



Memorandum

To: Carolyn Ruttan, Lake County

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Date: December 28, 2016

Subject: Lake County Groundwater Use and Storage

1.0 Introduction

1.1 Background

There are thirteen groundwater basins within Lake County (County) that are being managed under the *Lake County Groundwater Management Plan* (CDM 2006) adopted in 2006. The California Department of Water Resources (DWR) has identified two of these basins, Big Valley and Scotts Valley (see Figure 1), as medium priority basins under the Sustainable Groundwater Management Act (SGMA). Under SGMA, both basins must have an adopted Groundwater Sustainability Plan (GSP) by January 31, 2022.

As permitted under SGMA, Lake County has chosen to submit information to DWR in support of an Alternative to a Groundwater Sustainability Plan (Alternative). CDM Smith has reviewed several data sources to assist the County with the Alternative submittal. An Alternative must be submitted to DWR on or before January 1, 2017 and every five years subsequent to the initial submittal. The Alternative must be consistent with one of the following (Water Code §10733.6(b)):

1. A plan developed pursuant to Part 2.75 (commencing with Section 10750) or other law authorizing groundwater management.
2. Management pursuant to an adjudication action.
3. An analysis of basin conditions that demonstrates that the basin has operated within its sustainable yield over a period of at least 10 years.

This memorandum outlines several data sources that can be used to provide background on groundwater use, factors that affect groundwater, and groundwater conditions within the Big Valley and Scotts Valley groundwater basins and will make a demonstration that these groundwater basins have been managed with their sustainable yields.

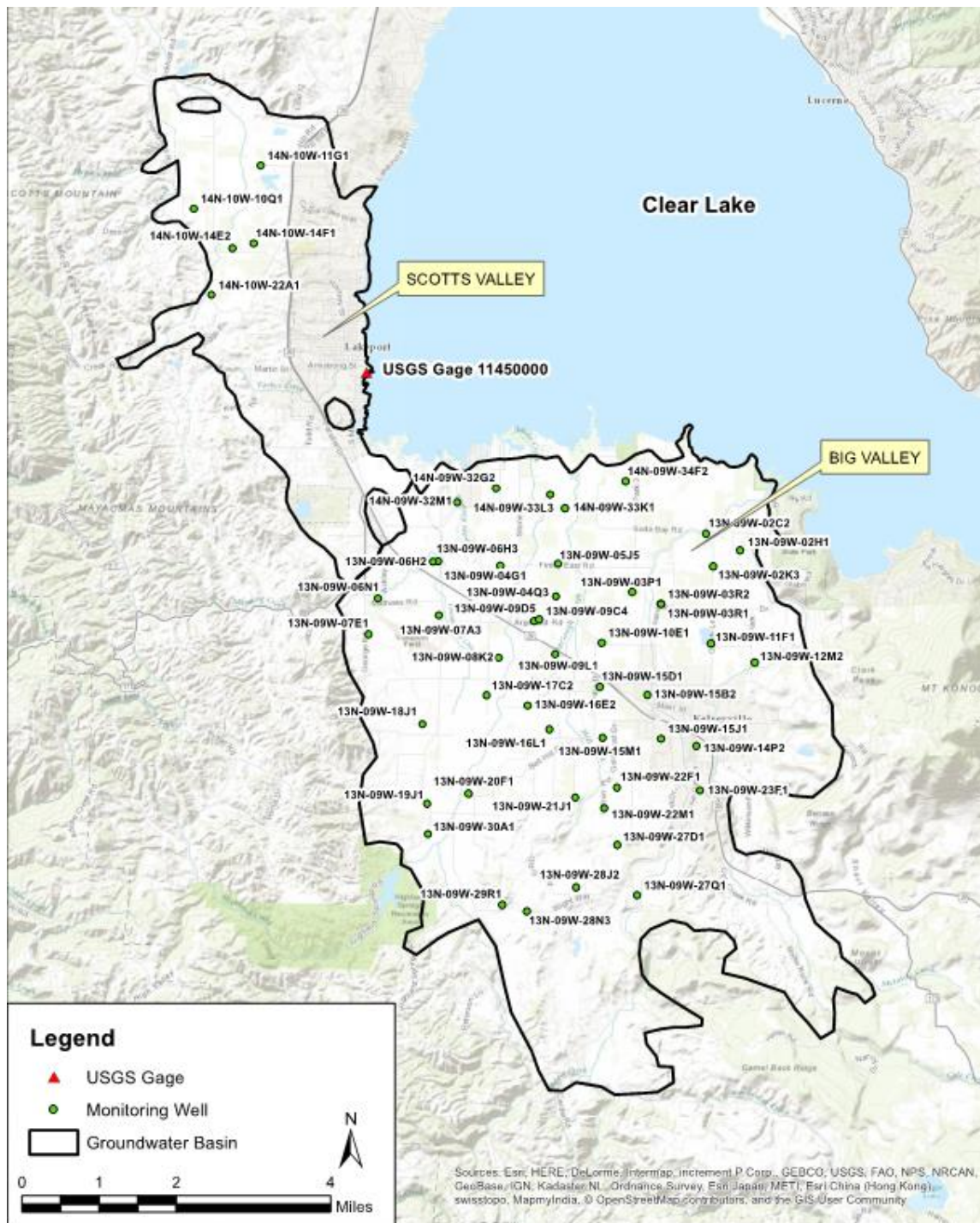


Figure 1. Location Map

1.1.1 Big Valley Groundwater Basin

The Big Valley Groundwater Basin (Big Valley) (DWR basin ID 5-015) covers 24,210 acres, supplies water to Kelseyville and is the largest agricultural area in the County. The basin is bordered by Clear Lake to the north, the Clear Lake Volcanics to the east, and the Franciscan Formation to the west and south. Adobe and Kelsey Creeks flow through Big Valley and drain to the north into Clear Lake. Additional information regarding the hydrogeologic conditions of the Big Valley basin can be found in many existing reports including the *Lake County Groundwater Management Plan* (CDM 2006). DWR estimates the storage capacity of Big Valley to be 105,000 acre-feet, with usable storage of approximately 60,000 acre-feet (DWR 2003).

1.1.2 Scotts Valley Groundwater Basin

The Scotts Valley Groundwater Basin (Scotts Valley) (DWR basin ID 5-014) covers 7,320 acres and supplies water to the City of Lakeport and adjacent areas, west of Clear Lake. The basin includes Scotts Valley, the foothills between Scotts Valley and Clear Lake, and the foothills immediately to the south of Lakeport. The south end of Scotts Valley serves as the principal recharge area for the entire valley (W. A. Wahler 1970). Surface water flow in Scotts Creek percolates into the aquifer at a rate of approximately 1,000 acre-feet per month (W. A. Wahler 1970). Additional information regarding the hydrogeologic conditions of the Scotts Valley basin can be found in many existing reports including the *Lake County Groundwater Management Plan* (CDM 2006). DWR estimates the storage capacity of Scotts Valley to be 5,900 acre-feet, with usable storage of approximately 4,500 acre-feet (DWR 2003).

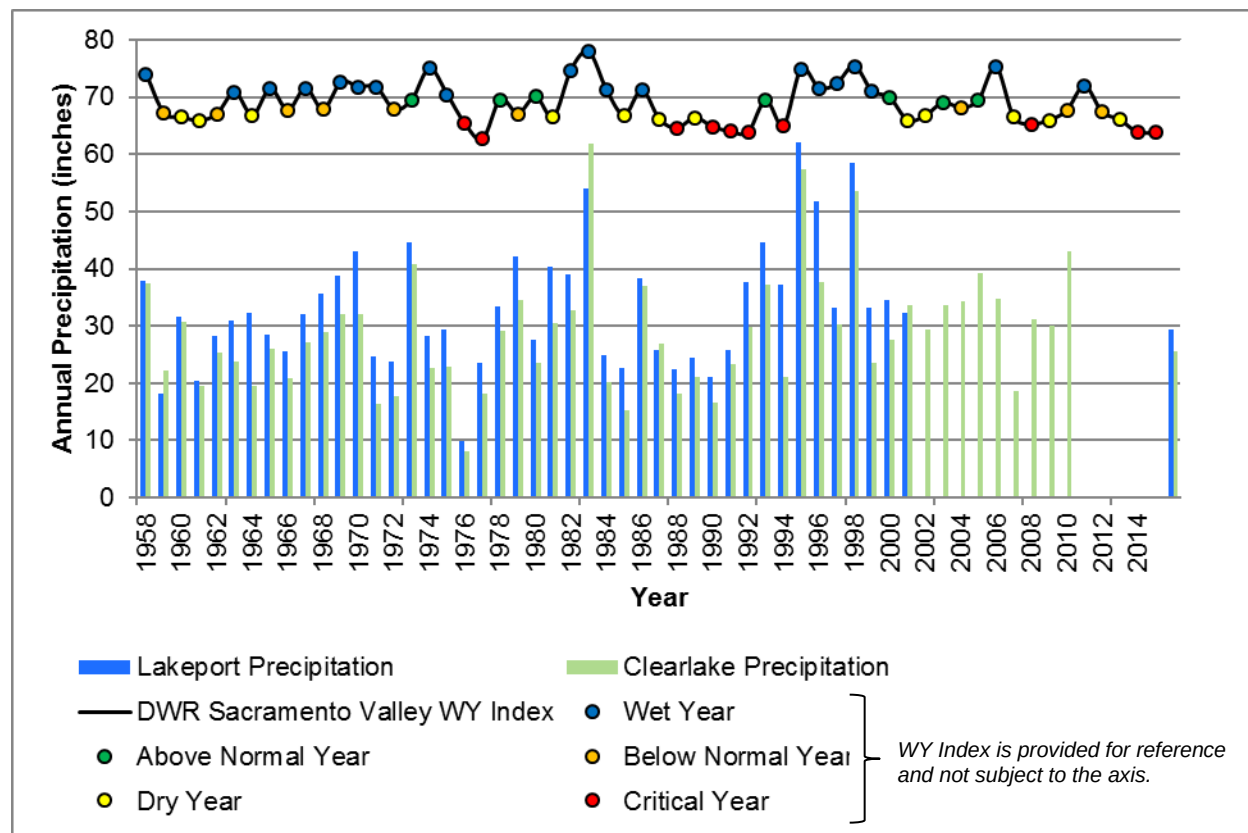
2.0 Groundwater Related Data

CDM Smith reviewed several data sources that relate to the use of groundwater and groundwater conditions within Big Valley and Scotts Valley. While several of these data sources are not direct measurements of groundwater, the data helps inform how groundwater has been and is currently being used within the basins, as well as the current state of groundwater resources.

2.1 Precipitation

Figure 2 shows the precipitation data for the Lakeport and Clearlake gages. Lakeport is located along the west shore of Clear Lake, in the Scotts Valley basin. Clearlake lies at the southeast corner of Clear Lake, and while it is not directly above either the Scotts Valley or Big Valley Basins, it provides a basis of comparison for hydrologic conditions in the region. DWR's Sacramento Valley Water Year Index has been added to Figure 2 to show the relationship between precipitation and water year types. The Index represents regional trends and is not directly a measure of conditions in the more mountainous Lake County region.

This figure provides context for data provided later in this memorandum. The data in this figure shows that since the late 1950s, the County has experience numerous periods of wet and dry conditions.



Source: University of California Statewide Integrated Pest Management Program

Note: Lakeport data from 2002 – 2015 and Clearlake data from 2011 – 2015 was considered questionable and was censored.

Figure 2. Lake County Precipitation with Sacramento Valley Water Year Index, 1958 – 2016

2.2 Lake Level

Clear Lake is the dominant surface water feature in the County. Figure 3 shows the recorded lake level at the U.S. Geological Survey's (USGS) gage 11450000 (Clear Lake at Lakeport). The data in Figure 3 show that lake levels have been fairly stable over the past 20 years, despite the recent drought. The lake level is roughly correlated with hydrologic trends (*i.e.*, when conditions are wetter and precipitation is higher, the overall lake levels are also higher; similarly, drier conditions result in lower levels). During a given year, the lake level ranges up to six feet seasonally, with peak levels in the spring and low levels in the fall. The annual maximum and minimum values vary by approximately 4 feet over this 20-year period.

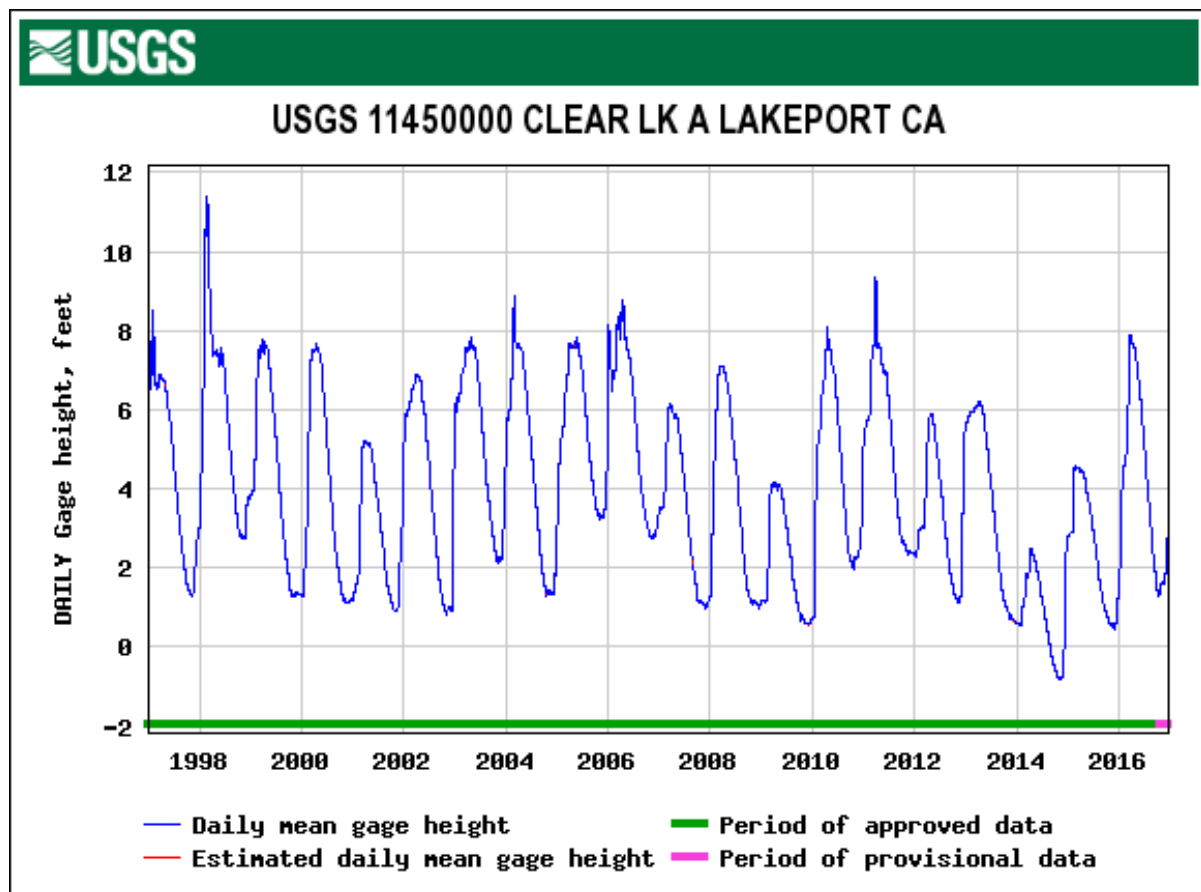


Figure 3. Clear Lake Stream Gage Height

2.3 Groundwater Well Elevations

There are 47 wells within the Big Valley basin and 5 wells in the Scotts Valley basin that are used to record groundwater levels (Figure 1). These basins are CASGEM compliant, as the measured groundwater level data is provided to DWR.

2.3.1 Big Valley Groundwater Elevations

Figure 4 shows the groundwater elevations over the last 20 years for six groundwater wells located throughout the Big Valley groundwater basin. The wells with higher groundwater elevations are in the southern part of the basin, further from Clear Lake. Additional groundwater level data for the Big Valley basin is provided in Attachment 1. The hydrographs show that groundwater levels in Big Valley fluctuate seasonally, with higher levels in the winter and lower in the summer. The annual fluctuations in groundwater levels range on the order of 10 to 35 feet per year. Groundwater levels, overall, also follow the longer-term wet/dry hydrologic condition trends. During wetter periods (*e.g.*, 1997, 2006), groundwater levels are higher than average. During drier periods (*e.g.*, 2007,

2015), water levels are lower. Overall, the groundwater levels in Big Valley groundwater basin appear to be relatively stable and are not substantially increasing or decreasing.

This corroborates the findings in Bulletin 118 (DWR, 2004 update), “A review of the hydrographs for long-term comparison of spring-spring groundwater levels [in the Big Valley groundwater basin] indicates a decline in groundwater levels of 5- to 10-feet associated with the 1976-77 and 1987-94 droughts, followed by a recovery in levels to pre-drought conditions of early 1970’s and 1980’s. Overall there does not appear to be any increasing or decreasing trend in the groundwater levels.”

