018) was reviewed in a geographic information system (GIS) and used to generate a preliminary map to serve as a guide for initial identification of potential GDEs in the Livermore Valley Groundwater Basin.

For more precise identification of potential GDEs, we developed a refined vegetation map by combining the Classification and Assessment with Landsat of Visible Ecology Groupings (CalVeg) dataset with several more recent datasets. Our refined vegetation map incorporates the following datasets:

[1] https://gis.water.ca.gov/app/NCDatasetViewer/ [Accessed April 28, 2021]

- Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg) – United States Department of Agriculture - Forest Service (USDA 2014). *Central Coast region: Imagery date: 1997–2013; Minimum mapping unit (MMU): 2.5-acre.*
- Urban Creeks Council 2014 CalVeg update for third-order and higher channels. *Minimum mapping unit (MMU): ~0.5 acre.* Urban Creeks Council (2014).
- Springtown Alkali Sink Preserve Wetlands Mapping Project, Aerial Information Systems, Inc. (AIS 2009). *Minimum mapping unit (MMU): as low as 200 ft sq in wetland areas, 1.2-acre in general study area.*
- Sycamore Alluvial Woodland Tree Survey in Arroyo Mocho and Arroyo Valley, Alameda County, CA, Zone 7 Water Agency, San Francisco Estuary Institute, H.T. Harvey & Associates (SFEI and H.T. Harvey 2017).

AIS (2009) was considered the highest quality vegetation mapping due to its high resolution. The sycamore woodland mapping was also considered high quality but is of limited extent. Because of the recent date, we next used the UCC (2014) along the channels underlain by the original CalVeg mapping (Figure 2).

Table 1 and Figure 2 show, respectively, the acreage and extent of each dataset.

Table 1. Vegetation and wetland data sources for the Livermore Valley Groundwater Basin.

Data source	Mapped area (acres)
CalVeg	36,254
CalVeg – UCC updates	22,906
AIS Springtown Mapping	10,329
Zone 7 Sycamore Survey	40
Total[1]	**69,531**

[1] Totals may not appear to sum exactly due to rounding error.

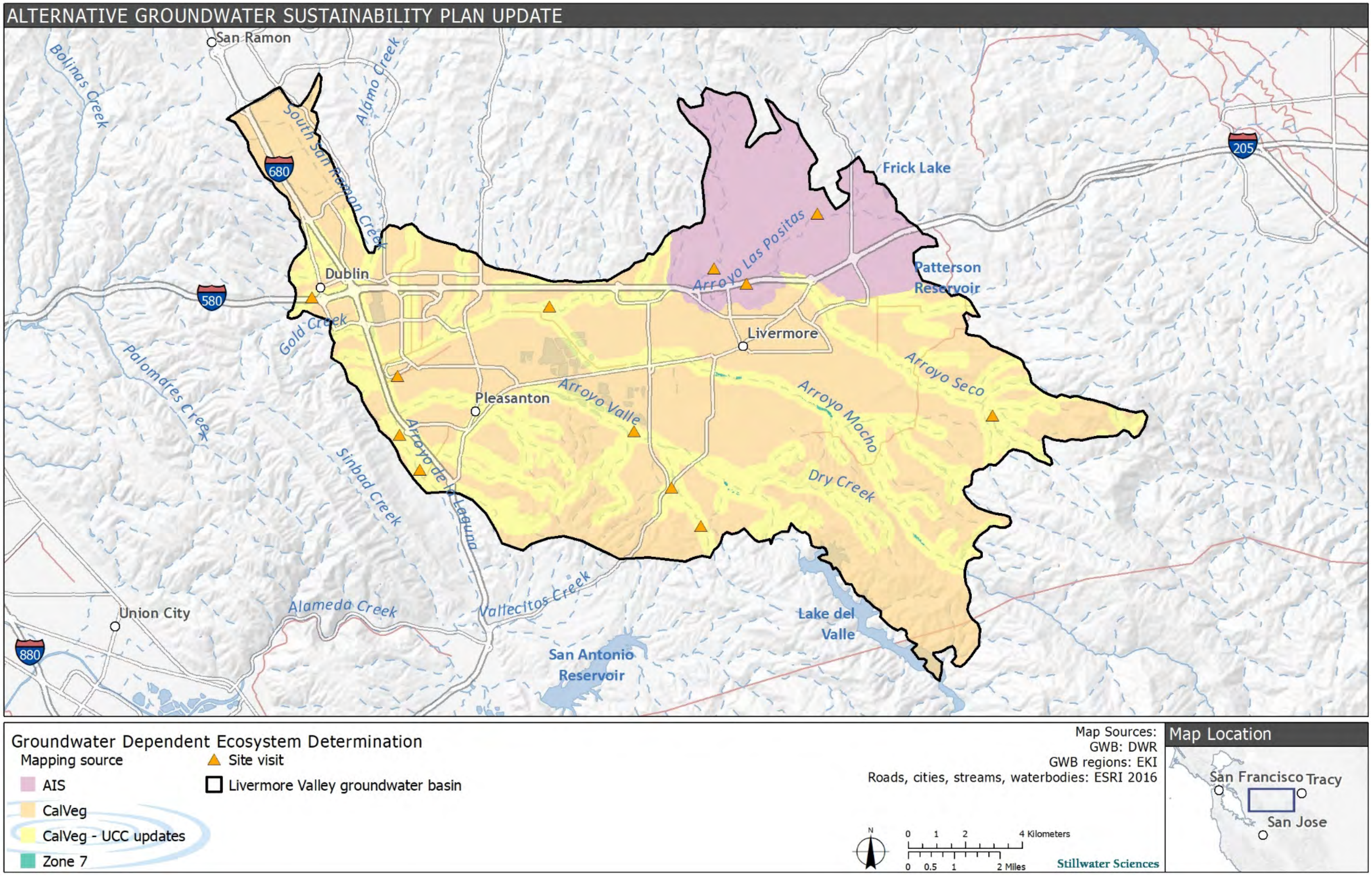

Figure 2. Extent of vegetation mapping data sources.

2.1.2 Procedure

The steps for defining and mapping GDEs outlined in Rohde et al. (2018) were used as a guideline for this process. A decision tree was applied to determine when species or biological communities were considered groundwater dependent based on definitions found in 23 CCR § 351(m) (State of California 2021) and Rohde et al. (2018). This decision tree, created to systematically and consistently address the range of conditions encountered, is summarized below; the term "unit" refers to an area with consistent vegetation and hydrology:

The unit is a GDE if groundwater is likely:

1. An important hydrologic input to the unit during some time of the year, AND
2. Important to survival and/or natural history of inhabiting species, AND
3. Associated with a regional aquifer used as a regionally important source of groundwater.

The unit is not a GDE if its hydrologic regime is primarily controlled by:

1. Surface discharge or drainage from a(n) upslope human-made structure(s), such as a mining pit, irrigation canal, irrigated fields, reservoir, cattle pond, or water treatment pond/facility.
2. Precipitation inputs directly to the unit surface. This excludes vernal pools from being GDEs where units are hydrologically supplied by direct precipitation and very local shallow subsurface flows from the immediately surrounding area.

Rohde et al. (2018) recommend that maps of potential GDEs be compared with local groundwater elevations to determine where groundwater is within the rooting depth of potential GDEs. Given uncertainties in extrapolating well measurements to GDEs and differences in surface elevation of wells and GDEs, Rohde et al. (2018) recommend assigning GDE status to vegetation communities either where groundwater is within 30 ft of the ground surface or where interconnected surface waters are observed.

2.1.3 Refine potential GDE map

The basin-wide vegetation and wetland map was reviewed, and each community was assigned a groundwater dependence category based on rankings for likelihood of connection to groundwater (i.e., unlikely or likely). This determination was based on species composition and the groundwater dependency of dominant species, whether they were considered groundwater dependent by the iGDE database (DWR 2021), and wetland indicator status (Lichvar et al. 2016).

These potential GDEs were then compared with groundwater depth (where known). Depth to groundwater contours for the Main Basin and Fringe Management Areas were provided by Zone 7 and EKI. In the Main Basin and Fringe Management Areas, phreatophytes that occur where groundwater is within 30 ft of the ground surface were identified as likely GDEs. Initial GDE maps used areas with groundwater depth less than 30 ft in a wet period, Spring 2019, using data provided by Zone 7 (Zone 7 2020). The map was revised to include areas where groundwater depths are less than 30 ft anytime between 2015-2020 using raster data of groundwater depth subsequently provided by EKI (EKI 2021).

Groundwater contours or rasters were not available for the Upland Management Area of the Livermore Valley Groundwater Basin due to the general lack of monitoring and production wells in this portion of the Basin. Where well data was available in the Upland Management Area, EKI evaluated potential groundwater dependence for GDEs that occurred within one kilometer (approximately 0.6 miles) of the well and had minimum depth to water observations less than 30 ft between 2015 and 2020. These potential GDEs were evaluated in the field to assess groundwater dependence.

The southern portion of the Upland Management Area contains extensive valley oak (*Quercus lobata*) and blue oak (*Quercus douglasii*) communities (Figure 3). Valley oaks are included as phreatophytes in California by Klausmeyer et al. (2018) suggesting that they can rely on groundwater for part of their water needs. Klausmeyer et al. (2018) did not include blue oaks in their list of phreatophytes, but focused studies in blue oak woodlands suggest they can depend on groundwater to meet their water needs (e.g., Miller et al. 2010). Though these oaks are deep-rooted (maximum rooting depths range from 30-80 ft, depending on the species) and occur where depth to groundwater is unknown, they are unlikely to be affected by groundwater management because they occur in hillslopes, where hydraulic gradients are steep and groundwater production is de minimis as evidenced by the lack of wells in the area (Zone 7 Water Agency 2016). As such, these communities were not included in the final GDE map presented in Figure 4.

Zone 7 made additional comments on the preliminary GDE map, noting discrepancies between mapped GDEs and current vegetation as well as recent stream restoration projects which may be connected to groundwater. The vegetation map was subsequently adjusted to ensure that mapped polygons aligned with the current extent of vegetation, with a focus on the restoration project areas identified in comments provided by Zone 7.

EKI performed a correlation analysis between depth to groundwater and two remote sensing indices that indicate GDE's health by GDE unit, the Normalized Derived Moisture Index (NDMI) and the Normalized Derived Vegetation Index (NDVI), which indicate the vegetation moisture and vegetation greenness, respectively. The premise of the analysis is that, since the NDMI and NDVI indices can quantify changes in the rates and patterns of vegetation growth and moisture levels in plants over time, the relationship between these two indices and the depth to groundwater can be evaluated to examine whether these measures of GDE "health" have a relationship to shallow groundwater conditions. The preliminary GDE map was subsequently revised based on the results of the correlation analysis provided by EKI.

The occurrence and extent of interconnected surface water is uncertain in the Livermore Valley Groundwater Basin. Potential reaches of interconnected surface water were identified by EKI based on analysis of streambed elevations relative to recent depth to groundwater observations. These reaches generally overlapped with mapped GDEs and were not evaluated separately. Man-made open water areas (e.g., Chain of Lakes and golf course ponds) were removed from the final GDE map.

2.1.4 Field visit

Stillwater Sciences and EKI identified 12 sites to examine in the field based on uncertainties in the preliminary GDE maps, as shown on Figure 2. These sites included gaps in the GDE map where vegetation appeared similar to GDEs that occurred immediately upstream and downstream of the site, riparian vegetation along channels, and mapped GDEs underlain by thick clay layers. Additionally, Stillwater scientists assessed potential GDEs where groundwater data was sparse (near Sycamore Park) and near Springtown. Groundwater dependence of these sites was determined by assessing various local water sources and the width of the riparian zone. Where riparian zones were narrow and relatively sparse, other water sources likely support the vegetation. Where existing vegetation and wetland areas extend beyond a narrow strip along the channel, groundwater dependence was considered likely. The results of the field investigation are shown in Table 2 and Figure 3, and the Final likely GDE map is presented in Figure 4.

2.2 Special-status Species

As part of the ecological inventory, special-status species and sensitive natural communities that are potentially associated with GDEs in the Livermore Valley Groundwater Basin were identified. For the purposes of this document, special-status species are defined as those:

- Listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- Designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- Designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- Designated as Bureau of Land Management (BLM) sensitive;
- Designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- Included on CDFW's most recent Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2020b) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

2.2.1 Data sources

Stillwater ecologists queried databases on regional and local occurrences and spatial distributions of special-status species within the Livermore Valley Groundwater Basin. Spatial database queries included potential GDEs plus a 1-mile buffer. Databases queried include:

- California Natural Diversity Database (CNDDB) (CDFW 2020);
- California Native Plant Society (CNPS) Manual of California Vegetation (2020);
- eBird (2021); and
- TNC freshwater species lists generated from the California Freshwater Species Database (CAFSD) (TNC 2020).

2.2.2 Procedure

Stillwater reviewed the database query results and identified special-status species and vegetation communities that may occur within or be associated with the vegetation and aquatic communities in or immediately adjacent to potential GDEs. Stillwater ecologists then consolidated these special-status species and sensitive community types into a list, along with summaries of habitat preferences, potential groundwater dependence, and reports of any known occurrences.

Wildlife species were evaluated for potential groundwater dependence using determinations from the Critical Species Lookbook (Rohde et al. 2019) or by evaluating known habitat preferences, life histories, and diets. Species GDE associations were assigned one of three categories:

- Direct—species directly dependent on groundwater for some or all water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season)
- Indirect—species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds)

- No known reliance on groundwater

Sensitive natural communities were classified as either likely or unlikely to depend on groundwater based on species composition using the same methodology as vegetation communities (Section 2.1.3). Plant species were evaluated for potential groundwater dependence based on their habitat (Jepson Flora Project 2020) and association with vegetation communities classified as GDEs. Special-status plant GDE associations were assigned one of three categories: likely, possible, or unlikely. The "possible" category was included to classify plant species with limited habitat data or where a species may have an association with a vegetation community identified as a GDE (e.g., Coast live oak, California sagebrush).

Database query results for local and regional special-status species occurrences were combined with their known habitat requirements to develop a list of groundwater dependent special-status species (Section 3.2) that satisfy the following criteria: (1) documented to occur within the GDE unit, or (2) known to occur in the region and suitable habitat present in the GDE unit.

3 RESULTS

3.1 Comparison with iGDE Database

The differences between the iGDE map (DWR 2021) and the final GDE map are shown in Figure 3. The primary differences are the addition of GDEs in the northeast portion of the basin where the AIS mapping occurred and removal of man-made open water polygons along Chain of Lakes (along Arroyo Valle) and near Dublin. Some changes reflect differences between the UCC update to the CalVeg map and Stillwater's edits to the map along Arroyo Mocho and Arroyo Valle. In particular, the width of the riparian vegetation along both rivers increased in places. The reclassification near Lake Boris on Arroyo Valle (downstream of Site I) reduced the extent of GDEs downstream of the lake. In addition, several changes were made based on the site visit (Figure 3, Table 2). The vegetation was removed along Arroyo Del Laguna and west of Pleasanton (Sites B, C, and D). These sites occur above a thick clay layer (known colloquially as the Overburden layer) that precludes connection to the aquifer. Observations during the field visit suggested that the riparian vegetation at Sites B–D was likely dependent on surface water rather than groundwater due to the relatively narrow riparian zone. Site L (Figure 3) was also removed since the very sparse riparian vegetation suggested the area was not connected to groundwater. Wetlands mapped within man-made lakes and ponds (e.g., Frick Lake in the eastern part of the basin) were also removed. The final GDE map is presented in Figure 4.

Table 2. Likely groundwater dependence of field sites.

Site	Site description	Groundwater dependence
A	Mature trees including oaks (*Quercus* spp.), redwood (*Sequoia sempervirens*), tree of heaven (*Ailanthus altissima*), eucalyptus (*Eucalyptus* spp.)	Likely, kept
B	Flood control channel with planted willows (*Salix* spp.)	Unlikely, removed
C	Narrow band of willows, cottonwoods (*Populus* spp.), and oaks; channel incised up to 30 ft	Unlikely, removed
D	Narrow band of willows, cottonwoods, and valley oaks (*Quercus lobata*)	Unlikely, removed
E	Narrow band of sparse riparian vegetation	Unlikely, removed
F	Valley oak, live oak (*Quercus agrifolia*) and willow	Likely, kept
G	Willows, live oak, eucalyptus; may have perennial flow	Likely, kept
H	Near Springtown; likely groundwater dependent	Likely, added
I	Similar to upstream and downstream GDEs	Likely, added
J	Mature riparian trees, little surface water	Likely, added
K	Sycamore Park; closed canopy, mature riparian trees	Likely, added
L	Sparse valley oaks along incised, intermittent channel	Unlikely, removed

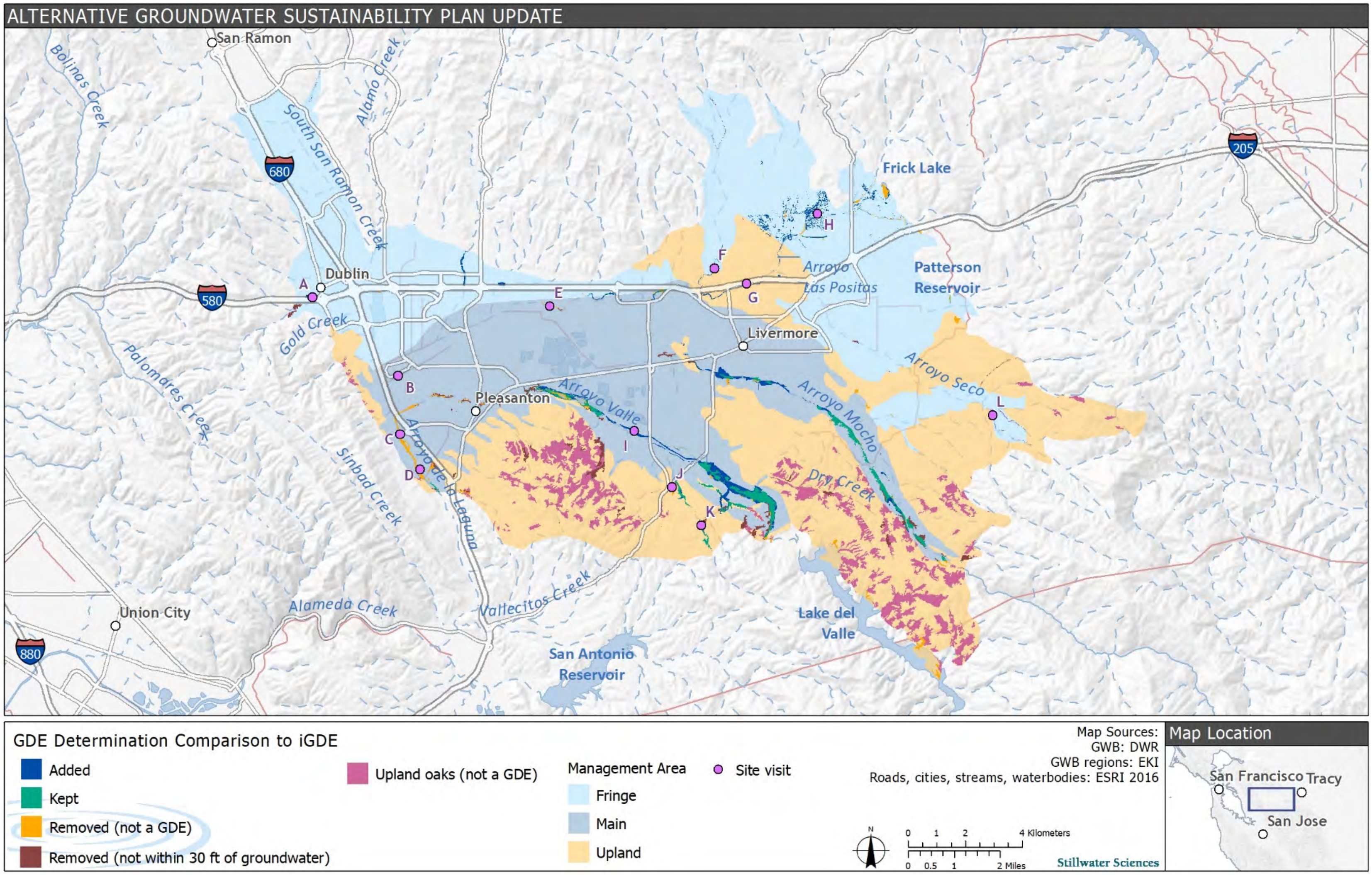

Figure 3. Comparison of the GDE map with the iGDE database (DWR 2021).

Note: The reasons for GDE removal are discussed in Section 3.1 and Table 2.

3.2 GDEs in the Livermore Valley Groundwater Basin

The Livermore Valley Groundwater Basin contains 1062 acres of likely GDEs, approximately 2% of the total basin area (Figure 4). The Main Basin Management Area contains approximately 69% of the total likely GDE area, the Fringe Management Area approximately 20%, and the Upland Management Area contains the remaining 11% of the GDEs. The most prevalent vegetation communities across all likely GDE units are the riparian mixed hardwood alliance and California sycamore alliance, which respectively comprise 40% and 30% of likely GDE area in the basin and are located almost entirely in the Main Basin Management Area. The Alkaline mixed grasses and forbs alliance comprises 10% of total likely GDE area and is located almost entirely in the Fringe Management Area.

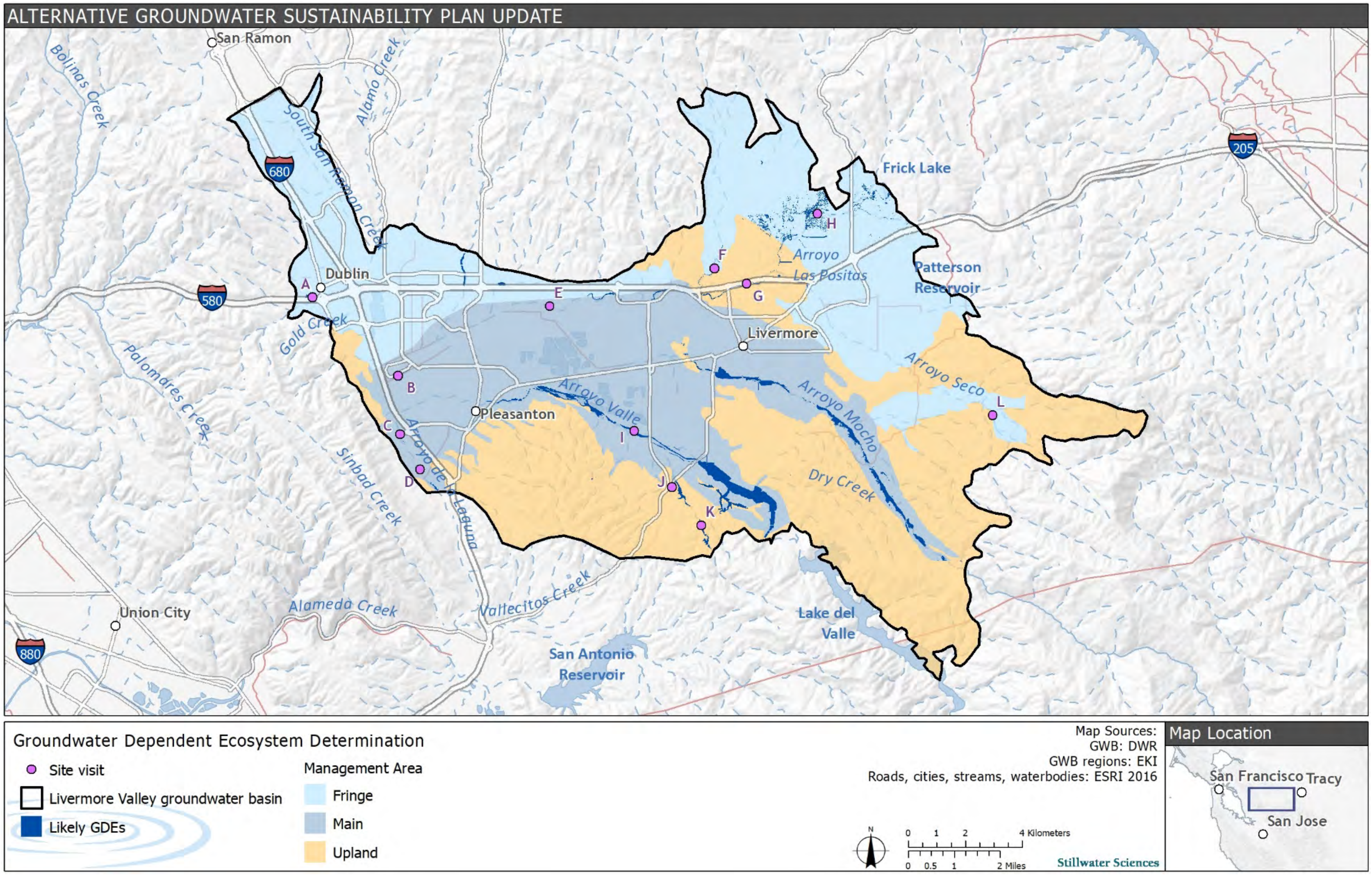

Figure 4. Groundwater dependent ecosystems in the Livermore Basin.

The Main Basin Management Area contains 737 acres of likely GDEs. The most prevalent vegetation communities are the California sycamore alliance (250 acres), riparian mixed hardwood alliance (239 acres), and valley oak alliance (212 acres) (Figure 5). GDEs typically occur along riparian zones, particularly Arroyo Mocho, Arroyo Valle, and Arroyo Las Positas. Additional GDEs occur in Sycamore Park in the upper extent of Arroyo Valle. The valley oak alliance is mostly found in the upstream portions of Arroyo Mocho within the main basin.

The riparian mixed hardwood alliance is comprised of willows (*Salix* spp.) and Fremont cottonwoods (*Populus fremontii*), which have maximum reported rooting depths in the literature of about 7 ft (The Nature Conservancy 2018) but can occur at relative elevations of 10–15 ft in some cases (Stillwater Sciences 2007). Maximum rooting depths for California sycamore (*Platanus racemosa*) are not reported in the literature, but American sycamore (*Platanus occidentalis*) has a maximum reported rooting depth of about 9 ft (The Nature Conservancy 2018). The valley oaks (Quercus lobata) that make up the valley oak alliance have the deepest rooting depth of the riparian vegetation found in the main basin measured maximum rooting depths up to 24 ft (The Nature Conservancy 2018).

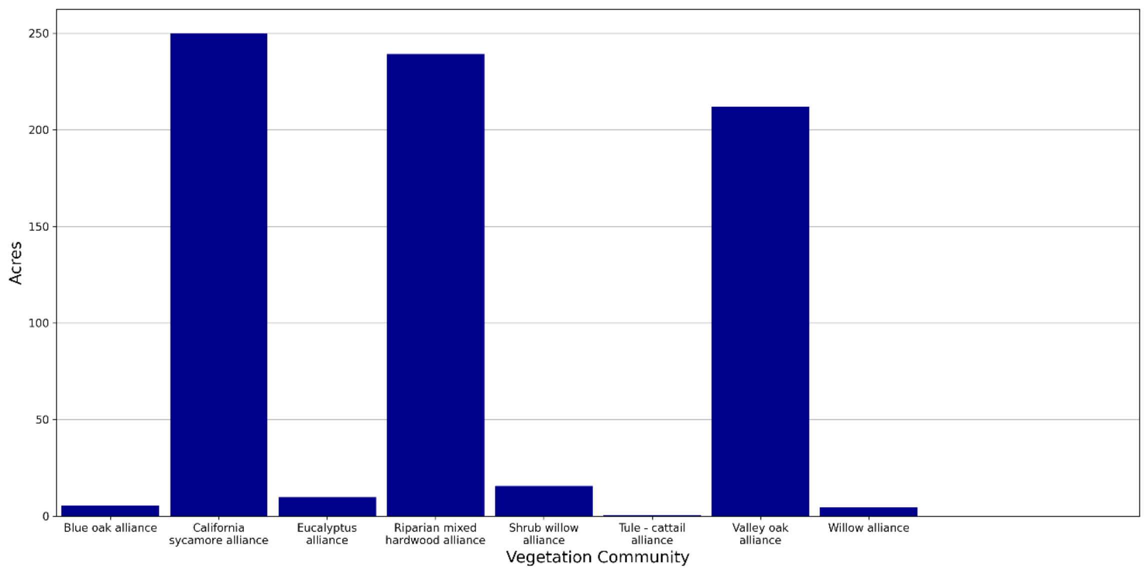

Figure 5. Likely GDE vegetation communities in the Main Basin Management Area, by acreage. Only eight likely GDE vegetation communities occur in the management area.

The Fringe Management Area contains 210 acres of likely GDEs. The most prevalent vegetation community is the alkaline mixed grasses and forbs alliance (100 acres). Other alkaline communities are also prevalent: alkaline mixed scrub alliance (29 acres) and alkaline flats (15 acres) (Figure 6). The GDEs in the Fringe Management Area occur along Arroyo Las Positas and the smaller spring-fed channels and wetlands in the northeast portion of the Fringe Management Area near Springtown (the northeasternmost site visit marker in Figure 4). Of the 144 acres of alkaline likely GDE vegetation communities, 54 acres occur in the Springtown Alkali Sink, as defined in the Zone 7 Alternative GSP (2016). The rooting depth of species in the alkaline mixed grasses and forbs alliance is unknown but is likely shallow (< 2 ft). The dominant species of the alkaline mixed scrub alliance is iodine bush (*Allenrolfea occidentalis*), which has reported maximum rooting depths of 2 ft. The dominant species of the tule-cattail alliance include sedges (*Carex* spp.), tules (*Scirpus* spp.), cattails (*Typha* spp.), and spikerushes (*Eleocharis* spp.). The rooting depth of these genera is typically less than 1 ft. The riparian mixed hardwood alliance has maximum rooting depths of about 7 ft (see above).

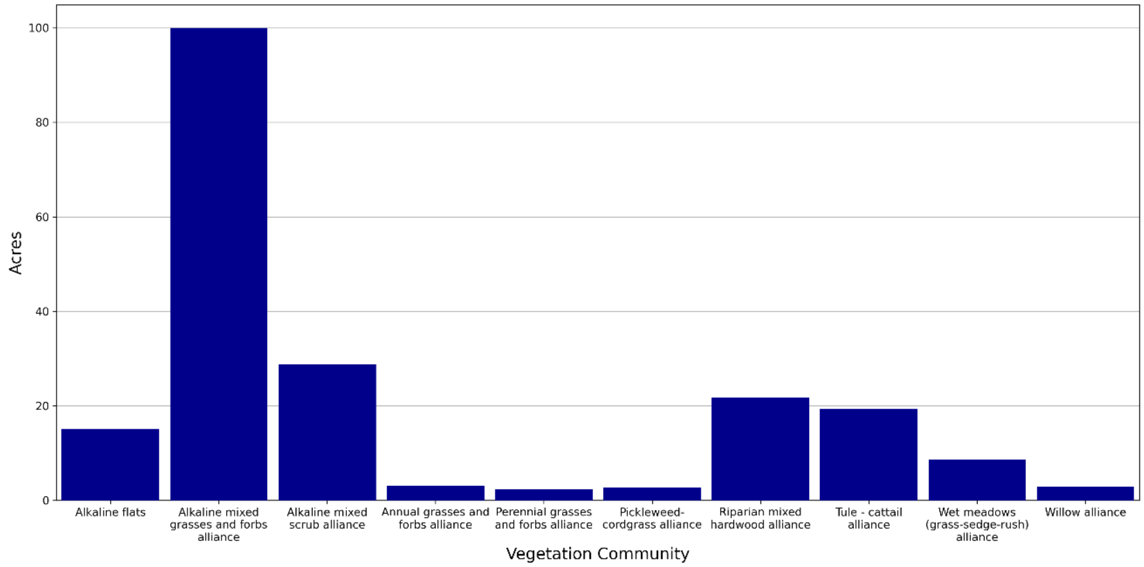

Figure 6. Ten most common likely GDE vegetation communities in the Fringe Management Area, by acreage.

The Upland Management Area contains 101 acres of likely GDEs. The most prevalent vegetation community is the riparian mixed hardwood alliance (74 acres) (Figure 7). GDEs in this unit occur in the riparian zones of smaller tributaries. The riparian mixed hardwood alliance is comprised of willows (*Salix* spp.) and Fremont cottonwoods (*Populus fremontii*), which have maximum reported rooting depths in the literature of about 7 ft (The Nature Conservancy 2018) but can occur at relative elevations of 10–15 ft in some cases (Stillwater Sciences 2007).