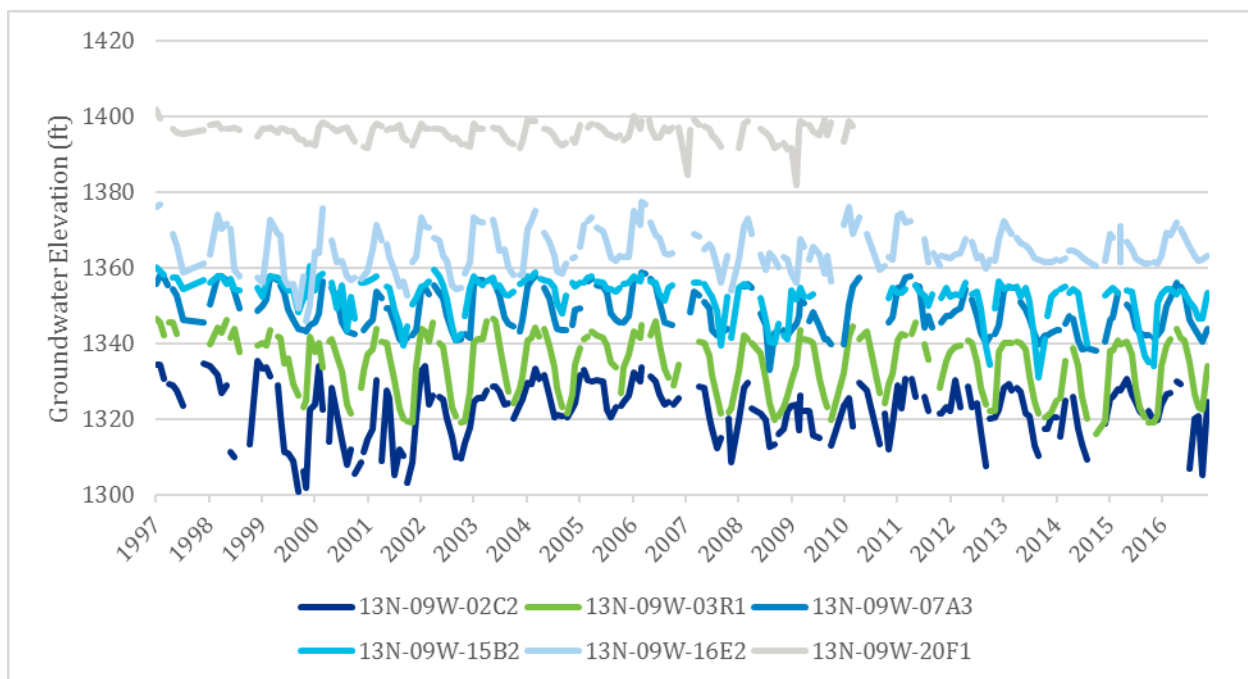


Figure 4. Representative Groundwater Elevations in the Big Valley Groundwater Basin, 1997 – 2016

2.3.2 Scotts Valley Groundwater Elevations

Figure 5 shows the groundwater elevations for four of the five wells in Scotts Valley that are identified in Figure 1. The fifth well only contained data through 2004, so it was not used in the comparison. Elevations are typically measured twice a year. Similar to Big Valley, groundwater levels tend to follow the wet/dry hydrologic condition trends with higher levels during wetter periods and lower levels during drier periods. Overall, the groundwater levels in the Scotts Valley groundwater basin appear to be relatively stable and are not substantially increasing or decreasing.

This corroborates the findings in Bulletin 118 (DWR, 2004 update), “Long-term comparison of spring-spring groundwater levels [in the Scotts Valley groundwater basin] indicates a slight decline in groundwater levels of up to 10-feet associated with the 1976-77 and 1987-94 droughts, followed

by a recovery in levels to pre-drought conditions of early 1970's and 1980's. Overall there does not appear to be any increasing or decreasing trend in the groundwater levels."

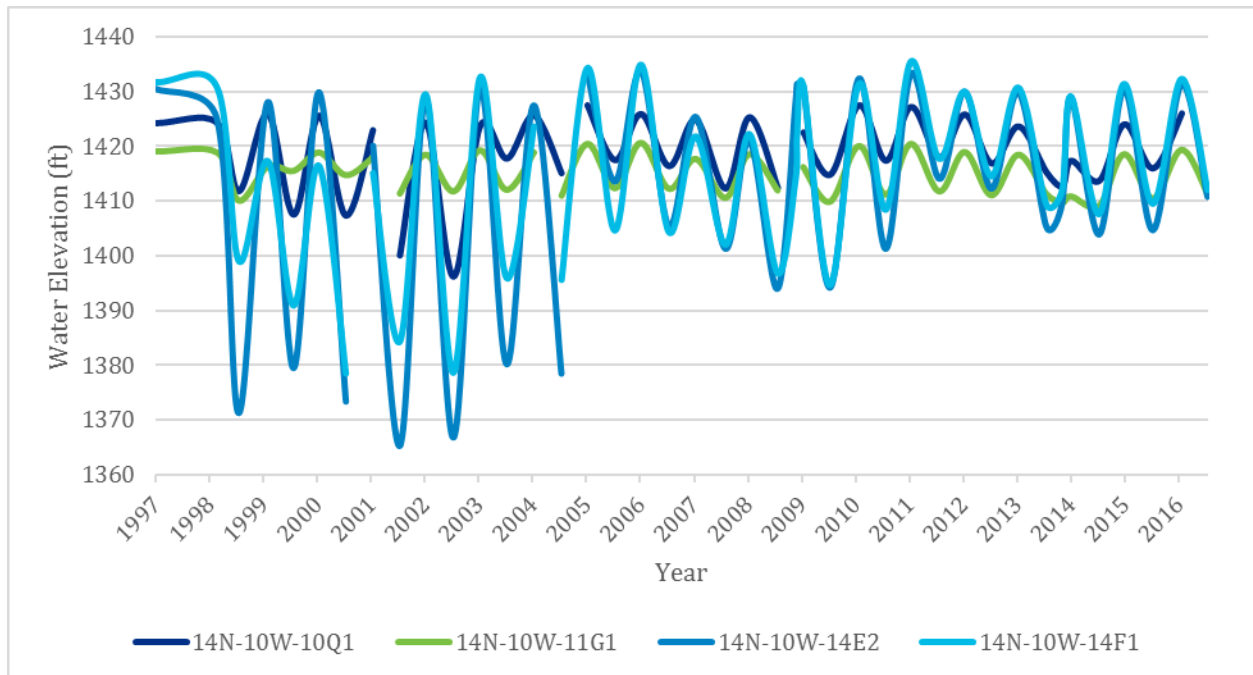


Figure 5. Groundwater Elevations in the Scotts Valley Groundwater Basin, 1997 – 2016

2.4 Population

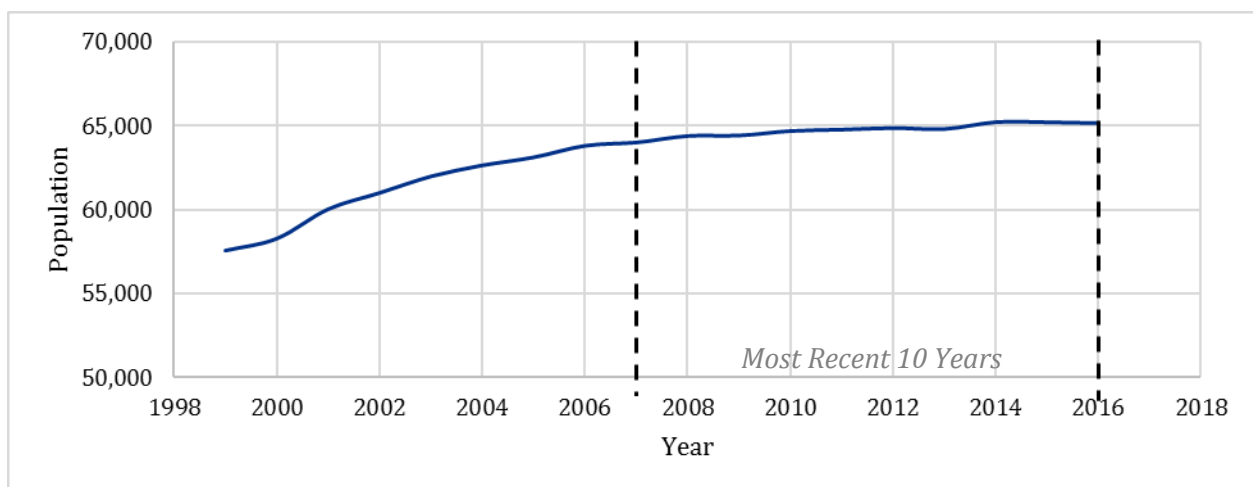
The State of California projected the population growth rate in the County to increase at a growth rate of about 1 percent per year, based on fertility, mortality, and migration assumptions (California Department of Finance 2014). However, historical data has shown a slower population growth for Lake County (Table 1). Between 1999 and 2016, the average annual percent population change (*i.e.*, year to year) in Lake County was 0.73 percent, but over the past 10 years, the change was closer to 0.21 percent, signaling that the population growth in the County has slowed. From 2010 through 2016, the population in Lake County has increased by about 460.

Table 1. Lake County Population

Year	Population (July 1) ¹	Annual Percent Change
1999	57,601	n/a
2000 ²	58,309	1.23%
2001	60,046	2.98%
2002	61,005	1.60%
2003	61,981	1.60%
2004	62,633	1.05%
2005	63,107	0.76%
2006	63,792	1.09%
2007	63,986	0.30%
2008	64,370	0.60%
2009	64,396	0.04%
2010 ²	64,665	0.42%
2011	64,745	0.12%
2012	64,839	0.15%
2013	64,781	-0.09%
2014	65,191	0.63%
2015	65,180	-0.02%
2016	65,128	-0.08%
Average Annual Percent Change, 1999 - 2016		0.73%
Average Annual Percent Change, 2007 - 2016		0.21%

¹ California Department of Finance, December 2011 and 2016

² U.S. Census, 2010, 2016



Source: State of California, December 2011 and 2016

Figure 6. Lake County Population

If population remains relatively constant, the demand for additional domestic and/or municipal use of groundwater will also remain relatively constant.

2.5 Groundwater Wells

Groundwater wells in Lake County are used for both domestic and irrigation purposes.

2.5.1 Big Valley Groundwater Basin

Figure 7 shows the number of groundwater wells installed per year in the Big Valley groundwater basin since 1970 (CDM 2006a, Ruttan 2016). Since 2006, the number of total wells installed, especially for irrigation purposes, has been generally decreasing. In general, more wells are installed during dry years, when there is less precipitation. These data do not account for wells that are abandoned, capped off, and are no longer in use. It is possible that newly installed wells may be replacing these older wells, so additional new wells do not necessarily mean there is an increase in groundwater usage. However, information regarding well replacement is not available.

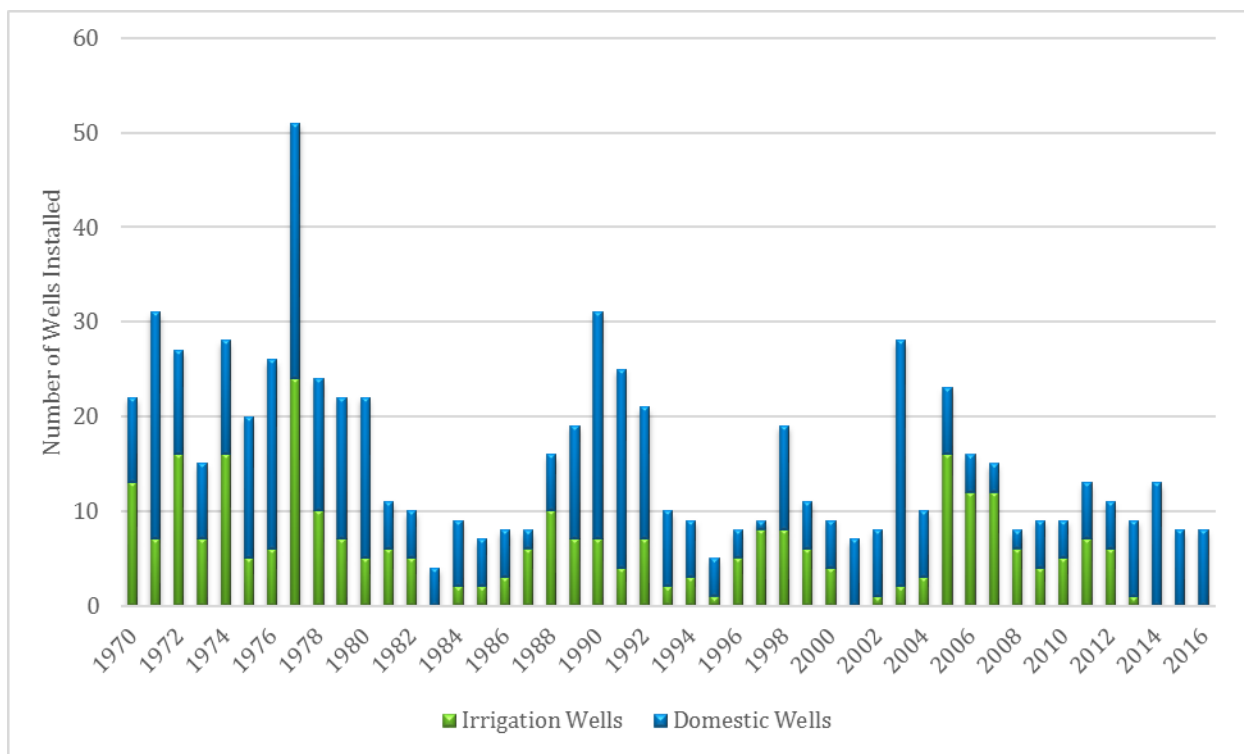


Figure 7. Well Completion in Big Valley, 1970 to 2016

2.5.2 Scotts Valley Groundwater Basin

Figure 8 shows the number of wells installed per year in the Scotts Valley groundwater basin since 1970 (CDM 2006a, Ruttan 2016). Since 2006, the number of total wells installed has been generally stable. These data do not account for wells that are abandoned, capped off, and are no longer in use.

It is possible that newly installed wells may be replacing these older wells, so additional new wells do not necessarily mean there is an increase in groundwater usage. However, information regarding well replacement is not available.

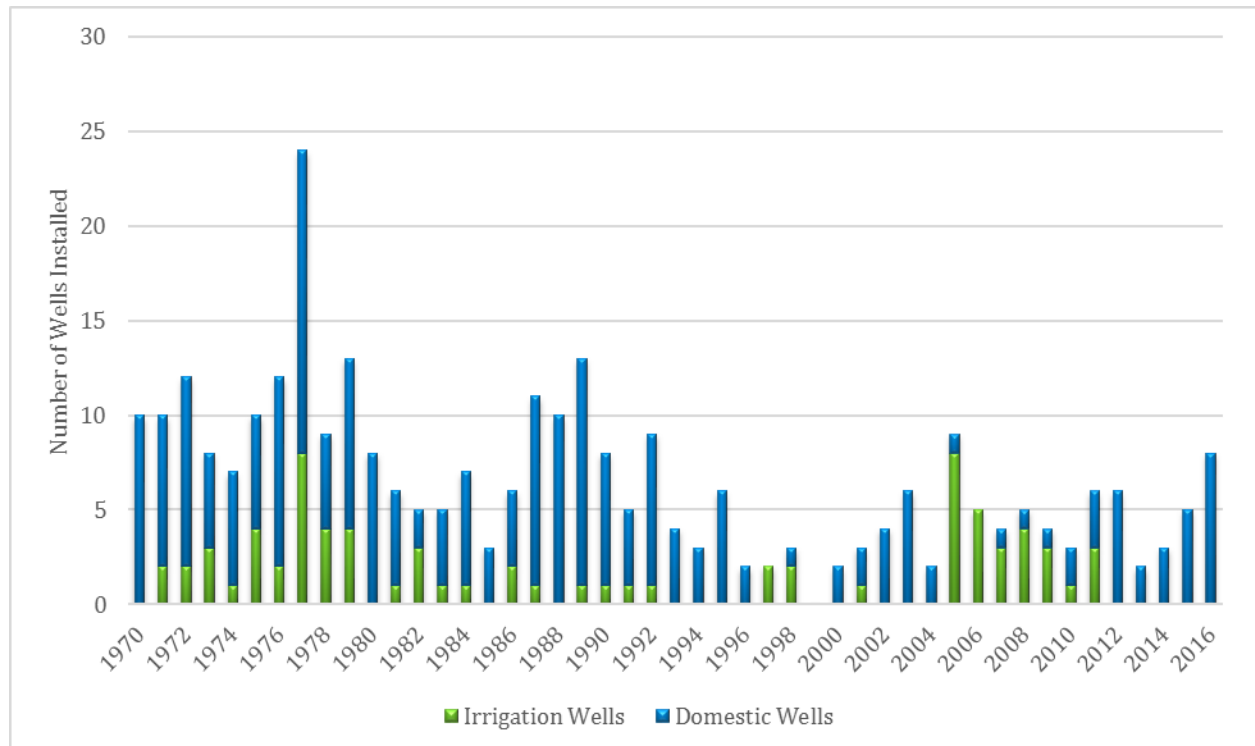


Figure 8. Well Completions in Scotts Valley, 1970 to 2016

2.6 Agricultural Use

Figure 9 shows the acreage of the predominant agricultural crops in the County from 2003 to 2015 (Ruttan 2016a). Agricultural acreage was not available for each groundwater basin. While there was a slight increase in total agricultural acreage from 2008 to 2015, the County believes that the distribution of crops has shifted from crops with a higher water demand (*e.g.*, pears) to less water intensive crops (*e.g.*, such as drip-irrigated vineyards). The amount of irrigated pasture has also significantly decreased. The lower number of new irrigation well installations (Section 2.5) supports the fact that even though total crop acreage has increased over the past few years, the water demand to support those crops has not substantially increased.

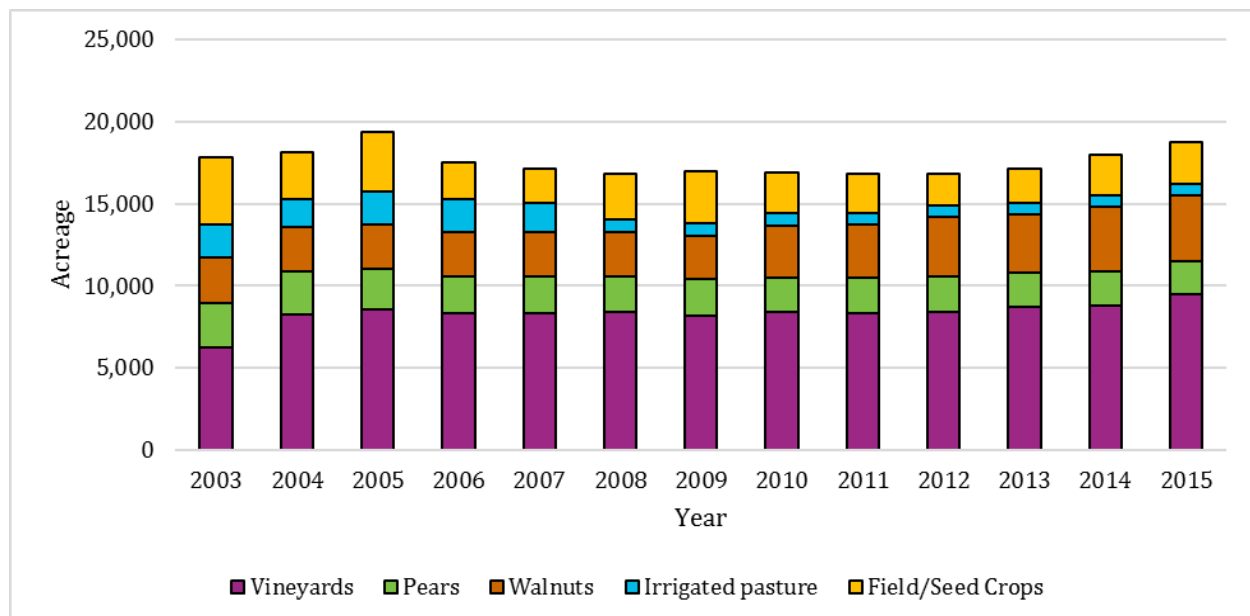


Figure 9. Major Agricultural Acreage within Lake County, 2003 to 2017

2.7 Municipal Supply

Data documenting countywide and/or basin wide municipal water supplied by groundwater is not available. However, the average water supply for the City of Lakeport over the last 7 years was 265 million gallons per year (Ruttan 2016b). Groundwater supplies approximately 87 percent of this supply, with the remaining 13 percent from surface water. Overall, there have been no significant increases in usage. The City of Lakeport suggested there was a 15 percent reduction in water use in 2015, likely due to conservation efforts.

2.8 Recharge Projects

2.8.1 Big Valley Groundwater Basin

The Kelsey Creek Detention Structure enhances the natural groundwater recharge from Kelsey Creek to the Big Valley Groundwater Basin by impounding water and increasing the recharge into the aquifer. The structure is normally operated during the spring, when groundwater is pumped for frost protection purposes. This project can be operated at various depths, ranging from 0.5 to 10 feet, with a maximum enhanced recharge rate of about 24 acre-feet per day. The supplemental spring recharge also helps to reduce drawdown in the summer and ensure a reliable groundwater supply when there is no recharge available.

2.8.2 Scotts Valley Groundwater Basin

There are no substantial groundwater recharge enhancement projects in Scotts Valley at this time. Natural surface water flow in Scotts Creek percolates into the aquifer in the southern portion of Scotts Valley at a rate of approximately 1,000 acre-feet per month as long as Scotts Creek is flowing (W. A. Wahler 1970).

3.0 Change in Groundwater Basin Storage

A current, detailed groundwater budget is not available for either the Big Valley or Scotts Valley groundwater basins. In lieu of a calculation of storage based on the quantification of all inflows and outflows, the change in groundwater storage in the basin has been estimated based on the measured change in groundwater levels.

The annual change in storage is estimated as the annual average change in groundwater level multiplied by the groundwater basin area and an assumed average specific yield. DWR's Bulletin 118 suggests that this method, while less preferable, is allowable.

3.1 Big Valley Groundwater Basin

3.1.1 Water Levels

The available groundwater level data in the basin since 1949 was summarized for all wells. The average fall water level was calculated at each well based on the available observations during September through November of each year. Then for each year, the average change in groundwater level was calculated as the average of all available wells for the given year. For each year between 2 and 45 wells contributed to the groundwater basin average, with an average of 35 wells. A few years had no data available. This approach to estimating an annual average change in water level is a generalized approach and does not account for the spatial distribution of wells. However, for the given purpose, this generalization appears appropriate.

A similar process was completed for all spring (March through May) observations. Figure 10 shows the annual average change in groundwater levels for the Fall and Spring observations.

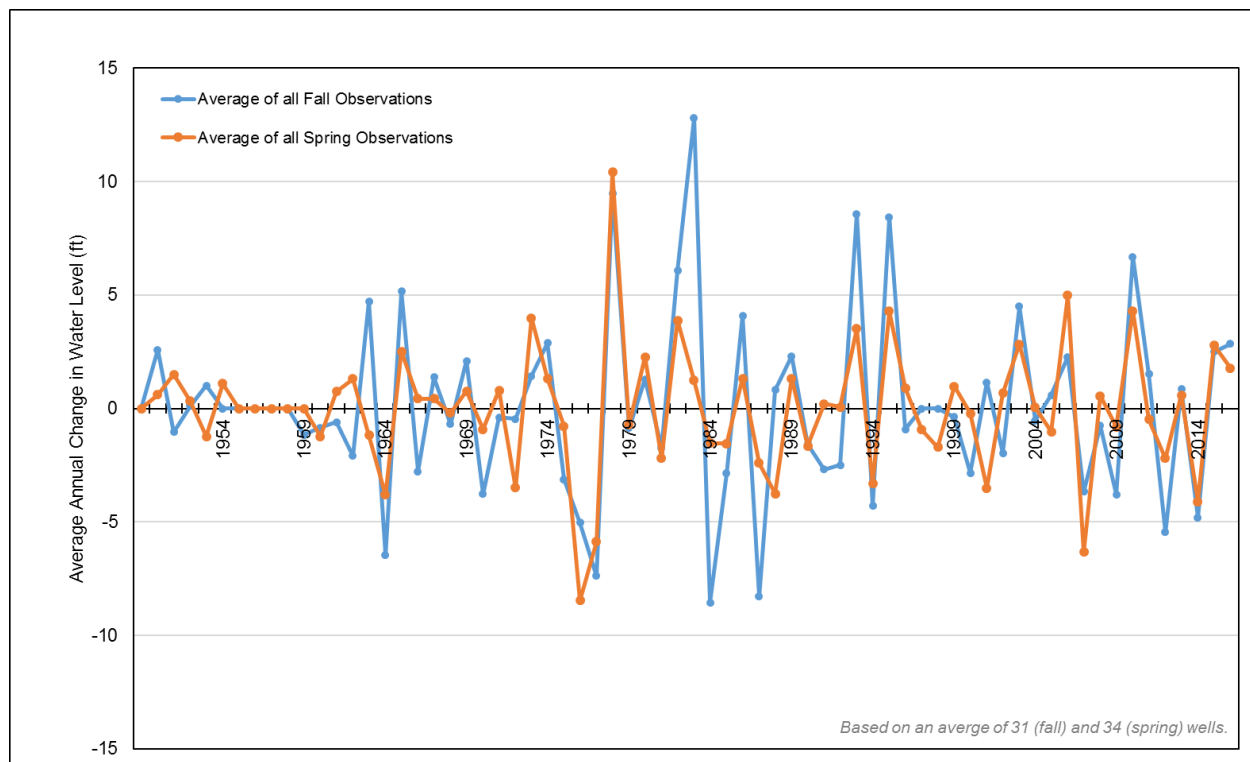


Figure 10. Annual Average Change in Water Level in the Big Valley Groundwater Basin

3.1.2 Change in Storage

Figure 11 shows the cumulative annual change in storage in the basin since 1949 based on both average spring and fall levels. The 10-year moving average of the cumulative storage is also plotted (dashed lines). This calculation relies on the basin area of approximately 24,210 acres and an assumed specific yield of 8 percent. As a reference, DWR's Sacramento Valley Water Year index was added to Figure 11. This index gives a general reference to the hydrologic conditions in the area (*i.e.*, dry vs. wet).

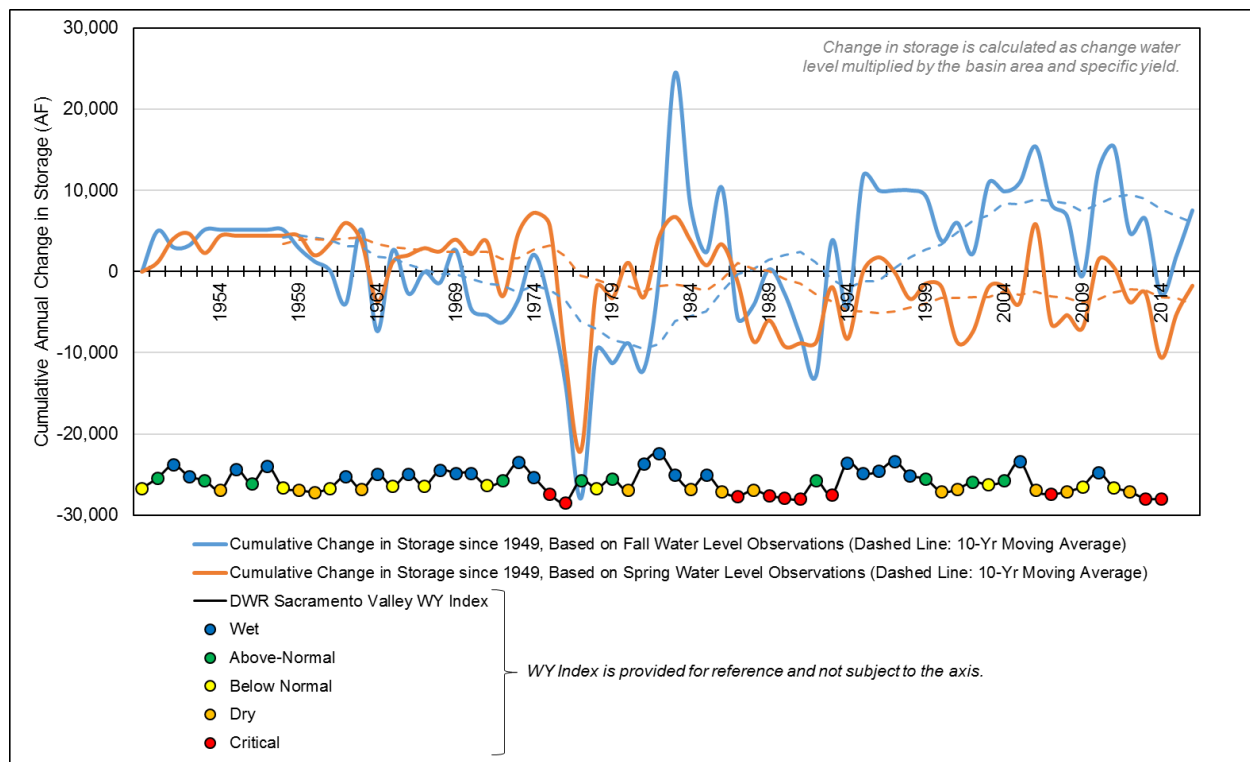


Figure 11. Cumulative Annual Change in Storage in the Big Valley Groundwater Basin

Figure 11 shows that over the period since 1949, the cumulative change in storage based on spring observations is approximately zero. The change in storage follows the same general trend as the hydrology. In others words, there tends to be a large loss in storage during drier periods. The change in storage then tends to be positive and recover in wetter periods. The change in storage line in Figure 11 based on fall readings shows a similar story. Overall, based on these calculations, the groundwater storage in the basin appears stable and is a demonstration that the Big Valley groundwater basin is being managed in a sustainable manner.

3.2 Scotts Valley Groundwater Basin

3.2.1 Water Levels

The available groundwater level data in the basin since 1949 was summarized for all wells. The average fall water level was calculated at each well based on the available observations during September through November of each year. Then for each year, the average change in groundwater level was calculated as the average of all available wells for the given year. For each year between 1 and 4 wells contributed to the average, with an average of 3 wells. A few years had no data available. This approach to estimating an annual average change in water level is a generalized approach and does not account for the spatial distribution of wells. However, for the given purpose, this generalization appears appropriate.

A similar process was completed for all spring (March through May) observations. Figure 12 shows the annual average change in groundwater levels for the Fall and Spring observations.

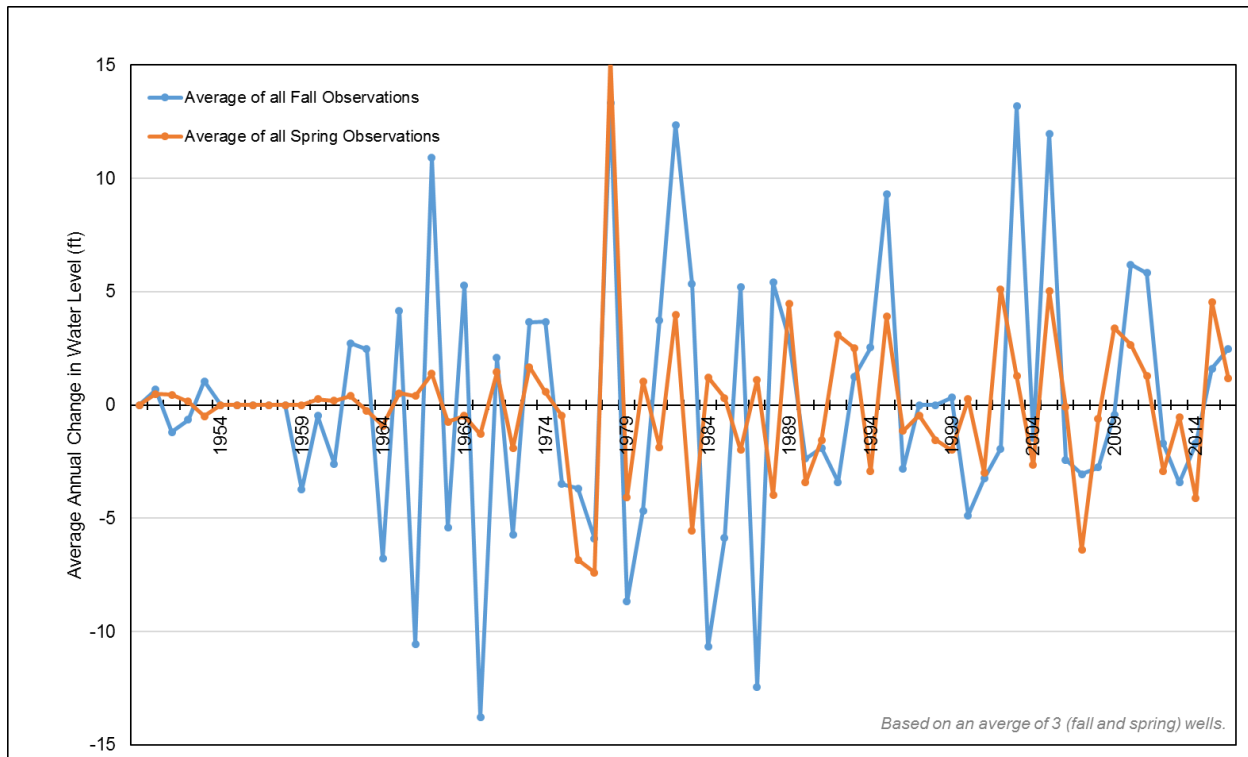


Figure 12. Annual Average Change in Water Level in the Scotts Valley Groundwater Basin

3.2.2 Change in Storage

Similar to the data presented for Big Valley, Figure 13 shows the cumulative annual change in storage in Scotts Valley since 1949 based on both average spring and fall levels. The 10-year moving average of the cumulative storage is also plotted (dashed lines). This calculation relies on the basin area of approximately 7,320 acres and an assumed specific yield of 8 percent. As a reference, DWR's Sacramento Valley Water Year index was added to Figure 13. This index gives a general reference to the hydrologic conditions in the area (*i.e.*, dry vs. wet).

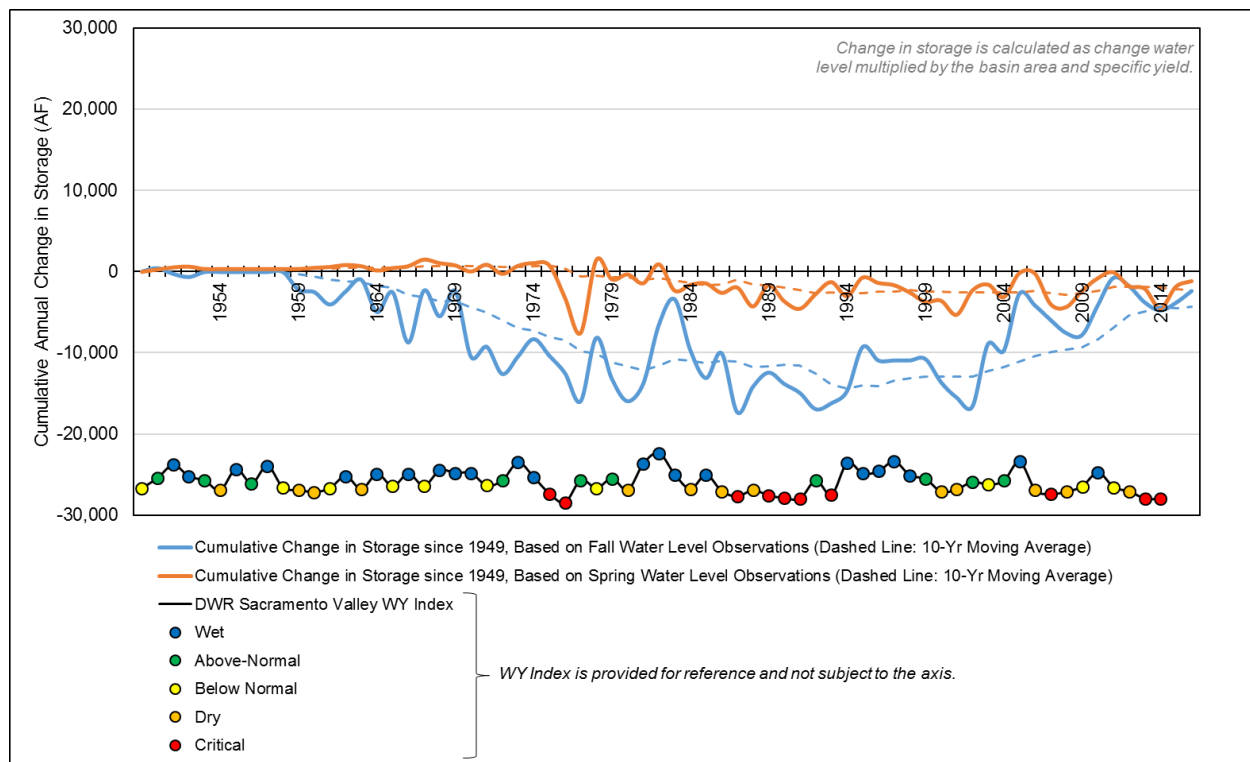


Figure 13. Cumulative Annual Change in Storage in the Big Valley Groundwater Basin

Figure 13 shows that over the period since 1949, the cumulative change in storage based on spring observations is approximately zero. The change in storage follows the same general trend as the hydrology. In others words, there tends to be a large loss in storage during drier periods. The change in storage then tends to be positive and recover in wetter periods. The change in storage line in Figure 13 based on fall readings shows that there was an overall loss in storage up until the late 1970s/early 1980s. After that period, the cumulative change in storage is stable to increasing. Overall, based on these calculations, the groundwater storage in the basin appears stable and is a demonstration that the Scotts Valley groundwater basin is being managed in a sustainable manner.

5.0 Conclusions

The data discussed in this memorandum were reviewed as related to groundwater conditions in the Big Valley and Scotts Valley groundwater basins. This review was provided to the County to support the County's submittal of Alterative documentation under SGMA for these two basins. While this memorandum is not meant as an exhaustive analysis, the data provided here gives a general picture of the groundwater conditions in the Big Valley and Scotts Valley groundwater basins.