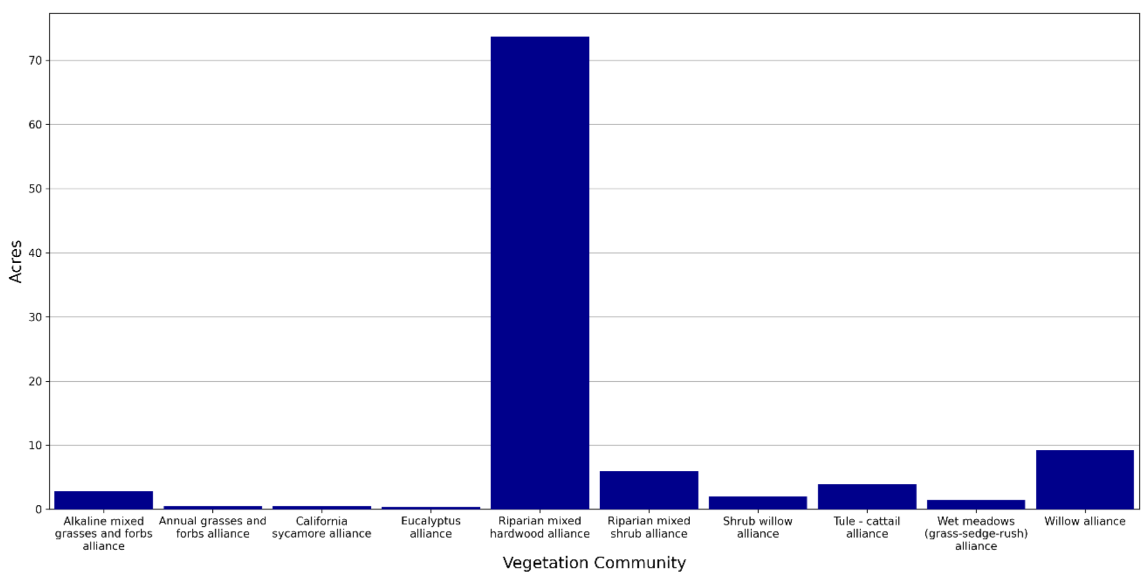

Figure 7. Ten most common likely GDE vegetation communities in the Upland Management Area, by acreage.

3.3 Special-status Species

3.3.1 Critical habitat

The Livermore Valley Groundwater Basin includes United States Fish and Wildlife Service (USFWS) designated critical habitat for four federally listed species: Alameda whipsnake (*Masticophis lateralis euryxanthus*) (936 acres), California red-legged frog (*Rana draytonii*) (7,273 acres), California tiger salamander (*Ambystoma californiense*) (0.5 acres), and vernal pool fairy shrimp (*Branchinecta lynchi*) (1,337 acres) (USFWS 2006a, USFWS 2010, USFWS 2005, USFWS 2006b). The locations of critical habitat for each species within the Livermore Valley Groundwater Basin are shown in Figure 8. Of the designated critical habitat, most of the habitat for the vernal pool fairy shrimp is co-located with mapped GDEs, but this species relies on vernal pools, which are dependent on rainfall, rather than groundwater and is therefore unlikely to be groundwater dependent. Most of the critical habitat for California red-legged frogs and Alameda whipsnake occurs outside of the defined GDEs, with approximately 2 acres of their critical habitat overlapping with a riparian GDE at the upstream end of Arroyo Mocho.

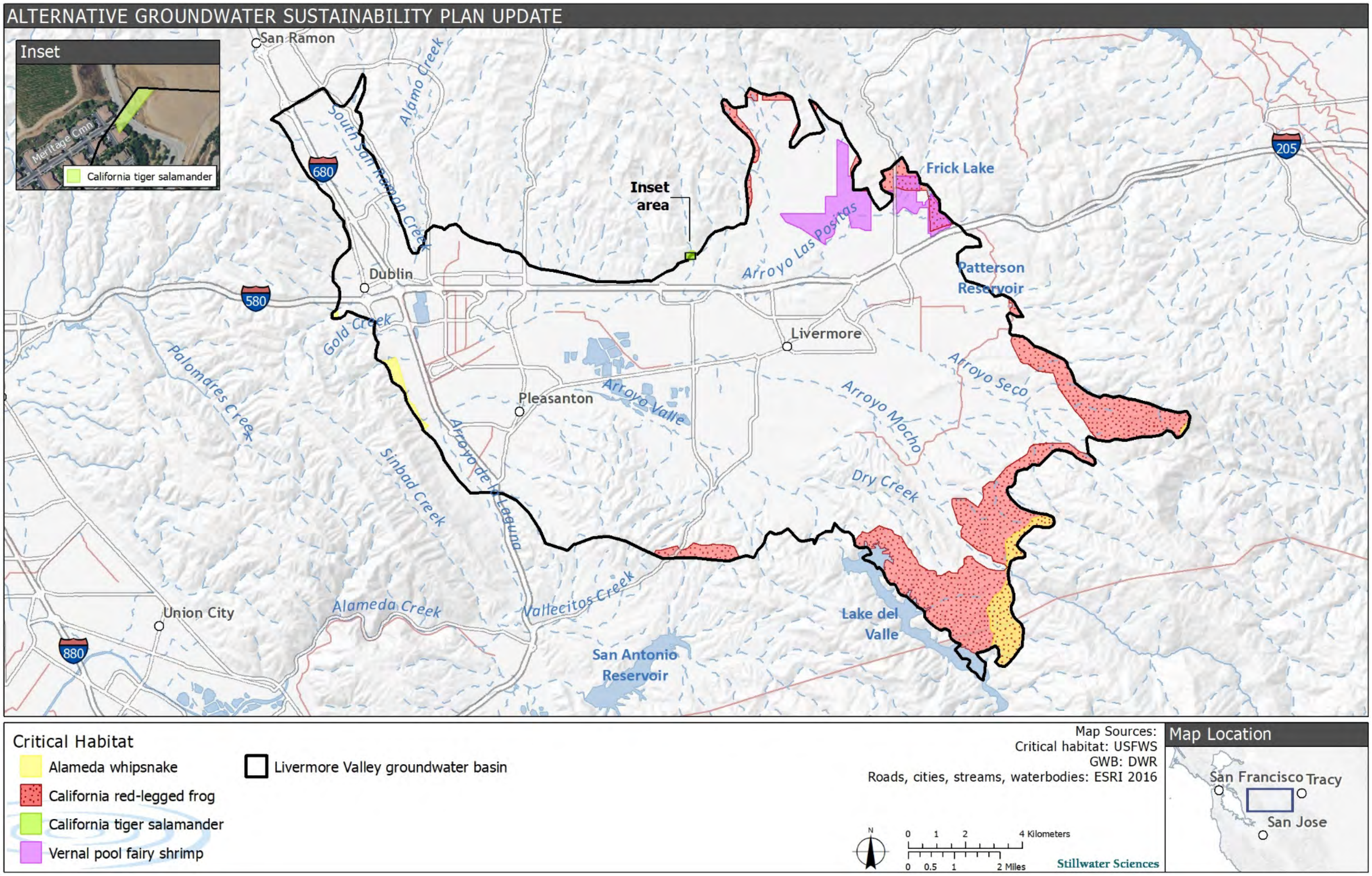

Figure 8. Designated critical habitat within the Livermore Valley Groundwater Basin.

3.3.2 Plants

Twenty-two special-status plants occur within the basin (Table 3). Of these, 12 were likely dependent upon groundwater, four were possibly dependent on groundwater, one was unlikely to be groundwater dependent, and five were not groundwater dependent (Table 3). All 12 special-status plants likely dependent on groundwater occurred in the Fringe Management Area, and three of the 12 also occurred in the Upland Management Area. The likely groundwater dependent special-status plants in the Fringe Area mostly were observed in or around the Springtown Alkali Sink.

Table 3. Groundwater dependance of special-status plant species in the Livermore Valley Groundwater Basin.

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Documented occurrence location**	**Query source[2]**
Alkali milk-vetch *Astragalus tener* var. *tener*	G2T1, S1, 1B.2	Likely	Fringe	CNDDB
Heartscale *Atriplex cordulata* var. *cordulata*	G3T2, S2, 1B.2	Likely	Fringe	CNDDB
Brittlescale *Atriplex depressa*	G2, S2, 1B.2	Likely	Fringe	CNDDB
Lesser saltscale *Atriplex minuscula*	G2, S2, 1B.1	Possible	Fringe	CNDDB
Big-scale balsamroot *Balsamorhiza macrolepis*	G2, S2, 1B.2	Not a GDE	Uplands	CNDDB
Big tarplant *Blepharizonia plumosa*	G1G2, S1S2, 1B.1	Not a GDE	Outside of basin	CNDDB
Congdon's tarplant *Centromadia parryi* subsp. *congdonii*	G3T1T2, S1S2, 1B.1	Possible	Fringe, Uplands	CNDDB
Hispid salty bird's-beak *Chloropyron molle* subsp. *hispidum*	G2T1, S1, 1B.1	Likely	Fringe	CNDDB
Palmate-bracted bird's-beak *Chloropyron palmatum*	G1, S1, 1B.1	Likely	Fringe, Uplands	CNDDB
Livermore tarplant *Deinandra bacigalupii*	G1, S1, 1B.1	Likely	Fringe	CNDDB
Hospital Canyon larkspur *Delphinium californicum* subsp. *interius*	G3T3, S3, 1B.2	Not a GDE	Main, Uplands	CNDDB

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Documented occurrence location**	**Query source[2]**
Jepson's coyote-thistle *Eryngium jepsonii*	G2, S2, 1B.2	Likely	Fringe	CNDDB
San Joaquin spearscale *Extriplex joaquinana*	G2, S2, 1B.2	Possible	Fringe	CNDDB
Stinkbells *Fritillaria agrestis*	G3, S3, 4.2	Unlikely	Fringe	CNDDB
Diablo helianthella *Helianthella castanea*	G2, S2, 1B.2	Possible	Fringe, on the edge of basin	CNDDB
Prostrate vernal pool navarretia *Navarretia prostrata*	G2, S2, 1B.2	Likely	Fringe	CNDDB
Hairless popcornflower *Plagiobothrys glaber*	GX, SX, 1A	Likely	Fringe, Uplands	CNDDB
California alkali grass *Puccinellia simplex*	G3, S2, 1B.2	Likely	Fringe, Uplands	CNDDB
Chaparral ragwort *Senecio aphanactis*	G3, S2, 2B.2	Not a GDE	Outside of Basin	CNDDB
Long-styled sand-spurrey *Spergularia macrotheca* var. *longistyla*	G5T2, S2, 1B.2	Likely	Fringe	CNDDB
Saline clover *Trifolium hydrophilum*	G2, S2, 1B.2	Likely	Fringe	CNDDB

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Documented occurrence location**	**Query source[2]**
Caper-fruited tropidocarpum *Tropidocarpum capparideum*	G1, S1, 1B.1	Not a GDE	Outside of Basin	CNDDB

[1] **Status codes:**

G = Global
T = Subspecies or variety
Federal
FT = Listed as threatened under the federal Endangered Species Act
FPT = Proposed as threatened under the federal Endangered Species Act
FD = Federally delisted

State
S = Sensitive
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

Rank

1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
3 Vulnerable—At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
5 Demonstrably Secure—Common; widespread and abundant.

Q Taxonomic questions associated with this name
Ranks such as S2S3 indicate a ranking between S2 and S3

California Rare Plant Rank (CRPR)

1B Plants rare, threatened, or endangered in California and elsewhere
2B Plants rare, threatened, or endangered in California, but more common elsewhere
4 More information needed about this plant, a review list
4 Plants of limited distribution, a watch list

CRPR Threat Ranks:

0.1 Seriously threatened in California (high degree/immediacy of threat)
0.2 Fairly threatened in California (moderate degree/immediacy of threat)
0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known

GDE Likelihood

Likely Species habitat includes multiple GDE habitats and the species has a wetland plant rating in the USACE Arid West Regional Supplement (FAC, FACW, or OBL)
Possible Species habitat range includes at least some GDE habitats (per CNPS and/or Jepson), however the species has an upland plant rating in the USACE Arid West Regional Supplement (FACU, UPL, or NL/UPL [i.e., not listed therefore considered upland])
Unlikely Species habitat associations do not include a potential GDE and it is associated with upland habitats. However, it has a plant rating in the USACE Arid West Regional Supplement of sometimes occurring in wetlands (e.g., FAC).
Not a GDE Species habitat associations do not include a potential GDE and it is associated with upland habitats. Also, it has an upland plant rating in the USACE Arid West Regional Supplement.

[2]**Query source:** CNDDB: California Natural Diversity Database (CDFW 2020a)

3.3.3 Terrestrial and aquatic wildlife

Thirty-one special-status terrestrial and aquatic wildlife species were identified as having the potential to occur within the Livermore Valley Groundwater Basin. Of these, 14 were potentially groundwater dependent species: two amphibian species, two reptile species, seven bird species, and three mammal species. Additional information on these groundwater dependent species, including regulatory status and habitat associations, is provided in Table 4. Ten of the groundwater dependent special status species are likely to occur in the Main Basin, eight of the groundwater-dependent special status species are likely to occur in the Fringe Management Area, and 13 of the groundwater-dependent special status species are likely to occur in the Upland Management Area.

Table 4. Groundwater-dependence of special-status terrestrial and aquatic wildlife species with potential to occur or suitable habit in the Livermore Valley Groundwater Basin.

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in the Livermore Valley Groundwater Basin[2]	Documented occurrence location	Query source[3]	GDE . association[4]	Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin
Invertebrates						
Longhorn fairy shrimp *Branchinecta longiantenna*	FE/–	Likely	Main, Fringe, Uplands	CNDDB, CAFSD	No known reliance on groundwater	Vernal pools; also found in sandstone rock outcrop pools, grass-bottomed pools, and claypan pools.
Vernal pool fairy shrimp *Branchinecta lynchi*	FT/–	Likely (critical habitat)	Fringe	CNDDB, CAFSD	No known reliance on groundwater	Vernal pools; also found in sandstone rock outcrop pools. The Livermore Valley Groundwater Basin includes 1,337 acres of USFWS designated critical habitat.
Crotch bumble bee *Bombus crotchii*	–/SCE	Likely	Fringe, Uplands	CNDDB	No known reliance on groundwater	Inhabits open grassland and scrub habitats in Coastal California east towards the Sierra-Cascade Crest. Nests are often located underground in abandoned rodent burrows, or above ground in tufts of grass, rock piles, or tree cavities.
Western bumble bee *Bombus occidentalis*	–/SCE	Likely	Fringe, Uplands	CNDDB	No known reliance on groundwater	Uses flowering plants in meadows and forested openings; abandoned rodent burrows are used for nest and hibernation sites for queens.

Common name *Scientific name*	**Status[1]** **Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Amphibian						
California red-legged frog *Rana draytonii*	FT/SSC	Likely (Critical Habitat)	Main, Fringe, Uplands	CNDDB, CAFSD	Direct	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat. Relies on surface water that may be supported by groundwater (Rohde et al. 2019). The Livermore Valley Groundwater Basin includes 7,273 acres of USFWS designated critical habitat.
California tiger salamander *Ambystoma californiense*	FT/ST	Likely (Critical Habitat)	Fringe, Uplands	CNDDB, CAFSD	No known reliance on groundwater	Grassland, oak savannah, or edges of woodland that provide subterranean refuge (typically mammal burrows); breeds in nearby temporary ponds, vernal pools, or slow-moving parts of streams. The Livermore Valley Groundwater Basin includes 0.5 acres of USFWS designated critical habitat.
Foothill yellow-legged frog *Rana boylii*	BLMS/SE	Likely	Main, Uplands	CNDDB	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. The frog is reliant on surface water that may be fed by groundwater.
Western spadefoot *Spea hammondii*	BLMS/SSC	Likely	Fringe, Uplands	CNDDB, CAFSD	No known reliance on groundwater	Areas with sparse vegetation and/or short grasses in sandy or gravelly soils; primarily in washes, river floodplains, alluvial fans, playas, alkali flats, among grasslands, chaparral, or pine-oak woodlands; breeds in ephemeral rain pools with no predators.

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Reptile						
Alameda whipsnake *Masticophis lateralis euryxanthus*	FT/ST	Likely (Critical Habitat)	Uplands	CNDDB	Indirect	Chaparral (northern coastal sage scrub and coastal sage) and rocky outcrops; may venture into adjacent habitats, including grassland, oak savanna, and woodlands. Relies on native vegetation that may be groundwater dependent vegetation (e.g., *Quercas* spp.) (Rohde et al. 2019). The Livermore Valley Groundwater Basin includes 936 acres of USFWS designated critical habitat.
Coast horned lizard *Phrynosoma blainvillii*	BLMS/SSC	Likely	Main, Fringe	CNDDB	No known reliance on groundwater	Open areas with sandy soil and/or patches of loose soil and low/scattered vegetation in scrublands, grasslands, conifer forests, and woodlands; frequently found near ant hills. Feeds on ants and other small invertebrates (e.g., spiders, beetles, and grasshoppers).
Northern California legless lizard *Anniella pulchra*	–/SSC	Possible	Outside of basin	CNDDB	No known reliance on groundwater	Occurs in moist, warm, loose soil with plant cover and in sparsely vegetated areas of chaparral, pine-oak woodlands, desert scrub, and stream terraces with sycamores, cottonwoods, or oaks. Forages in loose soil, sand, and leaf litter for larval insects, beetles, termites, and spiders.
San Joaquin coachwhip *Masticophis flagellum ruddocki*	–/SSC	Likely	Uplands	CNDDB	No known reliance on groundwater	Open, dry, treeless areas, including grassland and saltbush scrub; uses rodent burrows, shaded vegetation, and surface objects as refuge.
Southwestern pond turtle *Actinemys pallida*	BLMS/SSC	Likely	Main, Fringe, Uplands	CNDDB, CAFSD	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Feeds on aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, and occasionally frogs and fish. Relies on surface water that may be supported by groundwater (Rhode et al. 2019).

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Bird						
American peregrine falcon *Falco peregrinus anatum*	–/SFP	Likely	Main, Fringe, Uplands	CNDDB, eBird	No known reliance on groundwater	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water. Prey includes birds (e.g., shorebirds, ducks, grebes, gulls, pigeons, and songbird) and bats.
American White Pelican *Pelecanus erythrorhynchos*	–/SSC	Likely	Main, Fringe, Uplands	CAFSD, eBird	Indirect	Salt ponds, large lakes, and estuaries; loafs on open water during the day; roosts along water's edge at night. Forages for small fish in shallow water on inland marshes.
Bald eagle *Haliaeetus leucocephalus*	BGEPA, BLMS/SE, SFP	Likely	Main, Fringe, Uplands	CNDDB, CAFSD, eBird	Indirect	Large bodies of water or rivers with abundant fish, uses snags or other perches; nests in advanced-successional conifer forest near open water (e.g., lakes, reservoirs, rivers). Bald eagles are reliant on surface water that may be supported by groundwater and/or groundwater-dependent vegetation (Rhode et al. 2019).
Burrowing owl *Athene cunicularia*	BLMS/SSC	Likely	Main, Fringe, Uplands	CNDDB	No known reliance on groundwater	Level, open, dry, heavily grazed or low-stature grassland or desert vegetation with available burrows. Preys on invertebrates and vertebrates.
Golden eagle *Aquila chrysaetos*	BGEPA, BLMS/SFP	Likely	Main, Fringe, Uplands	CNDDB, eBird	No known reliance on groundwater	Open woodlands and oak savannahs, grasslands, chaparral, sagebrush flats; nests on steep cliffs or medium to tall trees. Primary prey are small to medium mammals and birds; also scavenges and catches fish.
Grasshopper sparrow *Ammodramus savannarum*	–/SSC	Likely	Main, Uplands	CNDDB	No known reliance on groundwater	Grasslands. Ground forager that feeds on insects, including grasshoppers.

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Loggerhead shrike *Lanius ludovicianus*	–/SSC	Likely	Main, Fringe, Uplands	CNDDB, eBird	No known reliance on groundwater	Open shrubland or woodlands with short vegetation and and/or bare ground for hunting; some tall shrubs, trees, fences, or power lines for perching; typically nests in isolated trees or large shrubs. Feeds on insects, amphibians, reptiles, small mammals, and birds.
Redhead *Aythya americana*	–/SSC	Likely	Main, Fringe, Uplands	CAFSD, eBird	Indirect	Freshwater emergent wetlands with dense stands of cattails (*Typha* spp.) and bulrush (*Schoenoplectus* spp.) interspersed with areas of deep, open water; forages and rests on large, deep bodies of water. Summer resident in southern California.
Swainson's hawk *Buteo swainsoni*	–/ST	Likely	Main, Fringe, Uplands	CNDDB, eBird	Indirect	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain fields. Swainson's hawks rely on groundwater-dependent vegetation in riparian woodland areas for nesting (Rohde et al 2019). Preys on mammals and insects.
Tricolored blackbird *Agelaius tricolor*	–/ST	Likely	Main, Fringe, Uplands	CNDDB, CAFSD, eBird	Indirect	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water with dense, tall emergent vegetation, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey.
White-tailed kite *Elanus leucurus*	BLMS/SFP	Likely	Main, Fringe, Uplands	CNDDB, eBird	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. Predominately preys on small mammals, but its diet also includes birds and lizards.

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Willow Flycatcher *Empidonax traillii*	–/SE	Likely	Main, Uplands	CAFSD, eBird	Indirect	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water. Reliant on groundwater-dependent riparian vegetation, including for nest sites that are typically located near slow-moving streams, or side channels and marshes with standing water and/or wet soils (Rohde et al 2019). Feeds on insects, fruits, and berries.
Mammals						
American badger *Taxidea taxus*	–/SSC	Likely	Fringe, Uplands	CNDDB	No known reliance on groundwater	Shrubland, open grasslands, fields, and alpine meadows with friable soils.
Pallid bat *Antrozous pallidus*	BLMS/SSC	Likely	Fringe, Main, Uplands	CNDDB	No known reliance on groundwater	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. Habitat and prey (e.g., insects and arachnids) not associated with aquatic ecosystems.
San Joaquin kit fox *Vulpes macrotis mutica*	FE, BLMS/ST	Likely	Outside of Basin	CNDDB	No known reliance on groundwater	Annual grasslands or open areas dominated by scattered brush, shrubs, and scrub.
San Joaquin pocket mouse *Perognathus inornatus*	BLMS/–	Possible	Outside of Basin	CNDDB	Indirect	Open grasslands, savanna, and desert shrub communities; often in areas with sandy washes and finely textured soils. Birthing dens are in burrows near the base of shrubs. Predominantly granivorous, eating seeds of annual and perennial grasses, shrubs, and forbs. Also feeds on soft-bodied insects, cutworms, earthworms, and even grasshoppers.

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in the Livermore Valley Groundwater Basin[2]**	**Documented occurrence location**	**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in Livermore Valley Groundwater Basin Groundwater Basin**
Townsend's big-eared bat *Corynorhinus townsendii*	BLMS/SSC	Likely	Main, Uplands	CNDDB	Indirect	Most abundant in mesic habitats, also found in oak woodlands, desert, vegetated drainages, caves or cave-like structures (including basal hollows in large trees, mines, tunnels, and buildings) and riparian communities. Feeds on moths, beetles, and soft-bodied insects and drinks water.
Yuma myotis *Myotis yumanensis*	BLMS/–	Likely	Main, Uplands	CNDDB	Indirect	Uses a variety of habitats, including riparian, agriculture, shrub, urban, desert, open forests, and woodlands. Distribution is strongly associated with water; drinks water and forages near or over waterbodies.

[1] **Status codes:**

Federal
- FE = Listed as endangered under the federal Endangered Species Act
- FT = Listed as threatened under the federal Endangered Species Act
- FPE = Federally proposed as endangered
- BGEPA = Federally protected under the Bald and Golden Eagle Protection Act
- BLMS = Bureau of Land Management Sensitive Species

State
- SE = Listed as Endangered under the California Endangered Species Act
- ST = Listed as Threatened under the California Endangered Species Act
- SCE = State Candidate Endangered
- SSC = CDFW Species of Special Concern
- SFP = CDFW Fully Protected species

[2] **Potential to Occur:**

Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity

[3] **Query source:**

CAFSD: California Freshwater Species Database (TNC 2021)
CNDDB: California Natural Diversity Database (CDFW 2020a)
eBird: (eBird 2021)

[4] **Groundwater Dependent Ecosystem (GDE) association:**

Direct: Species directly dependent on groundwater for some or all water needs
Indirect: species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds).
No known reliance on groundwater: Species is not known to rely on groundwater. For species associated with vernal pools, it is assumed that the seasonal water in the vernal pools originates from rainfall rather than groundwater.

4 SUMMARY

In the Livermore Valley Groundwater Basin, likely GDEs occur in all three management areas. Likely GDEs in the Main Basin Management Area typically occur along riparian zones along major channels (e.g., Arroyo Valle, Arroyo Mocho, and Arroyo Las Positas). Likely GDEs in the Fringe Management Area include riparian vegetation (willows and cottonwoods) and alkaline-tolerant plants that occur along spring-fed channels and wetlands in Springtown Alkali Sink in the northeast corner of the basin. Likely GDEs in the Upland Management Area occur in riparian zones along smaller tributaries.

Twelve special status plants identified in the basin are likely dependent on groundwater. Groundwater dependent special-status plant species occur primarily in the Fringe and Upland Management Areas. There are 14 groundwater dependent special-status wildlife species likely to occur in the basin. Groundwater dependent special-status wildlife are likely to occur in all three management areas.

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Attachment C: Surface Water Bodies and Monitoring Sites

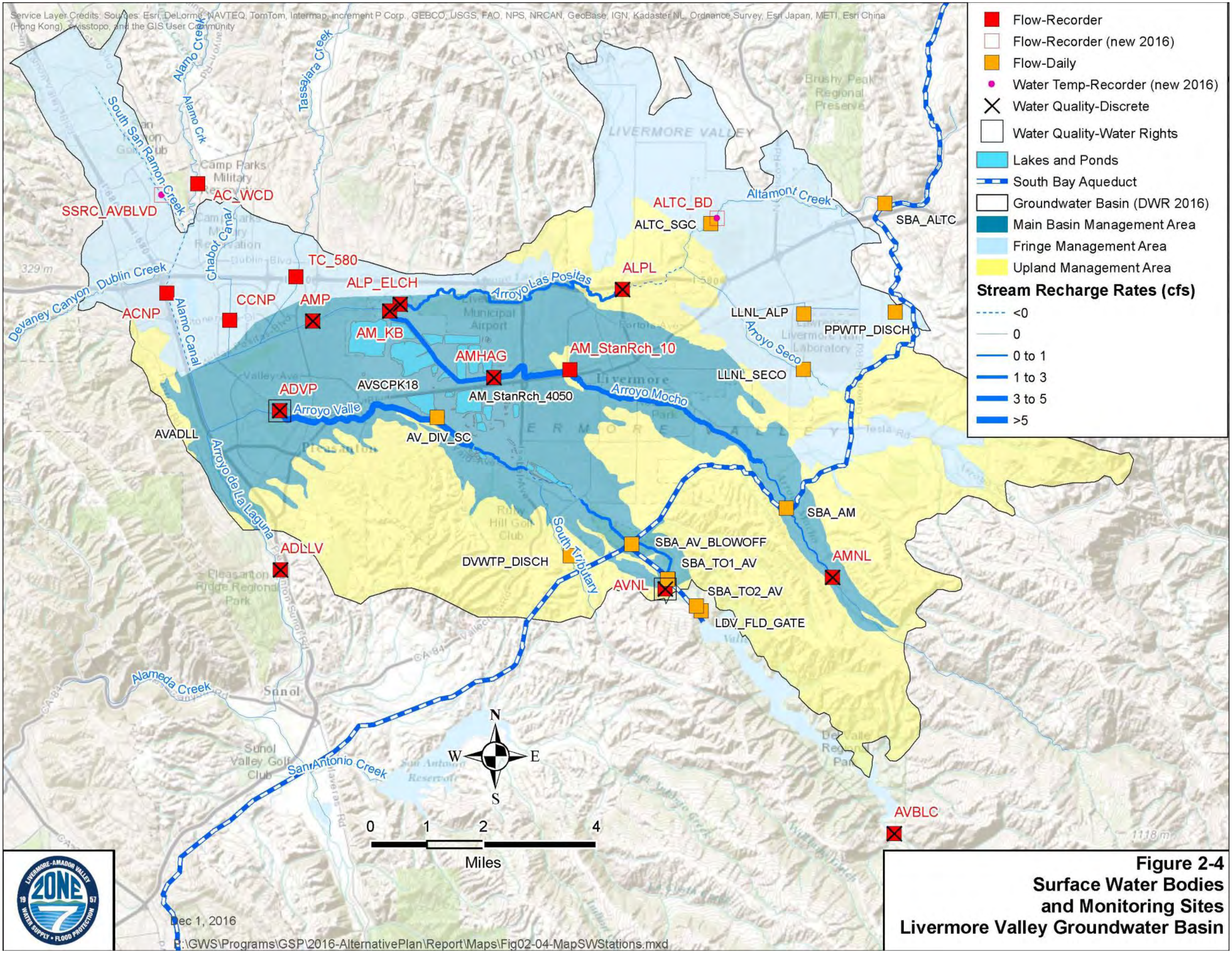
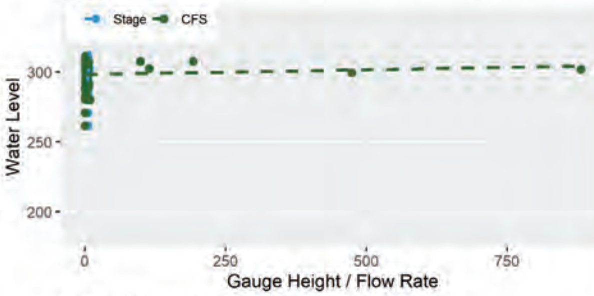


Figure 2-4
Surface Water Bodies and Monitoring Sites
Livermore Valley Groundwater Basin

Attachment D: Time Series Data and Correlation Plots by Stream Station

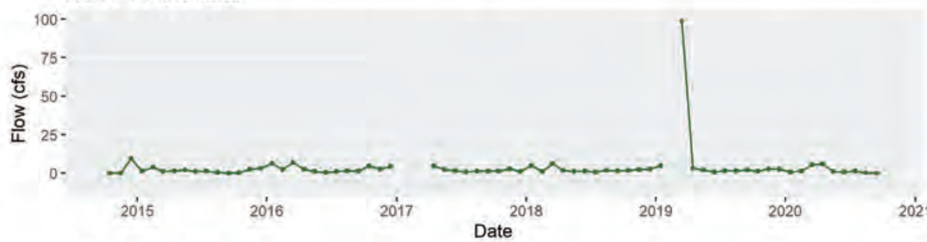
Linear Correlation

Linear Correlation Coefficient (Gauge Height) = 0.327 , p-value = 0.00618
Linear Correlation Coefficient (Flow Rate) = 0.0828 , p-value = 0.499



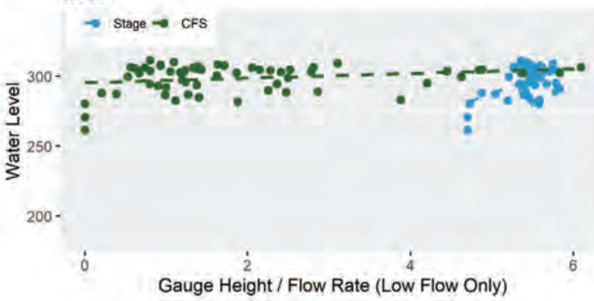
ADVP : Gauge Height

ADVP : Flow Rate

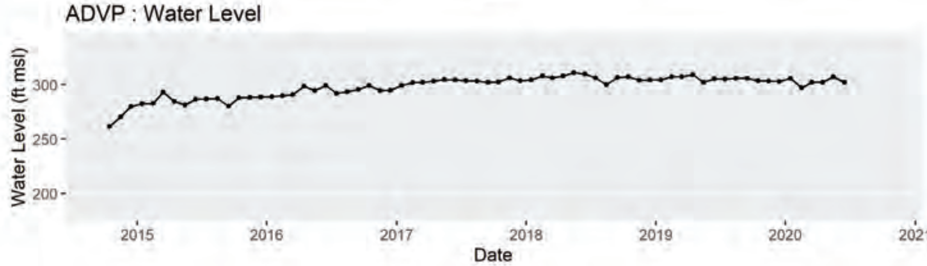


Linear Correlation: Low Flow

Linear Correlation Coefficient (Gauge Height) = 0.51 , p-value = 2.72e-05
Linear Correlation Coefficient (Flow Rate) = 0.243 , p-value = 0.0594

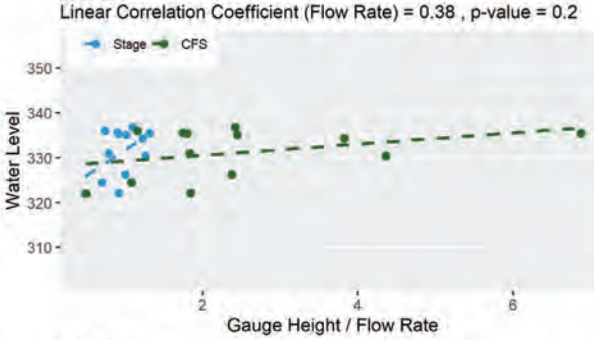


ADVP : Water Level



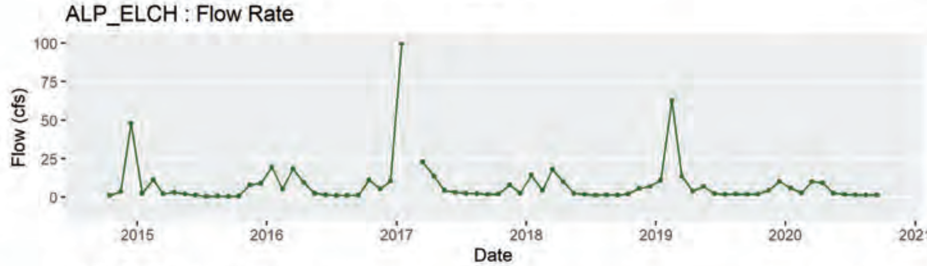
Linear Correlation

Linear Correlation Coefficient (Gauge Height) = 0.496 , p-value = 0.0846
Linear Correlation Coefficient (Flow Rate) = 0.38 , p-value = 0.2