The data described here supports the fact that groundwater conditions in the County are relatively stable. Groundwater levels and storage appear to be well correlated to historical hydrologic cycles of wet and dry periods, rather than to increased demand and use. Indicators of groundwater use, such as new well installations, population, and agricultural acreage, also indicate relatively stable future impacts on groundwater storage. The data that were analyzed in this memorandum is a demonstration that the Big Valley and Scotts Valley groundwater basins are being managed in a sustainable manner.

In future five-year updates to the County's Alternative, groundwater elevations for the key wells in each groundwater basins will be monitored and reported, along with any recent or proposed changes to how the groundwater basins are managed, *e.g.*, if recharge projects are proposed or implemented.

6.0 References

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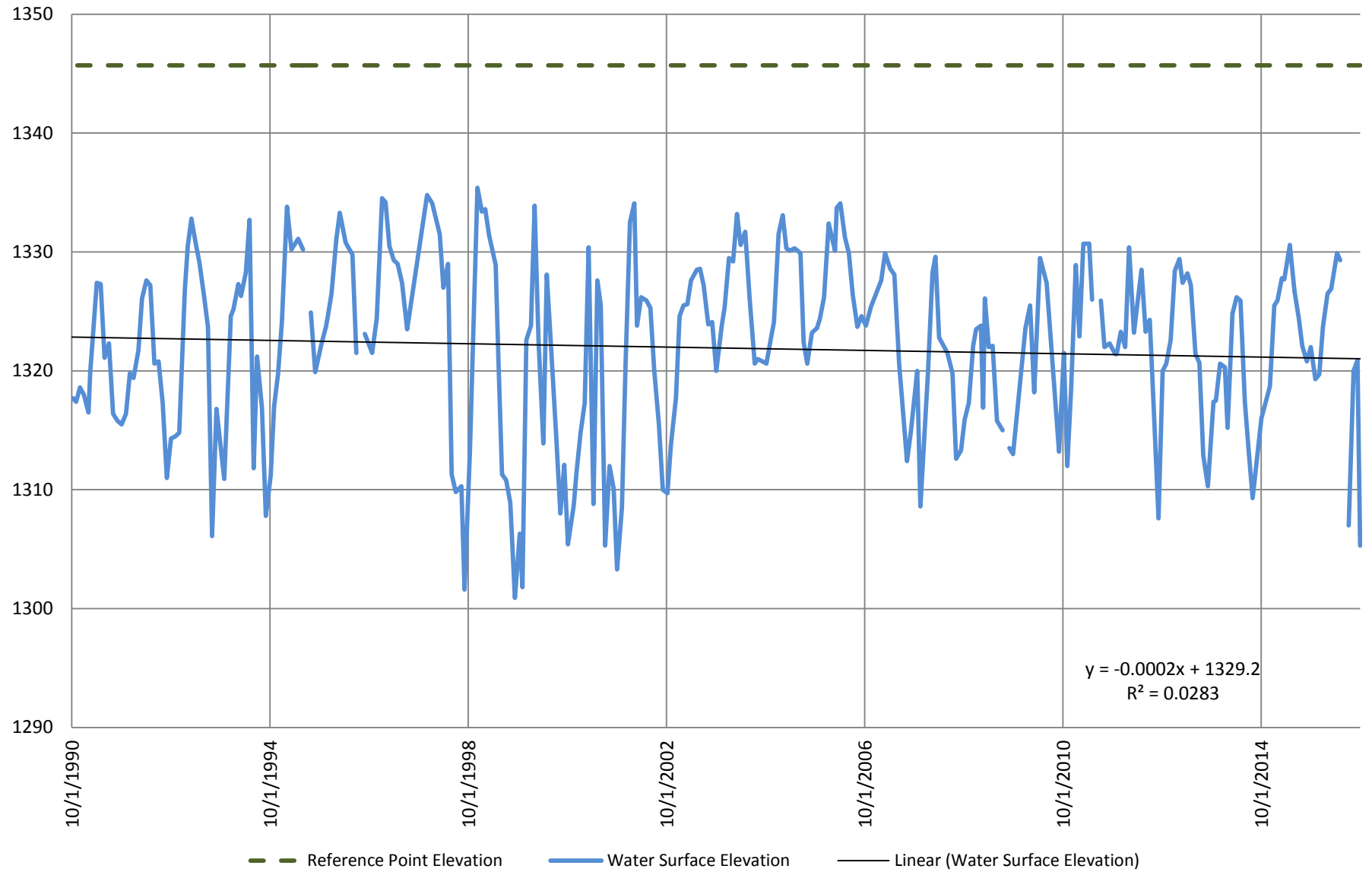
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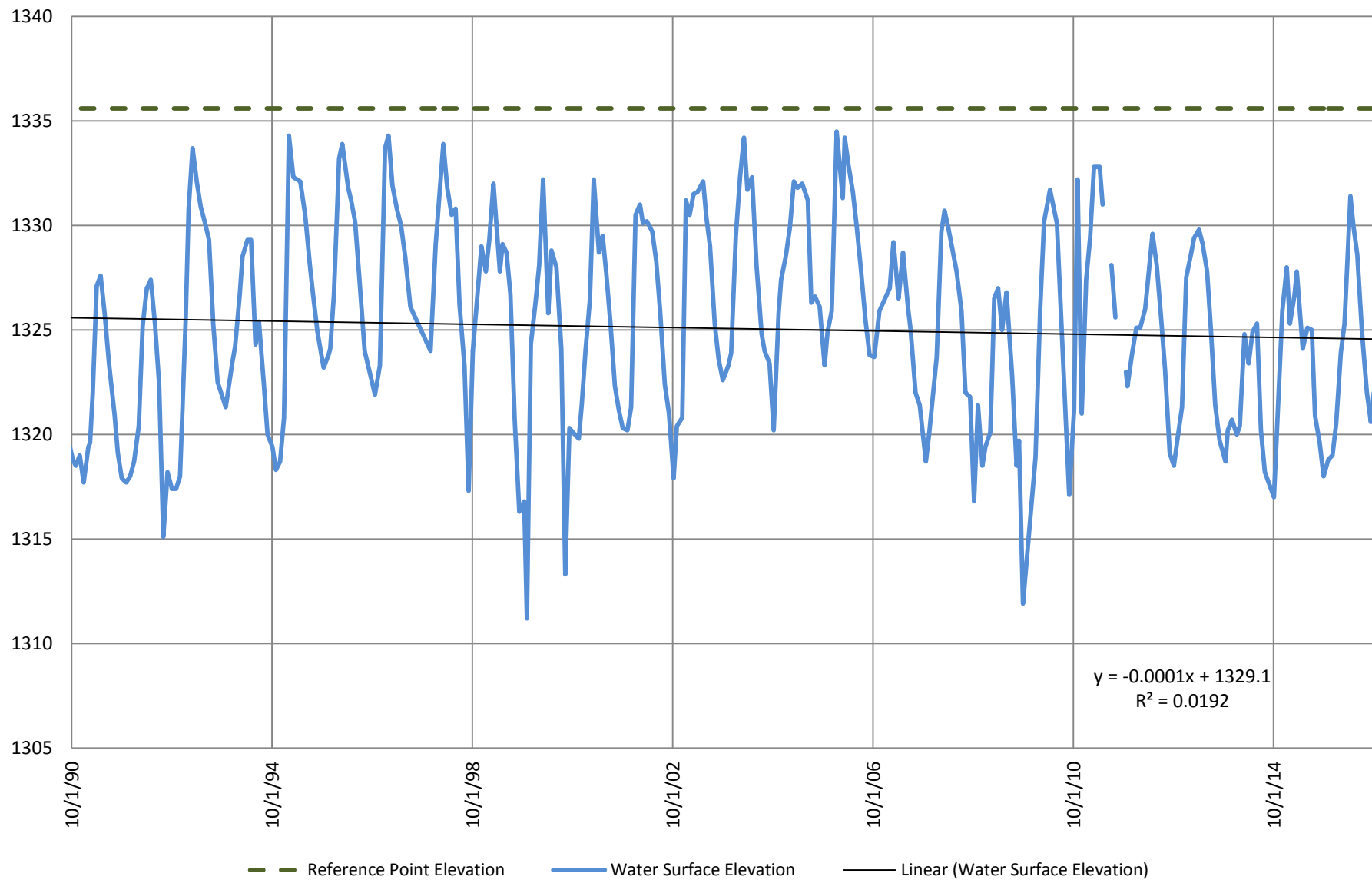


Attachment 1. Big Valley Groundwater Elevations

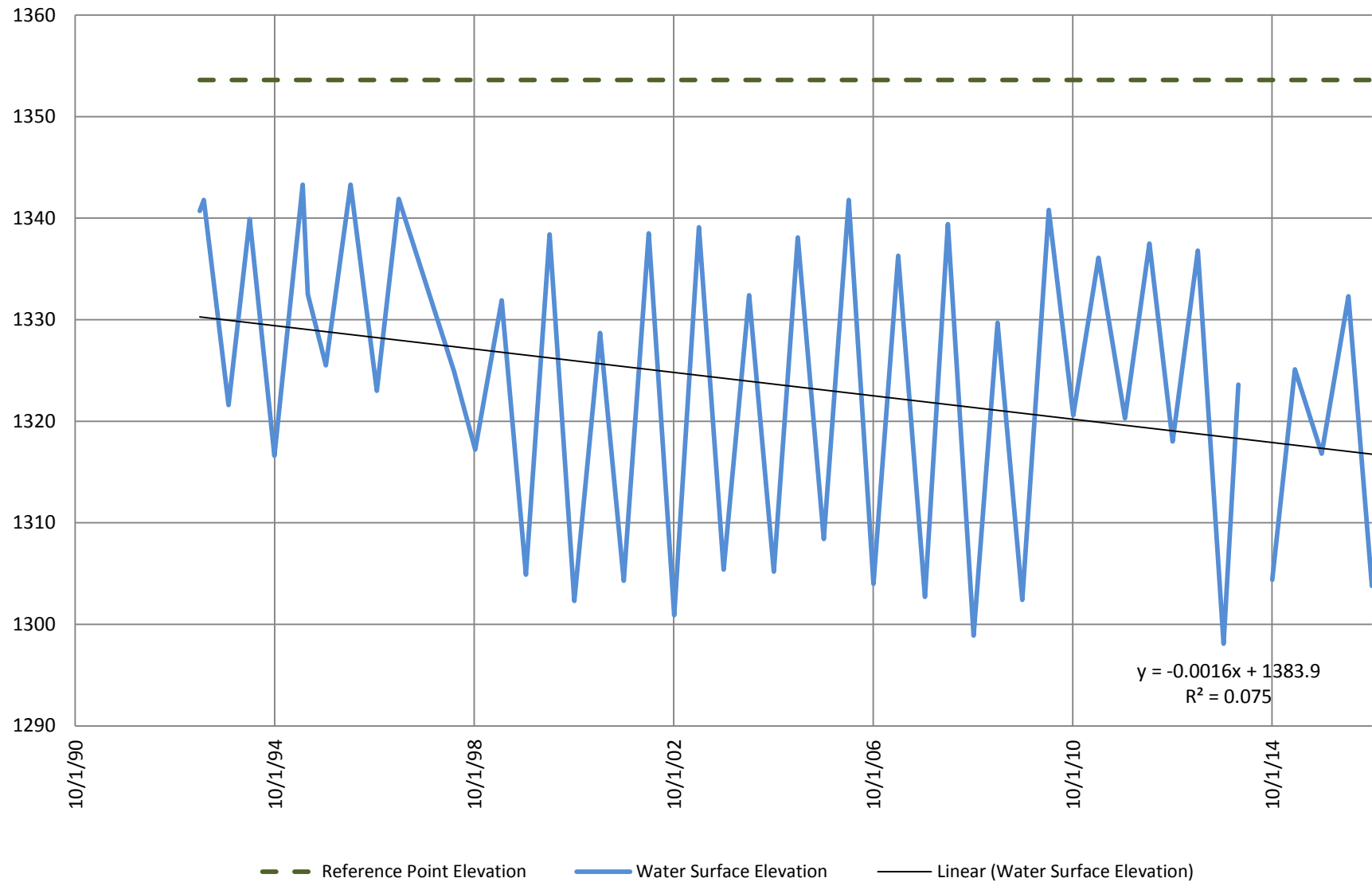
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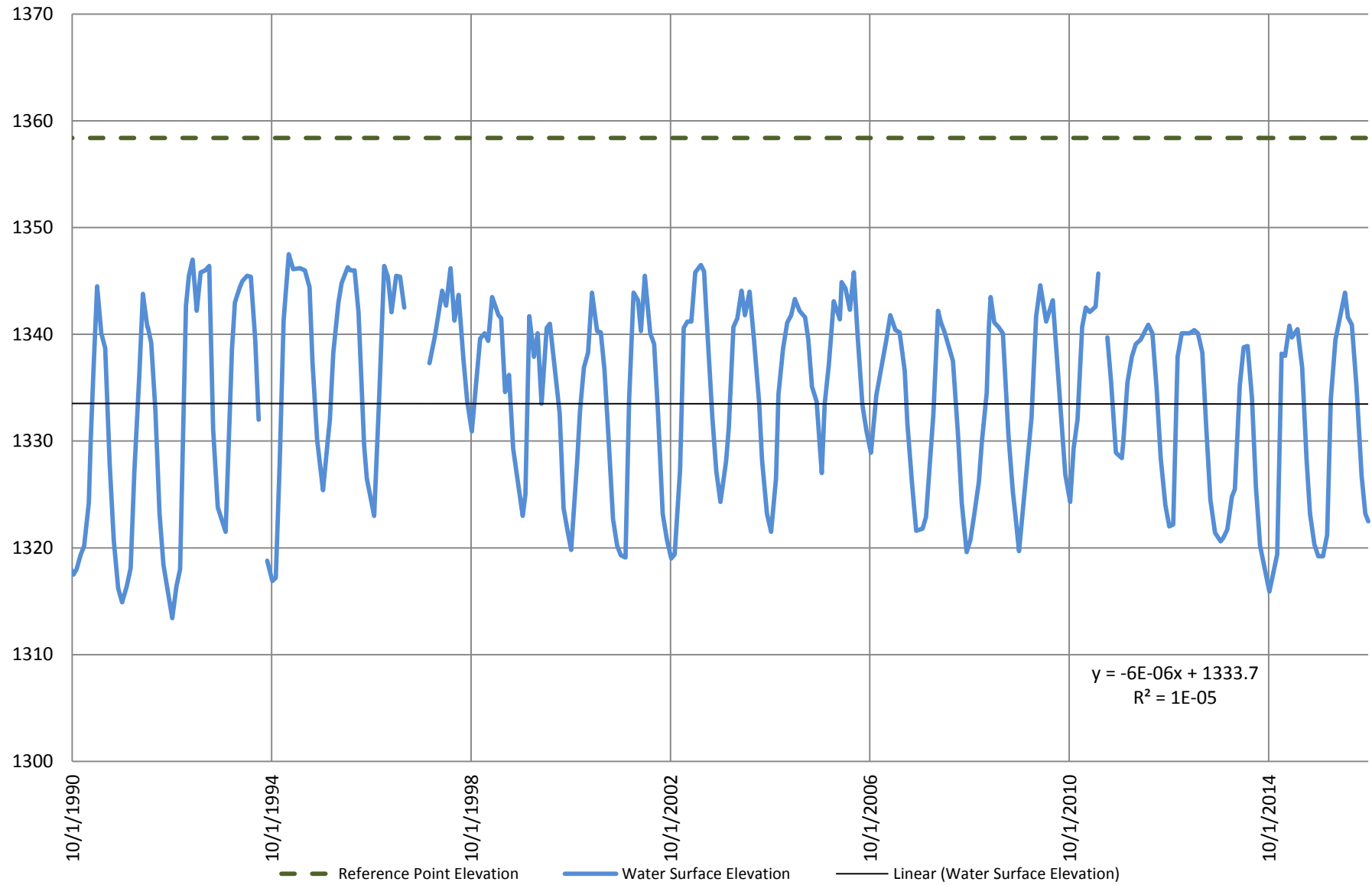
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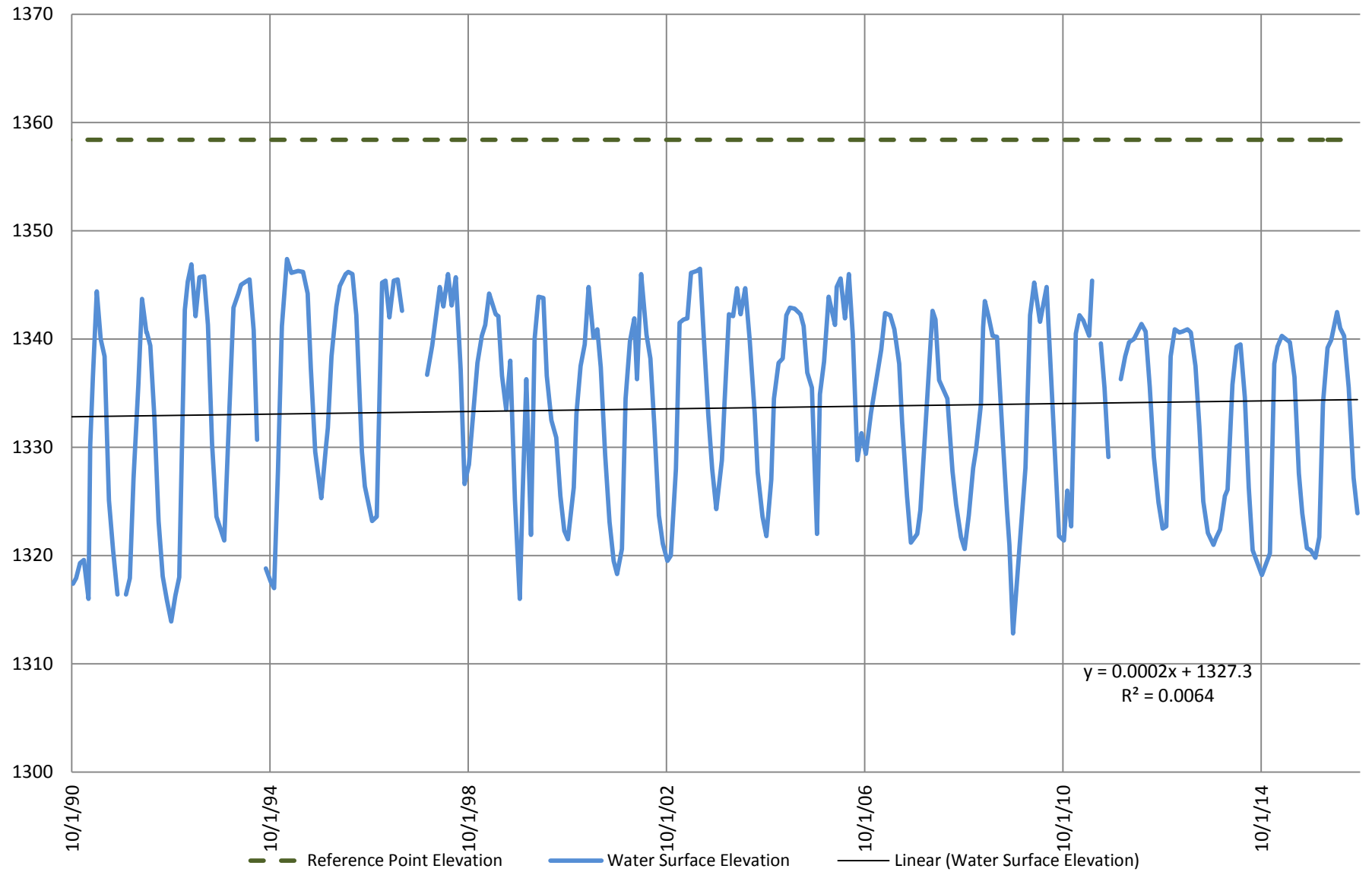
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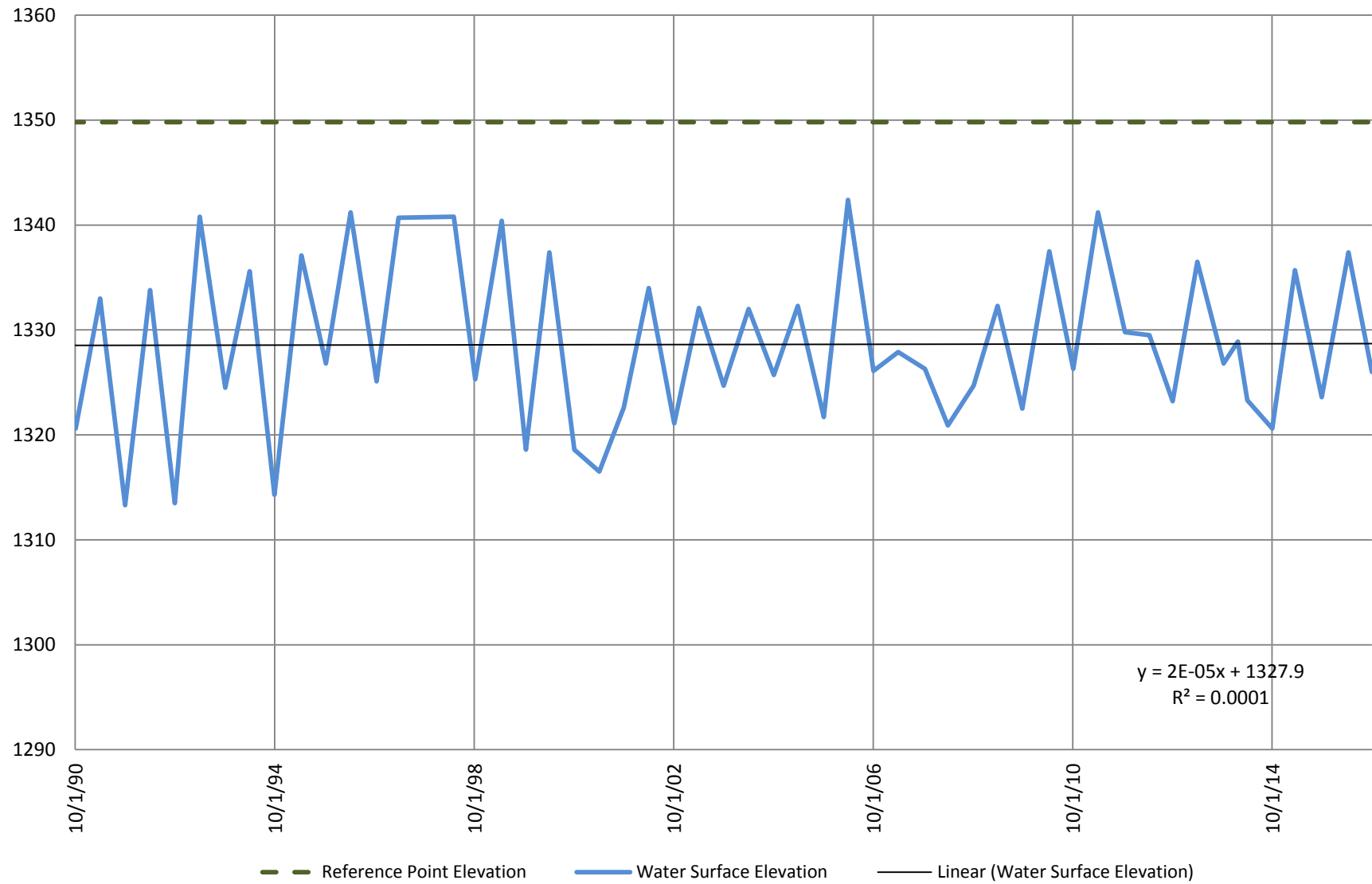
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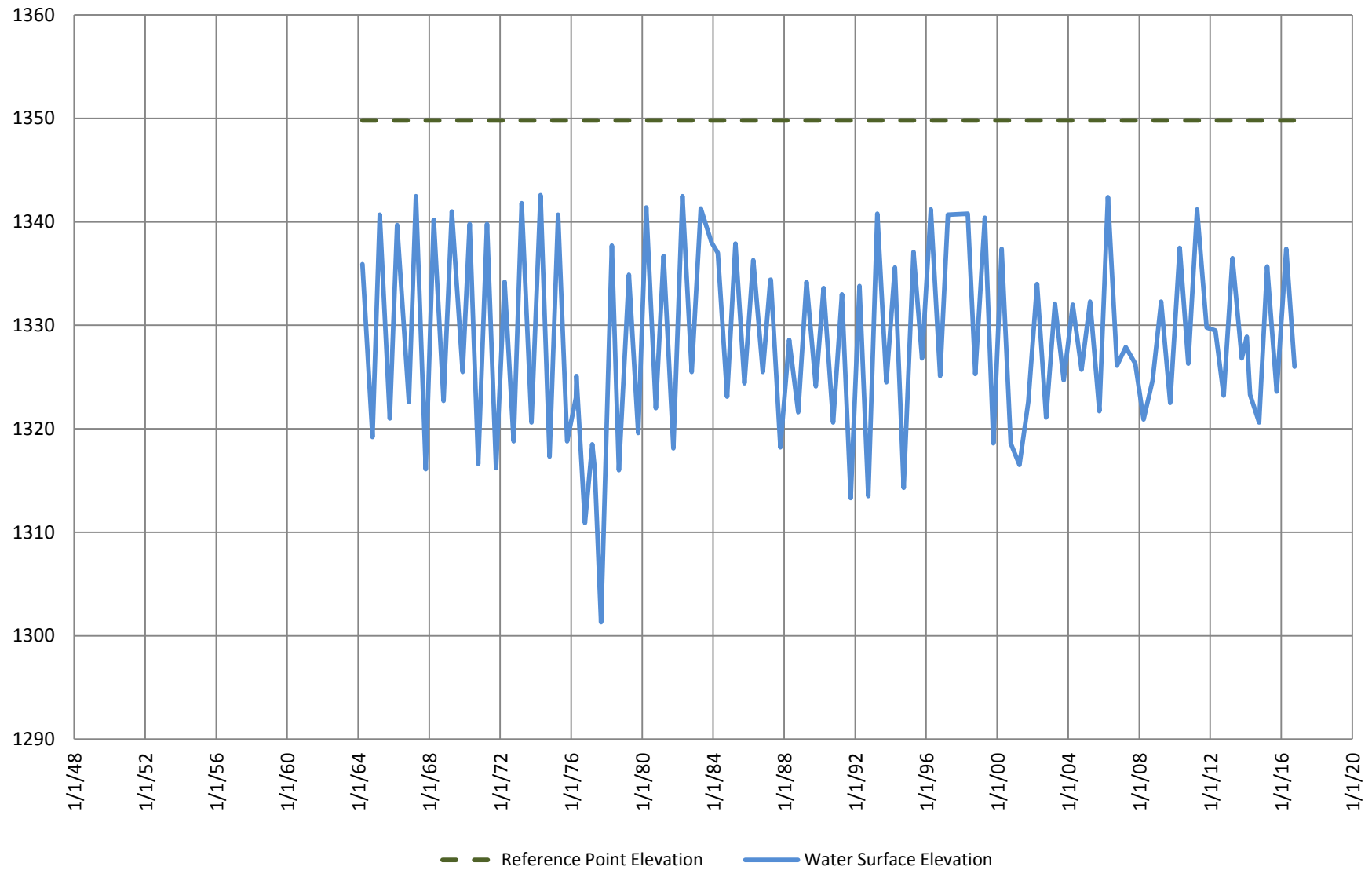
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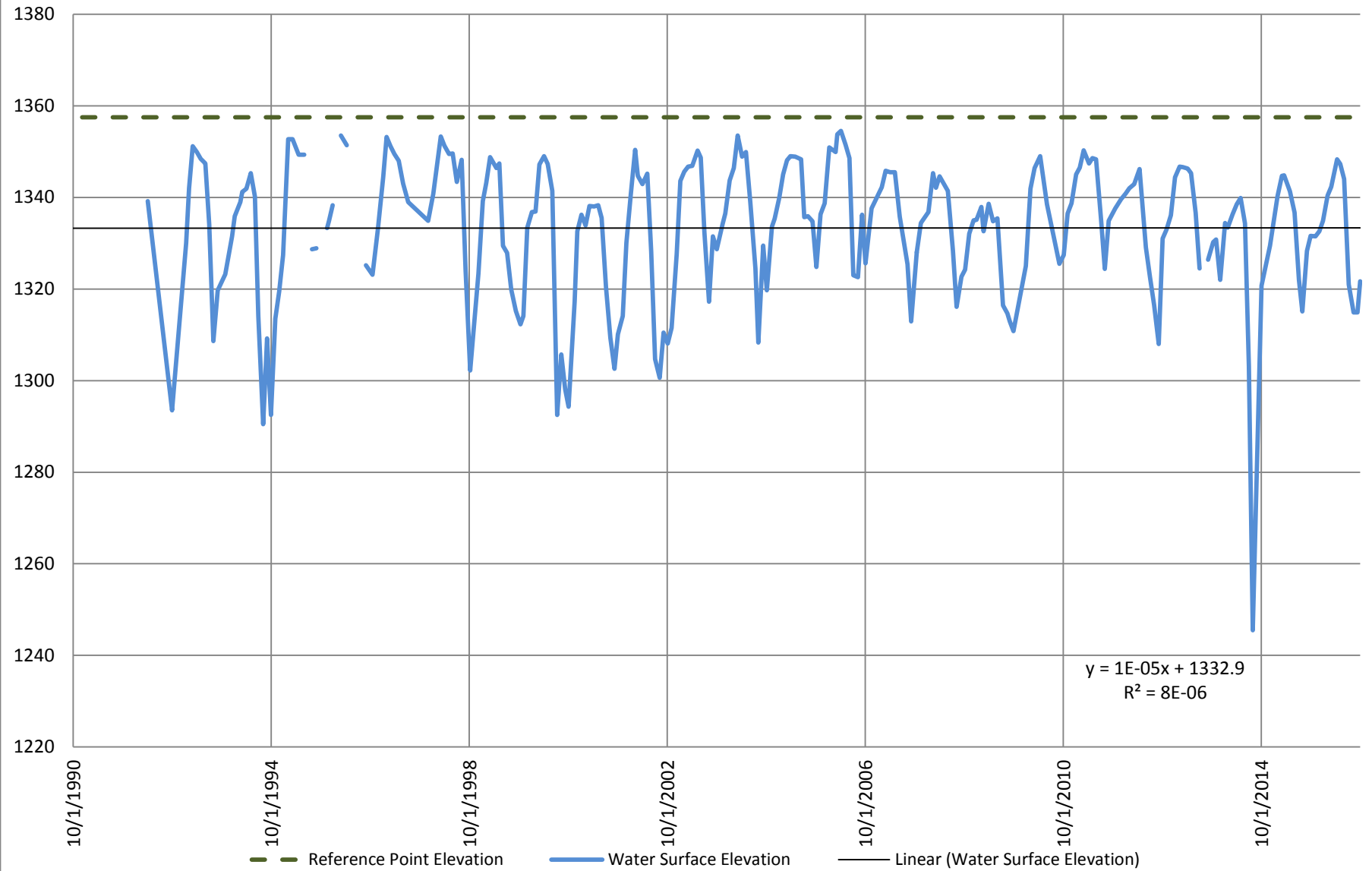
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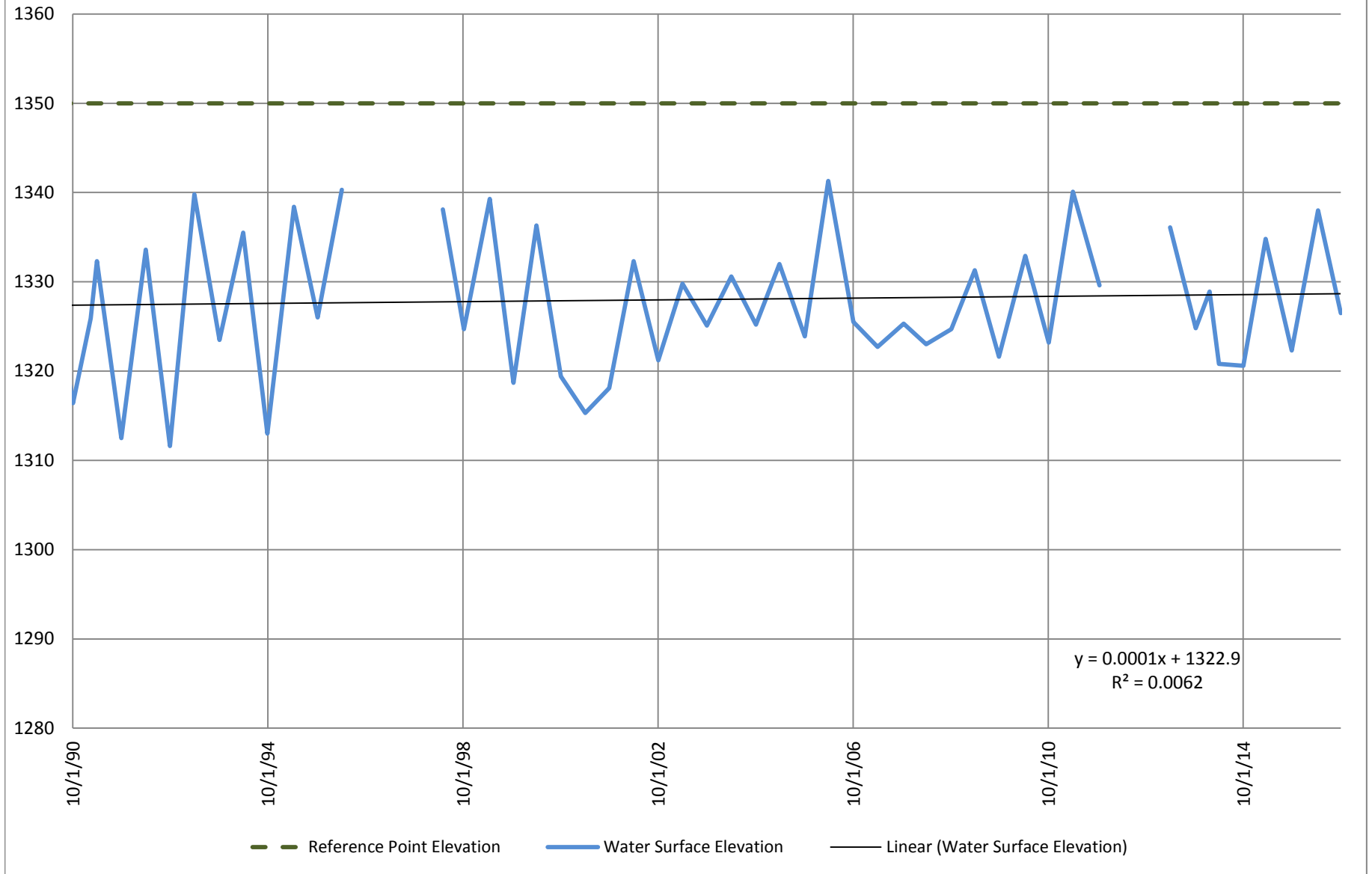
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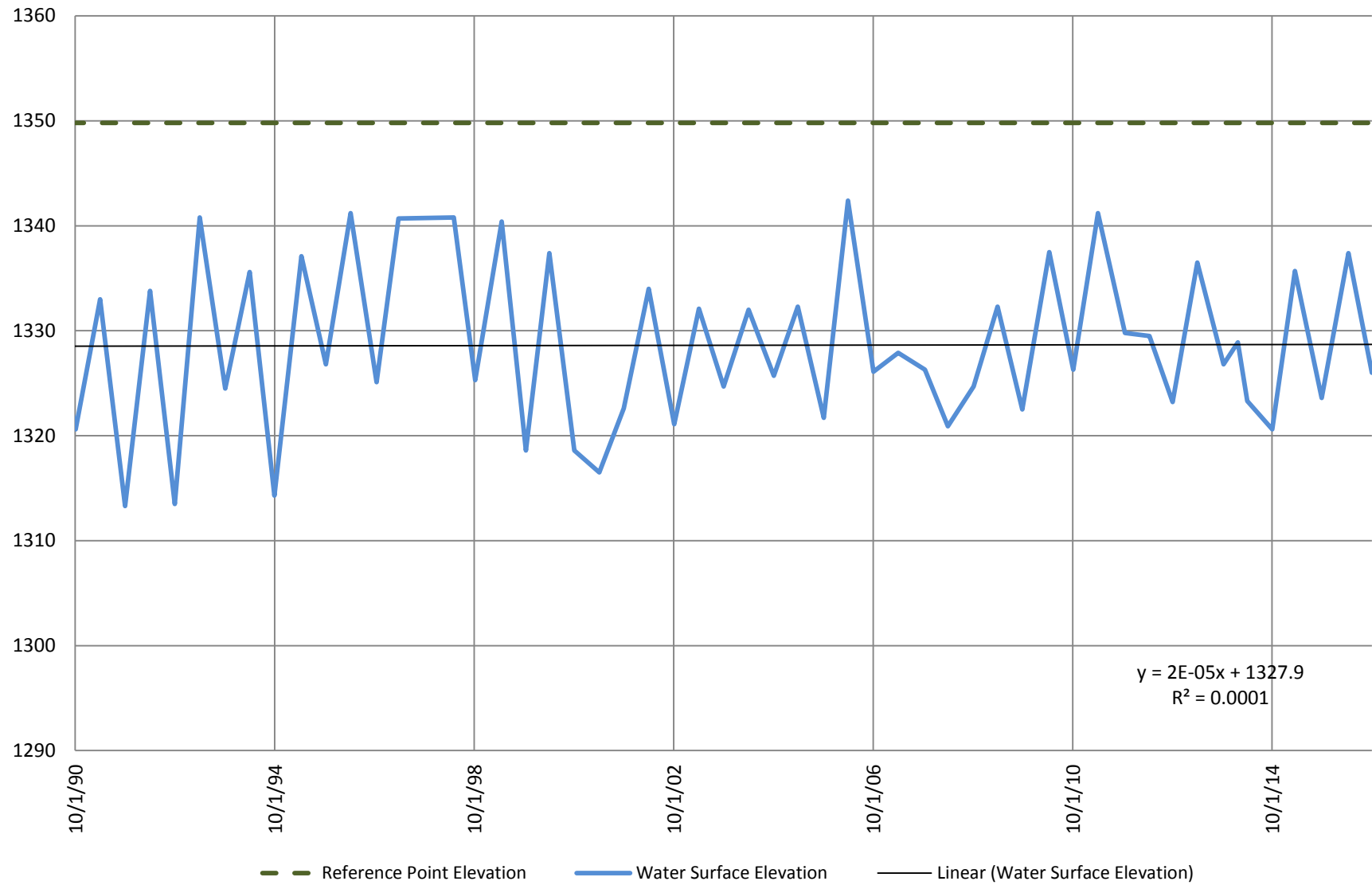