ALP_ELCH : Gauge Height

ALP_ELCH : Flow Rate



Linear Correlation: Low Flow

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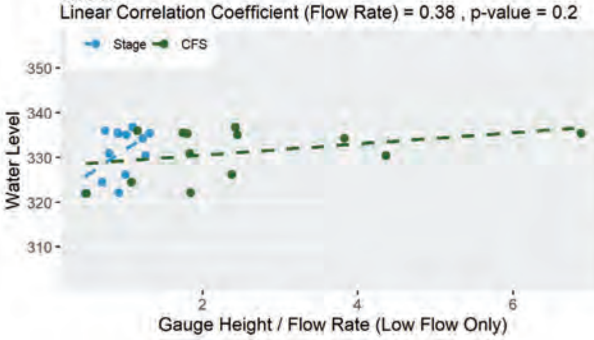
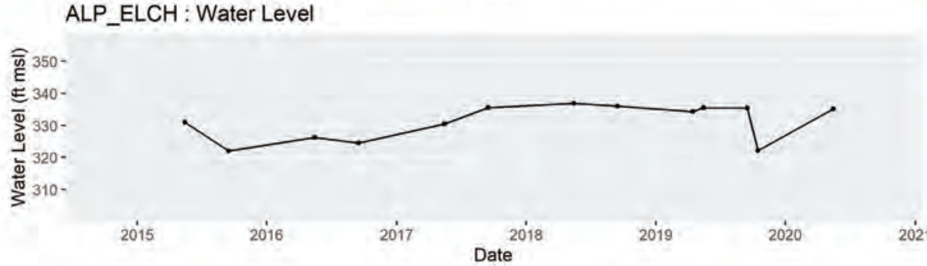
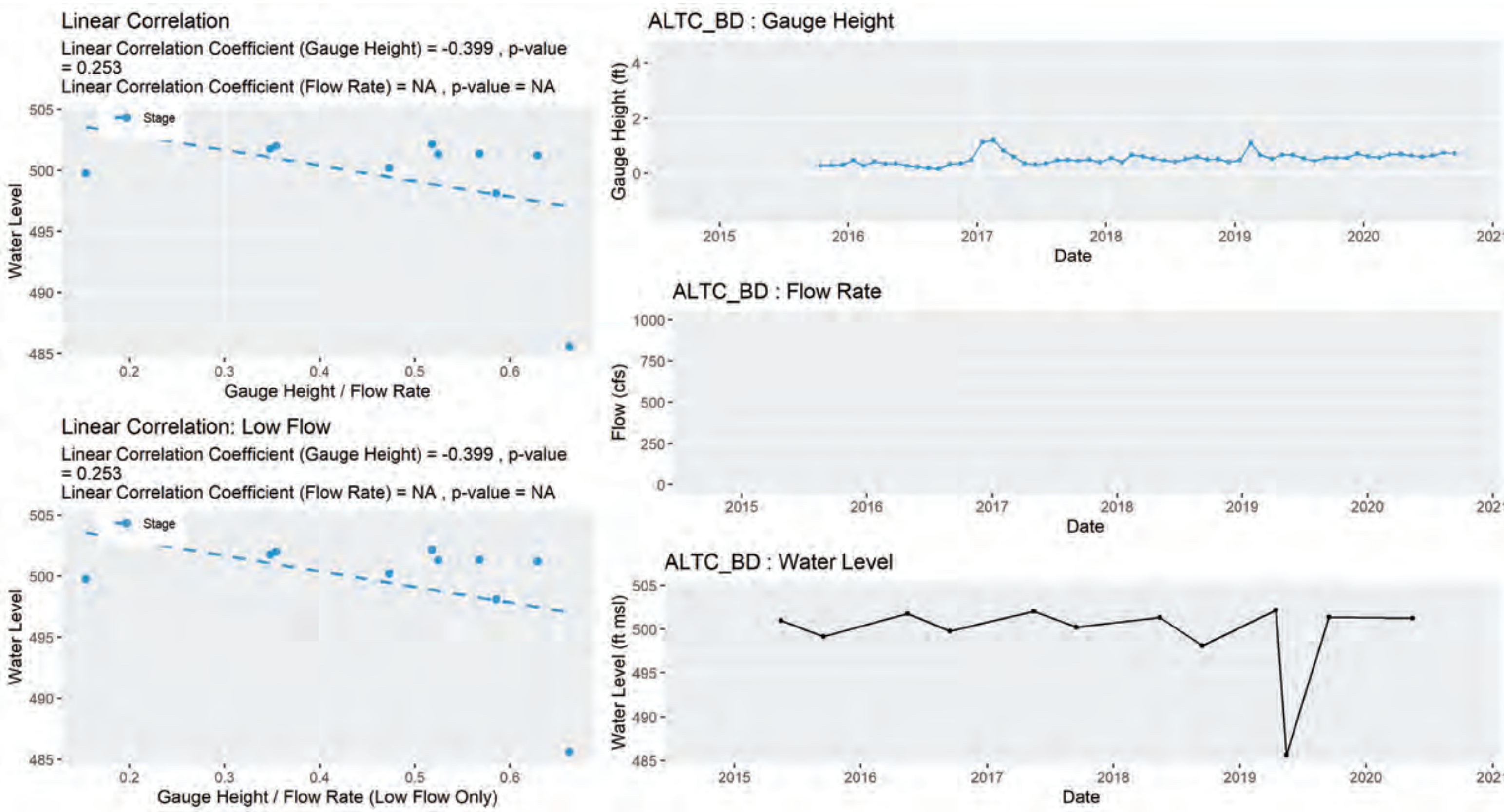
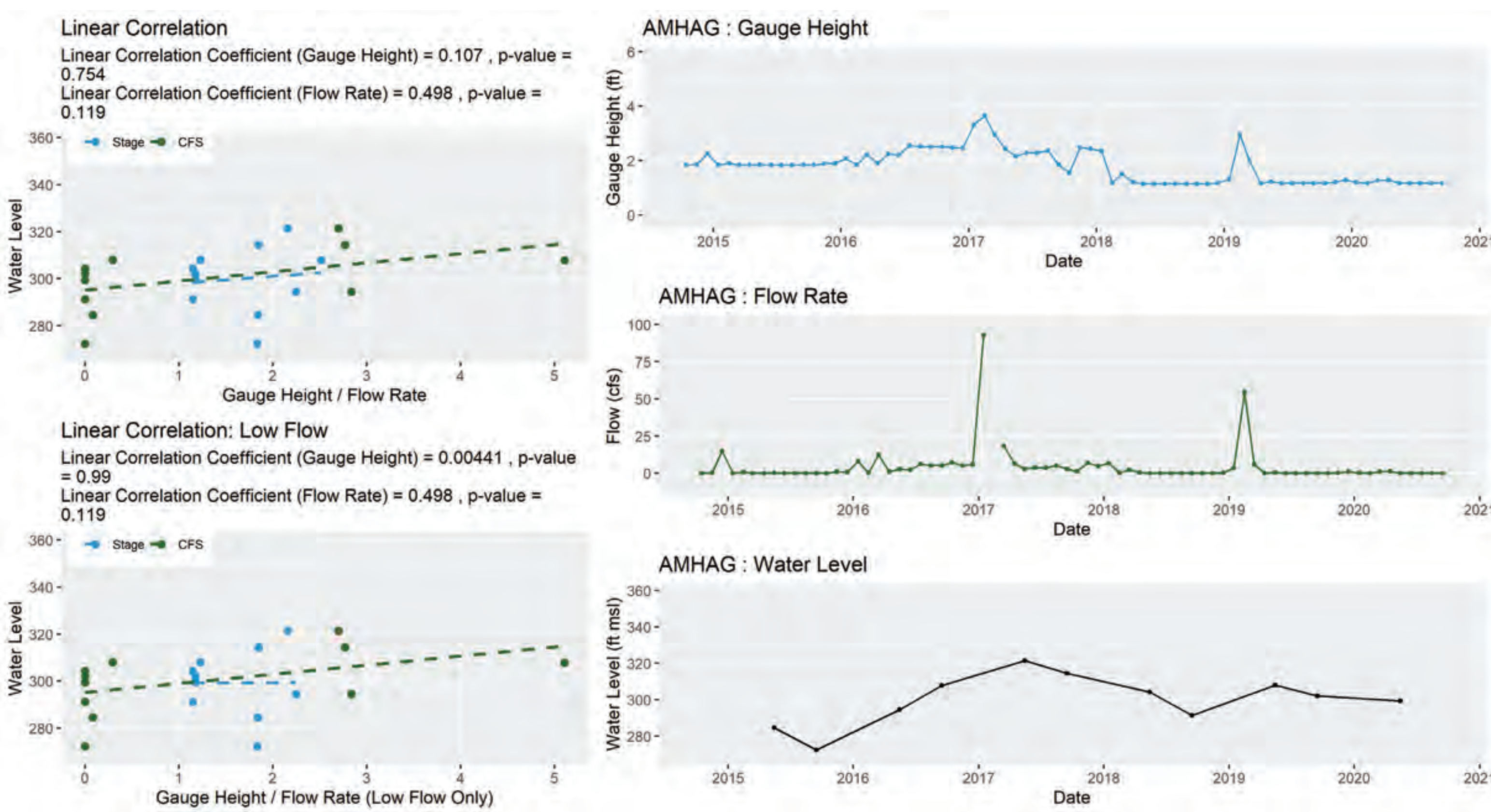
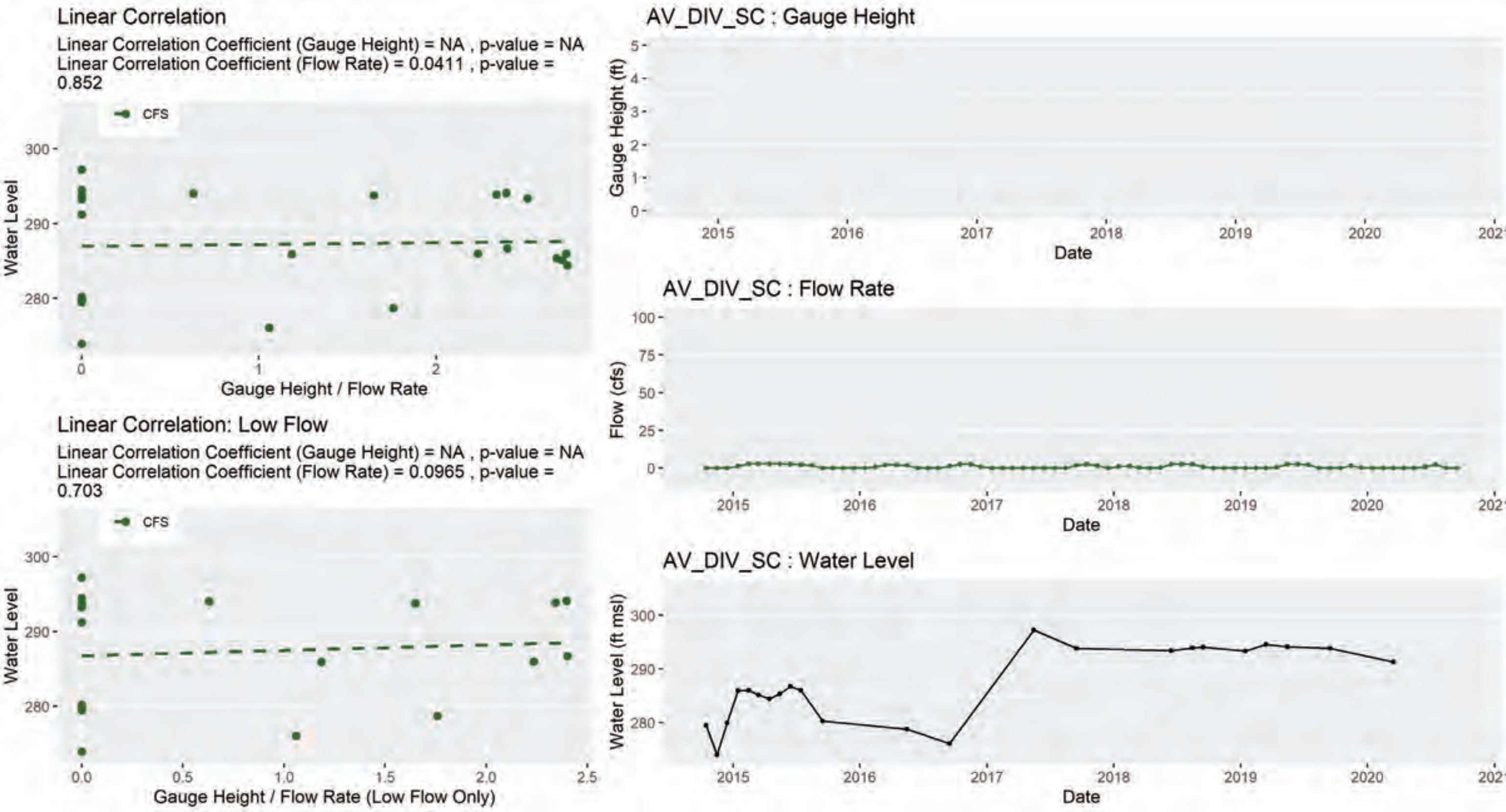


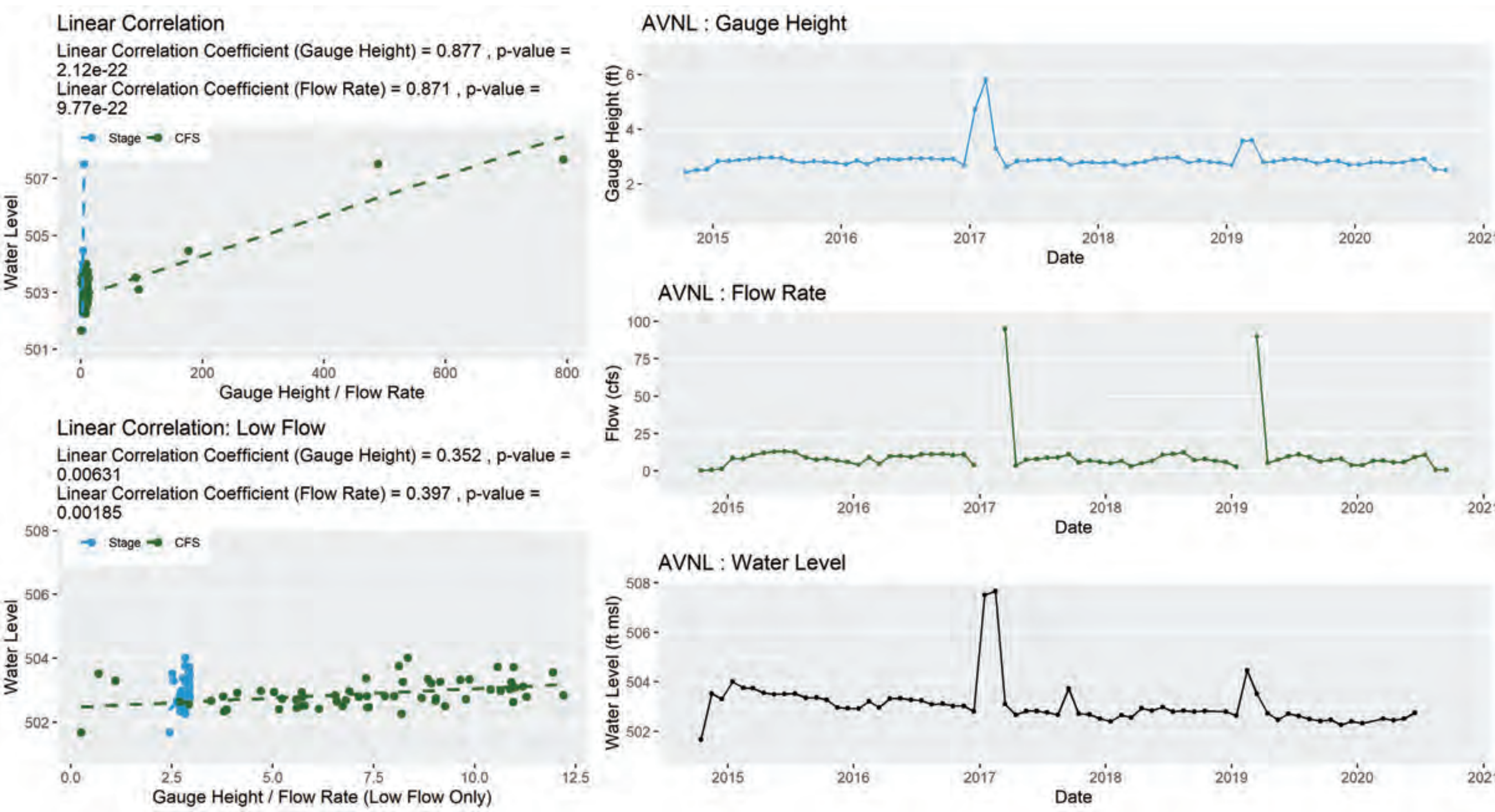
ALP_ELCH : Water Level

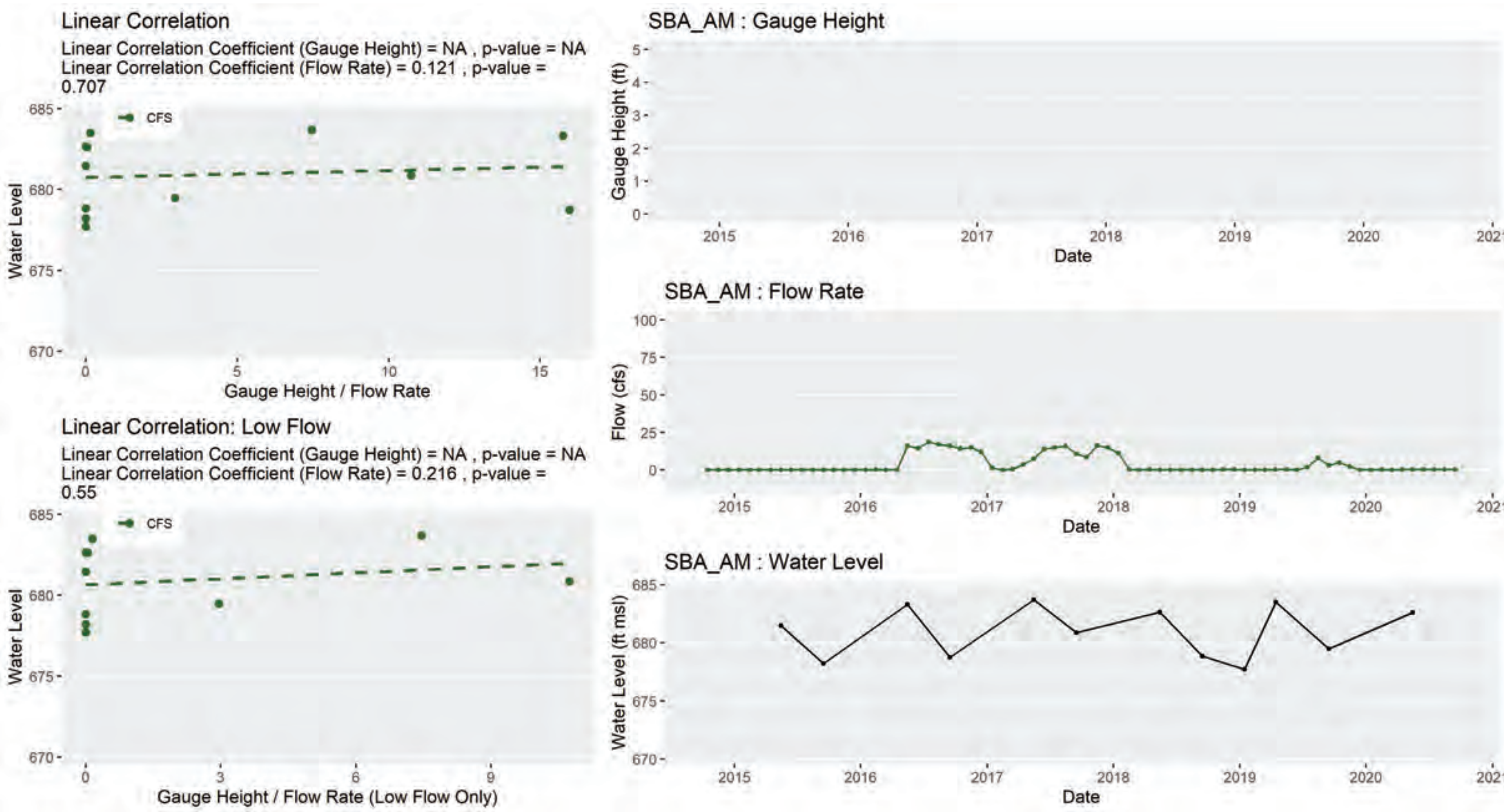


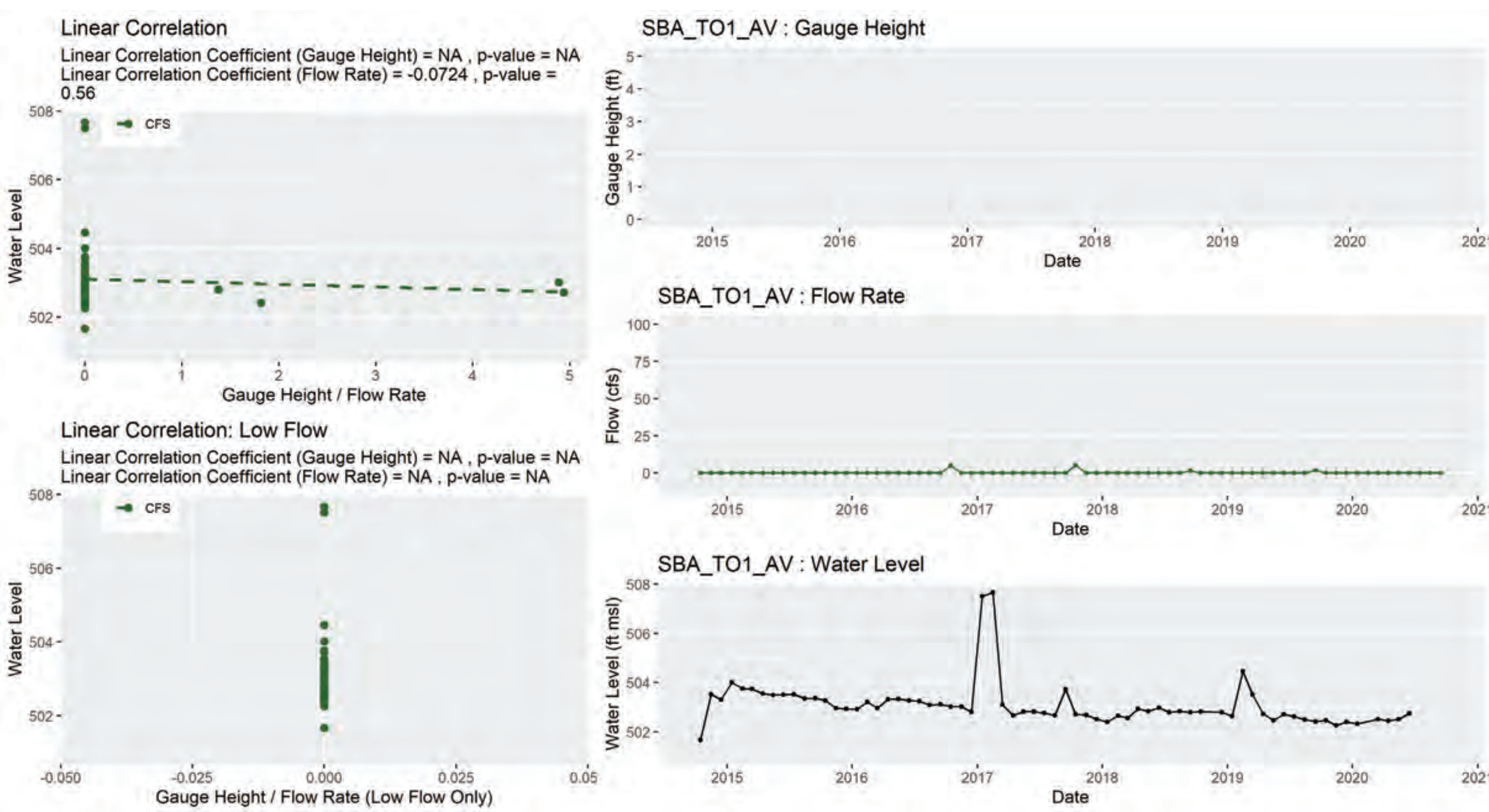

Linear Correlation
Linear Correlation Coefficient (Gauge Height) = -0.399 , p-value = 0.253
Linear Correlation Coefficient (Flow Rate) = NA , p-value = NA
Stage
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = -0.399 , p-value = 0.253
Linear Correlation Coefficient (Flow Rate) = NA , p-value = NA
Stage
Water Level
Gauge Height / Flow Rate (Low Flow Only)
ALTC_BD : Gauge Height
Gauge Height (ft)
Date
ALTC_BD : Flow Rate
Flow (cfs)
Date
ALTC_BD : Water Level
Water Level (ft msl)
Date


Linear Correlation
Linear Correlation Coefficient (Gauge Height) = 0.107 , p-value = 0.754
Linear Correlation Coefficient (Flow Rate) = 0.498 , p-value = 0.119
Stage
CFS
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = 0.00441 , p-value = 0.99
Linear Correlation Coefficient (Flow Rate) = 0.498 , p-value = 0.119
Stage
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)
AMHAG : Gauge Height
Gauge Height (ft)
Date
AMHAG : Flow Rate
Flow (cfs)
Date
AMHAG : Water Level
Water Level (ft msl)
Date


Linear Correlation
Linear Correlation Coefficient (Gauge Height) = NA , p-value = NA
Linear Correlation Coefficient (Flow Rate) = 0.0411 , p-value = 0.852
CFS
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = NA , p-value = NA
Linear Correlation Coefficient (Flow Rate) = 0.0965 , p-value = 0.703
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)
AV_DIV_SC : Gauge Height
Gauge Height (ft)
Date
AV_DIV_SC : Flow Rate
Flow (cfs)
Date
AV_DIV_SC : Water Level
Water Level (ft msl)
Date


Linear Correlation
Linear Correlation Coefficient (Gauge Height) = 0.877 , p-value = 2.12e-22
Linear Correlation Coefficient (Flow Rate) = 0.871 , p-value = 9.77e-22
Stage
CFS
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = 0.352 , p-value = 0.00631
Linear Correlation Coefficient (Flow Rate) = 0.397 , p-value = 0.00185
Stage
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)
AVNL : Gauge Height
Gauge Height (ft)
Date
AVNL : Flow Rate
Flow (cfs)
Date
AVNL : Water Level
Water Level (ft msl)
Date


Linear Correlation
Linear Correlation Coefficient (Gauge Height) = NA , p-value = NA
Linear Correlation Coefficient (Flow Rate) = 0.121 , p-value = 0.707
CFS
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = NA , p-value = NA
Linear Correlation Coefficient (Flow Rate) = 0.216 , p-value = 0.55
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)
SBA_AM : Gauge Height
Gauge Height (ft)
Date
SBA_AM : Flow Rate
Flow (cfs)
Date
SBA_AM : Water Level
Water Level (ft msl)
Date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CFS
Water Level
Gauge Height / Flow Rate
Linear Correlation: Low Flow
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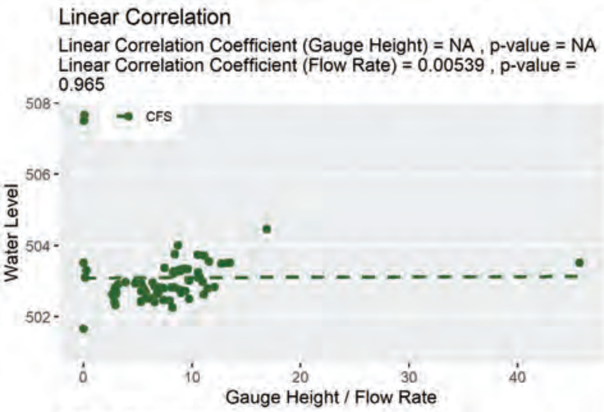
Linear Correlation Coefficient (Flow Rate) = NA , p-value = NA
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)
SBA_TO1_AV : Gauge Height
Gauge Height (ft)
Date
SBA_TO1_AV : Flow Rate
Flow (cfs)
Date
SBA_TO1_AV : Water Level
Water Level (ft msl)
Date



Linear Correlation
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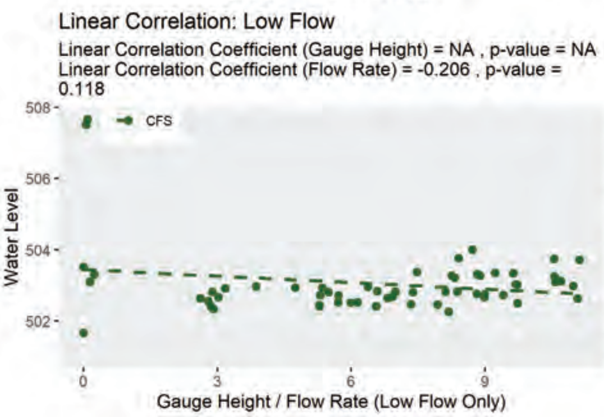
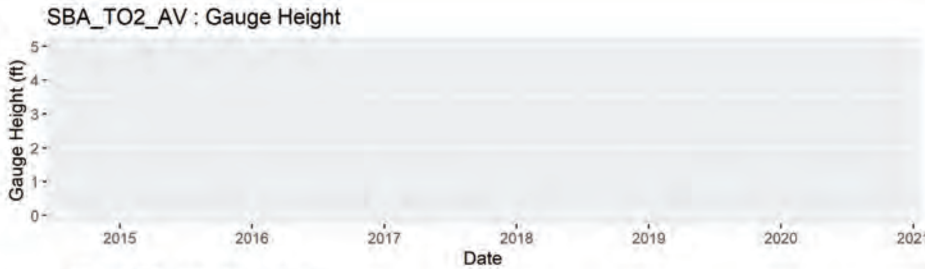
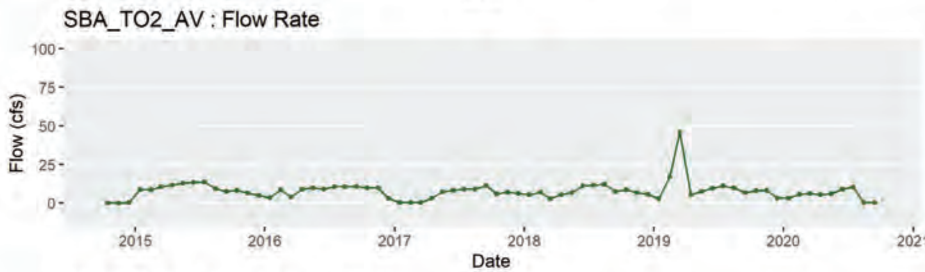
Linear Correlation Coefficient (Flow Rate) = 0.00539 , p-value = 0.965
CFS
Water Level
Gauge Height / Flow Rate



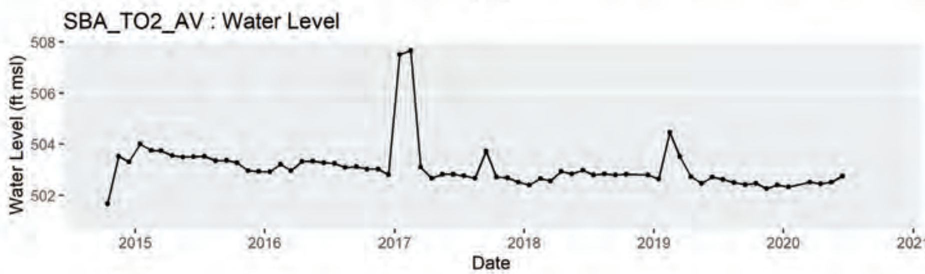
Linear Correlation: Low Flow
Linear Correlation Coefficient (Gauge Height) = NA , p-value = NA
Linear Correlation Coefficient (Flow Rate) = -0.206 , p-value = 0.118
CFS
Water Level
Gauge Height / Flow Rate (Low Flow Only)



SBA_TO2_AV : Gauge Height
Gauge Height (ft)
Date



SBA_TO2_AV : Flow Rate
Flow (cfs)
Date



SBA_TO2_AV : Water Level
Water Level (ft msl)
Date

Attachment E: Change in GDE Area Analysis

Change in GDE Area Analysis

Normalized Derived Vegetation Index (NDVI) is the most widely used vegetation metric in the literature and is a reliable measure of the photosynthetic chlorophyll content in leaves and vegetation cover.[1] The Nature Conservancy (TNC) Groundwater Dependent Ecosystem (GDE) Pulse calculated annual NDVI from surface reflectance corrected multispectral Landsat imagery, and applied a linear fit to the NDVI time series data to estimate the NDVI trends over specific timespan of interest. The NDVI trends can be viewed on the TNC GDE Pulse website (https://gde.codefornature.org/#/map).

Since NDVI is used to estimate vegetation greenness and provides a proxy for vegetation growth, change in GDE area can be estimated using TNC GDE Pulse raster data that shows the NDVI trends between 2014 and 2018.[2,3] Moderate to large increases in NDVI trends represent an increase in the GDE area and moderate to large decreases in NDVI trends represent a decrease in the GDE area. Therefore, the change in GDE area can be estimated by subtracting GDE area with decreasing NDVI trends from GDE area with increasing NDVI trends.

This analysis was performed in ArcGIS.[4] The statewide raster data that show NDVI trends between 2014 and 2018 were clipped using the likely GDEs' polygon within the Livermore Valley Groundwater Basin (Basin). Raster values of zero mean no change in NDVI trends. Positive and negative raster values mean increasing and decreasing NDVI trends respectively. For the purpose of this analysis, raster values that range from -628 to 628 were assumed to represent little or no change in NDVI trends.[5] For each likely GDE area within the Basin, the total number of raster pixels that fall within the GDE polygon boundary, the number of pixels that show increasing NDVI trends, and the number of pixels that show decreasing NDVI trends were summarized, as shown in **Table 1**. Change in area for each likely GDE was then calculated by dividing the difference between the increasing and decreasing NDVI trends' pixel counts by the total pixel count.

Percentages of GDE area reduction in 2014 compared to 2018 by likely GDEs are shown in **Table 1**. Figures included below show the raster data of NDVI trends by likely GDEs within the Basin. Compared to the 2018 GDE area, reductions in GDE area that range from -14% to 63% were observed, with an area weighted average of 40% (i.e., on average the GDE area in 2014 was 40% less than the GDE area in 2018).

---

[1] https://gde.codefornature.org/#/methodology

[2] Statewide raster data that show NDVI trends are provided by TNC on 30 August 2021.

[3] Since the Plan is not required to address undesirable results that occurred before, and have not been corrected by January 1, 2015 (Water Code Section 10727.2 (b)(4)), 2014 is selected as the start of the analysis timeframe. 2018 is selected as the end of the analysis timeframe since it is a recent wet year when GDE conditions might be above average.

[4] https://www.esri.com/en-us/arcgis/about-arcgis/overview

[5] The range of -628 to 628 is approximately two percent of the raster values' total range. It was selected by visually comparing raster pixels that fall within this range with the "little or no change" NDVI trend category from the TNC GDE Pulse website. Therefore, raster values larger than 628 represent moderate or large increase in NDVI trends, and raster values smaller than -628 represent moderate or large decreasing in NDVI trends.

Table 1. Change in GDE Area (2014-2018)

Likely GDEs	Total Pixel Count	Pixel Count of Increasing NDVI Trends	Pixel Count of Decreasing NDVI Trends	GDE Area Reduction in 2014 (a)
Arroyo Mocho - Riparian Mixed Hardwood & Sycamore	529	349	33	60%
Arroyo Mocho - Valley Oak	999	185	290	-11%
Arroyo Valle - Riparian Mixed Hardwood	769	527	46	63%
Arroyo Valle - Sycamore Grove	1954	1134	94	53%
Springtown Alkali Sink	971	633	42	61%
Upland - Riparian Mixed Hardwood	210	41	71	-14%
Arroyo Las Positas - Mixed Vegetation	303	88	86	1%
Potential GDEs to be Further Evaluated	203	127	20	53%
Area Weighted Average (%)				**40%**

Abbreviations:

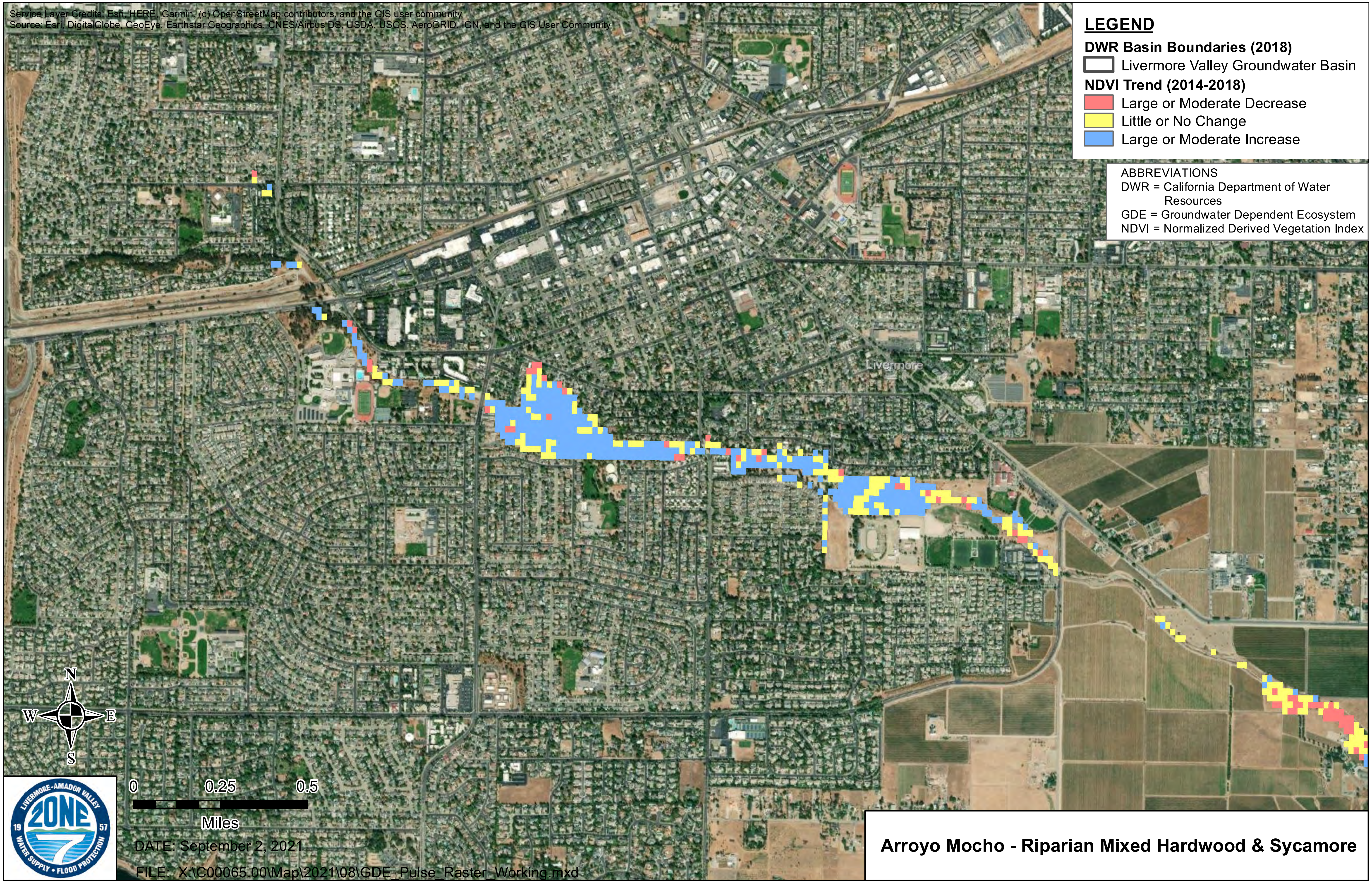
GDE = Groundwater Dependent Ecosystem

NDVI = Normalized Derived Vegetation Index

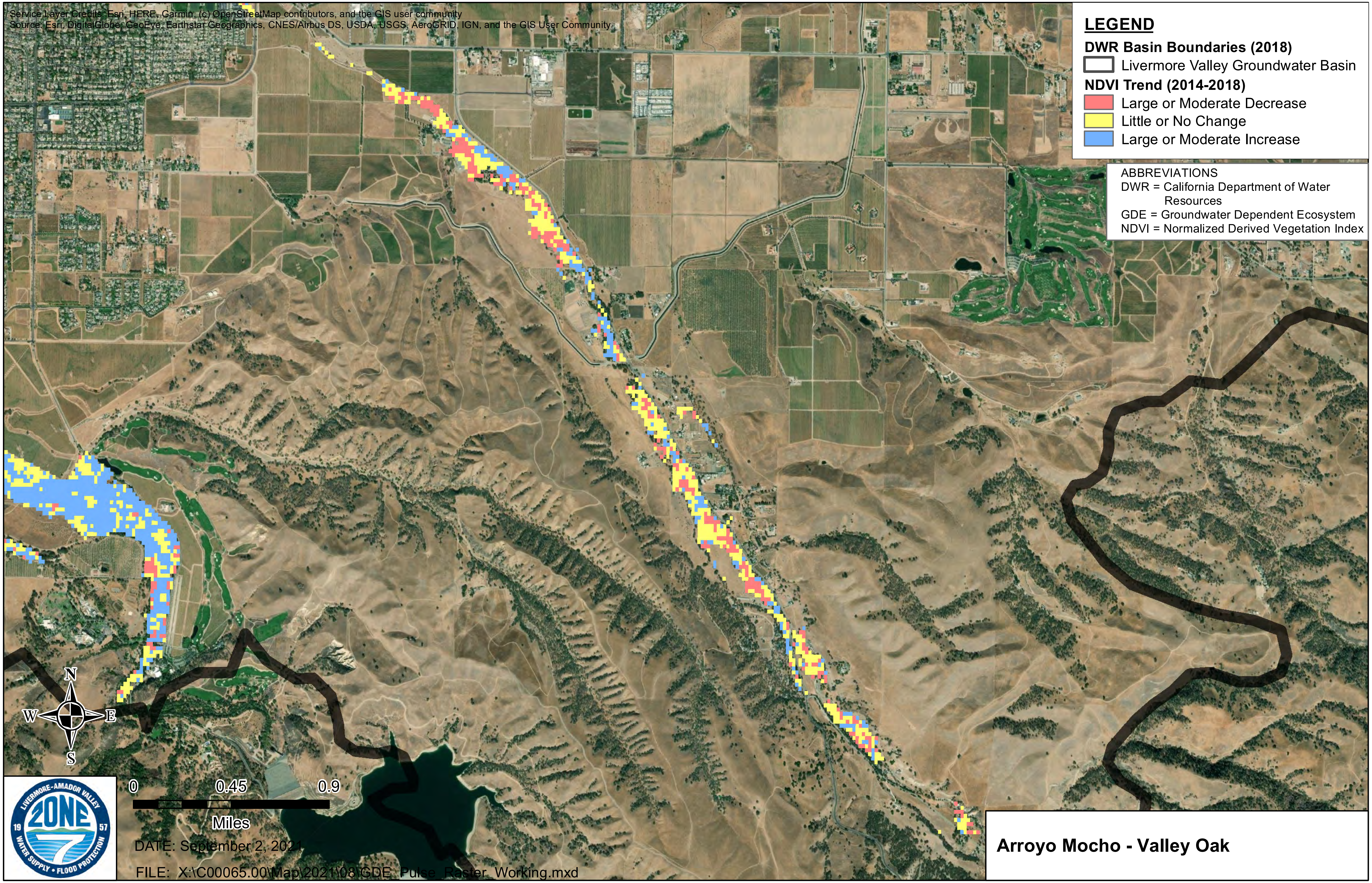
TNC = The Nature Conservancy

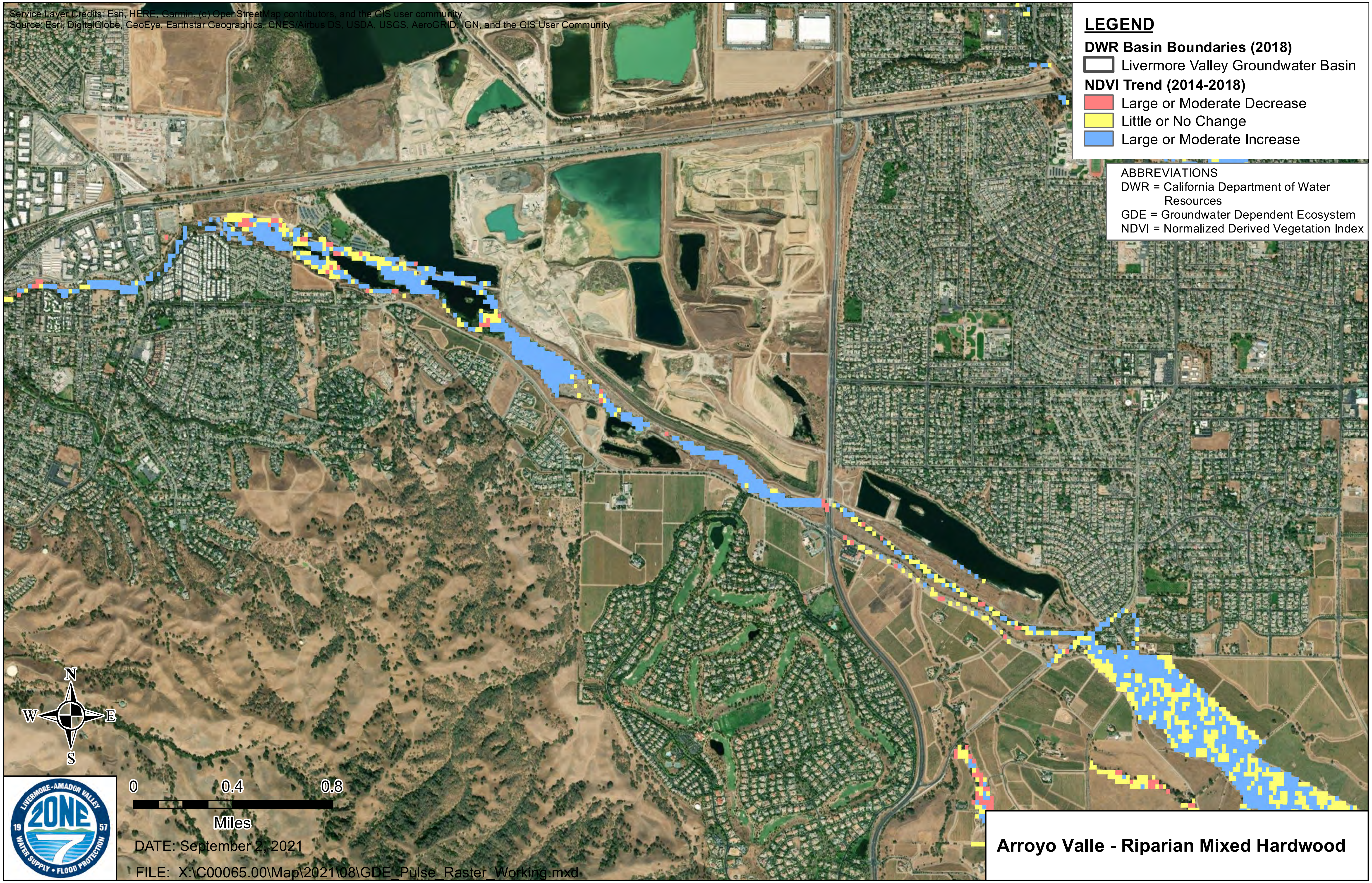
Notes:

(a) Positive percentages represent net reduction in GDE area and negative percentages represent net increase in GDE area in 2014 relative to 2018.



Arroyo Mocho - Riparian Mixed Hardwood & Sycamore


Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
DWR Basin Boundaries (2018)
Livermore Valley Groundwater Basin
NDVI Trend (2014-2018)
Large or Moderate Decrease
Little or No Change
Large or Moderate Increase
ABBREVIATIONS
DWR = California Department of Water Resources
GDE = Groundwater Dependent Ecosystem
NDVI = Normalized Derived Vegetation Index
N
W
E
S
0
0.45
0.9
Miles
DATE: September 2, 2021
FILE: X:\C00065.00\Map\2021\08\GDE_Pulse_Raster_Working.mxd
Arroyo Mocho - Valley Oak


Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
DWR Basin Boundaries (2018)
Livermore Valley Groundwater Basin
NDVI Trend (2014-2018)
Large or Moderate Decrease
Little or No Change
Large or Moderate Increase
ABBREVIATIONS
DWR = California Department of Water Resources
GDE = Groundwater Dependent Ecosystem
NDVI = Normalized Derived Vegetation Index
N
W
E
S
0
0.4
0.8
Miles
LIVERMORE-AMADOR VALLEY
ZONE 7
19 57
WATER SUPPLY • FLOOD PROTECTION
DATE: September 2, 2021
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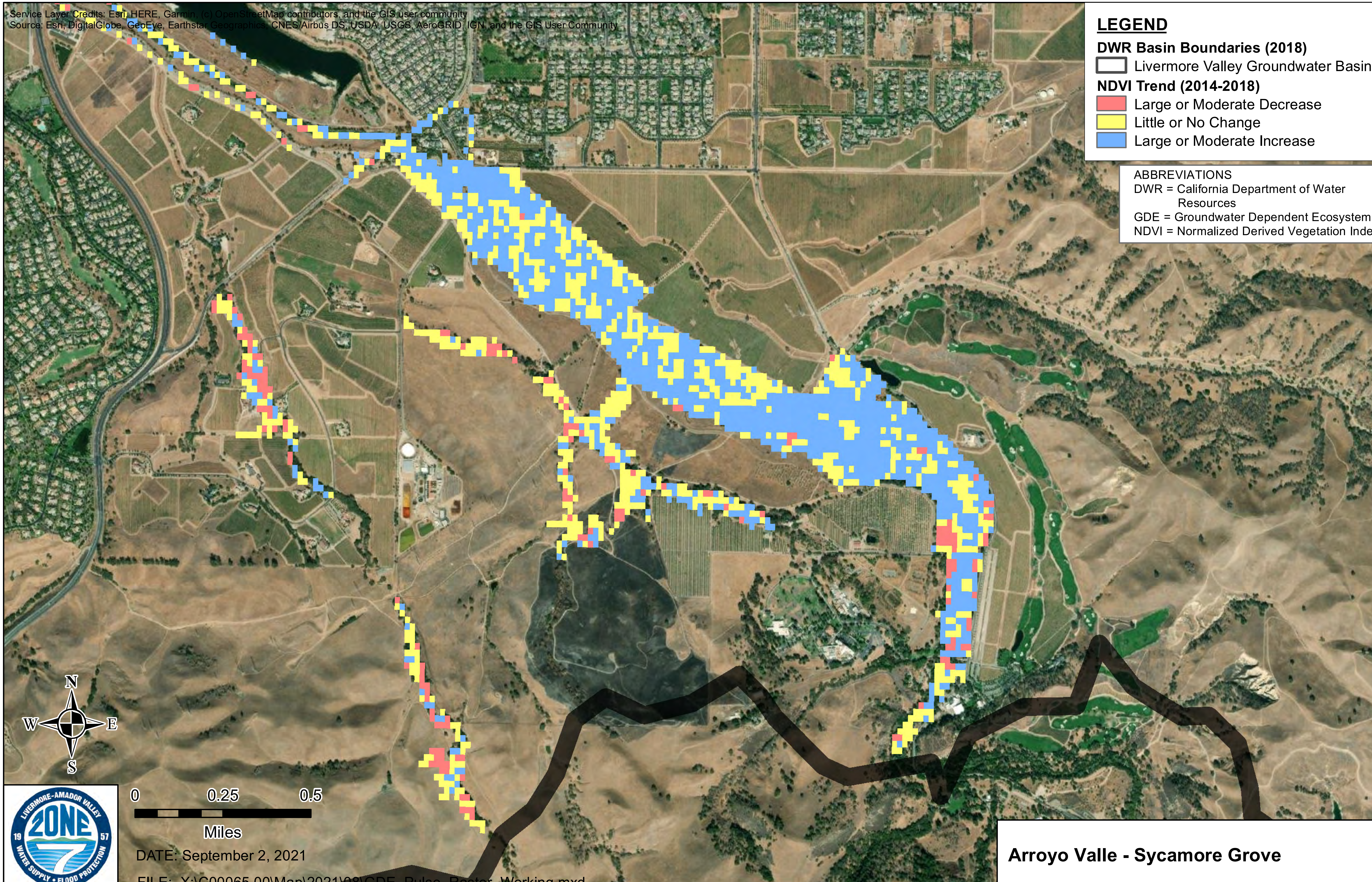
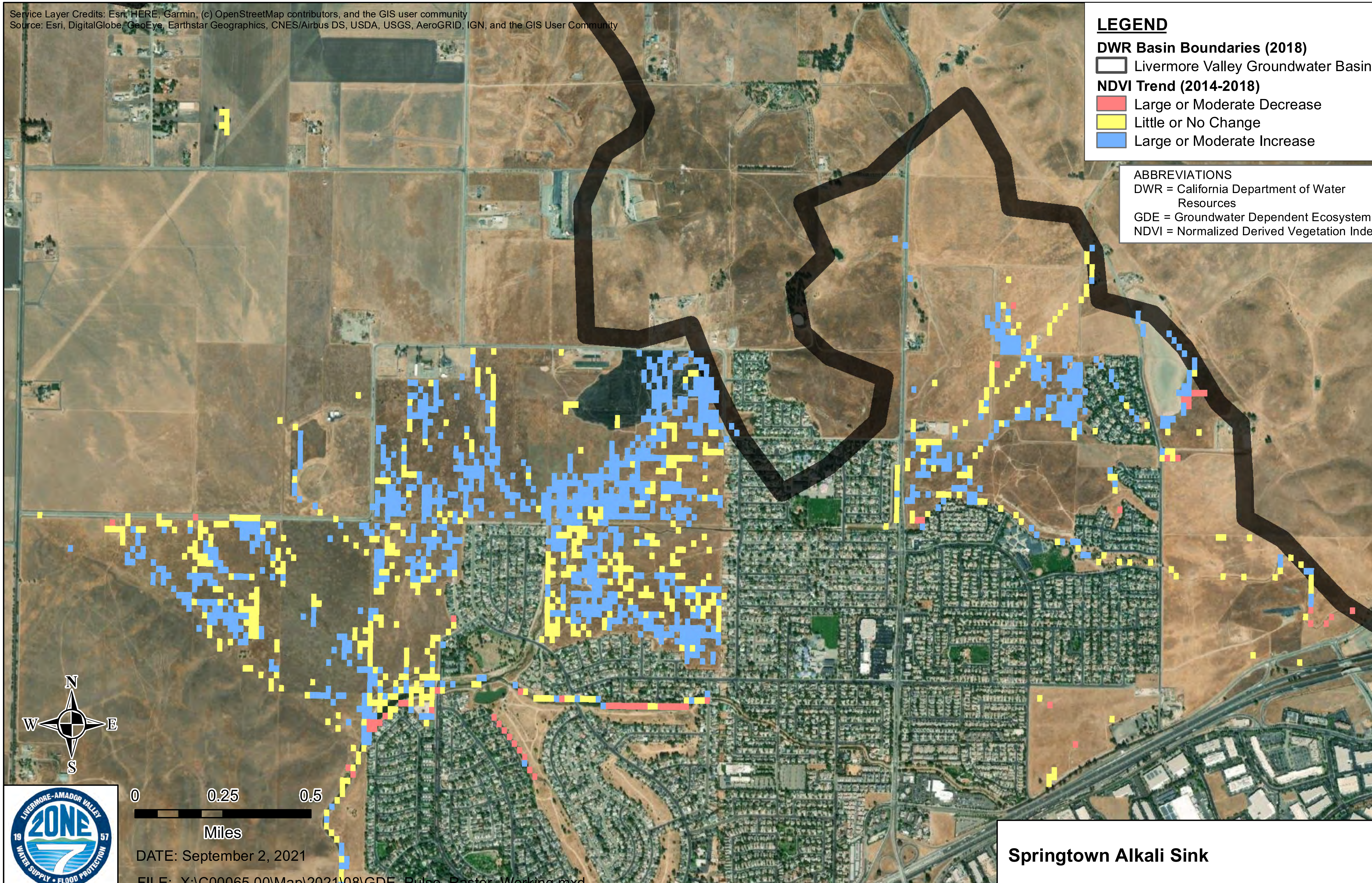
Arroyo Valle - Riparian Mixed Hardwood



Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
DWR Basin Boundaries (2018)
Livermore Valley Groundwater Basin
NDVI Trend (2014-2018)
Large or Moderate Decrease
Little or No Change
Large or Moderate Increase
ABBREVIATIONS
DWR = California Department of Water Resources
GDE = Groundwater Dependent Ecosystem
NDVI = Normalized Derived Vegetation Index
N
W
E
S
0
0.25
0.5
Miles
DATE: September 2, 2021
FILE: X:\C00065.00\Map\2021\08\GDE_Pulse_Raster_Working.mxd
Arroyo Valle - Sycamore Grove


Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
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ABBREVIATIONS
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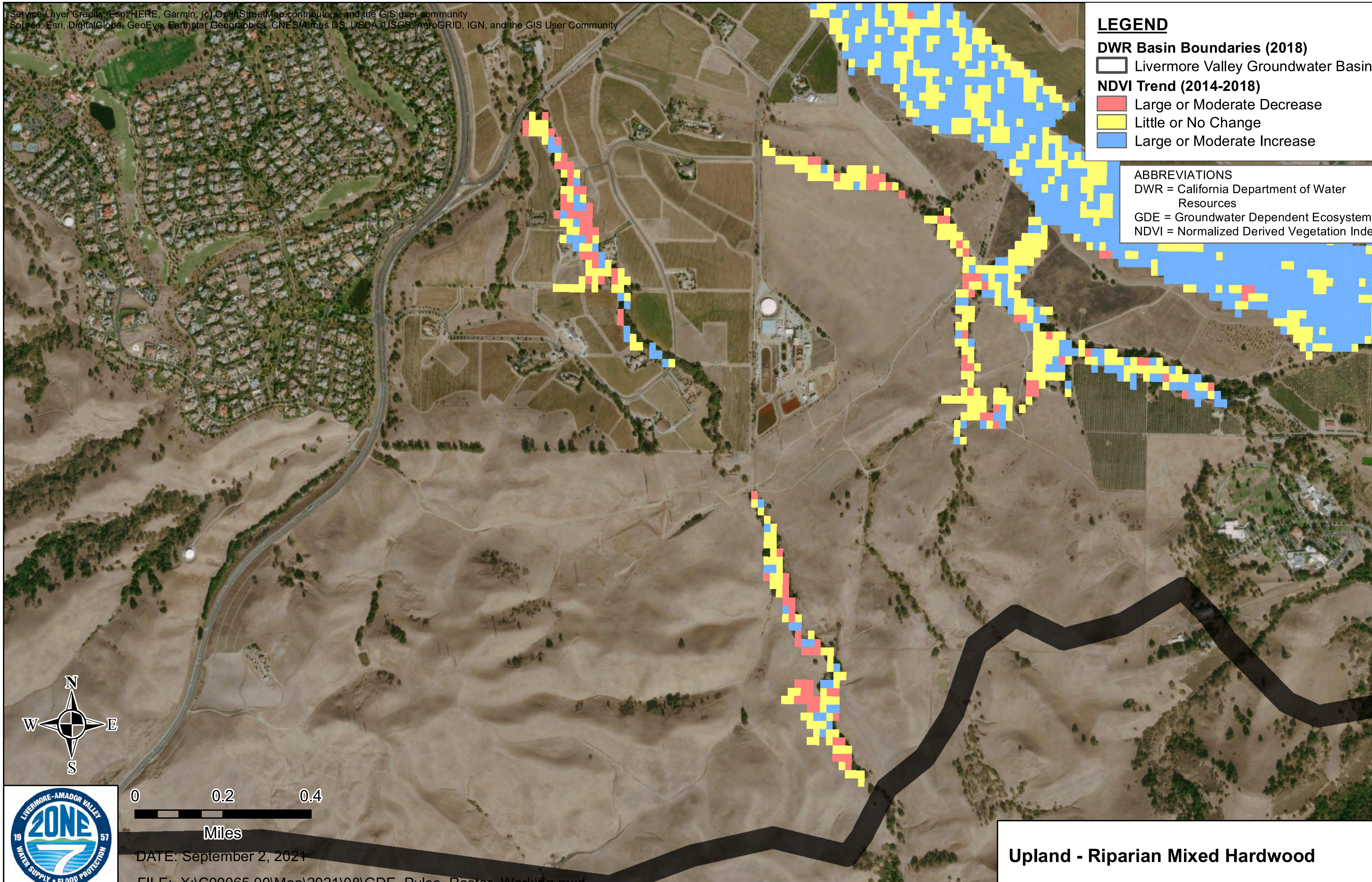
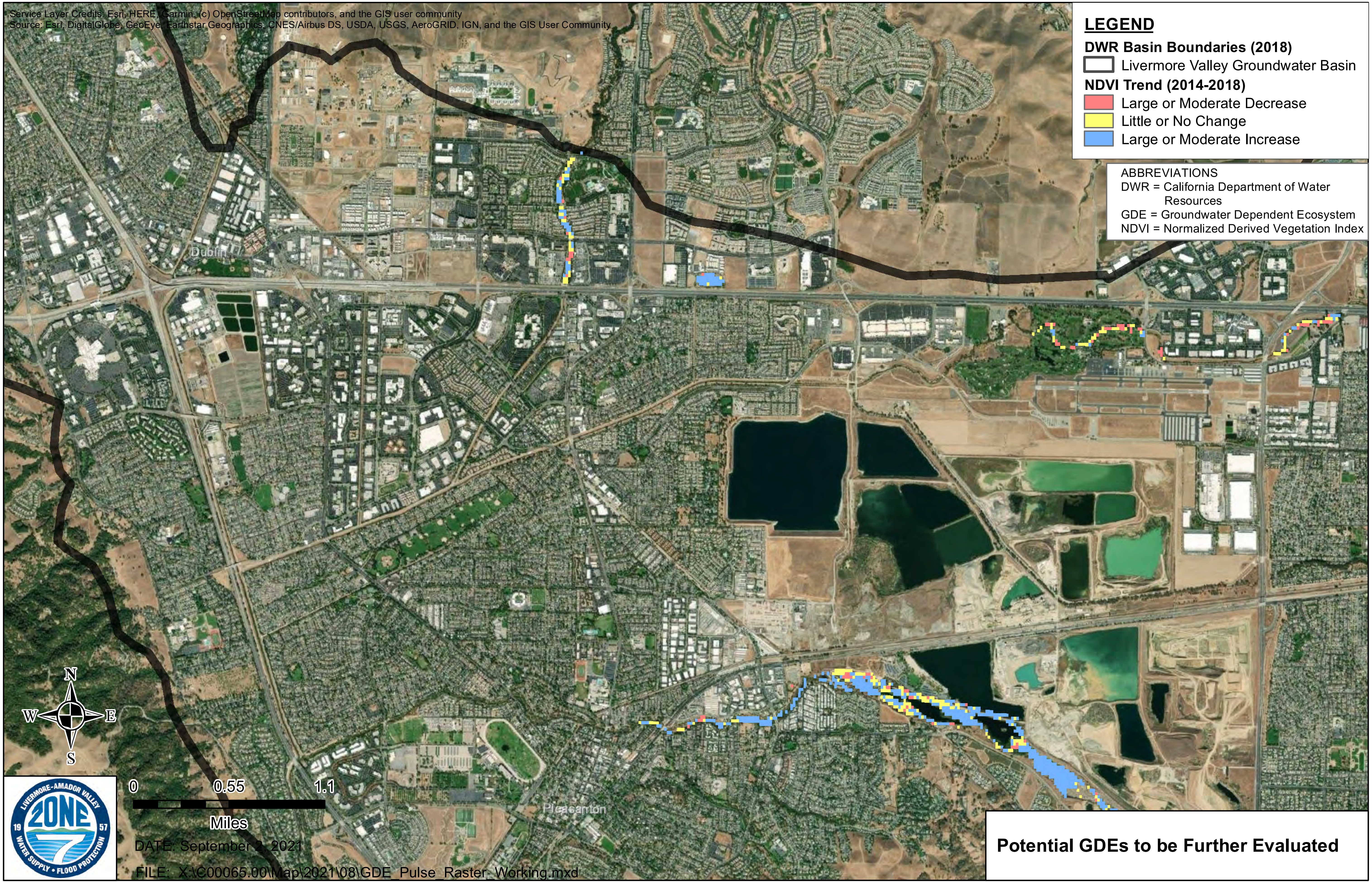
N
W
E
S
0
0.25
0.5
Miles
DATE: September 2, 2021
FILE: X:\C00065.00\Map\2021\08\GDE_Pulse_Raster_Working.mxd
Springtown Alkali Sink