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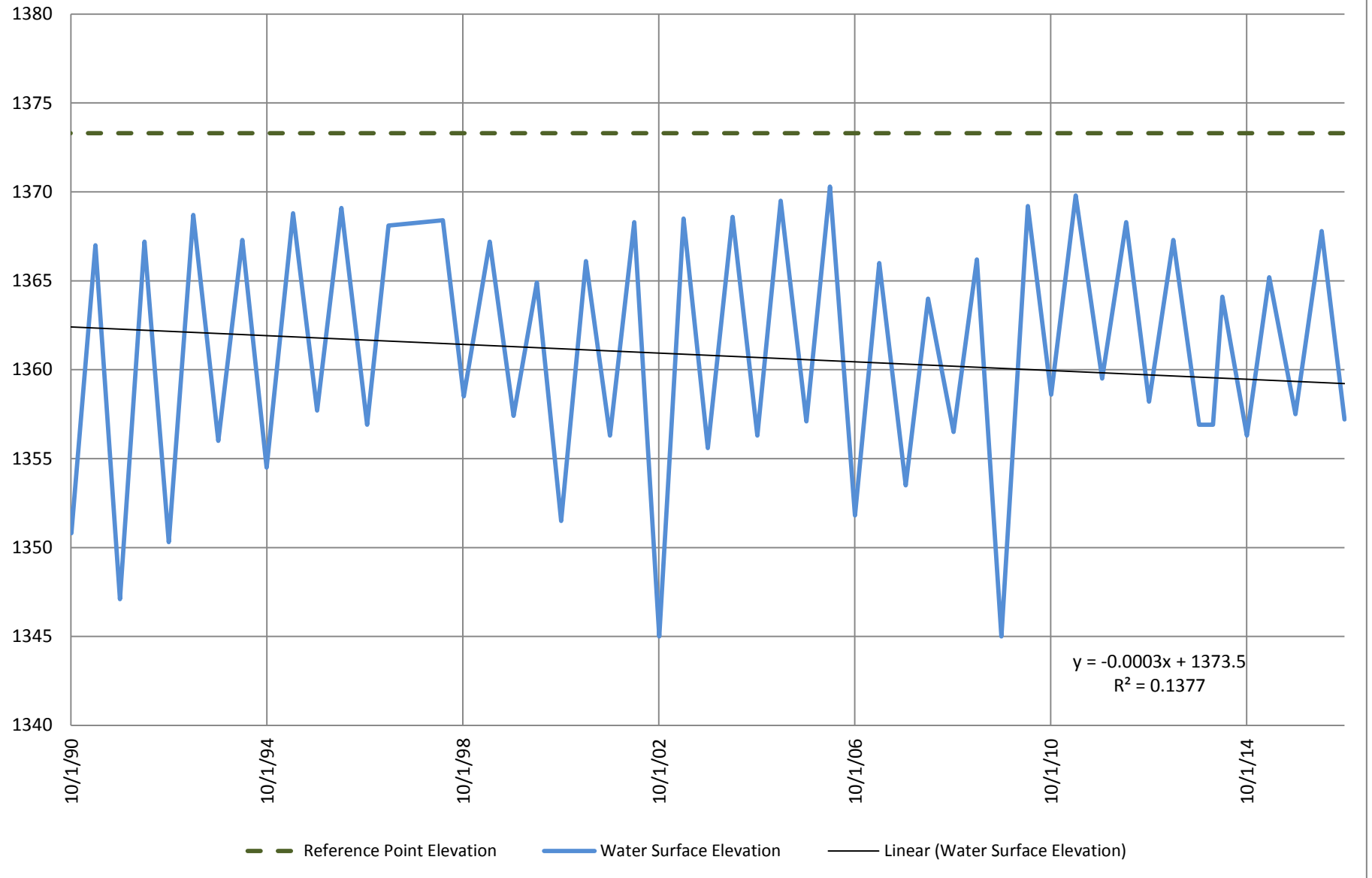


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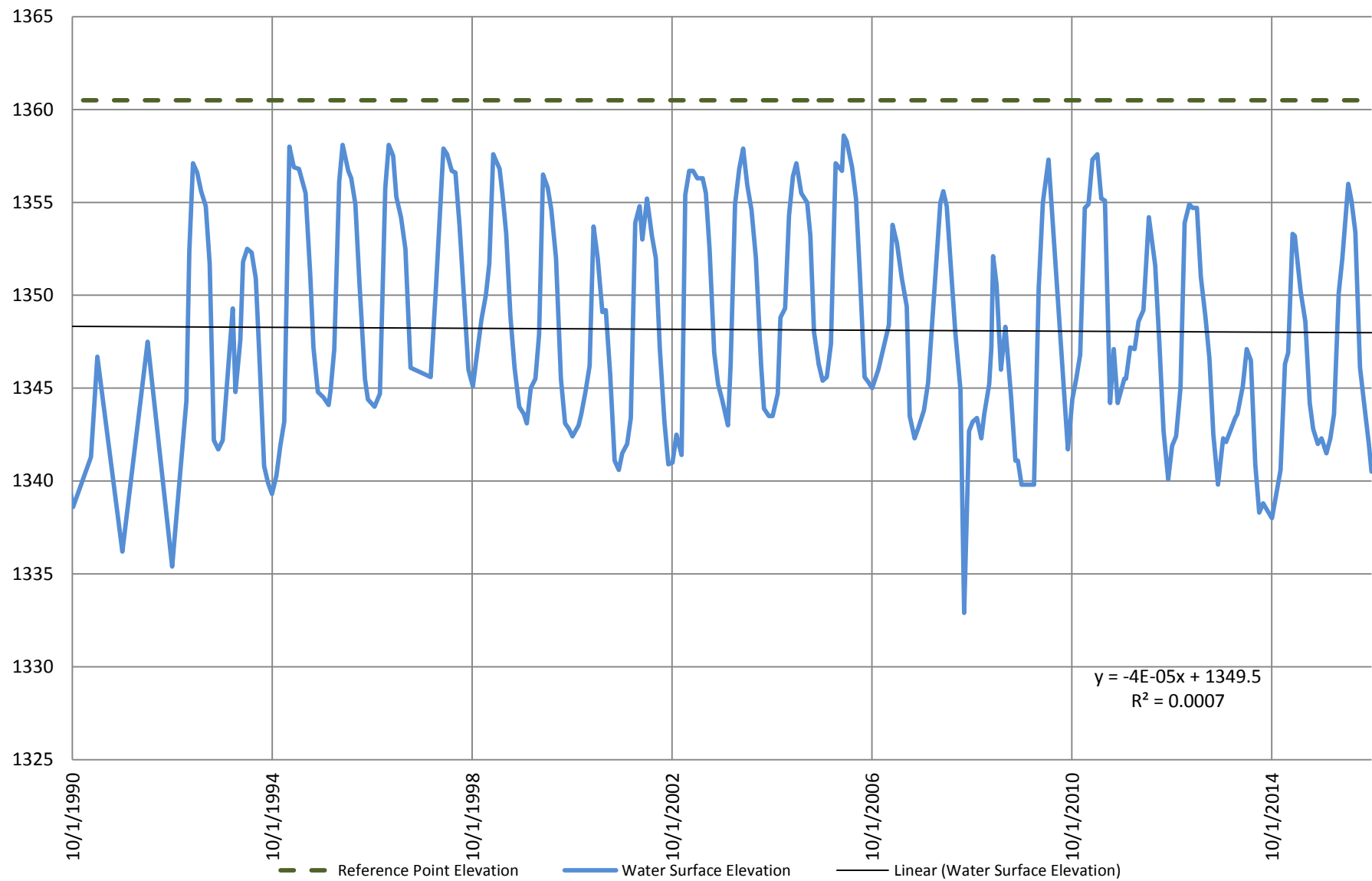
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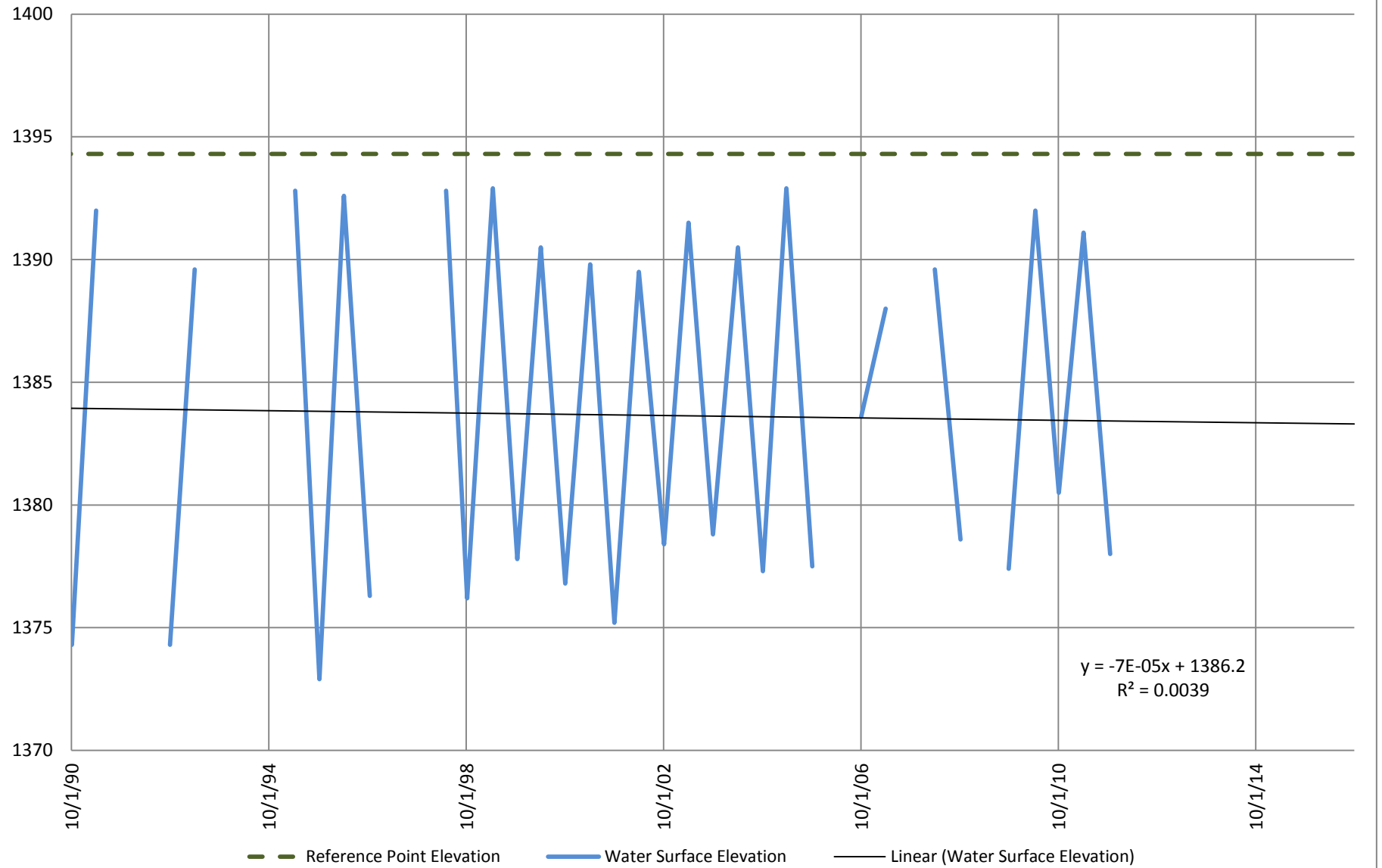
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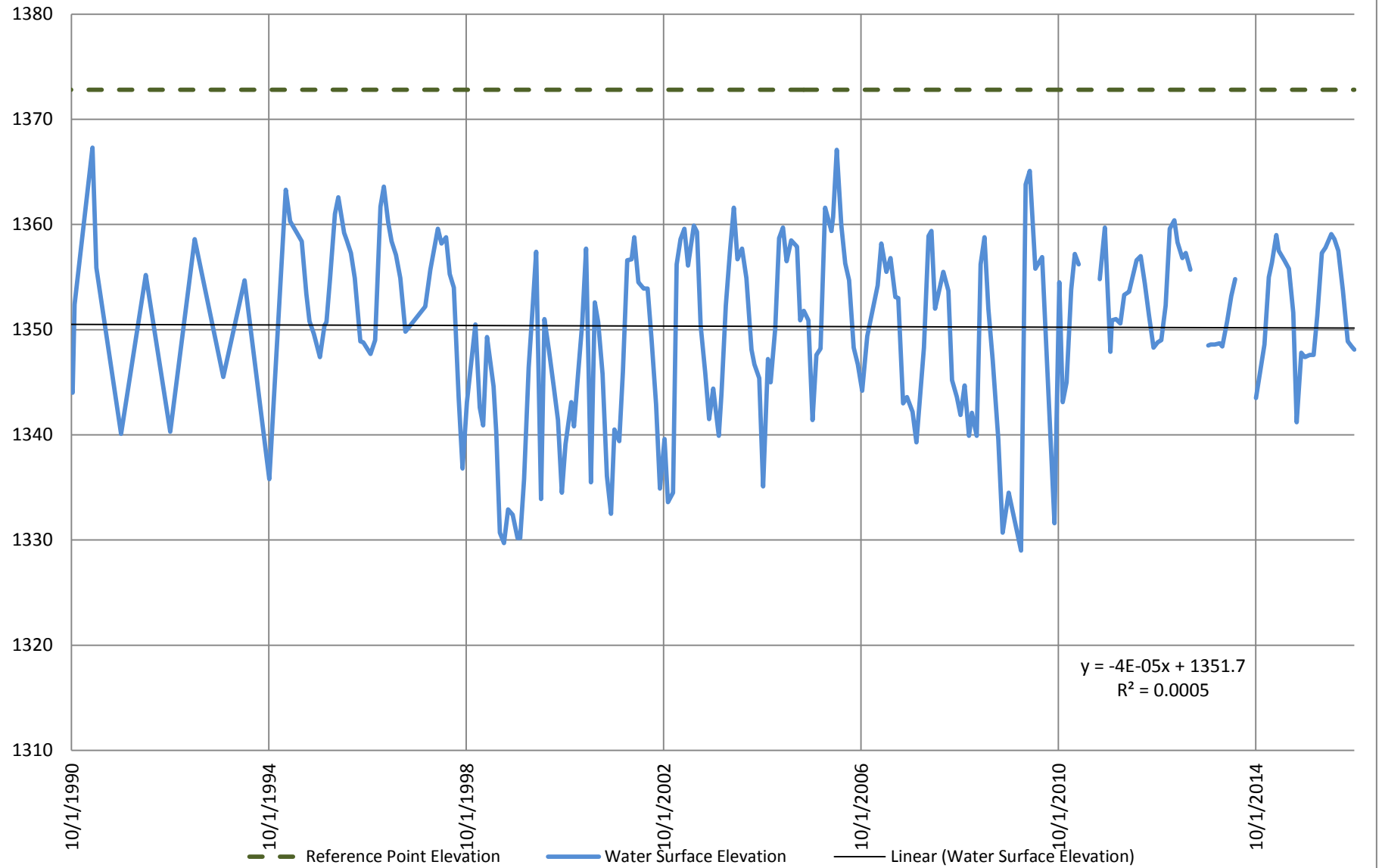
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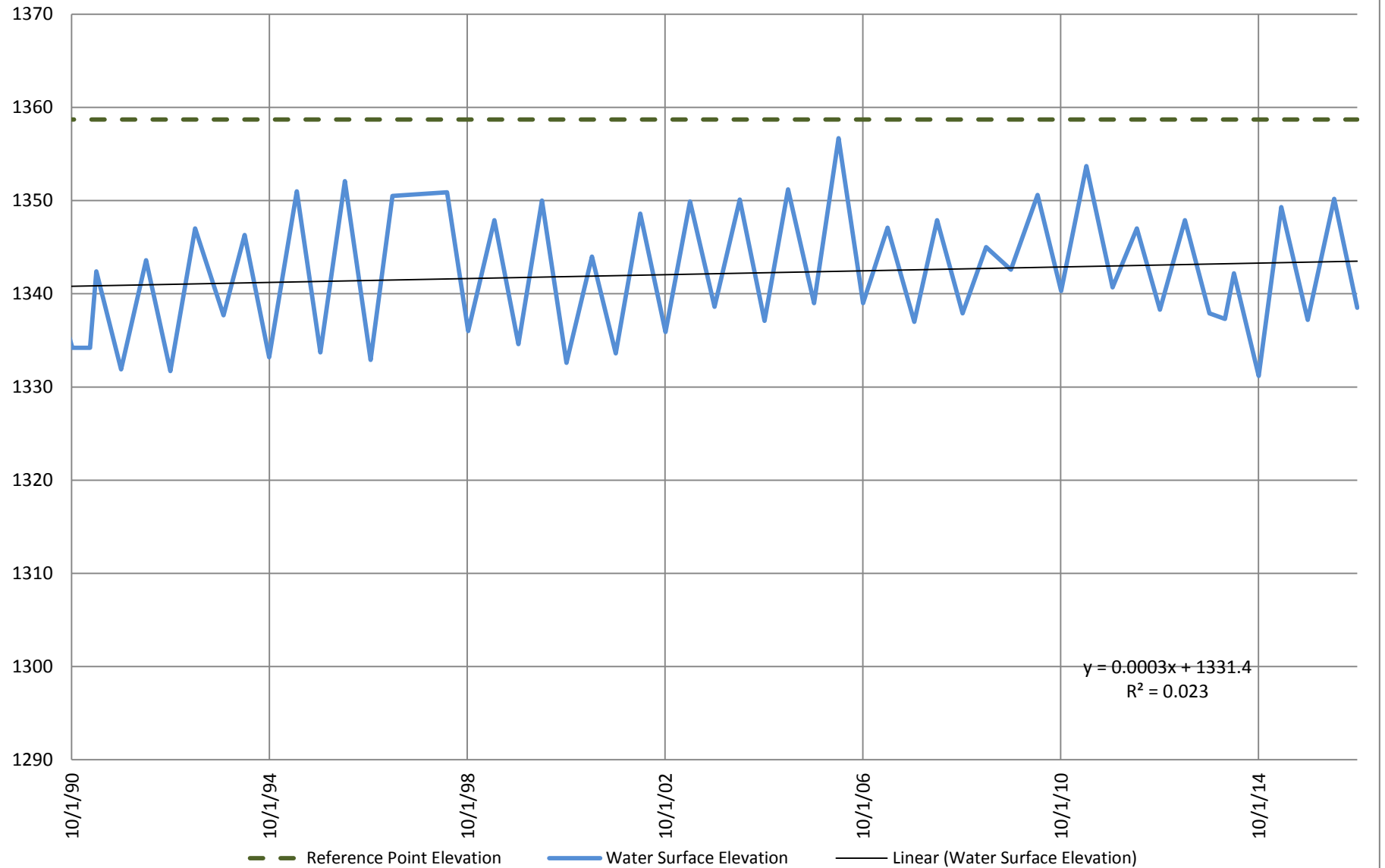
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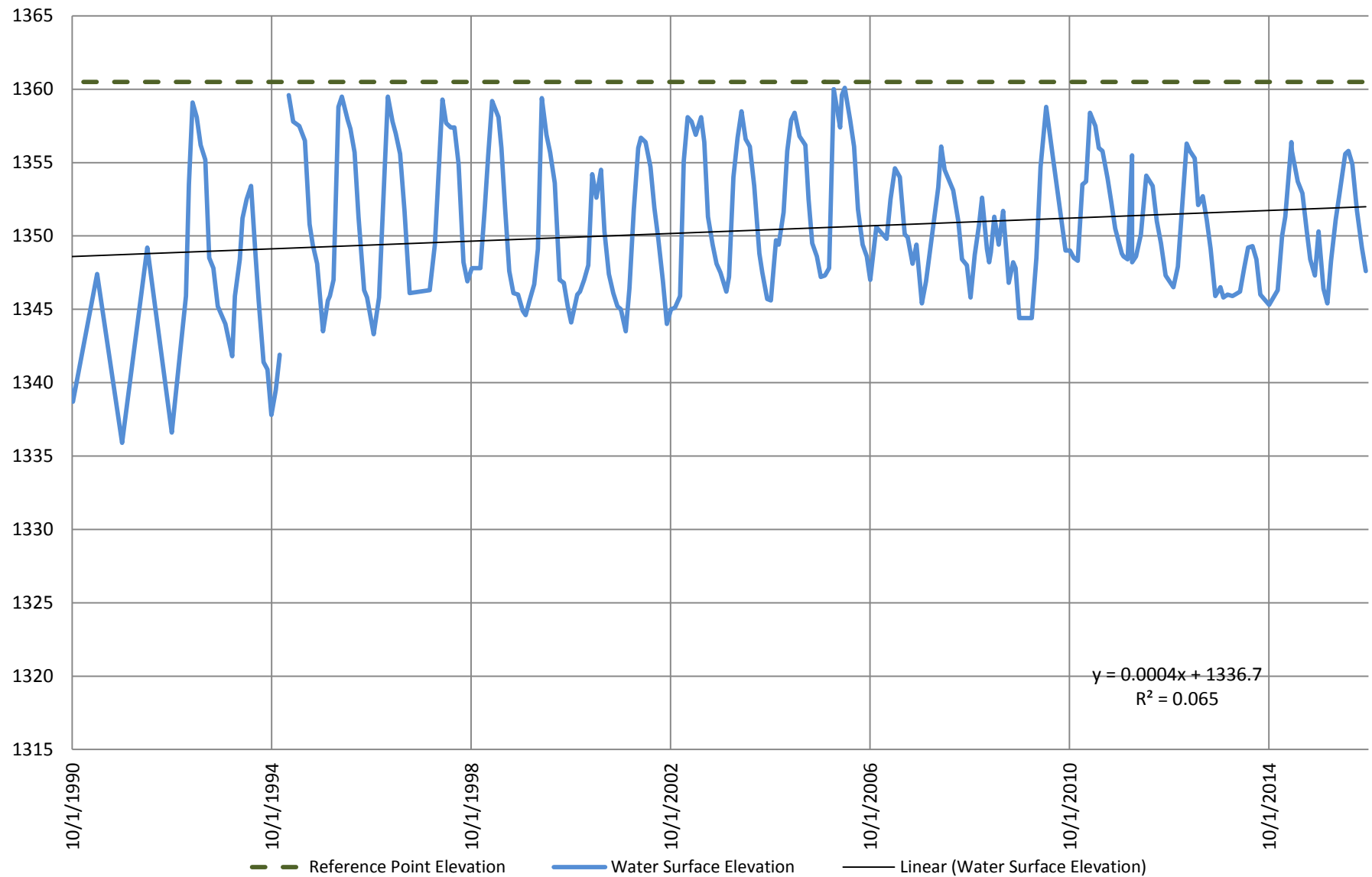
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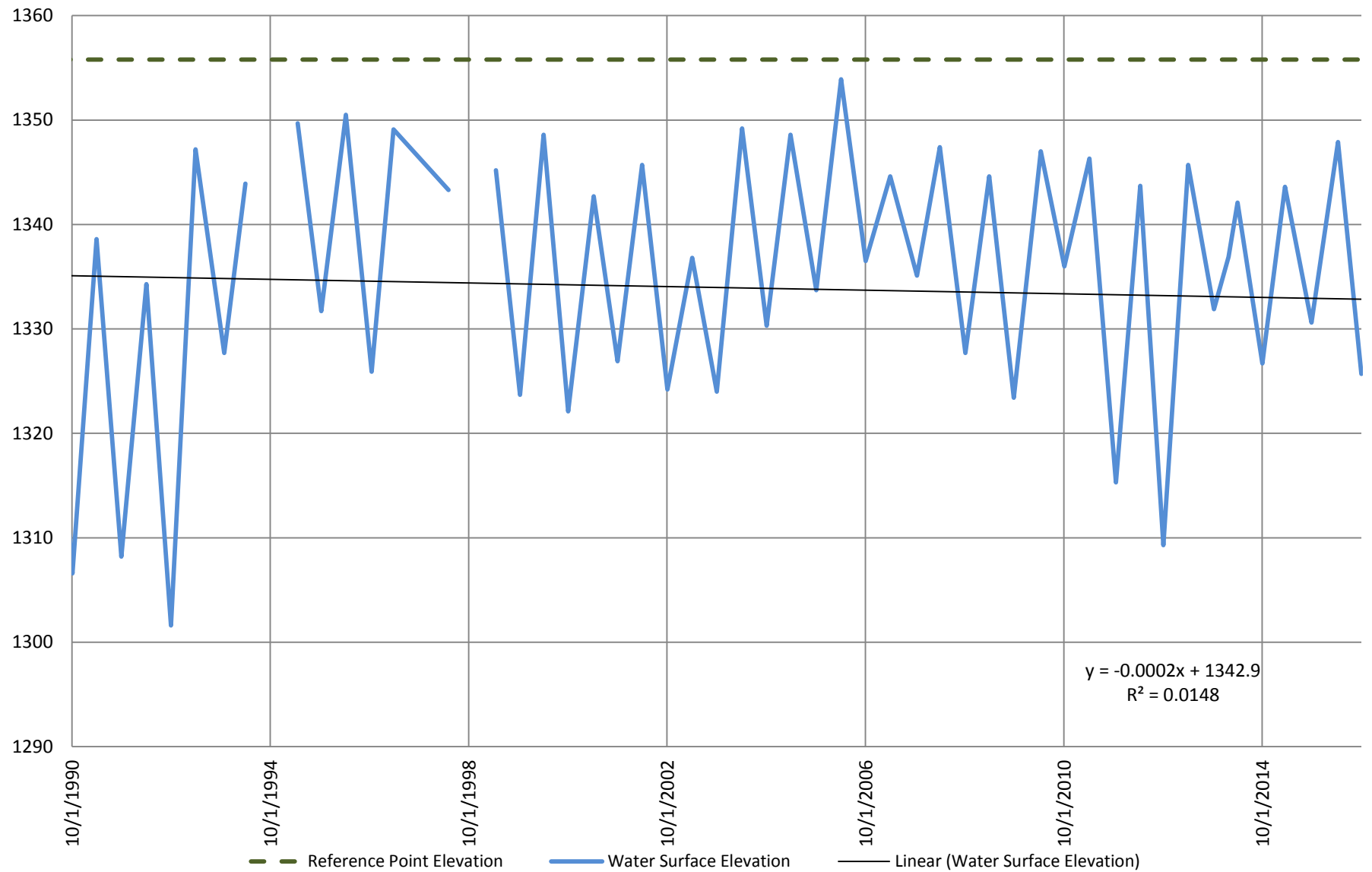
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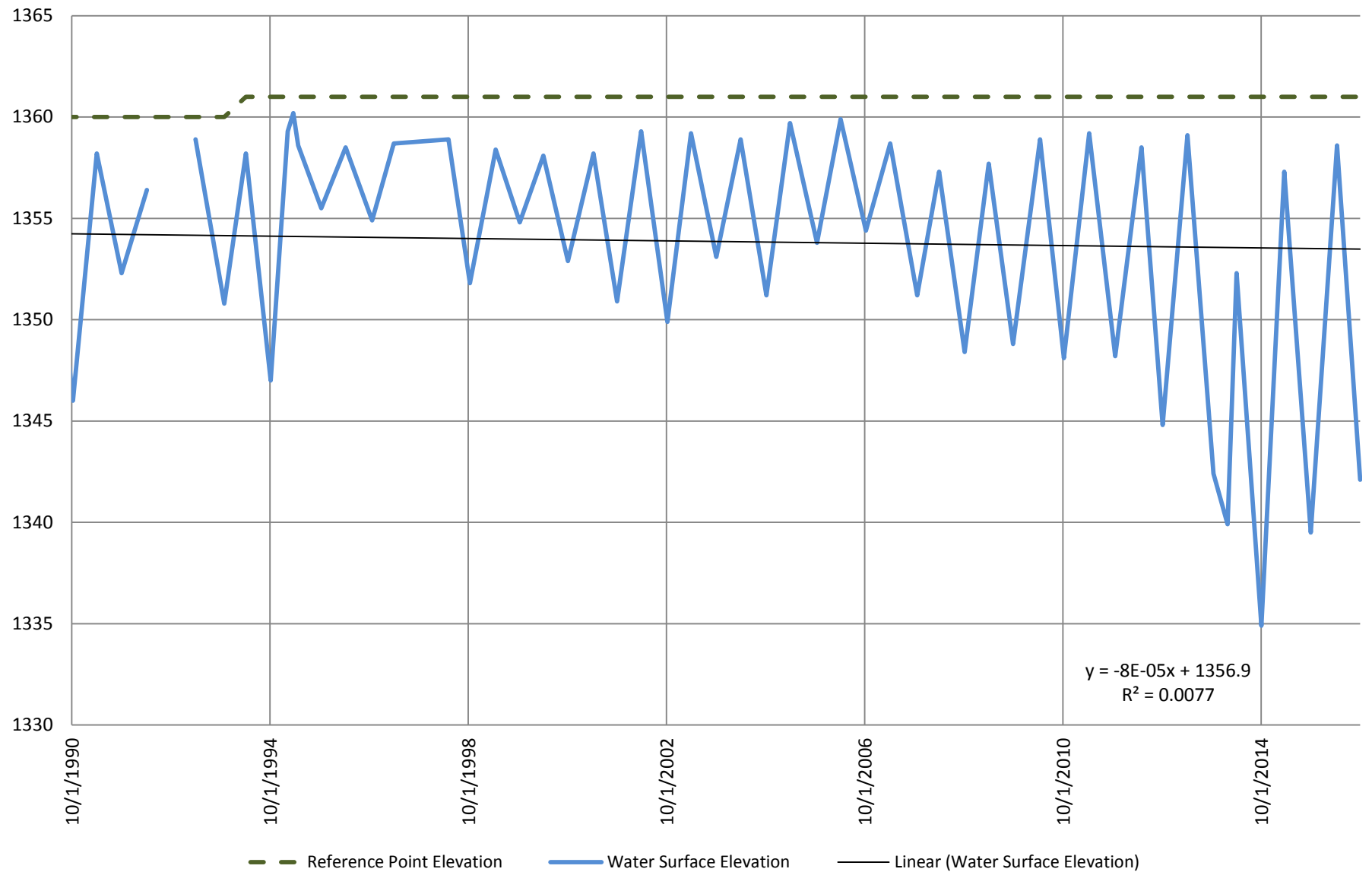