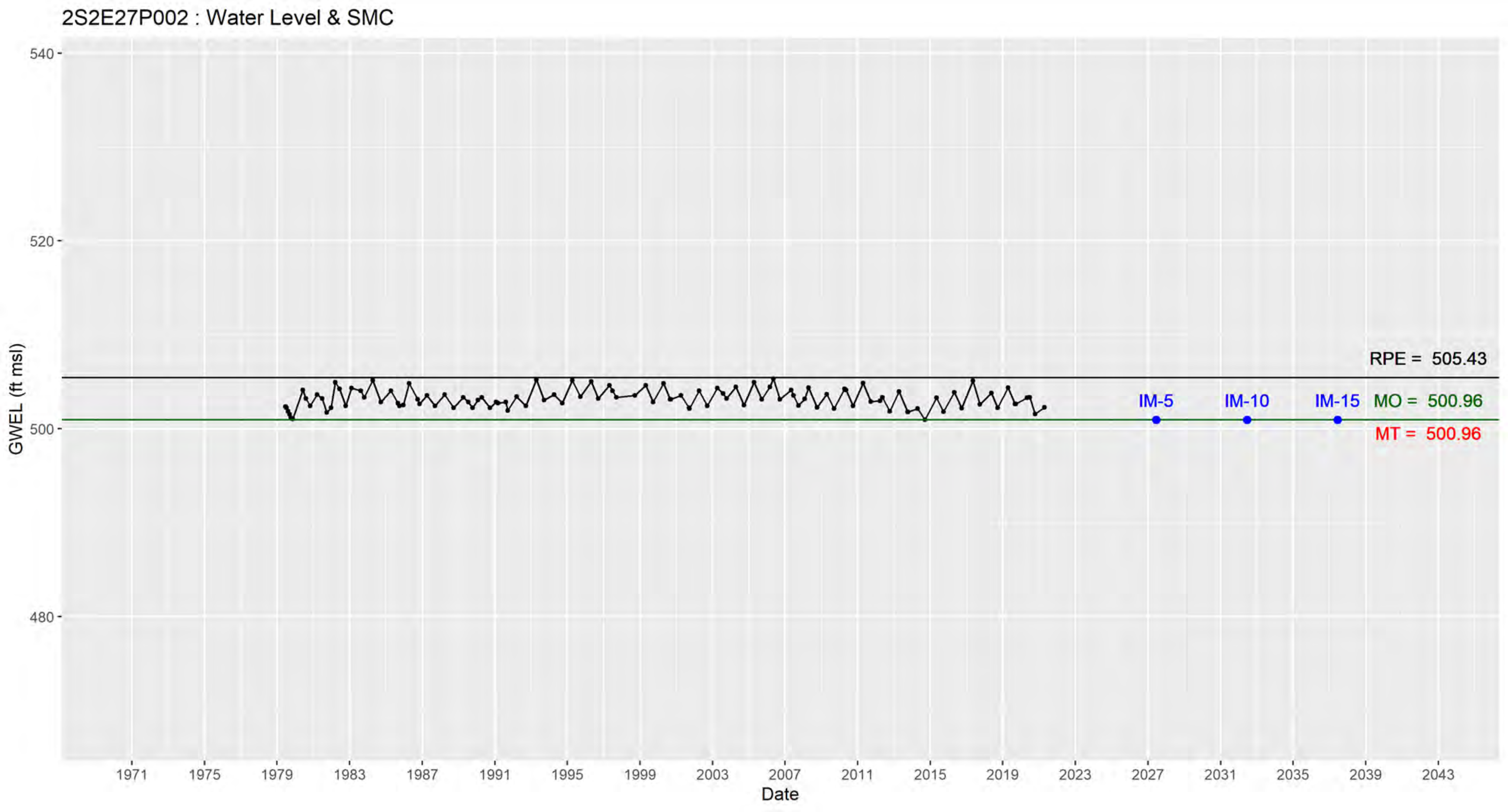
Upland - Riparian Mixed Hardwood

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
LEGEND
DWR Basin Boundaries (2018)
Livermore Valley Groundwater Basin
NDVI Trend (2014-2018)
Large or Moderate Decrease
Little or No Change
Large or Moderate Increase
ABBREVIATIONS
DWR = California Department of Water Resources
GDE = Groundwater Dependent Ecosystem
NDVI = Normalized Derived Vegetation Index
N
W
E
S
0
0.4
0.8
Miles
LIVERMORE-AMADOR VALLEY
ZONE 7
19
57
WATER SUPPLY • FLOOD PROTECTION
DATE: September 2, 2021
FILE: X:\C00065.00\Map\2021\08\GDE_Pulse_Raster_Working.mxd
Arroyo Las Positas -- Mixed Vegetation

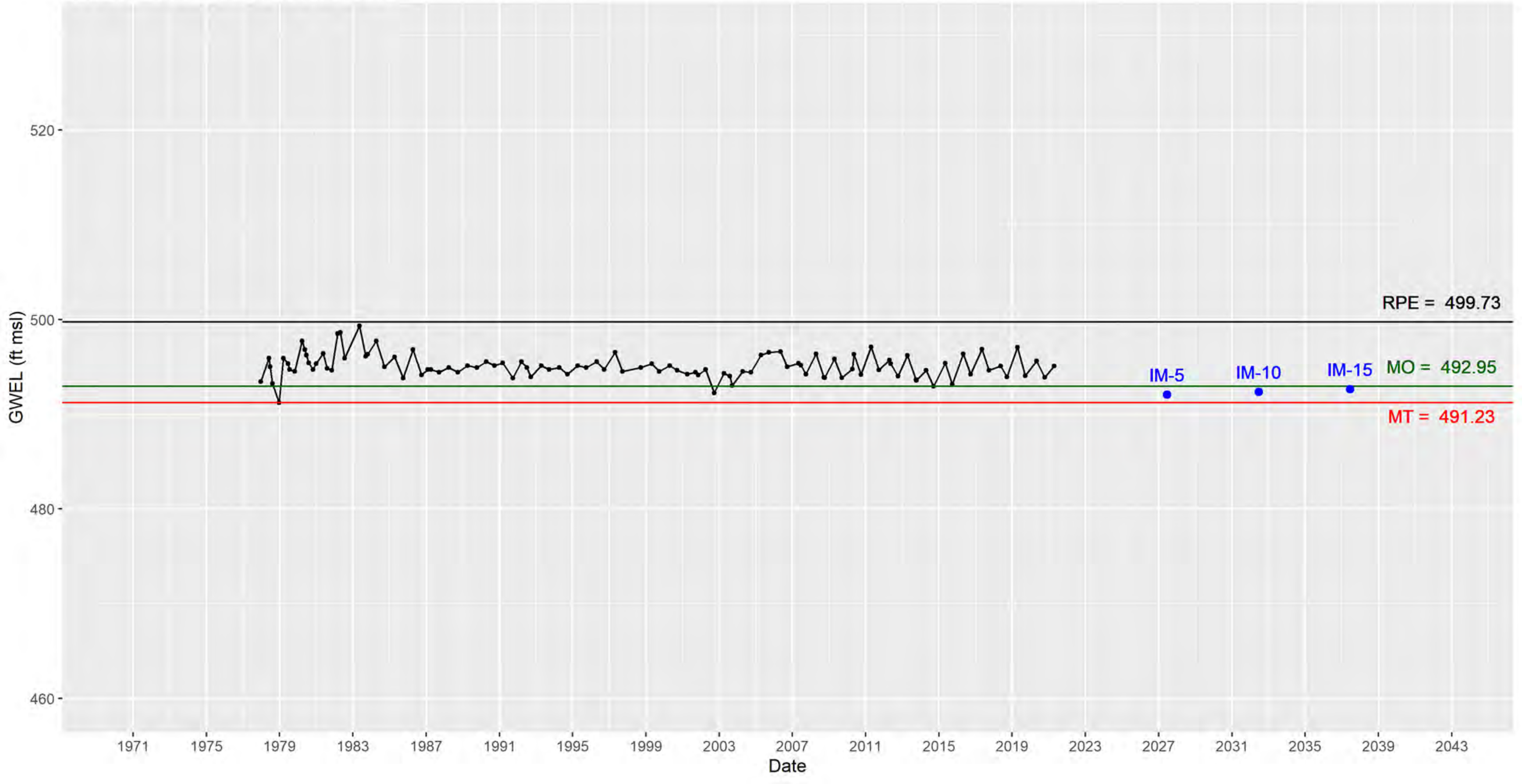


Potential GDEs to be Further Evaluated

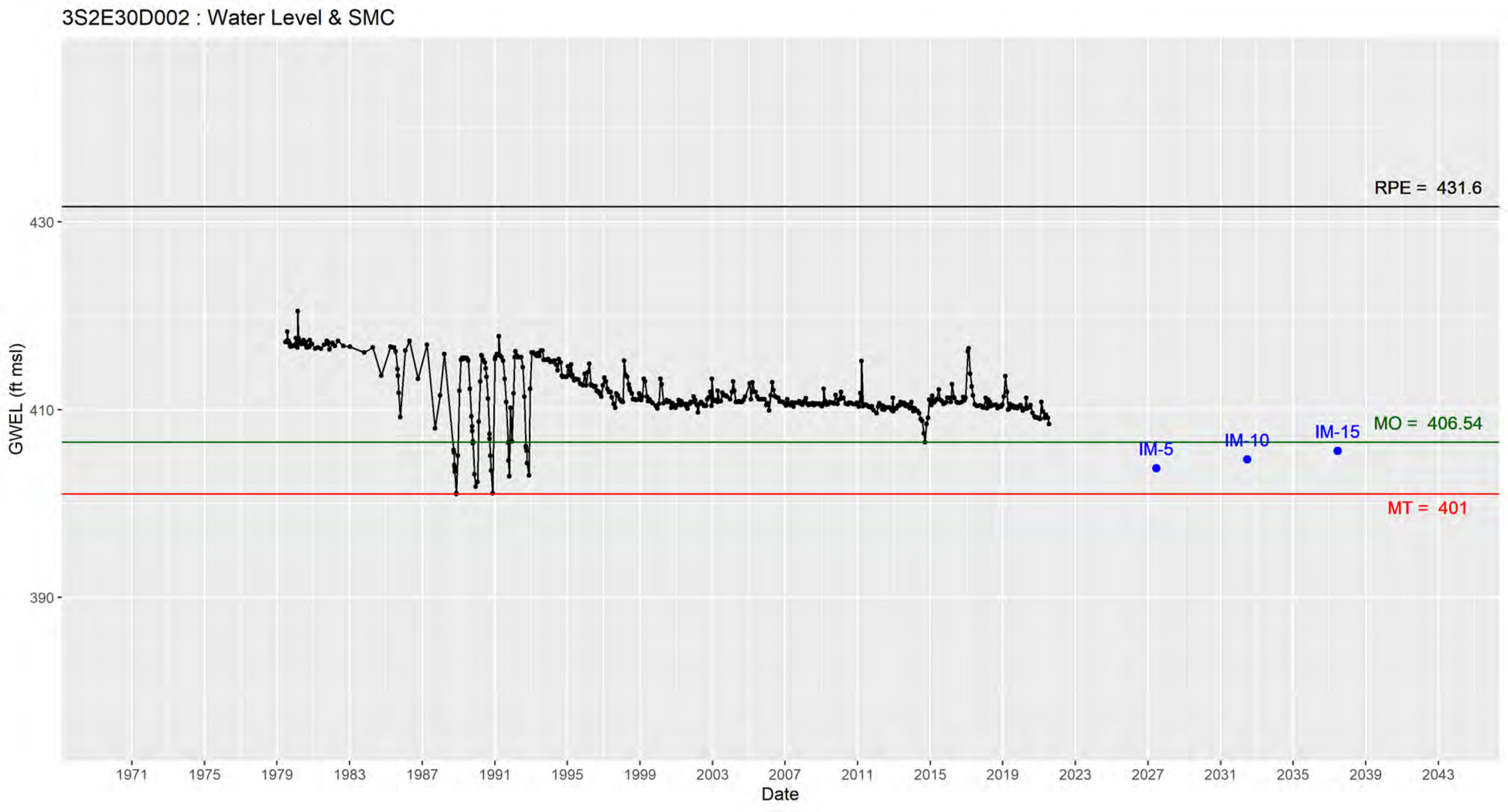
Attachment F: Water Levels and SMC Plots by RMW-ICSW

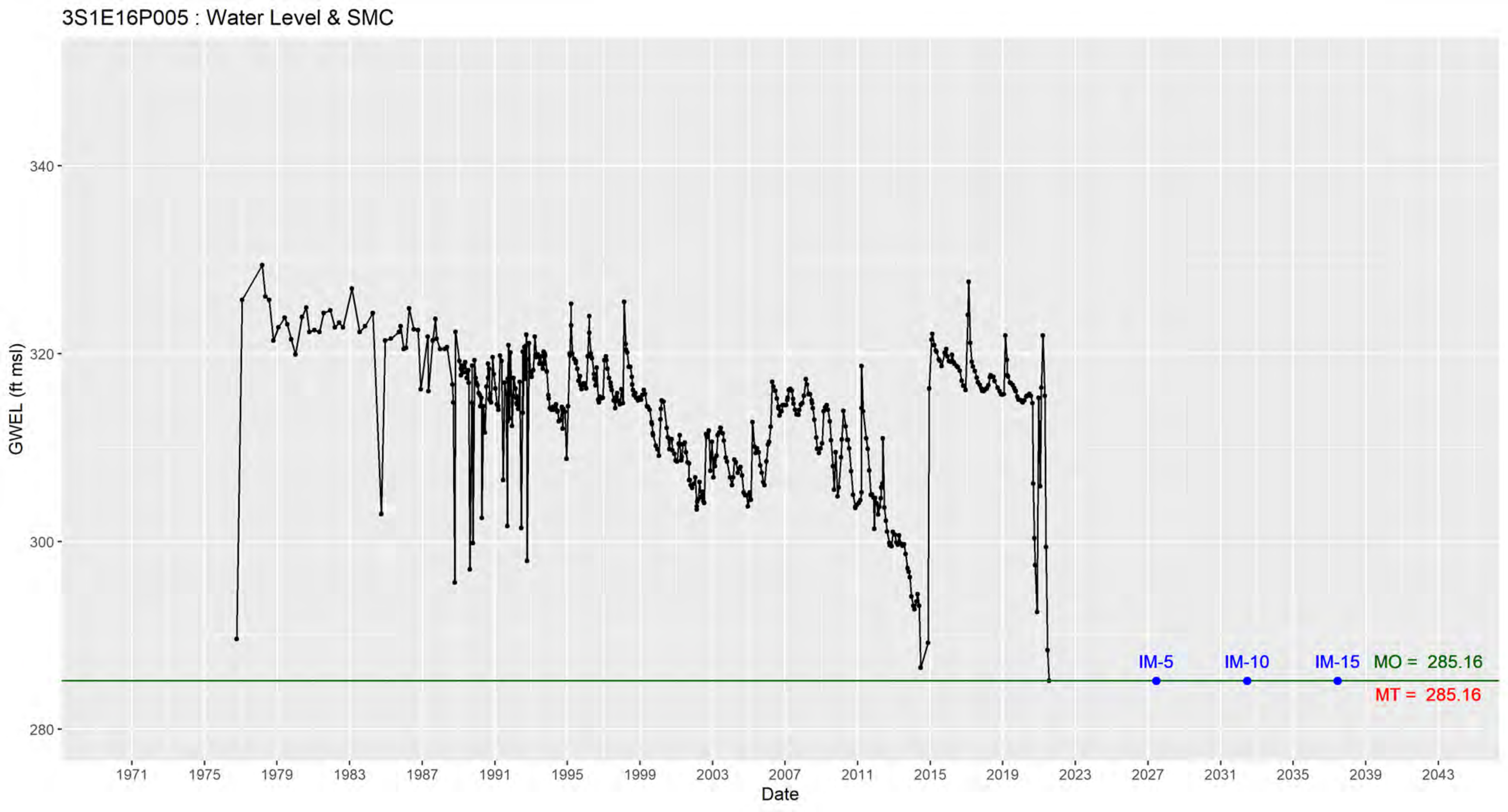

2S2E27P002 : Water Level & SMC
540
520
500
480
GWEL (ft msl)
RPE = 505.43
IM-5
IM-10
IM-15
MO = 500.96
MT = 500.96
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date

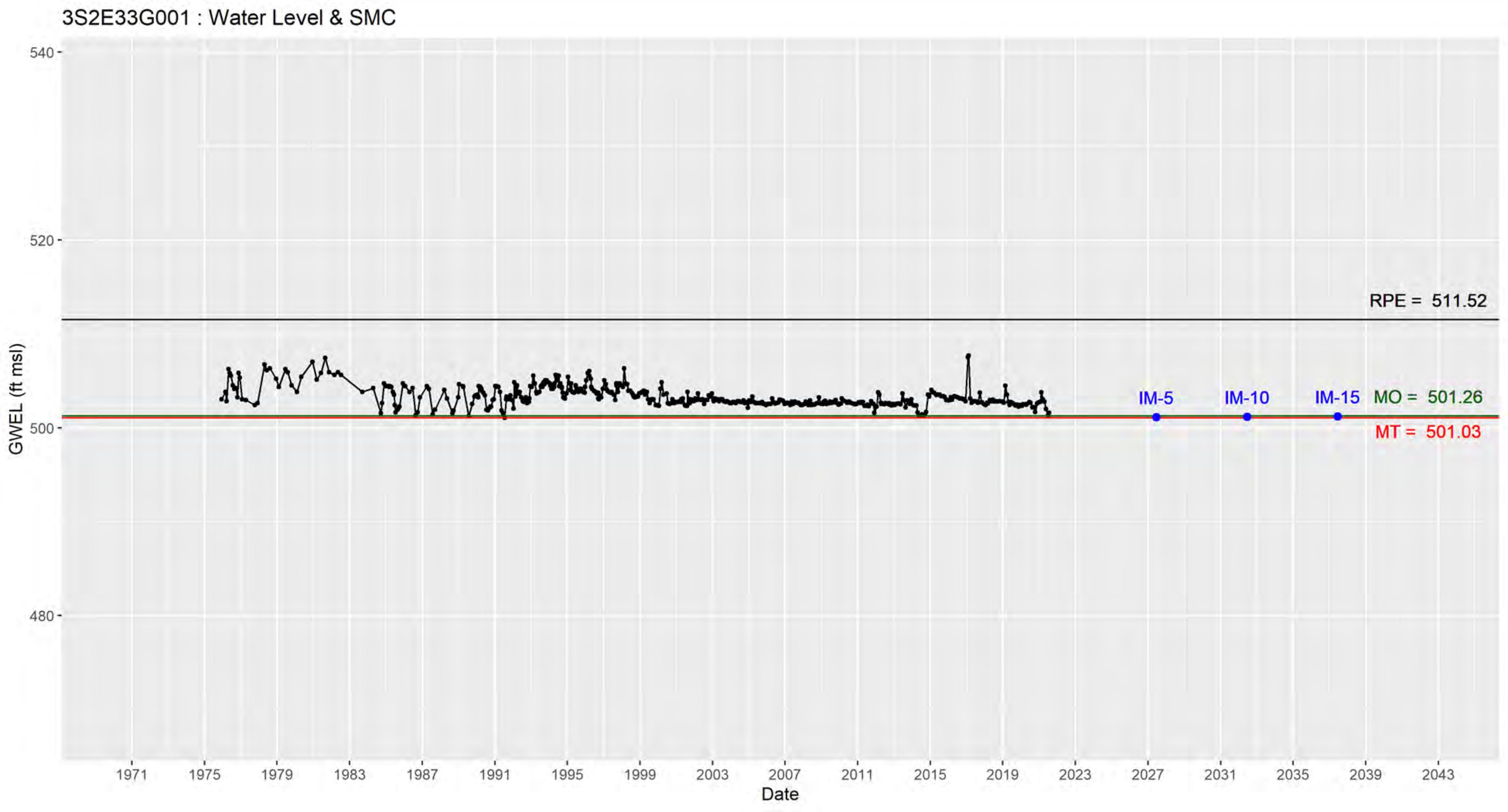
2S2E34E001 : Water Level & SMC



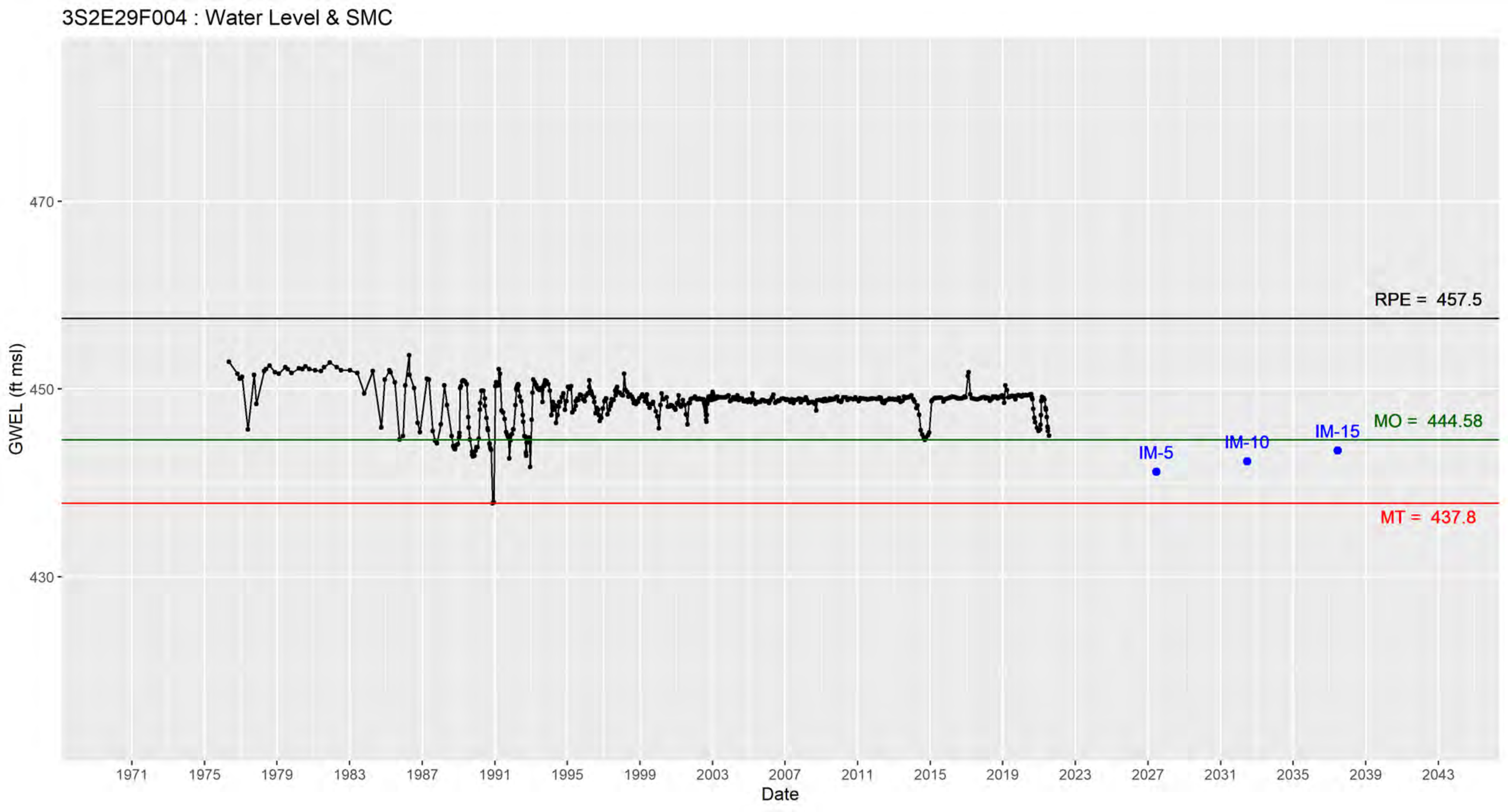
3S1E05K006 : Water Level & SMC
370
350
330
310
GWEL (ft msl)
RPE = 346.05
MO = 328.18
MT = 325.95
IM-5
IM-10
IM-15
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date


3S2E30D002 : Water Level & SMC
GWEL (ft msl)
430
410
390
RPE = 431.6
MO = 406.54
MT = 401
IM-5
IM-10
IM-15
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date

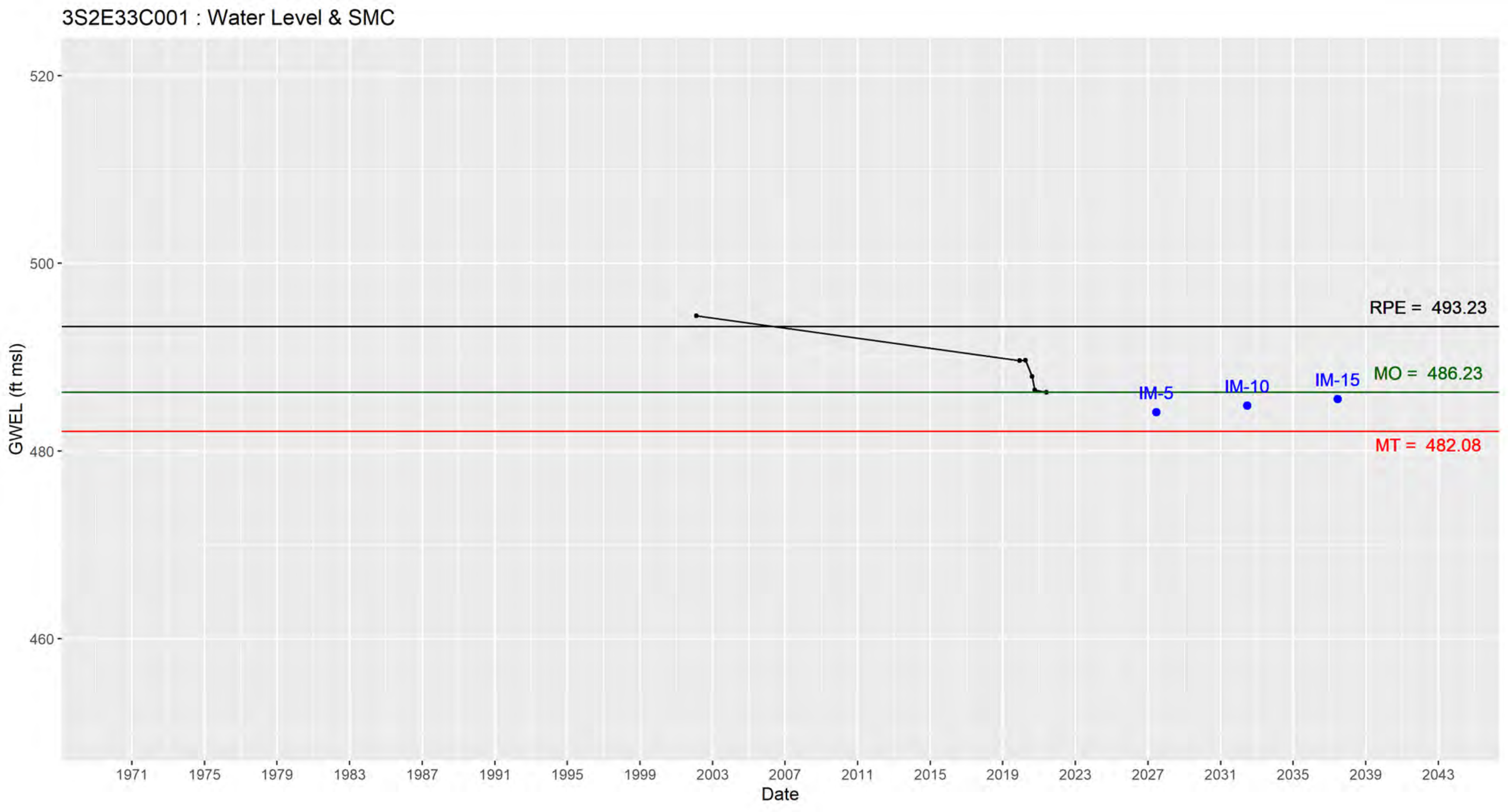

3S1E16P005 : Water Level & SMC
GWEL (ft msl)
340
320
300
280
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date
IM-5
IM-10
IM-15
MO = 285.16
MT = 285.16



3S2E33G001 : Water Level & SMC
540
520
500
480
GWEL (ft msl)
RPE = 511.52
IM-5
IM-10
IM-15
MO = 501.26
MT = 501.03
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date



3S2E29F004 : Water Level & SMC
GWEL (ft msl)
470
450
430
RPE = 457.5
MO = 444.58
MT = 437.8
IM-5
IM-10
IM-15
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date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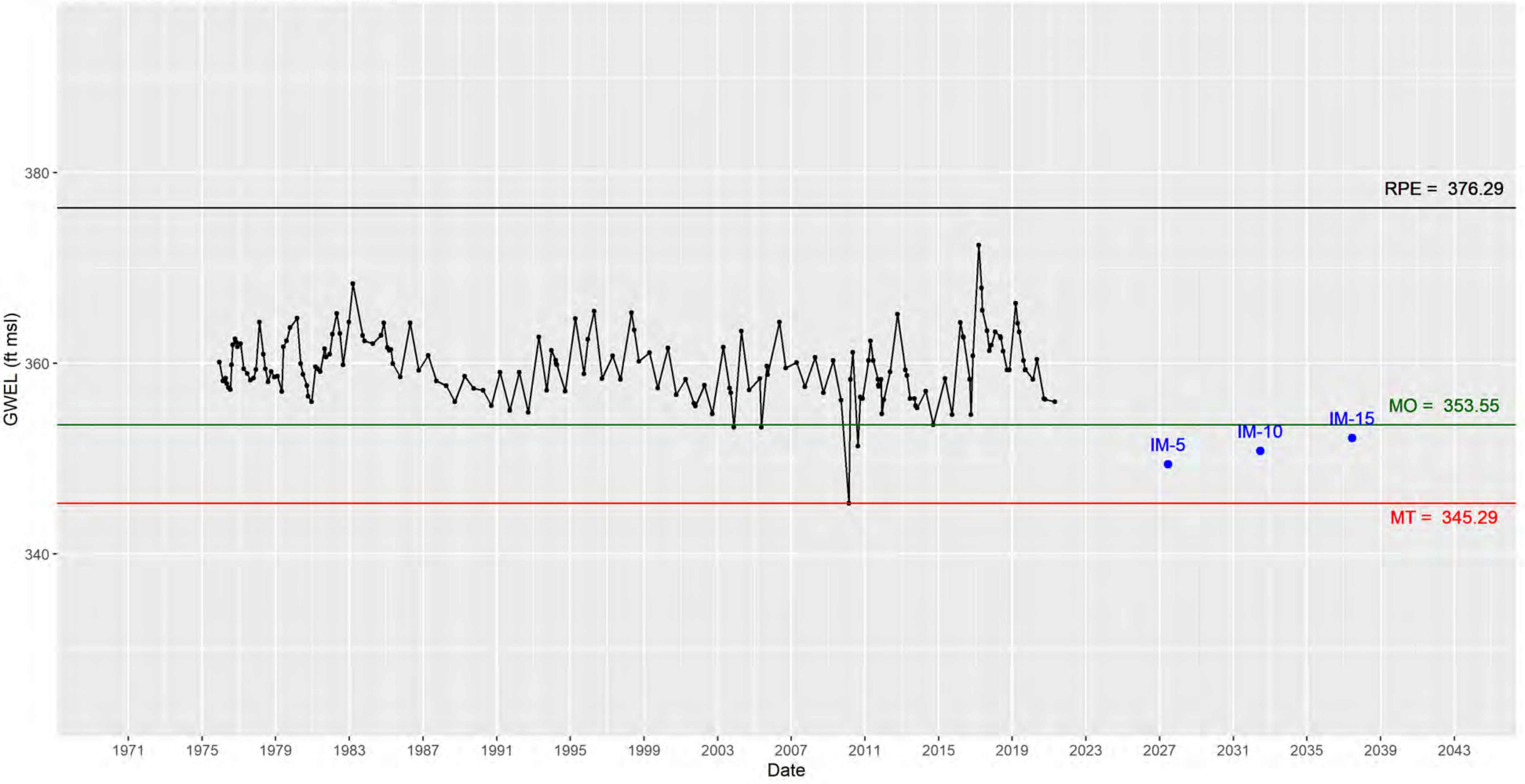
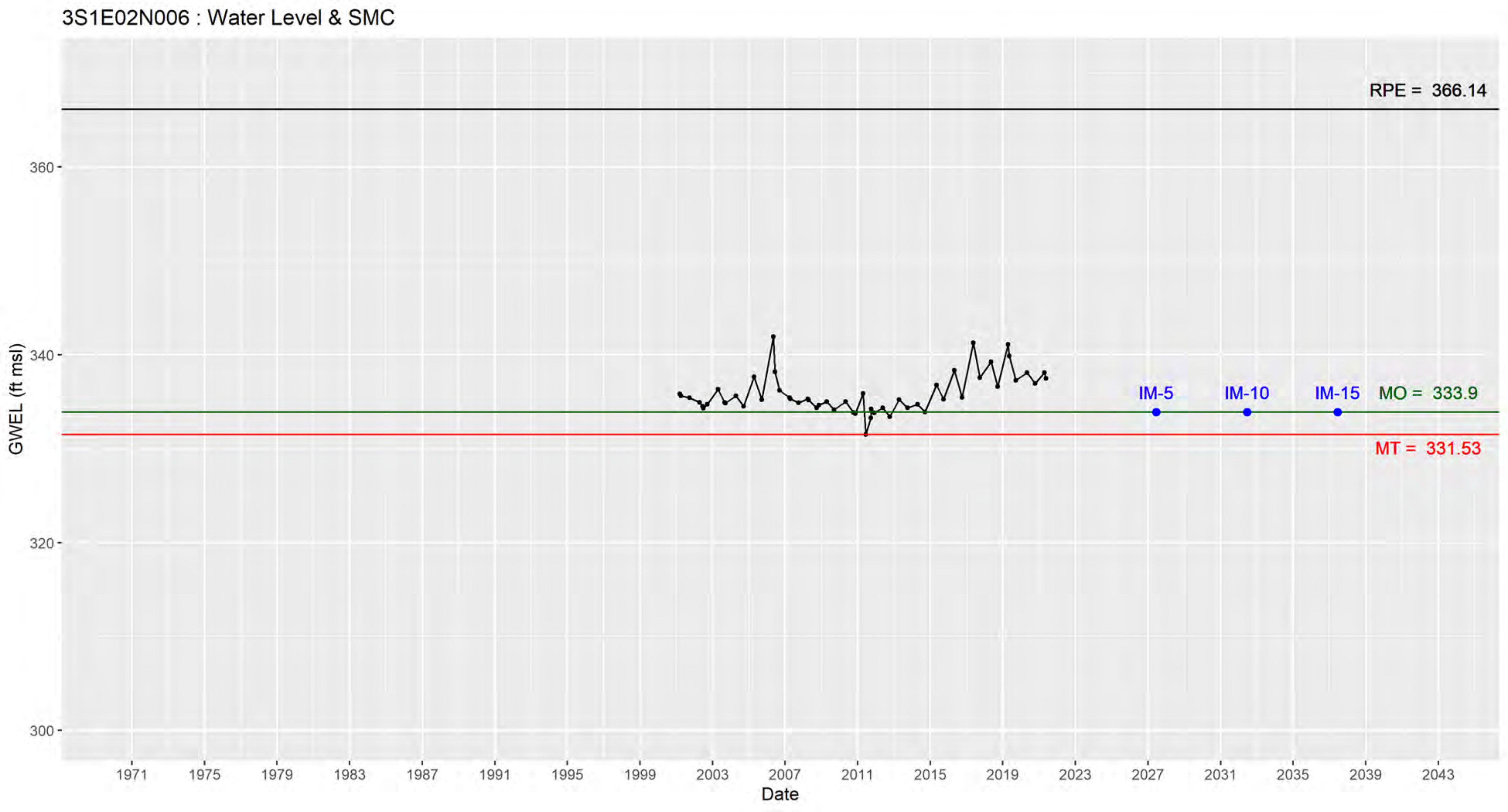
500
480
460
GWEL (ft msl)
RPE = 493.23
MO = 486.23
MT = 482.08
IM-5
IM-10
IM-15
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date

3S1E02R001 : Water Level & SMC

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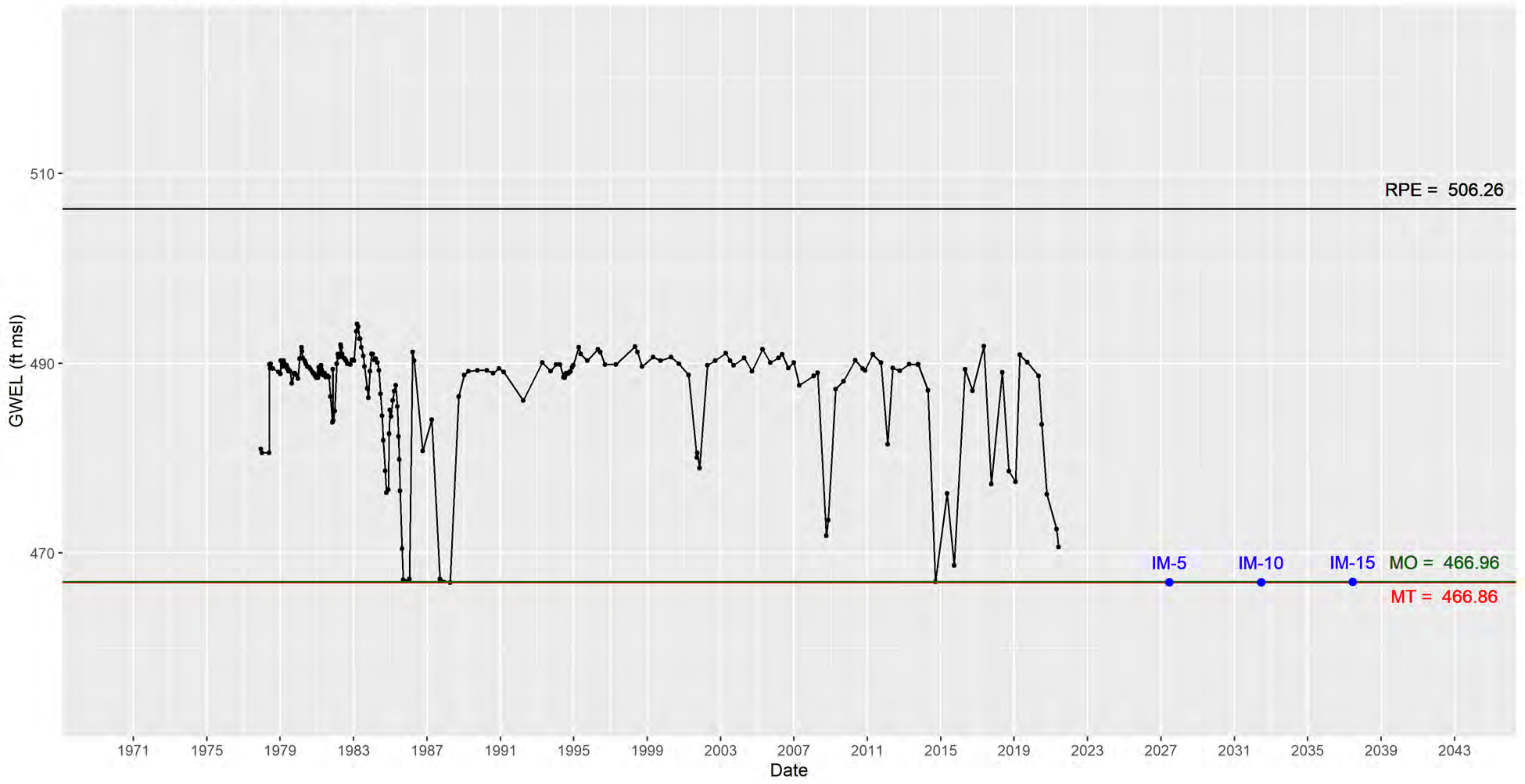
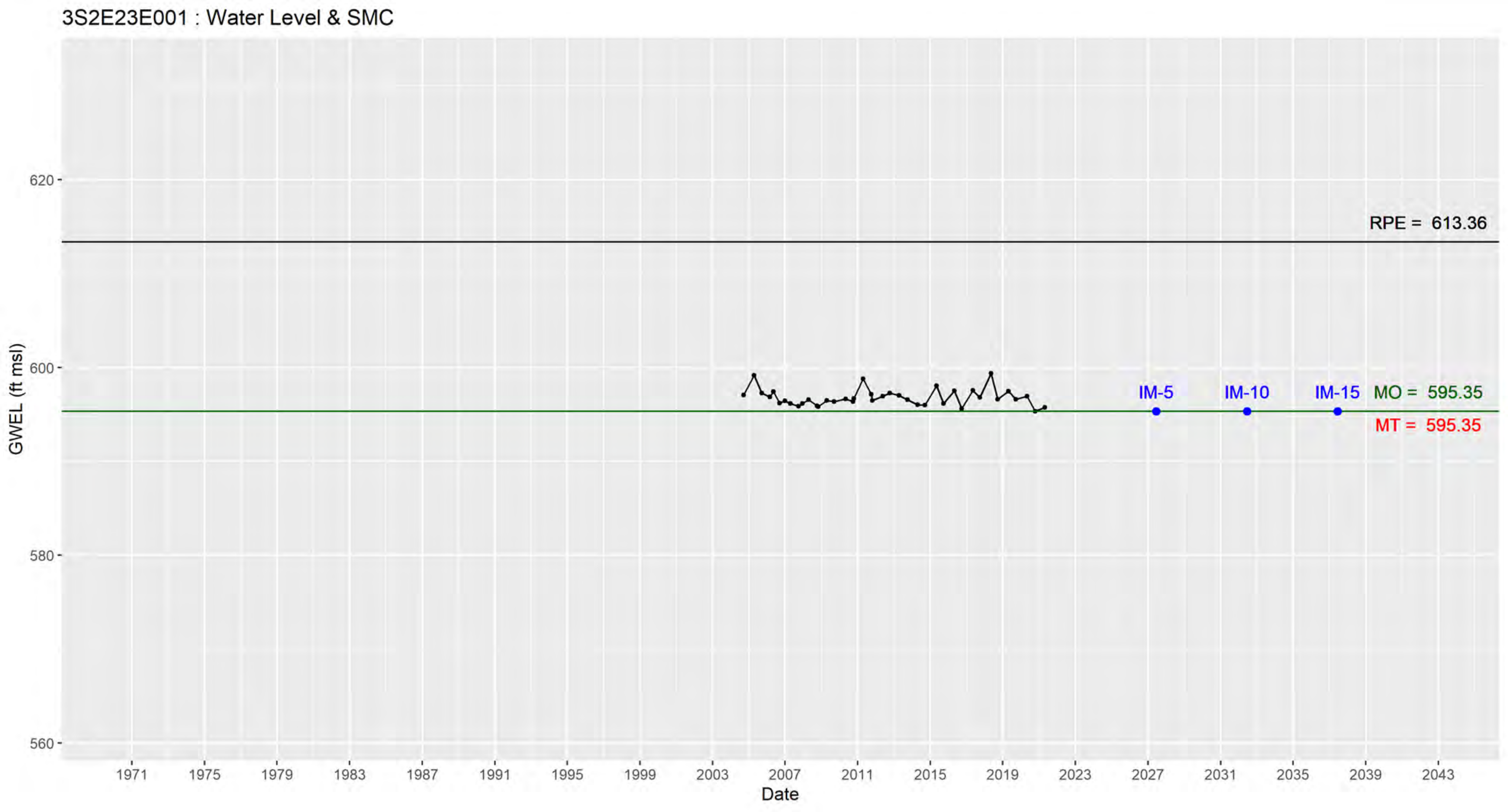
IM-5
IM-10
IM-15
MO = 333.9
MT = 331.53
GWEL (ft msl)
360
340
320
300
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date

3S2E16E004 : Water Level & SMC

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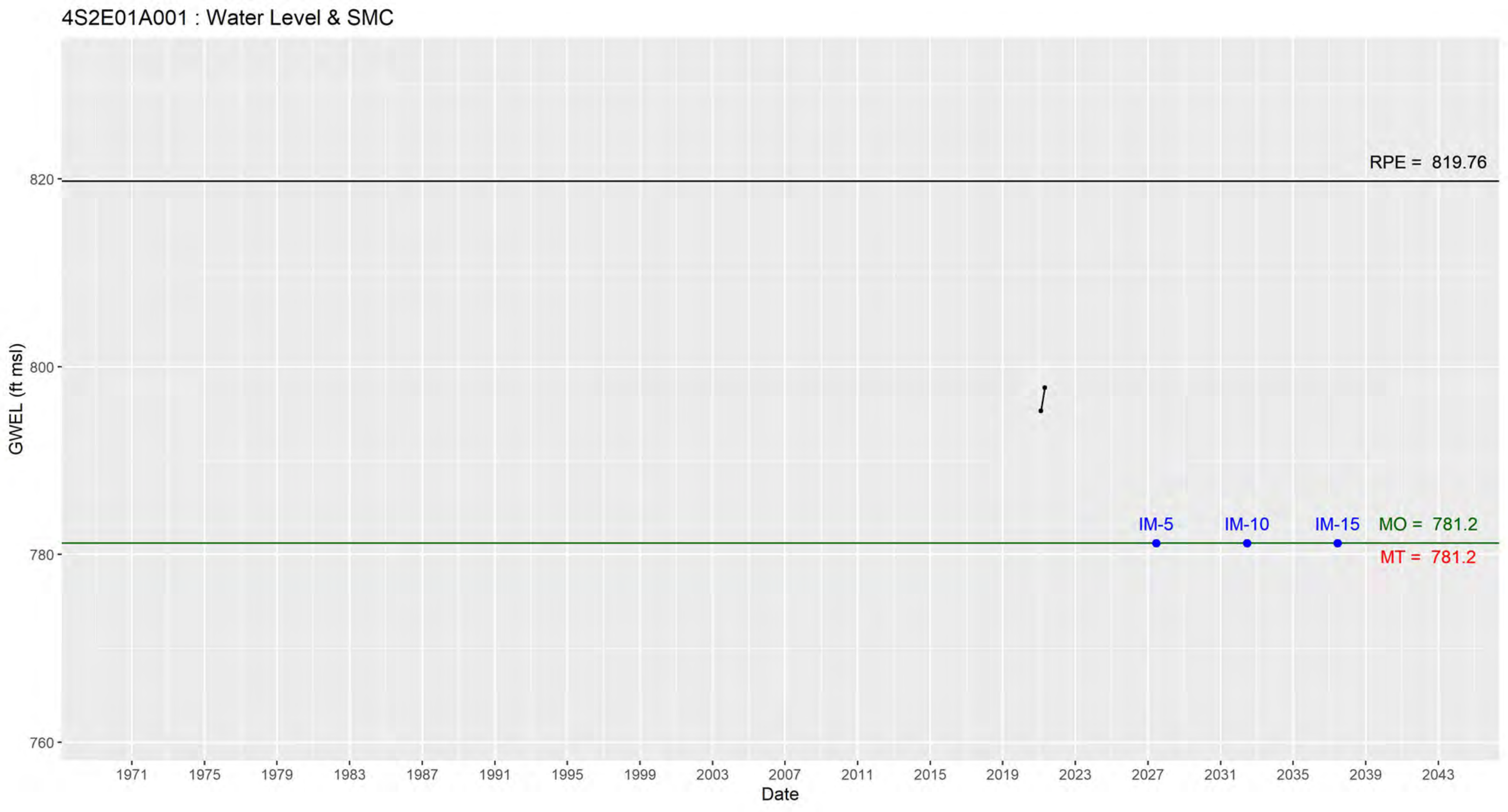
GWEL (ft msl)
620
600
580
560
RPE = 613.36
IM-5
IM-10
IM-15
MO = 595.35
MT = 595.35
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date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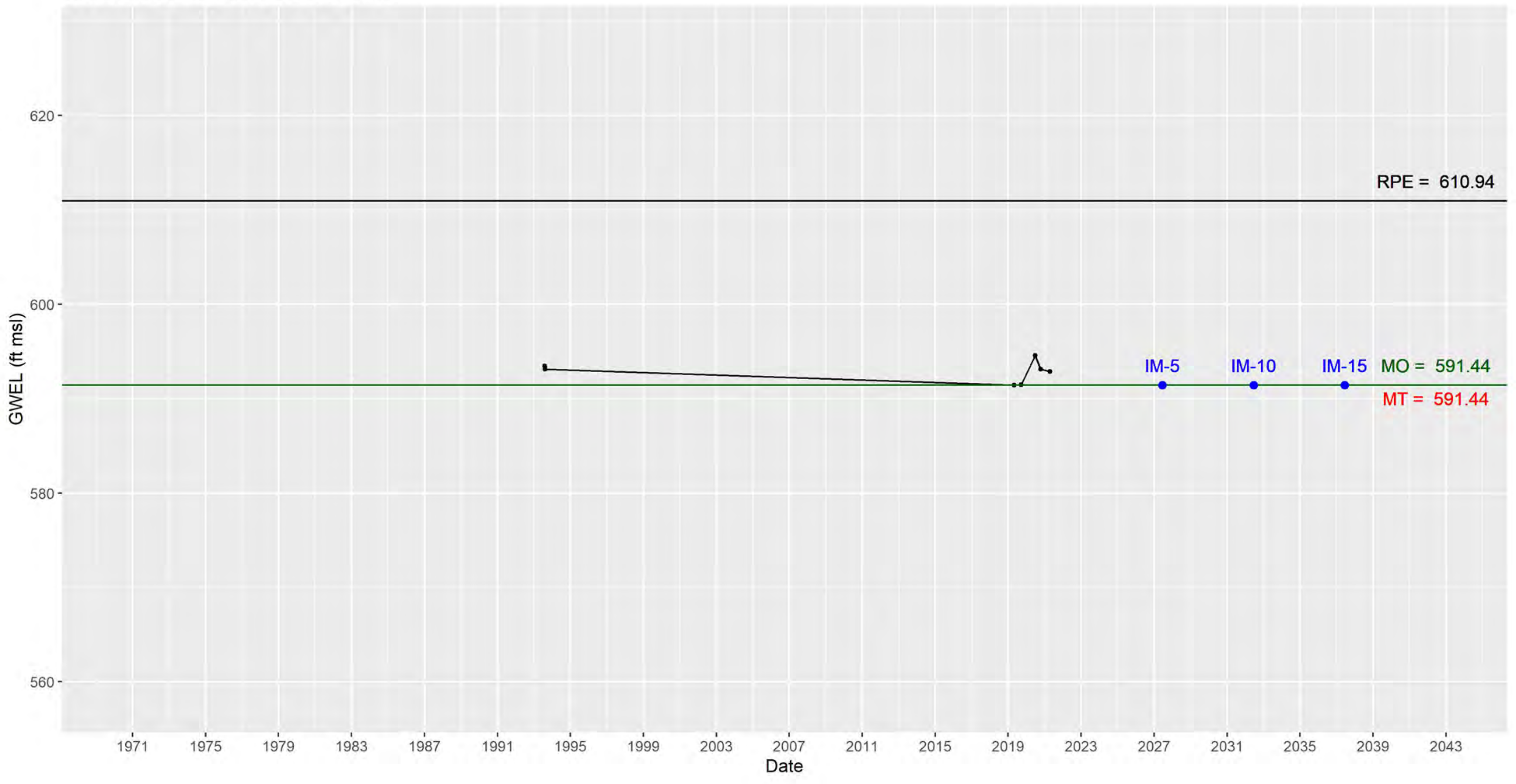
IM-5
IM-10
IM-15
MO = 781.2
MT = 781.2
GWEL (ft msl)
820
800
780
760
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
2027
2031
2035
2039
2043
Date

3S2E32E007 : Water Level & SMC



APPENDIX G

STANDARD OPERATING PROCEDURES

Appendix G

Standard Operating Procedures

Prepared by
Zone 7 Water Agency

PUBLIC REVIEW DRAFT
October 2021

TABLE OF CONTENTS

1 GROUNDWATER ELEVATION MEASUREMENT PROCEDURES

1.1 GENERAL

The common datum for all water and land surface elevations is in Mean Sea Level (MSL) in feet (ft), using the North American Vertical Datum of 1988 (NAVD88). To calculate the water elevation, Zone 7 measures the depth-to-water relative to a known reference point, or measures it directly using Zone 7's Real Time Kinematic (RTK) Global Positioning System (GPS) Unit (Sokkia GRX1).

For each field measurement event, Zone 7 completes a field sheet that includes the following columns:

- Site
- Sample Date
- Sample Time
- Reference Point
- Previous Measurement
- Depth To Water
- Groundwater Elevation
- Equipment Used
- Notes

All water elevation field measurements are compared to the previous measurement shown on the field sheet. Wells with suspicious levels are re-measured to check the elevation. Back in the office, groundwater elevation data are graphed and/or contoured to check the general accuracy of the data. Suspi-cious water levels are investigated and, if deemed invalid or questionable, are then (1) re-measured, if possible, or (2) noted as suspect in the database and are deleted from graphs and reports.

1.2 GROUNDWATER ELEVATIONS IN WELLS

1.2.1 Reference Points

For groundwater elevations in wells, Zone 7 measures depth-to-water from a surveyed reference point in each well, usually on the north side of the top of the well casing. These reference points are typically marked with a sharpie and/or a notch on the well casing. Whenever possible, reference point elevations are surveyed to 0.01' NAVD88 (or better) by a licensed surveyor or measured using Zone 7's GPS Unit (accurate to about 0.05 ft). When not possible, Zone 7 estimates the reference point elevation from the following (in order of preference):

ES.1. Pictometry
ES.2. Lidar
ES.3. Topographic Maps

1.2.2 Depth to Water Measurements

Zone 7 uses Solinst or Heron Water Level Meters to measure the depth to water. The elevation of the water surface in the well is computed by subtracting the depth-to-water from the reference point elevation. The field data is then entered into a database (**Section 1.5**) and made available to staff for further analysis.

Water levels are measured under static (or semi-static) conditions. Productions wells are typically turned off and allowed to equalize (same reading for one minute) prior to recording water levels. For those wells not controlled by Zone 7, or when a Zone 7 well cannot be switched off, no water levels measurements are taken for that measurement event. On the field sheet, a note (including the date and time) is made indicating that the well was pumping during the field visit. Pumping water levels are sometimes submitted by other agencies and are so noted in the database, but are not used to create groundwater elevation maps and contours.

1.3 GROUNDWATER ELEVATIONS IN SURFACE WATER BODIES

Zone 7 uses a GPS Unit to measure groundwater elevation in static surface water bodies, (e.g., mining area ponds). The GPS Unit is localized at the beginning of each field event using a known benchmark. In the field the GPS Unit is operated as per the manufacturers specifications and set so that the base of the unit represents the average water surface (i.e., on a rock or on the bank). The GPS reading is noted on a field sheet along with the date/time of the measurement and the equipment used. The accuracy of Zone 7's current GPS unit (Sokkia GRX1) is approximately 0.05 ft.

1.4 GROUNDWATER ELEVATION DATA FROM OTHERS

In some cases, other agencies or individuals (e.g., CWS and the City of Pleasanton) provide monthly water level data to Zone 7. Water levels measured by others are received a month or more after the actual measurement so a field-check measurement is usually not possible. However, the data is compared to previous measurements for accuracy, and if inconsistent, Zone 7 will contact the measurer for clarification or will flag the dataset as questionable.

1.5 GROUNDWATER ELEVATION DATA MANAGEMENT

Groundwater elevation data is transferred from the field sheets and imported into HydroGeoAnalst (HGA), a proprietary environmental database designed for storing and reporting chemistry, hydrology, and geologic data. The program includes a detailed QA/QC module that checks data integrity during import. Once imported into the database, Zone 7 uses the reporting and mapping tools within HGA to view and report the datasets. Zone 7 also exports datasets from HGA for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS.

2 GROUNDWATER QUALITY SAMPLING PROCEDURES

2.1 GENERAL

Groundwater samples are collected from all wells, mining area ponds, and surface water stations in Zone 7's programs provided a suitable sample can be obtained. Zone 7 staff typically samples water from municipal wells, various mining area ponds, and arroyos that communicate with groundwater. Zone 7 employs a contractor (Contractor, currently Blaine Tech Services) to perform groundwater sampling from the majority of the non-municipal wells in the program. Both Zone 7 staff and Contractor must follow the procedures below.

2.2 FIELD PREPARATION

Prior to sampling, field personnel perform the following:

ES.4. Zone 7 prepares well data sheets of all wells to be sampled for the year. Well data sheets include a map, coordinates, photographs, well depth, well diameter, screen interval, and any sampling notes or instructions specific to that well.

ES.5. For contracted sampling events, the contractor contacts Zone 7s' Laboratory at least a week prior to desired sampling dates to schedule sample delivery and to confirm that the laboratory can analyze the anticipated number of samples in a timely manner. The contractor delivers all samples on Monday through Thursday in consideration of holding times for certain analyses.

ES.6. Zone 7 obtains and/or provides sample containers, sample labels, chain of custody sheet, and parameter stability sheets for purging.

ES.7. If indicated on the well data sheets, field personnel contact the owner to pre-arrange schedule and to access the property and well.

2.3 FIELD INSTRUMENT CALIBRATION

Upon arrival to the first well of each sampling day, the sampler performs a field instrument calibration for pH and specific conductance.

ES.8. Accuracy of pH meters should be +/- 0.1 pH unit of the standard.

ES.9. Accuracy of specific conductance (SC) should be within 5% of the standard.

ES.10. Calibrations are recorded in instrument log books as well as on the chain of custody for that sample day.

2.4 WATER SAMPLING

2.4.1 General

Static depth to water level (for wells) or water elevation (for surface water bodies) are measured and recorded prior to pumping/sampling. In the case of nested wells, static water levels for all associated nested wells are measured before any of them are pumped.

All sampling and purge water stability records are logged and stored in a binder specifically for that purpose. Samples are typically filtered through a single use 0.45-micron filter in the field, except when not appropriate for the analytes being tested (e.g., for VOC sampling, see **Section 2.5.3**). If field-filtering is not possible, the field personnel indicate on the Chain of Custody that the sample is to be filtered by the lab prior to sampling.

Sample labels are filled out completely and placed on all sample bottles.

2.4.2 Wells with No Dedicated Pump

For wells without dedicated pumps, the most appropriate/efficient sampling method for each well, either *Well-Volume Purge and Sample* or *Low Flow Sampling*, is indicated on Zone 7's stability sheets. Detailed instructions for each sampling method are provided below.

2.4.2.1 Well-Volume Purge and Sample

This method involves purging static groundwater from the well so that the water in the well is representative of groundwater. During the purging period, the purged groundwater is monitored for specific conductance, pH, and temperature to determine stability. The stabilization criteria are listed below in **Section 2.4.4**. Samples are collected after the parameters have stabilized.

No purge water is discharged to storm drains; however since groundwater from all wells are believed to be uncontaminated, purge water can be discharged to a permeable ground surface at the well site as long as the discharge does not cause excessive erosion and does not enter a storm drain. If there are no permeable surfaces at the well site, the purge water is containerized and transported to a Zone 7-approved location for surface discharge.

- ES.11. Samples are collected after the parameter stabilization criteria specified below have been met.
- ES.12. A minimum of three casing volumes are purged. If stability is not reached prior to five casing volumes purged, then a sample is collected when five casings have been purged.
- ES.13. The sample SC, pH, and temperature readings are measured in the field and recorded on a field data sheet provided by Zone 7.
- ES.14. Readings are taken at every ½ well volume purged or every three to five minutes.
- ES.15. If a well purges dry, it must recover to 80% of original water column before the sample is collected. If recovery time takes more than one hour, the sample is collected at end of the day or the following morning (within 24 hours from drying of well).

2.4.2.2 Low Flow Sampling

ES.16. A bladder pump is lowered to specified depth, which is typically halfway down the well screen interval. If there are multiple screen intervals, then the shallowest screen interval is used.
ES.17. The pumping rate is adjusted so that it is less than natural recovery rate of the well (usually between 0.1L and 0.5L/minute), and so that drawdown is no more than 0.33 feet (ft).
ES.18. Water quality readings and water level readings (to monitor drawdown) are taken every three to five minutes. The sample is collected when the parameter stabilization criteria (**Section 2.4.4**) are met.

2.4.3 Wells with Dedicated Pumps

Several wells in Zone 7's program have dedicated submersible pumps, most of which are active pumping wells. The sample is collected when the parameter stabilization criteria (**Section 2.4.4**) are met.

ES.19. For active wells, the sampler opens the sample tap and purge water for five minutes and then collects the sample.
ES.20. Inactive wells are purged for five minutes. After five minutes have passed, the sampler then begins recording water quality parameters every three to five minutes until parameter stabilization occurs.

2.4.4 Parameter Stabilization Criteria

Samples are collected after the specific conductance (SC) and pH have stabilized as follows:

ES.21. **SC** - the difference between the maximum and minimum values of the last three readings must be no more than 5%.
ES.22. **pH** - the difference between the maximum and minimum values of the last three readings must be less than or equal to 0.1 units.

2.4.5 Grab Sampling from Surface Water Bodies

When collecting water samples from surface water bodies, the field personnel avoid sampling water that has been stirred up. Field personnel collect samples choosing Option 1 or 2, below, as appropriate while standing on the edge of the water body or on a rock. The field personnel:

OPTION 1

ES.23. Hold the uncapped bottle upside down and submerse it,
ES.24. Tip bottle upright and allow water to fill bottle, and
ES.25. Remove bottle from water and screw on cap.

OPTION 2 (recommended for soft-sediment water bodies)

ES.26. Use a large, clean dip sampler to collect water,
ES.27. Rinse sampler in stream water three times,
ES.28. Collect stream water, and
ES.29. Fill sample bottles with water from the dip sampler.

2.5 SAMPLING CONTAINERS

2.5.1 General

The field personnel avoid touching the inside or lip of all sample bottles or caps. Each sample container is labeled with the site name/number, sample date, and sample time. Sample containers are selected as required by the EPA Method regulations.

2.5.2 Metals and Minerals

The majority of the water samples taken as part of Zone 7's water quality program are analyzed for metals and minerals. For these analyses, field personnel fill both a 1L bottle (no preservatives) and a 0.5L bottle (no preservatives).

2.5.3 VOC Sampling

Occasionally, Zone 7 samples water for volatile organic compound (VOC) analyses. VOC samples are collected with as little agitation or disturbance as possible.

ES.30. Stainless steel or Teflon bailers are used to collect VOC samples after purging and sampling.
ES.31. Unfiltered groundwater samples for VOC analysis are collected in three 40 ml glass VOA vials supplied by Zone 7. The vials are preserved with hydrochloric acid to allow for a two-week holding time.
ES.32. The vial is filled so that there is a meniscus above the top of the vial and absolutely no bubbles or headspace are present in the vial after it is capped. After the cap is tightened, the vial is inverted and tapped to dislodge any hidden air bubbles. If bubbles are present, the vial is topped off using a minimal amount of sample to re-establish the meniscus. Care is taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial is obtained and the sample re-collected.

2.6 SAMPLE STORAGE AND DELIVERY

Samples are stored in a cooler with ice or icepacks so that the cooler temperature is approximately four degrees Celsius. Field personnel complete a Chain of Custody for each sample day. Samples are then delivered within the analyte holding times, along with the Chain of Custody and water quality instrument calibration logs, to Zone 7's laboratory.

2.7 WATER QUALITY DATA MANAGEMENT

Zone 7's laboratory generates an electronic data deliverable (EDD) file that contains the sample results. This data is imported into HGA, a proprietary environmental database designed for storing chemistry, hydrology, and geologic information. The program includes a detailed QA/QC module that checks data integrity during import. Once imported into the database, Zone 7 uses the reporting and mapping tools within HGA to view and report the datasets. Zone 7 also exports datasets from HGA for use in other programs such as Microsoft Excel, Microsoft Access, and ArcGIS.

3 SURFACE WATER FLOW

3.1 GENERAL

All relevant information is recorded in a gauge house log sheet and on field note sheets.

3.2 FIELD VISIT

Upon arrival at the site, field personnel:

- ES.33. Look for evidence of vandalism/theft/high water destruction to gauge house, solar panels, cellular antennas, outside staff gauges, crest stage gauges, gauge height sensor conduit, and electronics within gauge house.
- ES.34. Verify recorder powers on and is recording data, wires are connected and in good order, and battery is not leaking acid.
- ES.35. Check battery voltage and replace battery if below 12.1 volts.
- ES.36. Check solar panel and clean if dirty.
- ES.37. Check channel banks and path to outside staff gauge to make sure they are clean, clear, stabile, and safe to approach. If not, field personnel use appropriate tools to clear (rake, shovel, broom, pruners, etc.).

Upon completion of the field visit, the gauge house is locked up.

3.3 GAUGE MEASUREMENT

During field visits, the field personnel often read the outside staff gauge and compare it to the recorder stage. During low flow, the field personnel reset the recorder stage if it differs from outside staff gauge by 0.02 ft or more. If there is a difference during high flow, field personnel try to observe what may be causing the difference and reset the recorder stage if appropriate.

Field personnel clean excess debris or algae from the control, and then allow time for stage to stabilize before taking another outside staff gauge reading for comparison to the recorder stage.

3.4 DISCHARGE MEASUREMENTS

For discharge measurements, field personnel look at the flow and mentally determine if it is safe to perform a wading discharge measurement. A general rule of thumb is that if the following condition is true:

Stream Depth (ft) x Stream Velocity (ft/s) > 10

Then the field personnel do not wade into the stream and perform the discharge measurement from the nearest bridge.

Discharge measurements and computations are performed in accordance with guidelines set forth in *United States Geological Survey Water-Supply Paper 2175, Measurement and Computation of Streamflow: Volume 1 and 2*. After the discharge measurement, field personnel recheck the outside staff gauge and recorder readings.

3.5 SURFACE WATER FLOW DATA MANAGEMENT

Zone 7 uses a proprietary program called Aquarius Time-Series (Aquarius) for managing surface water time-series datasets. The program allows Zone 7 to build rating curves, apply corrections, create comparison graphs, derive statistics, and report datasets.

4 SURFACE WATER QUALITY

4.1 GENERAL

Water quality samples are collected at most of Zone 7's surface water stations. Stream water sampling procedures are the same as those presented in **Section 2** except for the procedures described below.

4.2 SURFACE WATER SAMPLE COLLECTION

When collecting water samples from streams, the field personnel avoid sampling water that has been stirred up. The field personnel collect samples (choosing Option 1 or 2, below, as appropriate) while standing on the edge of the water body or on a rock. If this is not possible, the field personnel reach upstream as far as possible to avoid collecting stirred up water. The field personnel:

OPTION 1

- ES.38. Hold the uncapped bottle upside down and submerse it,
- ES.39. Tip bottle upright and allow water to fill bottle near top, and
- ES.40. Remove bottle from water and screw on cap.

OPTION 2 (recommended for soft-sediment water bodies and low-flow streams)

ES.41. Use a large, clean dip sampler to collect water,
ES.42. Rinse sampler in stream water three times,
ES.43. Collect stream water, and
ES.44. Fill sample bottles with water from the dip sampler.

5 MUNICIPAL GROUNDWATER PRODUCTION DATA

Zone 7 records its groundwater production using its own SCADA system. As part of Zone 7's agreements with its retailers, Zone 7's retailer agencies provide their own groundwater production data to Zone 7. Zone 7 and Pleasanton production data are available in a daily format. CWS provides monthly totals.

Zone 7 staff does not collect groundwater production data from domestic, industrial, or agricultural wells in the valley. These volumes are estimated using Zone 7's Areal Recharge Model, IDC, or typical pumping rates.

6 CLIMATOLOGICAL

6.1 TIPPING BUCKET

Once a month Zone 7 staff visits the rain tipping buckets to download 15-minute rainfall data. The rain gauges are visually inspected to ensure there is no debris clogging the rain gage. Field personnel inspect the associated rainfall data logger and using a field sheet, then record date, time, total rainfall accumulation and battery voltage. The 15-minute rainfall data is then downloaded from the logger to a Zone 7 laptop.

At the end of the water year, field personnel perform a standard monthly check and download the 15-minute rainfall data. Then for annual maintenance, field personnel
ES.45. open up the tipping bucket,
ES.46. check the bubble level to ensure a level surface,
ES.47. manually tip the rain gage,
ES.48. confirm that the associated data logger is correctly recording the tips,
ES.49. reassemble the tipping bucket, and
ES.50. reset the data logger rainfall total is reset to 0.00" for the start of the new water year.

6.2 CIMIS

Zone 7 staff performs maintenance for the California Irrigation Management Information System (CIMIS) station in the City of Pleasanton. Maintenance standards for the station call for a maintenance visit every 3-4 weeks during the warmer months of the year and every 5-6 weeks in the cooler months. The maintenance visit includes checking the sensors for accuracy and/or operation and cleaning or replacing sensors as required.

7 LAND SURFACE ELEVATION MONITORING

Zone 7's Land Surface Elevation Monitoring Program involves conducting high precision spirit level surveys of benchmarks across the Bernal and Amador Sub-basins. These benchmark stations have been selected to represent generally stable features (e.g. bridge buttresses) founded in deeper soils so as not to be affected by shallow soils movement (e.g., expansive soils).

The main circuit (A1-1.0 and A1-17.0) starts and ends at stable bedrock elevation stations and passing through or near Zone 7 and City of Pleasanton wellfields. From this main circuit, several looped or branched circuits are also surveyed in the same manner to assess ground surface elevation changes within other Zone 7 wellfields. Elevations and vertical distances between certain wellhead features, such as concrete pads, floors, pedestals, casing flanges and water level reference points are also monitored for change.

The normal monitoring frequency is twice per year for Circuits A1, B1, B3 and B4 and the wellhead features, corresponding with the semi-annual groundwater level monitoring events (spring and fall), and only during the fall event for Circuit B5.

Zone 7 contracts out the level survey measurements to a California-licensed surveyor. The contractor typically utilizes a three-man survey crew that conducts a differential level loop to collect elevations using an Electronic digital/bar-code leveling system based on Federal Geodetic Control Subcommittee (FGCS) standards and Specifications for Third-Order Differential Leveling Surveys. The contractor supplies Zone 7 with a copy of all field notes, benchmark data sheets, and a map showing the approximate route for the level runs and points

APPENDIX H

STAKEHOLDER COMMUNICATION AND ENGAGEMENT PLAN

Zone 7 Water Agency

STAKEHOLDER COMMUNICATION & ENGAGEMENT PLAN

FOR THE LIVERMORE VALLEY GROUNDWATER BASIN

August 2020

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Glossary / Abbreviations

AB	Assembly Bill
ACCDA	Alameda County Community Development Agency
ACEH	Alameda County Environmental Health
ACWD	Alameda County Water District
AF	acre-feet
AFY	acre-feet per year
ARM	Areal Recharge Model
C&E	Communication & Engagement
CCE	California Conservation Easements
CCR	California Code of Regulation
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
COL	Chain of Lakes
CPA	California Protected Area
CWC	California Water Code
DAC	Disadvantaged Communities
DSRSD	Dublin San Ramon Service District
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utilities District
EBRPD	East Bay Regional Park District
ft	feet
GDE	Groundwater-Dependent Ecosystem
GPQ	Groundwater Pumping Quota
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
LARPD	Livermore Area Recreation and Park District
LAVQAR	Livermore Amador Valley Quarry Area Reclamation
LLNL	Lawrence Livermore National Laboratory
MOU	Memorandum of Understanding
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OWTS	Onsite Wastewater Treatment System
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SBA	South Bay Aqueduct
SCEP	Stakeholder Communication and Engagement Plan
SDWIS	Safe Drinking Water Information System
SFPUC	San Francisco Public Utilities Commission
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SLDMWA	San Luis & Delta-Mendota Water Authority

SWP	State Water Project
TDS	total dissolved solids
TVC	Tri-Valley Conservancy
TWRC	Tri-Valley Water Retailers Group

1. INTRODUCTION

The Zone 7 Water Agency Groundwater Sustainability Agency (Zone 7) has developed this Stakeholder Communication and Engagement Plan (SCEP) to describe its approach to Communication & Engagement (C&E) throughout the 2021 Alternative Groundwater Sustainability Plan (2021 Alt GSP) development and implementation process. This SCEP was prepared in accordance with the California Water Code (CWC), the GSP Regulations (Title 23 of the California Code of Regulations [CCR] §354.10 [see text boxes inserted below]), and was informed by the California Department of Water Resources (DWR) *Guidance Document for Groundwater Sustainability Plan Stakeholder Communication and Engagement* (DWR, 2018).

1.1. SGMA Overview

The Sustainable Groundwater Management Act (SGMA) is a combination of three bills signed by the California Governor Jerry Brown in 2014: Assembly Bill (AB) 1739, Senate Bill (SB) 1168, and SB 1319[1]. This landmark legislation recognizes that groundwater is most effectively managed at the local level and provides local agencies with a framework and timeline to achieve or maintain groundwater sustainability.

In SGMA, sustainable groundwater management is defined as management of groundwater supplies in a manner that can be maintained in planning and implementation phases without causing "Undesirable Results". Undesirable Results include the "significant and unreasonable" chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and interconnected surface waters.

1.2. Communication & Engagement Plan Elements

The required elements of a SCEP and associated processes as documented in the GSP Regulations are summarized below.

§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

[1] Some minor changes of the legislation were made in SB 13 and AB 617 pertaining to Groundwater Sustainability Agency (GSA) formation, and AB 1390 and SB 226 pertaining to groundwater adjudication processes.

The C&E efforts described in this SCEP will help to ensure that beneficial uses and users of groundwater within the Livermore Valley Groundwater Basin (Basin) are adequately considered during the 2021 Alt GSP development and implementation process as required by GSP Regulations (23-CCR §354.10). Specifically, in this SCEP:

- **Section 2** includes a description of Zone 7's decision-making process (23-CCR §354.10(d)(1));
- **Section 3** identifies beneficial users within the Basin (23-CCR §354.10(a)) and describes how Zone 7 intends to engage with them, building upon its current understanding of stakeholders within the Basin (23-CCR §354.10(d)(3) and CWC §10723.4);
- **Section 4** includes a summary of information relating to communication by Zone 7 with other agencies and interested parties (23-CCR §354.10(d)(3));
- **Section 5** identifies and documents opportunities for public engagement and how public input and response will be incorporated into the 2021 Alt GSP development and implementation process (23-CCR §354.10(c); §354.10(d)(2) and §354.10(d)(4));
- **Section 6** describes the C&E implementation timeline, including when this SCEP will be updated to inform the public about the 2021 Alt GSP development and implementation progress, including the status of projects and management actions (23 CCR §354.10(d)(4)); and
- **Section 7** describes how Zone 7 will assess its C&E implementation during 2021 Alt GSP development and implementation.

2. GROUNDWATER SUSTAINABILITY AGENCY OVERVIEW

As shown in **Figure 1**, the "Plan Area" that is covered by the 2021 Alt GSP and managed by Zone 7 is the entire Livermore Valley Groundwater Basin. For the purposes of SGMA compliance, this SCEP is focused on the entirety of the Plan Area and outlines how Zone 7 intends to engage Basin stakeholders in the development and implementation of the 2021 Alt GSP.

2.1. GSA Description and Service Area Boundary

Zone 7 is one of the ten active zones of the Alameda County Flood Control and Water Conservation District (District). The Zone 7 service area encompasses approximately 425 square miles (272,000 acres) within the eastern portion of Alameda County and includes the Livermore-Amador Valley, the Sunol Valley, and portions of the Diablo Range (Zone 7, 2016a). Major cities within Zone 7 include the Cities of San Ramon, Dublin, Livermore, and Pleasanton.

The Zone 7 service area overlies almost all of the Livermore Valley Groundwater Basin (DWR 2-10), all of the Sunol Valley Groundwater Basin (DWR 2-11), and a small section of the Tracy Subbasin in the adjacent San Joaquin Valley Groundwater Basin (DWR 5-22.15). Consistent with its management responsibilities, duties, and powers, Zone 7 is designated in SGMA as the exclusive Groundwater Sustainability Agency (GSA) within its boundaries and, in electing to be the GSA for the Basin, will continue to exercise its groundwater management authority consistent with the District Act and with SGMA (Zone 7, 2016a).

A small portion of the Basin extends into Contra Costa County beyond the Zone 7 service area and into the service areas of the East Bay Municipal Utilities District (EBMUD), the City of San Ramon, and the Dublin San Ramon Service District (DSRSD). To provide management of this portion of the Basin, Zone 7 and the other overlying agencies have developed and adopted a Memorandum of Understanding (MOU) under which Zone 7 serves as the GSA for the Contra Costa portion of the Basin (Zone 7, 2016a).

The Sunol Valley Groundwater Basin is designated as very low priority and is therefore not subject to SGMA[2]. In the Tracy Subbasin, Zone 7 has executed a MOU with the San Luis & Delta-Mendota Water Authority (SLDMWA) to support SGMA compliance (Zone 7, 2016a), and a GSP for that subbasin is anticipated in January 2022.

[2] Per CWC §10727 (a), "A groundwater sustainability plan shall be developed and implemented for each medium- or high priority basin by a groundwater sustainability agency to meet the sustainability goal established pursuant to this part." Per CWC §10720.7 (b), "The Legislature encourages and authorizes basins designated as low- and very low priority basins by the department to be managed under groundwater sustainability plans pursuant to this part. Chapter 11 (commencing with Section 10735) does not apply to a basin designated as a low- or very low priority basin."

2.2. GSA Structure and Decision-Making Process

> *§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:*
> *(d) A communication section of the Plan that includes the following:*
> *(1) An explanation of the Agency's decision-making process.*

Key decisions regarding the 2021 Alt GSP development and implementation will be made by the Zone 7 Board of Directors (Board), which is also the governing body of the Zone 7 GSA.

2.2.1. Zone 7 Board Structure and Meetings

Zone 7 is overseen by a seven-member Board that is elected by the community to provide strategic guidance and planning for Zone 7's policies, programs and finances. Board members serve four-year terms and represent the public throughout the Livermore-Amador Valley.

Zone 7 Board meetings are open to the public and are held on the third Wednesday of every month at 7:00 p.m. at Zone 7's offices, located at 100 North Canyons Parkway in Livermore. Due to the COVID-19 pandemic, and pursuant to the Governor's Executive Order (N-29-20), Board meetings have recently been held online. Video recordings of the meetings are open to the public and can be accessed through the Tri-Valley Community Television website (http://www.tri-valleytv.org/?q=node/59). Board meeting agendas and packets are posted to the Zone 7 website (http://www.zone7water.com/library/board-meetings).

2.2.2. Board Committee Structure and Meetings

Board decision making is supported by four Board Committees including the Administrative Committee, the Liaison Committee, the Finance Committee, and the Water Resources Committee. Each Board Committee is composed of three Board members. Committee meetings are open to public and held on an "as needed" basis (Zone 7, 2012). Board committee assignments can be found on the Zone 7 website (http://www.zone7water.com/about-us/board-of-directors). The Water Resources Committee addresses both water and flood protection matters and will have direct involvement in the 2021 Alt GSP development and implementation.

2.2.3. Zone 7 Organizational Structure

The Board provides direction to Zone 7 management and staff through the Zone 7 General Manager and general counsel (Zone 7, 2016a). The General Manager is assisted by two Assistant General Managers with respective responsibility for Engineering and Finance. Three other Core Managers oversee the core functions of the Agency: Engineering, Operations and Maintenance, and Integrated Water Resources. Groundwater management falls under the Integrated Water Resources function and coordinates within the group to also achieve stream management and flood protection, long-term planning, watershed and water quality protection, environmental planning, Asset Management and Capital Improvement Program planning (Zone 7, 2016a). Zone 7's organizational chart is included as **Appendix A**.

2.3. Desired Outcome of 2021 Alt GSP Development and Implementation

For more than 50 years, Zone 7 has managed imported and local surface and groundwater resources for beneficial uses in the Basin. Given Zone 7's ongoing sustainable management of the Basin, DWR determined that the 2016 Alt GSP adopted by Zone 7 satisfied the objectives of the SGMA and approved the Plan in 2019[3].

As part of its approval of the 2016 Alt GSP, DWR provided four suggestions for how the 2021 Alt GSP could be improved (see **Appendix B**). Zone 7 successfully applied for a Sustainable Groundwater Management (SGM) Grant funded by the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (Proposition 68) to support the suggested refinements. As such, Zone 7's goal in developing and implementing the 2021 Alt GSP is to respond to DWR's comments while continuing to demonstrate that: (1) the Basin is being operated within its Sustainable Yield;[4] and (2) Zone 7 is successfully managing the groundwater resources within the Basin to prevent Undesirable Results.

2.4. Challenges for the Plan Area

Zone 7 anticipates and plans to address the following challenges in its development of the 2021 Alt GSP:

- A small portion of the Basin extends into Contra Costa County and outside of Zone 7's statutory boundaries. Coordination efforts are required among multiple entities, including Contra Costa County, Contra Costa County Water Agency, the City of San Ramon, DSRSD, and EBMUD. Zone 7 entered into a MOU with each of the above entities and has assumed the GSA role for that portion of the Basin (see **Appendix C**). Zone 7 will continue to actively involve and work cooperatively with these local agencies in its SGMA-related planning and programs.
- Urban and irrigated agriculture are the primary land uses in the Plan Area, including a portion of the City of Livermore that is a Disadvantaged Community (DAC). Some stakeholders may be concerned regarding how SGMA compliance could impact that land and water use, or costs. Zone 7 aims to be open and transparent in any decisions that will have a substantial impact on beneficial users of groundwater in the Plan Area and to engage stakeholders in the decision-making process to consider their interests and concerns.
- Based on varying geologic, hydrogeologic, and groundwater conditions, the Basin has three different Management Areas (23 CCR §354.20(a)), including the Main Basin, Fringe Subareas, and Upland Area. Groundwater pumping in the Fringe and Uplands Management Areas is minor relative to the Main Basin. Groundwater levels and other data are routinely monitored in portions of the Fringe and Uplands Management Areas; however, there are some areas of the Basin that are not adequately monitored. As part of the 2021 Alt GSP development, Zone 7 will be working to fill these data gaps.

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[3] The DWR Approval Letter regarding the Zone 7 2016 Alt GSP is posted on the Zone 7 website (http://www.zone7water.com/library/groundwater), accessed August 2010.

[4] SGMA defines Sustainable Yield as the maximum quantity of water (calculated over a base period representative of long-term conditions in the basin and including any temporary surplus) that can be withdrawn annually from a groundwater supply without causing an undesirable result. In 1992, Zone 7 Water Agency calculated the natural sustainable yield for the Basin at 7,214 acre-feet per year (Zone 7, 2016a).

- Zone 7 supports the current and expanded use of recycled water in the Tri-Valley, which results in lower consumption of potable water supplies, by updating the Salt Management Plan to address nutrient management and supporting retailer grant applications for recycled water infrastructure funding. Zone 7 has also been working closely with the retailers in exploring potential options for expanding recycled water use beyond irrigation applications. Potable reuse offers the benefits of being local and drought-proof; however, some key implementation issues remain to be resolved, including the need for using multiple treatment technologies for reliable purification and the feasibility of groundwater injection. Portions of the 2021 Alt GSP work will provide additional data and tools that can help evaluate the feasibility of these potential options to expand recycled water use.

3. STAKEHOLDER IDENTIFICATION AND COMMUNICATION

> *§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:*
> *(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.*

Zone 7 cooperates with the Regional Water Quality Control Board (RWQCB) - San Francisco Bay Region in the implementation of the Water Quality Control Plan (Basin Plan; RWQCB, 2015). In the Basin Plan, the RWQCB identifies beneficial uses and water quality objectives for surface water and groundwater in the Livermore Valley. Consistent with the Basin Plan, and in accordance with the interests listed in CWC §10723.2[5], Zone 7 identified current beneficial uses and users of groundwater and cooperative programs with groundwater users in the Basin in the 2016 Alt GSP (Zone 7, 2016a). Those key cooperative programs is summarized in **Table 1**, and beneficial uses and users of groundwater are described further below and in **Table 2**. Zone 7 welcomes all of the beneficial users of groundwater in the Basin, and the parties representing those interests, to participate in the 2021 Alt GSP development and implementation process through the venues for engaging described in **Section 5.**

3.1. Holders of Overlying Groundwater Rights

3.1.1. Agricultural Users

Zone 7 maintains maps of agricultural use within its service area, the majority of which are developed as vineyards or grazing, and tracks agricultural well locations. Agricultural demand accounted for a major portion of Basin groundwater use prior to the 1970s, but decreased significantly once imported surface water became available in 1974 (Zone 7, 2016a). Zone 7 provides approximately 5,600 acre-feet per year (AFY) of untreated surface water to local agriculture while agricultural pumping averaged approximately 400 AFY between 1974 and 2015 (Zone 7, 2016a; 2016b). Individual groundwater users have been active

[5] § 10723.2. The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans. These interests include, but are not limited to, all of the following:
(a) Holders of overlying groundwater rights, including:
(1) Agricultural users, including farmers, ranchers, and dairy professionals.
(2) Domestic well owners.
(b) Municipal well operators.
(c) Public water systems.
(d) Local land use planning agencies.
(e) Environmental users of groundwater.
(f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies.
(g) The federal government, including, but not limited to, the military and managers of federal lands.
(h) California Native American tribes.
(i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems.
(j) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency.

participants in prior Zone 7 groundwater-related planning efforts and numerous private well owners participate in Zone 7 groundwater monitoring programs.

3.1.2. Domestic Well Owners

As shown in the 2016 Alt GSP, there are numerous domestic wells located within the Plan Area. Individual groundwater users have been active participants in prior Zone 7 groundwater-related planning efforts and numerous private well owners participate in Zone 7 groundwater monitoring programs.

However, the actual quantity and distribution of active domestic wells within the Plan Area remains a source of uncertainty. Zone 7 seeks to compile additional information on the number, location and status of domestic wells, especially in the Fringe and Uplands Management Areas of the Basin. Zone 7 will be conducting direct outreach to land- and well-owners as part of the 2021 Alt GSP process to identify potential wells for future monitoring.

3.1.3. Commercial and Industrial Users

Groundwater is used for golf course irrigation; otherwise there is limited direct use of groundwater by commercial entities within the Basin.

A major industrial land use in the Plan Area is aggregate mining, conducted by various mining companies. Groundwater is extracted to dewater localized areas to facilitate the active mining of gravel. The extracted groundwater is stored in holding ponds and can be used for industrial mining purposes such as gravel washing and dust control. Zone 7 worked closely with Alameda County Planning Department and the mining companies in developing a quarry reclamation plan that recognizes the importance of groundwater recharge and conveyance through the mining area. This resulted in the Specific Plan for Livermore Amador Valley Quarry Area Reclamation (LAVQAR), wherein the mining area reclamation is being implemented to include a series of "lakes" (the Chain of Lakes [COL]) that will be owned and operated by Zone 7 for flood control and managed aquifer recharge (Alameda County Board of Supervisors, 1981).

3.2. Municipal Well Operators

Municipal pumpers constitute the majority of groundwater use within the Basin and include Zone 7, the City of Pleasanton, California Water Service (Cal Water), the San Francisco Public Utilities Commission (SFPUC), and the Alameda County Fairgrounds. In addition to Zone 7's ten municipal wells, Cal Water operates 12 wells in the Livermore area, the City of Pleasanton operates three wells, and SFPUC operates two wells (Zone 7, 2016a). The DSRSD receives pumped groundwater through Zone 7 (Zone 7, 2016a).

In 1992, Zone 7 calculated the natural sustainable yield for the basin at 7,214 AFY and collaborated with its retailers to allocate the yield (Zone 7, 2016a). As a result, each retailer is limited to an annual independent Groundwater Pumping Quota (GPQ), which is generally based on average historical use and is pro-rated based on the agreed upon natural sustainable yield. Together, the retailers are permitted to pump a total average of 7,214 AFY without paying recharge fees to Zone 7. Groundwater extraction is reported to Zone 7 on a monthly basis. Retailer-specific pumping averages are tracked by Zone 7, including a process of carry-overs (limited to 20% of the GPQ) and the assessment of recharge fees for all groundwater pumped in excess of the GPQ and carry-over credit (Zone 7, 2016a).

Zone 7 pumping is for municipal purposes, salt management, demand peaks, and to address any shortage or interruption in its surface water supply or treatment (Zone 7, 2016a). Zone 7 pumps only groundwater that has been stored in the Basin as part of its aquifer recharge program (i.e., over the long-term, Zone 7 only pumps groundwater in volumes equivalent to or less than its active recharge; Zone 7, 2016a). The timing and quantity of Zone 7's active recharge efforts are typically dependent upon available supply, available recharge capacities, source water quality, and regulatory requirements. Zone 7 pumping has ranged from zero (for example, in the wet years of the early 1980s) to significant pumping during the drought years, for example from 1987 to 1992 and from 2007 to 2009 (Zone 7, 2016a).

3.3. Public Water Systems

Zone 7 supplies the majority of the water within the Plan Area through its four retailers, including Cal Water, DSRSD, City of Livermore and City of Pleasanton. Three of these retailers (DSRSD, City of Livermore and City of Pleasanton) are public water supply agencies. The SFPUC supplies groundwater to the Castlewood Development in the western portion of Pleasanton (Zone 7, 2016a). Alameda County Fairgrounds, in Pleasanton, has a small water system that relies on groundwater.

The retailers and Zone 7 work together through various means of communication including the Tri-Valley Water Retailers Group (TWRG), consisting of staff from each retailer, and Liaison Committee meetings, consisting of both elected officials and staff (Zone 7, 2016a). Policy-level discussions related to water resources management is held through either the Water Resources Committee or Liaison Committee meetings. In addition to these formal meetings, the staff from operations and planning regularly meet to discuss annual operations, safety and emergency response, and long-term water supply planning (Zone 7, 2016a).

Zone 7 maintains close coordination with these public water systems within its service area. To the extent that additional public water systems are identified, they will be considered and engaged during the development and implementation of the 2021 Alt GSP.

3.4. Local Land Use Planning Agencies

The Basin is located mostly in Alameda County, with a northern extension into Contra Costa County. Cities overlying portions of the Basin include San Ramon, Dublin, Pleasanton, and Livermore. The Counties and Cities are responsible for land use planning in the Plan Area.

There are two Park Districts in the Valley: the East Bay Regional Park District (EBRPD) and the Livermore Area Recreation and Park District (LARPD). The Lake Del Valle State Recreation Area and Shadow Cliffs Regional Recreation Area located on the southern side of the Basin are operated by EBRPD (Zone 7, 2016a). In addition, the Tri-Valley Conservancy (TVC) protects open space for parks, farms, trails, ranches and wildlife habitat in the Tri-Valley. Most of the lands managed by TVC are in the Fringe and Upland Management Areas of the Basin (TVC, 2019).

Zone 7 maintains close coordination with the land use planning entities within its service area. To the extent that additional local land use planning agencies are identified, they will be considered and engaged during the development and implementation of the 2021 Alt GSP.

3.5. Environmental Users of Groundwater

Based on the 2016 Alt GSP and comments provide by DWR, there may be areas of the Basin that are considered a groundwater-dependent ecosystem (GDE), or where there is known surface water-groundwater interaction. These areas include, but are not necessarily limited to:

- The Springtown Alkali Sink (Sink) that is habitat for over a dozen Federally-listed, state-listed or state-listed-as-sensitive plant and animal taxa and includes plant communities that are globally or regionally rare or otherwise degraded. The Sink is also designated as Critical Habitat for vernal pools and some vernal pool species, and identified as predicted habitat for California red-legged frog, by the US Fish and Wildlife Service[6]. Recognized as such, most of the alkali sink and adjacent creeks are protected either as Preserves of the City of Livermore or conservation easements, or are owned and managed by Zone 7 or the Federal Communications Commission (Zone 7, 2016a).
- The prehistoric Pleasanton marsh complex extended over thousands of acres, including much of the Bernal and Castle Subareas and extending north into the Dublin Subarea and east into the Amador Subarea (Zone 7, 2016a). The existence of the marsh complex reflected the limited outlet of the Livermore-Amador Valley along Arroyo de la Laguna, resulting in shallow groundwater levels and ponding of floodwater. Arroyo de la Laguna is situated along the western edge of the Livermore-Amador Valley (and the former Pleasanton Marsh) and extends southward into the Sunol Valley Groundwater Basin, where it joins Alameda Creek (Zone 7, 2016a).

A significant focus of the 2021 Alt GSP is focused on improved delineation of GDEs in the Basin. To the extent that additional environmental users of groundwater are identified, they will be considered, and appropriate representatives will be engaged during the development and implementation of the 2021 Alt GSP.

3.6. Surface Water Users

Surface drainage features within the Basin include the Arroyo Valle, Arroyo Mocho, and Arroyo las Positas as principal streams, with Alamo Creek, South San Ramon Creek, and Tassajara Creek as minor streams draining from the north. All streams converge on the west side of the Basin to form Arroyo de la Laguna, which flows south, exiting the Livermore Valley and joining Alameda Creek in Sunol Valley. Both the Arroyo Valle and Arroyo Mocho originate in the woodland forests of the Burnt Hills region in Santa Clara County, in the sub-watershed above Lake Del Valle. These two streams and their tributaries cover the largest drainage areas within the Zone 7 service area. The Arroyo Las Positas mainly flows westerly along Interstate 580 and is fed by the Arroyo Seco, Altamont Creek, Cayetano Creek, Collier Canyon Creek, and Cottonwood Creek (Zone 7, 2016a).

As the water wholesaler for the Tri-Valley Area, Zone 7 imports surface water from the State Water Project (SWP) through the South Bay Aqueduct (SBA) for treatment, storage, and groundwater recharge. As part of Zone 7's managed recharge efforts, the imported water is discharged into the Arroyo Valley and Arroyo Mocho, where the underlying gravels allow the water to percolate into the Basin. Zone 7 supplies treated drinking water to its four retailers (i.e., Cal Water, Pleasanton, Livermore and DRSD), which deliver water

[6] See the California Department Fish and Wildlife interactive map https://apps.wildlife.ca.gov/bios/.

to customers in their specific service areas. Zone 7 also supplies untreated surface water for local industry and agriculture.

Numerous saline springs have been observed east of the Basin associated with upwelling along faults, especially those in the Greenville fault zone. Although minor springs contribute to the upper reaches of the Arroyo Mocho and Arroyo Valle above Lang Canyon, none of these springs contribute sufficient runoff to the arroyos to cause continuous flow in the streams (i.e., most are isolated and are subject to tectonic shifts and climatic conditions that impact the amount of flow emanating) (Zone 7, 2016a).

Other surface water bodies include the Chain of Lakes, which when completed will consist of ten quarry lakes in the western central Basin, and Lake Del Valle, a portion of which is located within the southern end of the Basin.

A significant focus of the 2021 Alt GSP is focused on improved delineation of surface water/groundwater interaction in the Basin. To the extent that additional areas of groundwater/surface water are identified, they will be considered and appropriate representatives will be engaged during the development and implementation of the 2021 Alt GSP.

3.7. The Federal Government

Based on application of DWR's SGMA Data Viewer, within the Plan Area there are several areas of California Department of Fish and Wildlife (CDFW) owned and operated lands and conservation easements, Nonprofit California Protected Area (CPA) holdings, and California Conservation Easements (CCE).

The Camp Parks Military Reservation/Reserve Forces Training Area is located on the northern boundary of the Basin and is operated by the Department of Defense/United States Army. The facility is a semi-active mobilization and training center for army reserve personnel to be used in case of war or natural disaster. The site also includes a federal correctional institution (Zone 7, 2016a).

To the extent that additional Federal and State landowners are identified, they will be also be considered and engaged during the development and implementation of the 2021 Alt GSP.

3.8. California Native American Tribes

There are no identified California Native American tribal lands within the Plan Area.

3.9. Disadvantaged Communities

There are three block groups identified as DACs based on an average household income less than 60% to 80% of the State median (U.S. Census, 2016). There are currently 2,598 disadvantaged households in the City of Livermore, with a total population of 6,678. Zone 7 will coordinate with the City of Livermore and community representative or groups, as appropriate, with respect to how to best engage with, and address the needs of, this DAC.

3.10. Groundwater Monitoring Entities

Zone 7 implements a groundwater elevation monitoring program within the Basin to track groundwater levels and flow, identify short- and long-term trends, estimate subsurface flows between Basin Management Areas, and support water budget and storage analyses. The groundwater elevation monitoring program consists of about 240 wells including 18 nested wells providing local information on vertical gradients (Zone 7, 2016a). These data will be incorporated into the 2021 Alt GSP.

3.11. Additional Stakeholders

As a water supply wholesaler, Zone 7 maintains close relationships with other groundwater users in the basin, and coordinates their actions with the groundwater monitoring and management activities of others (Zone 7, 2016a). **Table 1** below provides a summary of key cooperative programs.

Table 1. Summary of Cooperative Water Resource Management Programs

Water Resources Management Program	Other Local Agency	Zone 7 Cooperative Role
Onsite Wastewater Treatment System (OWTS)	Alameda County Environmental Health (ACEH)	Reviews permit applications; Zone 7 approval is required in some cases
Toxic Sites Surveillance (TSS)	RWQCB and ACEH	Tracks progress of site investigation/cleanup and provides input to lead agencies
Surface Mining Permits	Alameda County Community Development Agency (ACCDA)	Reviews permit changes and provides input as a future owner
Water Quality/Groundwater Elevation Monitoring	Retailers (City of Pleasanton, City of Livermore, DSRSD, Cal Water); Lawrence Livermore National Laboratory (LLNL)	Data sharing of water quality and elevation data
Referral Process (Development Reviews/ **California Environmental Quality Act** [CEQA] Reviews)	Cities of Pleasanton, Livermore, and Dublin, and Alameda County.	Review proposed site plans and comment on existing infrastructure as well as potential impacts
South Bay Contractors	Alameda County Water District (ACWD) and Santa Clara Valley Water District (SCVWD)	Work with other water agencies on allocating water supply available for recharge
Integrated Regional Water Management	San Francisco Bay Area water agencies	Local representative

Water Resources Management Program	Other Local Agency	Zone 7 Cooperative Role
Liaison Committee	Cities, retailers, DSRSD, Elected Officials	Local representative to provide input and information
Tri-Valley Potable Reuse Feasibility Study	Retailers	Evaluating feasibility of potable reuse for the Valley

Zone 7 has established positive ongoing working relationships with numerous other agencies involved in the basin including, but not limited to DWR, RWQCB, Alameda County, Contra Costa County, CDFW, U.S. Fish and Wildlife Service, National Marine Fisheries Service (NOAA-NMFS), and the U.S. Army Corps of Engineers. For example, Zone 7 was an early signatory to a Statement of Understanding for the development of NOAA-NMFS Multispecies Recovery Plan that explores responsible water management for the preservation of Oncorhynchus mykiss (steelhead trout) within the Alameda Creek watershed.

For development of the 2004 Salt Management Plan, Zone 7 assembled a Groundwater Management Advisory Committee including citizens and stakeholders and an independent Technical Advisory Group (including key stakeholders and water retailers). Similarly, the 2015 Nutrient Management Plan was developed with support and input from the RWQCB, ACEH, ACCDA, Zone 7 retailers, and other stakeholders and interested public. Most recently, the Tri-Valley Potable Reuse Feasibility Study was developed through a process involving a series of public Round Table discussions among representatives of Zone 7 and the retailers, along with extensive outreach to the public, including a survey (Zone 7, 2016a).

Table 2. Stakeholder Identification and Planned Engagement Summary

Organization/ Individual	Type of Stakeholder (a)	Anticipated Key Interests	Anticipated Key Issues (b)	Relevant Alt GSP Sections	Level of Engagement and Rationale (c)
Retailers (d)	Municipal Users and Public Water Systems	Preserving access to high quality groundwater for municipal uses	• Water quality degradation • 2021 Alternative Groundwater Sustainability plan (Alt GSP) development and implementation costs • Increased Recycled Water Use	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Agricultural Water Users	Agricultural Users	Preserving access to high quality groundwater for irrigation	• Potential curtailment of pumping • 2021 Alt GSP development and implementation costs	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Domestic Well Users	Domestic Well Owners	Preserving access to high quality groundwater for domestic users	• Water quality degradation • Declining water levels • 2021 Alt GSP development and implementation costs	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Industrial Well Users	Industrial Users	Continue to operate mining field	• Water quality degradation • Declining water levels from increased mining pit depths • 2021 Alt GSP development and implementation costs	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Commercial Well Users	Commercial Users	Continue to irrigate golf course	• Water quality degradation • 2021 Alt GSP development and implementation costs	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users

Organization/ Individual	Type of Stakeholder (a)	Anticipated Key Interests	Anticipated Key Issues (b)	Relevant Alt GSP Sections	Level of Engagement and Rationale (c)
SFPUC	Municipal Well Users	Preserving access to high quality groundwater for municipal uses	• Water quality degradation	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Alameda County Fairgrounds	Public Water System	Preserving access to high quality groundwater for municipal uses	• Water quality degradation	• Plan Area • Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Alameda County, Contra Costa County, City of San Ramon, City of Dublin, City of Pleasanton, and City of Livermore	Local Land Use Planning Agency	Managing County-wide or City-wide land use	• Implications for land use planning	• Plan Area • Projects and Management Actions	Inform and involve to avoid negative impact to these users
East Bay Regional Park District, Livermore Area Recreation and Park District, and Tri-Valley Conservancy	Local Land Use Planning Agency	Managing Regional-wide land use	• Implications for land use planning	• Plan Area • Projects and Management Actions	Inform and involve to avoid negative impact to these users
California Department of Fish and Wildlife, and Camp Parks Military Reservation / Reserve Forces Training Area	Federal Government	Managing Regional-wide land use	• Implications for land use planning	• Plan Area • Projects and Management Actions	Inform and involve to avoid negative impact to these users

Organization/ Individual	Type of Stakeholder (a)	Anticipated Key Interests	Anticipated Key Issues (b)	Relevant Alt GSP Sections	Level of Engagement and Rationale (c)
Groundwater Dependent Ecosystem (e)	Environmental Users	Preserving interconnected surface water and groundwater interactions	• Water quality degradation • Declining water levels	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Surface Drainage Features (f)	Surface Water Users	Preserving interconnected surface water and groundwater interactions	• Declining water levels	• Basin Setting • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users
Disadvantaged Communities	Disadvantaged Communities	Preserving access to high quality groundwater for domestic and municipal uses	• 2021 Alt GSP development and implementation costs	• Plan Area • Sustainable Management Criteria • Projects and Management Actions	Inform and involve to avoid negative impact to these users

Notes:

(a) Type of stakeholder based on CWC §10723.2 (e.g., agricultural groundwater users, municipal well operators, etc.).

(b) Any documented issues (media coverage, statements, reports, etc.), specific issues such as past events, or issues that have been otherwise communicated to or are anticipated by Zone 7.

(c) Level of engagement based on the International Association of Public Participation Spectrum of Public Participation, as referenced in DWR's Guidance Document for Groundwater Sustainability Plan Stakeholder Communication and Engagement (DWR, 2018).

(d) Retailers in the Basin include California Water Service, Dublin San Ramon Service District, City of Livermore, and City of Pleasanton.

(e) Known or suspected Groundwater Dependent Ecosystems within the Basin include the Springtown Alkali Sink and the prehistoric Pleasanton marsh complex.

(f) Surface drainage features within the Basin include the Arroyo Valle, Arroyo Mocho, and Arroyo las Positas as principal streams, with Alamo Creek, South San Ramon Creek, and Tassajara Creek as minor streams. Other surface drainage features include numerous saline springs and the South Bay Aqueduct.

4. STAKEHOLDER ENGAGEMENT AND FREQUENTLY ASKED QUESTIONS

> *§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:*
> *(d) A communication section of the Plan that includes the following:*
> *(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.*

Zone 7 has developed objectives that support a basic philosophy of working cooperatively with groundwater stakeholders in the Basin including the public, irrigation and domestic well owners, gravel mining companies, TWRG, water purveyors, and planning agencies. These objectives include:

- develop information, policies, and procedures for the effective long-term management of the groundwater basin;
- inform the public and relevant governmental agencies of the Zone's water supply potential and management policies and to solicit their input and cooperation; and
- work cooperatively with the gravel mining industry to implement the Chain of Lakes reclamation plan.

Zone 7 involves the public, stakeholders and local agencies in its planning and programs through meetings, data sharing, and online media and has memorialized this approach as an operational policy in the Agency's 1987 Statement on Groundwater Management (Zone 7, 2016a)[7].

Zone 7's C&E efforts described herein specifically aim to provide beneficial uses and users of groundwater within the Basin with opportunities to engage in the 2021 Alt GSP development and implementation process. Zone 7 will provide on-going outreach opportunities through the specific communication venues discussed in **Section 5**.

Zone 7 further aims to convey consistent high-level messaging to all stakeholders throughout 2021 Alt GSP development and implementation. As such, Zone 7 has developed a summary of anticipated questions as well as responses. **Table 3** will be updated to add additional, frequently received questions as well as to build upon responses based on 2021 Alt GSP development progress.

Table 3. Likely Stakeholder Questions and Responses

Likely Questions	Responses
How can I participate in the 2021 Update of Alt GSP development and implementation process?	Zone 7 Board meetings are open to the public and held on the third Wednesday of every month. Board meeting agendas and packets are posted to the Zone 7 website: (http://www.zone7water.com/library/board-meetings).

[7] Objectives include: "To inform the public and relevant governmental agencies of the Zone's water supply potential and management policies, and to solicit their input and cooperation."

Likely Questions	Responses
What types of management actions or projects have been done or are going to occur in my area?	Zone 7 has implemented several management actions that are outlined in the Well Master Plan (2003), Salt Management Plan (2004), Nutrient Management Plan (2015), and 2016 Alt GSP. Additional management actions or projects have not been identified yet, as we are in the preliminary stages of the 2021 Alt GSP development.
Are pump meters going to be required?	At this point Zone 7 does not plan to require meters for single family residential, domestic, or agricultural wells.
Can groundwater management activities improve water challenges in DACs?	Zone 7 has implemented several long-term management actions (listed above) to improve the water quality and to ensure future water supply for DACs.
Who is paying for 2021 Alt GSP development and implementation?	Funding for the 2021 Alt GSP development is provided by Zone 7 and the DWR SGM Grant funded by Proposition 68.
How will Zone 7 resolve groundwater conflicts?	The Livermore Valley Groundwater Basin is not adjudicated; therefore, the State of California governs water rights and ownership. Zone 7 will work with landowners and the State to provide guidance and local data to resolve groundwater conflicts.
Why does my water taste funny/musty?	During the warm summer months, algae that produces a musty/muddy odor can grow in the surface waters of the South Bay Aqueduct (SBA), from which the Tri-Valley gets 80% of its water supply. DWR, which controls the SBA, treats the water periodically to minimize the growth of algae. Zone 7 is also in the process of building two ozone facilities that provide additional treatment to reduce the musty taste caused by algae. Consumer Confidence Report provided information on local drinking water quality can be accessed through the website here: http://www.zone7water.com/36-public/content/120-consumer-confidence-report.
Why is my water so hard? Why are there white spots on my glassware or car after washing?	In the late 1980s, total dissolved solids (TDS) concentrations increased in the Basin and have been relatively steady since that time. Zone 7 has been proactively addressing TDS concentrations, including implementing demineralization projects, both ongoing (Mocho Wellfield demineralization) and planned (Tri-Valley Recycled Water Project).
Is my water contaminated with Nitrate/Chromium/Boron/PFAS?	While these constituents of concern are present in the Basin, Zone 7 closely monitors the extent of these constituents and ensures that the concentrations of these constituents do not exceed any drinking water limits when introduced into the water distribution system.

Likely Questions	Responses
Does my well require CEQA compliance?	Currently CEQA compliance for supply wells is discretionary (i.e., at the discretion of the local agency); however, the California Supreme Court is currently evaluating whether or not this should be mandatory or not.
Is groundwater pumping causing land subsidence?	Zone 7 surveyed the land surface in the vicinity of our municipal wells in Pleasanton between 2002 and 2018 and has been monitoring the land surface over the entire Tri-Valley using InSAR since 2016. We have not seen any evidence of inelastic land subsidence from groundwater pumping.

5. VENUES FOR ENGAGING

§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

Zone 7 has historically provided, and will continue to provide, a variety of opportunities for engagement with stakeholders per (23-CCR §354.10(d)(1)). Stakeholder input received will inform and be incorporated into corresponding sections of the 2021 Alt GSP, as appropriate.

A list of public meetings at which the 2021 Alt GSP has been discussed or considered by Zone 7 is included as **Appendix D** and will be updated regularly (23-CCR §354.10(b)).

5.1. Zone 7 Board Meetings

Zone 7 Board meetings are open to the public and are held on the third Wednesday of every month at 7:00 p.m. at Zone 7's offices, located at 100 North Canyons Parkway in Livermore. Due to the COVID-19 pandemic, and pursuant to the Governor's Executive Order (N-29-20), Board meetings have recently been held online. Video recordings of the meetings are available to the public and can be accessed through the Tri-Valley Community Television website (http://www.tri-valleytv.org/?q=node/59). Board meeting agendas and packets are posted to the Zone 7 website (http://www.zone7water.com/library/board-meetings).

Zone 7 intends to inform its stakeholders of key updates and decisions regarding the 2021 Alt GSP during public Board meetings. These meetings provide a key venue for public engagement and discussion and will be where comments on the 2021 Alt GSP will be documented and addressed, as appropriate. Presentation materials will be posted on the SGMA website, discussed below.

As part of the Alt GSP implementation efforts, Zone 7 will continue to use the Board meetings as a venue to inform the public about 2021 Alt GSP implementation progress, including the status of projects and actions (23-CCR §354.10(d)(4)).

5.2. Website Communication

Zone 7 regularly updates its website (https://www.zone7water.com/) with Board meeting materials as described in **Section 2.2.1**. It also includes a webpage that includes significant reports related to its water resources and groundwater (https://www.zone7water.com/library/reports-planning-documents). Stakeholders can sign up to receive newsletters and other communications from Zone 7 directly from the website: https://www.zone7water.com/news/enewsletter-signups.

A new, dedicated webpage that briefly summarizes SGMA, the Alt GSP, Annual Reporting, and Five-Year Update process will be developed as part of the 2021 Alt GSP development effort. This updated webpage will provide information to the public and other agencies to encourage public involvement in the SGMA process.

5.3. Stakeholder Outreach

Zone 7 currently envisions directly engaging with key stakeholders throughout the development of the 2021 Alt GSP (e.g., Tri-Valley Retail Group and the local land use and regulatory agencies). Zone 7 will keep records of all stakeholder outreach efforts, which will also be included as **Appendix D**.

Zone 7 initiated an "Open House" event in October 2019, and intends to hold similar public engagement event annually to showcase Zone 7's facilities, operations, and projects, including SGMA and other groundwater management efforts. Website and radio advertisement links for the 2019 Open House Are shown in **Appendix D**. However, due to the COVID-19 pandemic, public engagement event for 2020 has not yet been decided.

5.4. Public Review of Draft Materials

Zone 7 plans to make a public draft version of the 2021 Alt GSP available for public review for a period of at least 30 days. A Public Hearing prior to the adoption of the Plan will also be held. Feedback received on the draft document will be noted and responses incorporated into the Final 2021 Alt GSP (23-CCR §354.10(c)).

5.5. Agencywide Annual Report

Every year, Zone 7 produces an agencywide annual report, which can be accessed directly from the website: http://www.zone7water.com/reports-a-planning-documents. The agencywide annual report includes information regarding Zone 7's key accomplishments, outreach and education events, supply and demand, and water quality.

6. IMPLEMENTATION TIMELINE

Zone 7's C&E implementation efforts will be aligned with the 2021 Alt GSP development timeline, as described in **Table 4** below.

Table 4. 2021 Update of Alternative Groundwater Sustainability Plan and Communication & Engagement Efforts by Phase

Alt GSP Element	Timeframe	2021 Alt GSP Efforts	C&E Efforts
Plan Stakeholder Engagement	July 2020 – December 2021	• Data collection and review	• Develop and begin to implement SCEP • Begin website update
Groundwater Level Program Update	July 2020 – December 2021	• Data collection and review • Revise Depth to Water and Historic Low Maps • Review/Develop Measurable Objectives, Minimum Thresholds	• Outreach to existing well owners • Conduct meetings with key stakeholders • Present progress update at one (1) Board meeting • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development
Groundwater Storage Program Update	July 2020 – September 2021	• Extend Existing Hydrogeologic Framework • Migrate and Extend Areal Recharge Model (ARM) • Review/Develop Measurable Objectives, Minimum Thresholds	• Conduct meetings with key stakeholders • Present progress update at one (1) Board meeting • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development
Groundwater Quality Program Update	July 2020 – December 2021	• Update TDS and Nitrate Projections • Evaluate Effectiveness of NMP • Review/Develop Measurable Objectives, Minimum Thresholds	• Conduct meetings with key stakeholders • Present progress update at one (1) Board meeting • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development
Land Subsidence Program Update	July 2020 – December 2021	• Evaluate Use of InSAR	• Conduct meetings with key stakeholders • Present progress update at one (1) Board meeting • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development

Surface Water - Groundwater Interaction / GDE Program Update	July 2020 – September 2021	• Confirm presence of GDEs • Assess Groundwater Needs for Sustainability • Review/Develop Measurable Objectives, Minimum Thresholds • Evaluate the Need for New Monitoring Locations and Protocols	• Conduct meetings with key stakeholders • Present progress update at one (1) Board meeting • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development
Prepare 2021 Alt GSP Report	July 2020 – December 2021	• Compile complete draft 2021 Update of Alt GSP • Revise draft 2021 Update of Alt GSP (if necessary) per stakeholder feedback • Finalize 2021 Update of Alt GSP Chapter and submit to DWR	• Distribute public review draft 2021 Alt GSPs for public review • Incorporate feedback from public review in 2021 Alt GSP • Present progress update at one (1) Board meeting • Hold Public Hearing to adopt 2021 Alt GSP • Update SCEP, as needed to reflect C&E efforts during 2021 Alt GSP development

7. EVALUATION AND ASSESSMENT

Zone 7 intends to assess its C&E implementation during the 2021 Alt GSP development process, as shown in **Table 4**. Zone 7 will also present brief summaries of C&E progress at Zone 7 Board meetings and will lead a discussion about lessons learned and what can be improved as part of future SGMA implementation. The following questions will guide C&E evaluation:

- What worked well?
  - What allowed us insight into stakeholder concerns?
  - What types of materials best communicated GSP development to stakeholders?
- What didn't work as planned?
  - Could materials (e.g., presentation slides, fact sheets, website pages) have been improved to better communicate 2021 Alt GSP development progress?
  - Are certain stakeholder groups less represented in the 2021 Update of Alt GSP development process than they should be?
- What do we plan on doing differently during the next phase based on what we have learned?
- How much of our C&E budget have we spent relative to work completed? Do we have enough remaining budget to complete our C&E plan?
- Are there any outreach venues that need to be added to the implementation timeline?
- What are the next steps?

REFERENCES AND TECHNICAL STUDIES

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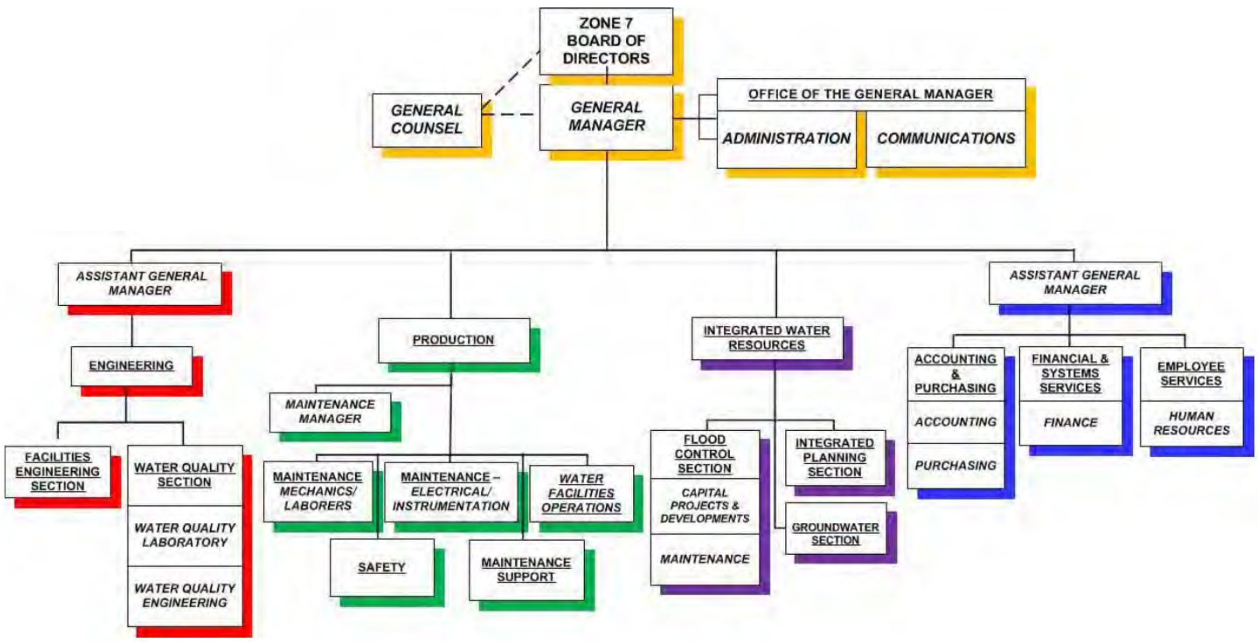
APPENDIX A

Zone 7 Organizational Chart



APPENDIX B

Summary of DWR Recommendations

The following recommended actions include information that the District may wish to include in the first five-year update of the Alternative to facilitate the Department's ongoing evaluation and assessment of the Alternative as well as recommendations for improvements to the Alternative.

Recommended Action 1.
Staff recommends that in the first update to the Alternative Report, the Agency identify those groundwater levels taken at representative monitoring sites, that are used to define the minimum threshold for the Basin, to facilitate the Department's ongoing responsibility to evaluate the Alternative Report.

Recommended Action 2.
Staff recommends that the Agency should develop quantitative minimum thresholds for the chronic lowering of groundwater levels for the Fringe and Upland management areas to better align with the requirements for management areas and definition of minimum thresholds, as defined in 23 CCR Sections 354.20(b)(2) and 354.28(b)(6).

Recommended Action 3.
Staff recommends that the Agency develop quantitative minimum thresholds for reduction of groundwater storage for the Fringe and Upland management areas to better align with the requirements for management areas and definition of minimum thresholds, as defined in 23 CCR Sections 354.20(b)(2) and 354.28(b)(6).

Recommended Action 4.
Staff recommends that the Agency include monitoring groundwater levels at additional locations in the Uplands Management Area to monitor changes in groundwater conditions and manage the groundwater resources to prevent undesirable results in future updates to the Alternative Report. The Agency should identify the frequency and timing when groundwater levels would be collected at new monitoring stations, and other relevant monitoring well construction information in accordance with the GSP Regulations.

APPENDIX C

Memorandums of Understanding with Other Agencies

MEMORANDUM OF UNDERSTANDING
AMONG
ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT,
CONTRA COSTA COUNTY,
CONTRA COSTA COUNTY WATER AGENCY,
CITY OF SAN RAMON,
EAST BAY MUNICIPAL UTILITY DISTRICT
AND
DUBLIN SAN RAMON SERVICES DISTRICT

This memorandum of understanding (MOU) is made and entered among Contra Costa County (CCC), Contra Costa County Water Agency (CCCWA), the City of San Ramon (San Ramon), the East Bay Municipal Utility District (EBMUD) and the Dublin San Ramon Services District (DSRSD) (together, the Five Parties) and Zone 7 of the Alameda County Flood Control and Water Conservation District (Zone 7) in consideration of the factual recitals and mutual obligations contained herein.

WITNESSTH

WHEREAS, the Sustainable Groundwater Management Act of 2014 (SGMA) requires the formation of Local Groundwater Sustainability Agencies (GSAs) and the adoption of Groundwater Sustainability Plans for high- and medium-priority basins within five to seven years; and

WHEREAS, while the majority of the Livermore-Amador Valley Groundwater Basin (DWR Groundwater Basin No. 2-10, hereinafter referred to as "Basin No. 2-10"), a medium priority basin, lies within the boundaries of Alameda County and the jurisdiction of Zone 7, portions lie within the boundaries of Contra Costa County and the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD; and

WHEREAS, SGMA identified Zone 7 as the exclusive local agency to be the GSA for managing groundwater within its statutory boundaries (Water Code, § 10723, subd. (c)(1)(A)), and those statutory boundaries include the portion of Basin No. 2-10 lying within Alameda County, which comprises the majority of the basin; and

WHEREAS, the Five Parties agree it would be prudent for Zone 7 to also manage the small remaining portion of Basin No. 2-10 that lies within the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD to achieve effective groundwater management; and

WHEREAS, it is in the interests of the Five Parties and Zone 7 to maintain current levels of jurisdictional authority while striving for holistic, sustainable groundwater basin management; and

WHEREAS, it is mutually beneficial to create this agreement to establish a delegation of authority to allow Zone 7 to be the GSA for the remaining portion of Basin No. 2-10 within the jurisdictions of CCC, CCCWA, San Ramon, DSRSD, and EBMUD to assure sustainable groundwater management;

NOW, THEREFORE, the Five Parties and Zone 7 do hereby agree as follows:

1. Purposes of MOU. The purposes of this MOU are (1) for each of the Five Parties to agree to confer to Zone 7 certain Delegated Authority (as that term is defined in Paragraph 2.A below) within the Delegated Area (as that term is defined in Paragraph 3 below), and (2) for Zone 7 to agree to exercise the Delegated Authority within the Delegated Area.

2. Authority and Responsibility.

   A. Upon execution of this MOU, and upon final approval by California Department of Water Resources recognizing Zone 7 as the GSA responsible for the portion of Basin No. 2-10 lying within the area described in Paragraph 3 of this MOU, the Five Parties agree to delegate to Zone 7 all functions, powers, duties, and authority of a GSA conferred by SGMA. Notwithstanding any other provision of this MOU, the following authority shall not be delegated to Zone 7: (1) CCC shall continue to be the well permitting agency for all areas within its jurisdiction, (2) San Ramon and CCC shall continue to be the land use agencies for all areas within their respective jurisdictions, and (3) EBMUD and DSRSD shall continue to be the water supply agencies for all areas within their respective jurisdictions. The authority delegated by this Paragraph 2.A is referred to herein as the "Delegated Authority".

   B. Zone 7 agrees to assume and exercise all responsibilities required of a GSA, and to enforce all provisions and requirements contained in the Groundwater Sustainability Plan to be adopted for Basin No. 2-10 in accordance with SGMA. Zone 7 shall continue to monitor groundwater elevations within the Designated Area and to enter data into CASGEM as required in order to maintain grant eligibility.

3. Geographic Extent of Delegated Authority. The Delegated Authority shall have effect in that portion of Basin No. 2-10 which lies within the jurisdictional boundaries of each of the Five Parties, which portion is depicted in Exhibit A and is referred to herein as the "Delegated Area".

4. Records. Zone 7 shall provide each of the Five Parties copies of all documents, reports, studies and other records created in the course of its exercise of the Delegated Authority which affects or relates to groundwater management within the Delegated Area. CCC shall provide Zone 7 with copies of all well permits issued or environmental reports received (including well completion reports) and any water level measurements taken within the Delegated Area. Zone 7 and the Five Parties shall cooperate and coordinate in responding to requests made under the California Public Records Act regarding records related to groundwater management within the Delegated Area.

5. Term. This MOU becomes valid and effective immediately upon execution by each of the Five Parties and Zone 7 and shall remain in effect unless terminated pursuant to Paragraph 9, below.

6. Entire Agreement. This MOU shall constitute the entire agreement among the Five Parties and Zone 7 relating to the delegation of authority provided by SGMA as relates to Basin No. 2-10. This MOU supersedes and merges all previous understandings, and all other agreements, written or oral, between the parties and sets forth the entire

understanding of the parties regarding the subject matter thereof.

7. Counterparts and Copies. This MOU may be executed in any number of counterparts, each of which may be deemed an original and all of which collectively shall constitute a single instrument. Photocopies, facsimile copies, and PDF copies of this MOU shall have the same force and effect as a wet ink original signature on this MOU.

8. Amendment. This MOU may be amended at any time by a written agreement duly executed by each of the Five Parties and Zone 7.

9. Termination.

A. This MOU may be voluntarily terminated in full at any time by a writing signed by each of the Five Parties and Zone 7.

B. Any of the Five Parties may elect to terminate its participation in this MOU at any time. Termination of such party's participation in this MOU shall not become effective until after both of the following have occurred: (1) the terminating party provides written notice to all other signatories to this MOU of its intent to terminate its participation, and (2) one year has elapsed following the date of such written notice, during which time the terminating party may make efforts to assume the GSA role for the portion of the Delegated Area within the terminating party's jurisdiction. The termination of any of the Five Parties' participation in this MOU shall not affect the continuing validity of the MOU with respect to the remaining signatories.

C. Zone 7 may provide written notice to each of the Five Parties of its intent to terminate the Agreement, and the MOU shall cease to be of further effect one year following delivery of Zone 7's notice, during which time Zone 7 shall continue to exercise the Delegated Authority within the Delegated Area to allow adequate time for the Five Parties to address GSA related requirements for their respective portions of the Delegated Area.

10. Signatures. The individuals executing this MOU represent and warrant that they have the legal capacity and authority to do so on behalf of their respective legal entities.

IN WITNESS WHEREOF, the parties hereto have executed this MOU as follows:

CONTRA COSTA COUNTY	ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT
By:______________________	By: [signature] 21 Apr 2016
President, BOS Dated:	G.F. Duerig Dated:

understanding of the parties regarding the subject matter thereof.

7. Counterparts and Copies. This MOU may be executed in any number of counterparts, each of which may be deemed an original and all of which collectively shall constitute a single instrument. Photocopies, facsimile copies, and PDF copies of this MOU shall have the same force and effect as a wet ink original signature on this MOU.

8. Amendment. This MOU may be amended at any time by a written agreement duly executed by each of the Five Parties and Zone 7.

9. Termination.

A. This MOU may be voluntarily terminated in full at any time by a writing signed by each of the Five Parties and Zone 7.

B. Any of the Five Parties may elect to terminate its participation in this MOU at any time. Termination of such party's participation in this MOU shall not become effective until after both of the following have occurred: (1) the terminating party provides written notice to all other signatories to this MOU of its intent to terminate its participation, and (2) one year has elapsed following the date of such written notice, during which time the terminating party may make efforts to assume the GSA role for the portion of the Delegated Area within the terminating party's jurisdiction. The termination of any of the Five Parties' participation in this MOU shall not affect the continuing validity of the MOU with respect to the remaining signatories.

C. Zone 7 may provide written notice to each of the Five Parties of its intent to terminate the Agreement, and the MOU shall cease to be of further effect one year following delivery of Zone 7's notice, during which time Zone 7 shall continue to exercise the Delegated Authority within the Delegated Area to allow adequate time for the Five Parties to address GSA related requirements for their respective portions of the Delegated Area.

10. Signatures. The individuals executing this MOU represent and warrant that they have the legal capacity and authority to do so on behalf of their respective legal entities.

IN WITNESS WHEREOF, the parties hereto have executed this MOU as follows:

CONTRA COSTA COUNTY	ZONE 7 OF THE ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT
By: [signature]	By:________________________
President, BOS Dated:12/22/16	G.F. Duerig Dated:

CONTRA COSTA WATER AGENCY

By:______________________________

CITY OF SAN RAMON

By:______________________________

DUBLIN SAN RAMON SERVICES DISTRICT

By:______________________________

EAST BAY MUNICIPAL UTILITY DISTRICT

By:______________________________ 8/19/16
Richard Sykes Dated:
Director of Water
and Natural Resources

CONTRA COSTA WATER AGENCY

By:______________________________

CITY OF SAN RAMON

By:______________________________

DUBLIN SAN RAMON SERVICES DISTRICT

By: [signature] 10/20/16

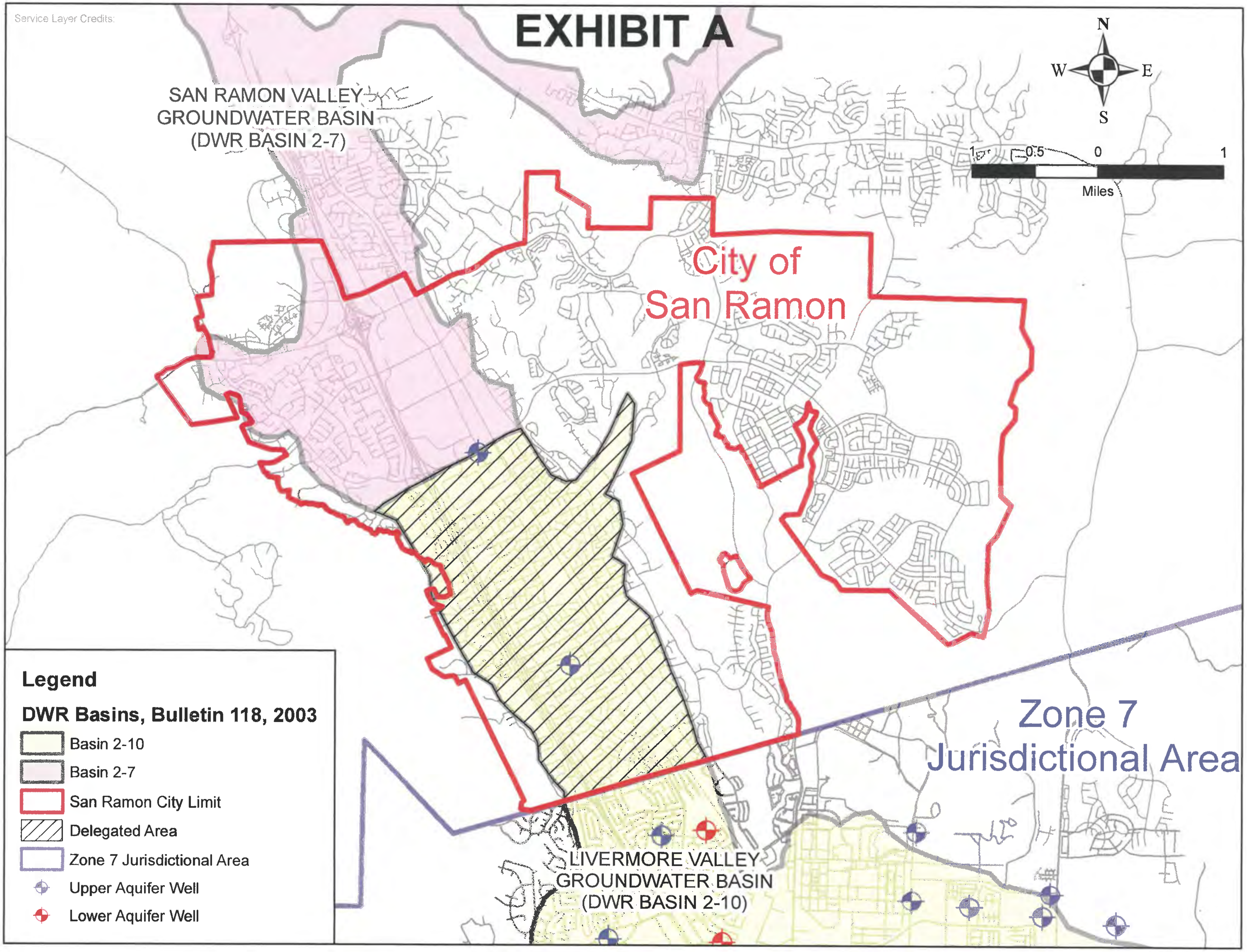
Dan McIntyre Dated:
General Manager

EAST BAY MUNICIPAL UTILITY DISTRICT

By:______________________________

Richard Sykes Dated:
Director of Water
and Natural Resources

EXHIBIT A


Service Layer Credits:
N
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SAN RAMON VALLEY GROUNDWATER BASIN (DWR BASIN 2-7)
City of San Ramon
Zone 7 Jurisdictional Area
LIVERMORE VALLEY GROUNDWATER BASIN (DWR BASIN 2-10)
Legend
DWR Basins, Bulletin 118, 2003
Basin 2-10
Basin 2-7
San Ramon City Limit
Delegated Area
Zone 7 Jurisdictional Area
Upper Aquifer Well
Lower Aquifer Well

APPENDIX D

Stakeholder Outreach Efforts (updated 8/10/2020)

Date	Stakeholder	Outreach Efforts	Contacted	Outreach Response
Oct 12, 2019	Public	• Zone 7 Open House	• Public advertisements	Staff answered verbal questions from the public
June 17, 2020	Public	• Presentation at Board meetings: Grant Project 2021 Update to Alternative Groundwater Sustainability Plan for Livermore Valley Groundwater Basin	• Public	No comments or questions from the public
June 23, 2020	Public	• E Newsletter: Zone 7 Groundwater Management Efforts Supported with Half Million Dollar Grant	• Public	No comments or questions from the public
October 16, 2020	Public	• A dedicated webpage for the Alternative GSP is developed (www.zone7water.com/altgsp). This webpage will provide information to the public and other agencies to encourage public involvement in the SGMA process	• Public	No comments or questions from the public
January 21, 2021	RWQCB	• Presentation on the background of the 2021 Alternative GSP Update, and the salt and nutrient management tasks that will be included in the Alternative GSP update.	• RWQCB	No comments or questions from RWQCB
May 5, 2021	Public	• Presentation at Board meetings: Proposition 68 Grant Progress Alternative Groundwater Sustainability Plan 2021 Update	• Public	No comments or questions from the public