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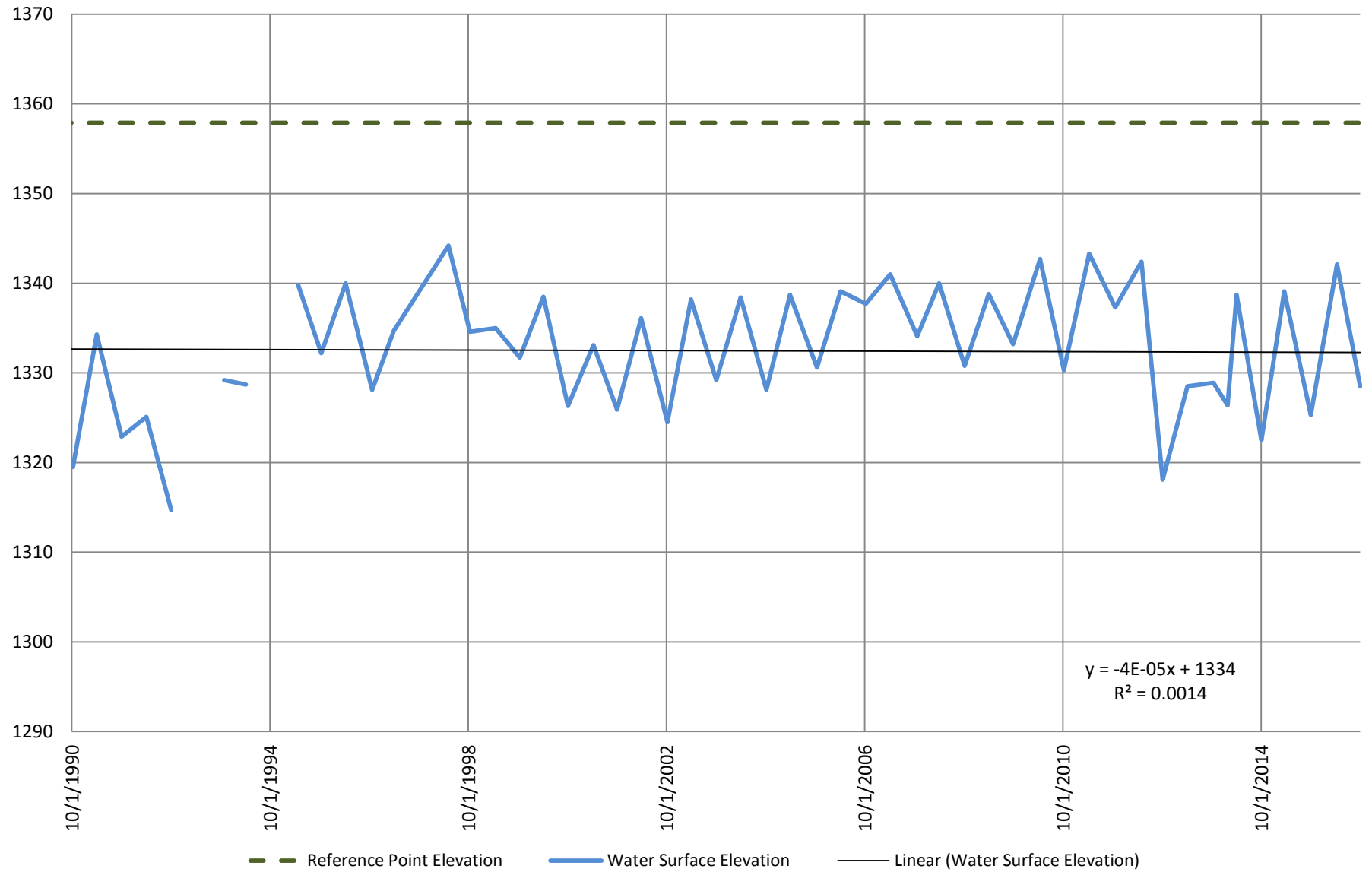
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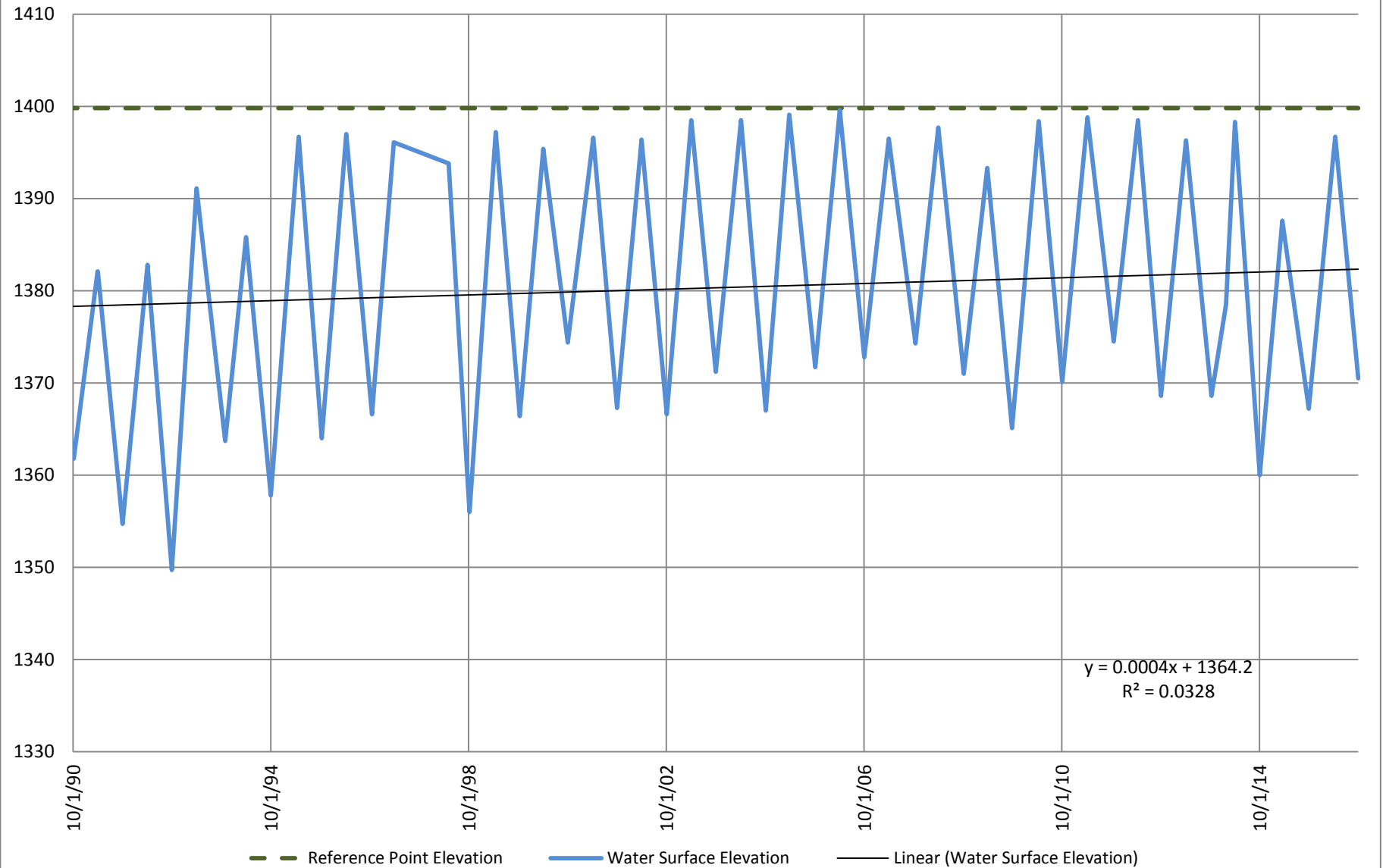
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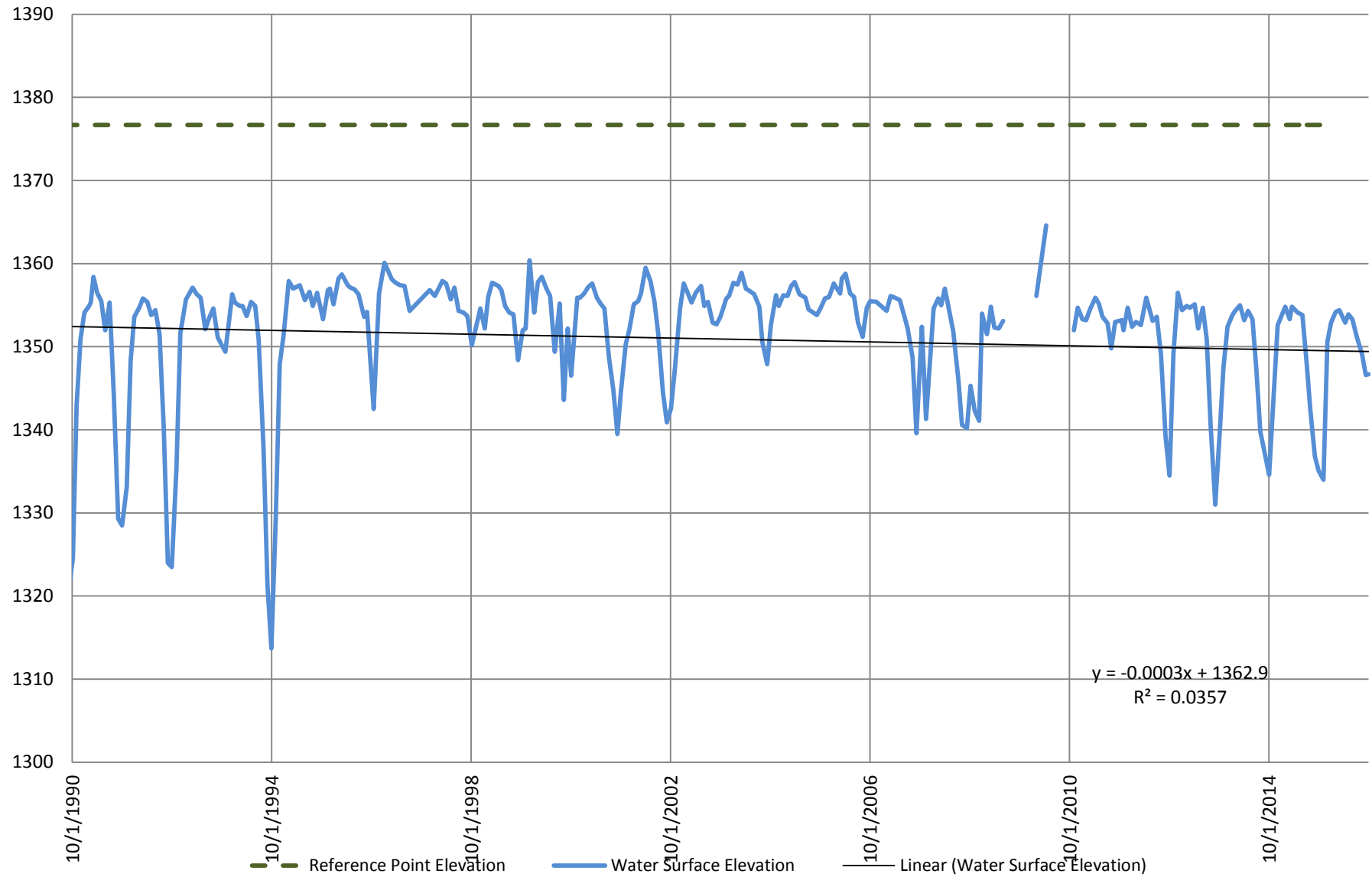
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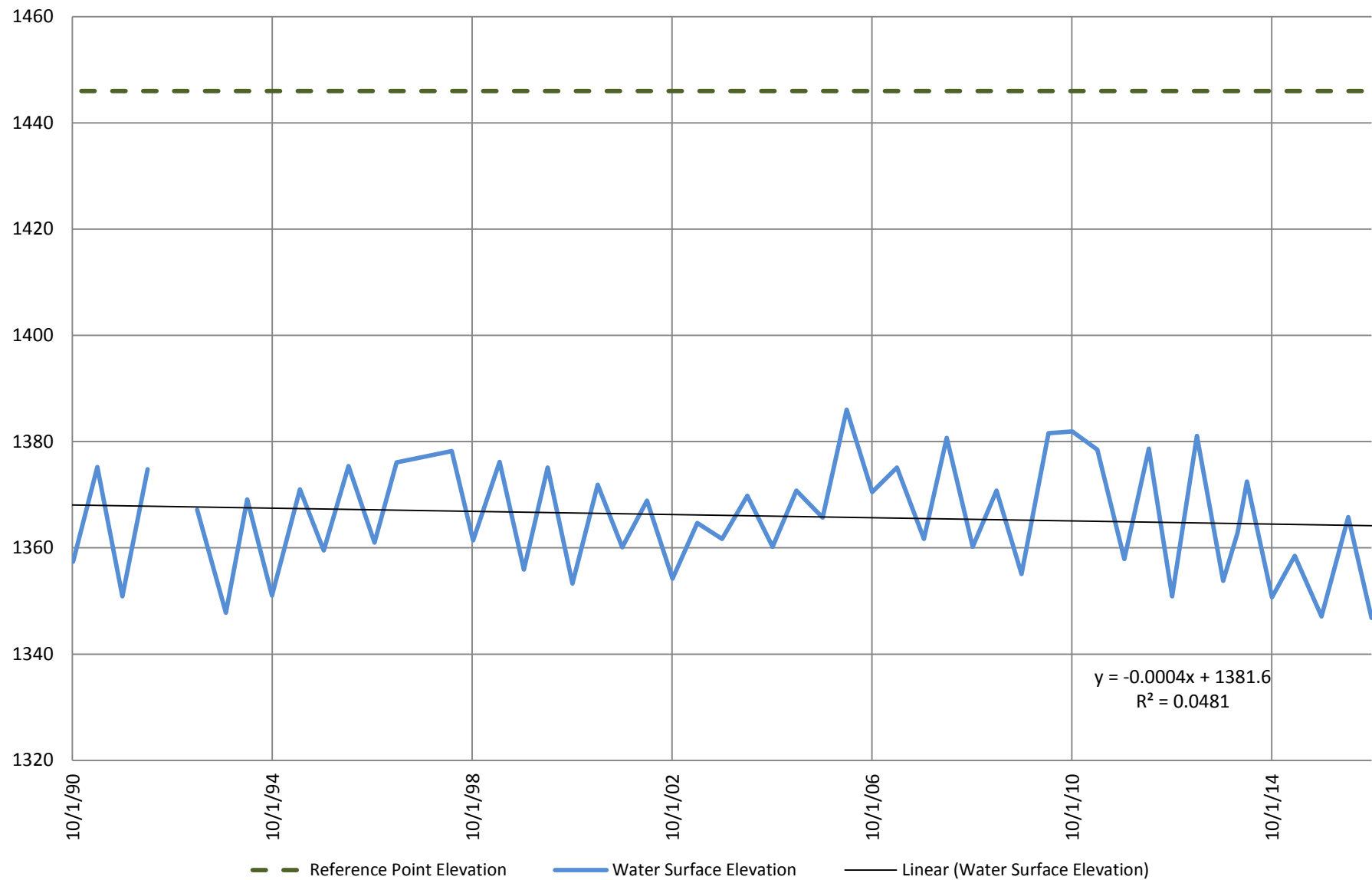
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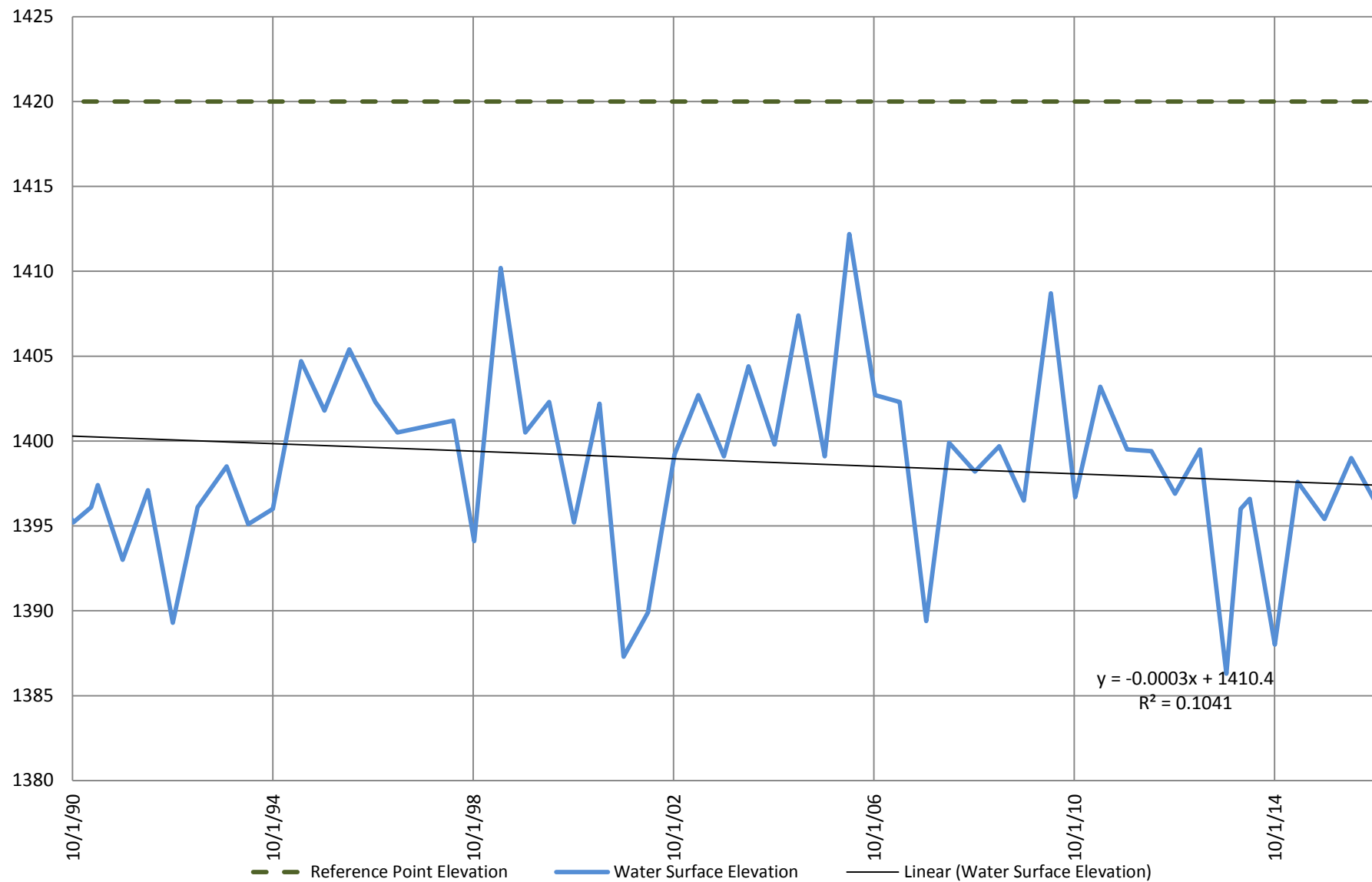
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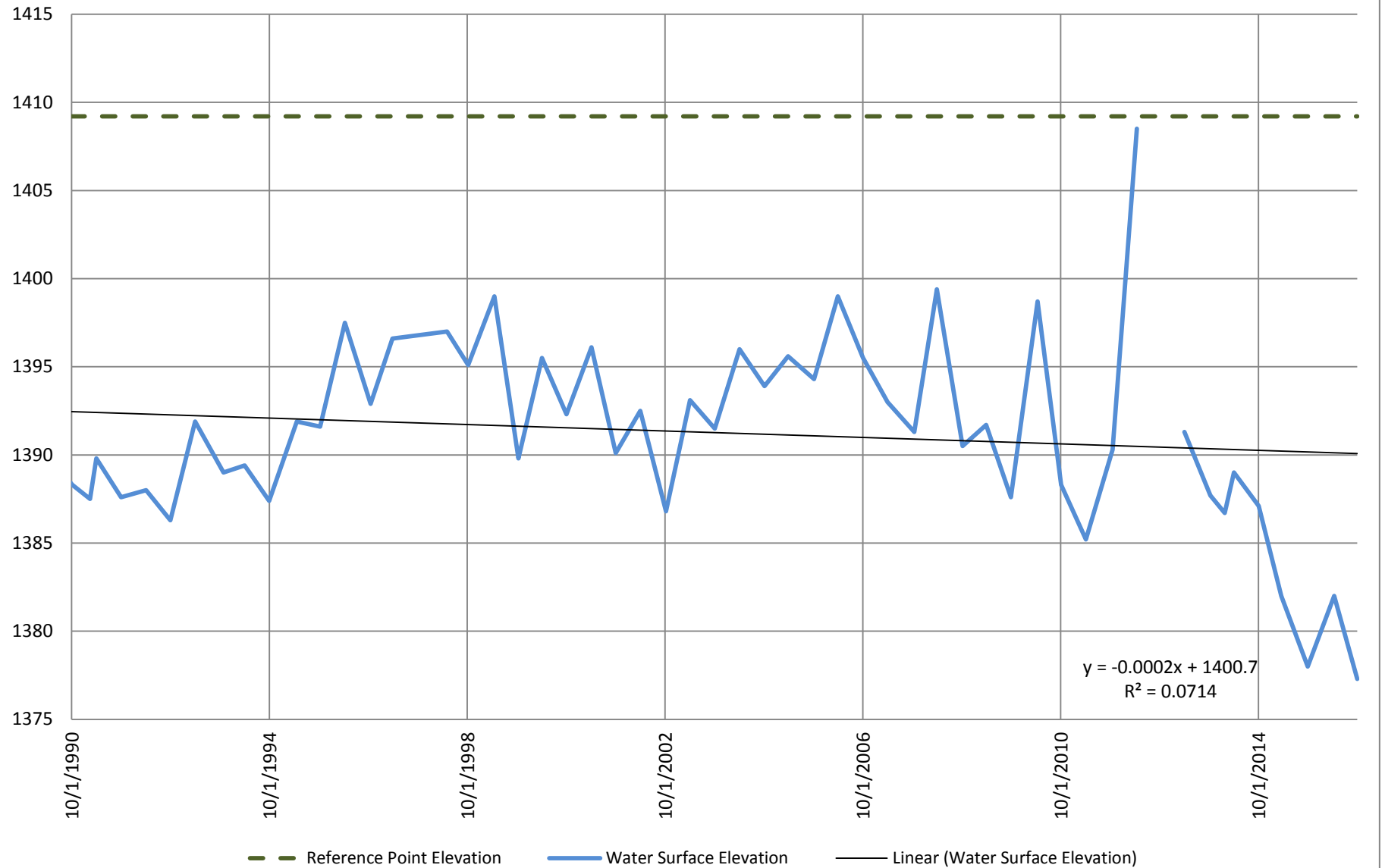
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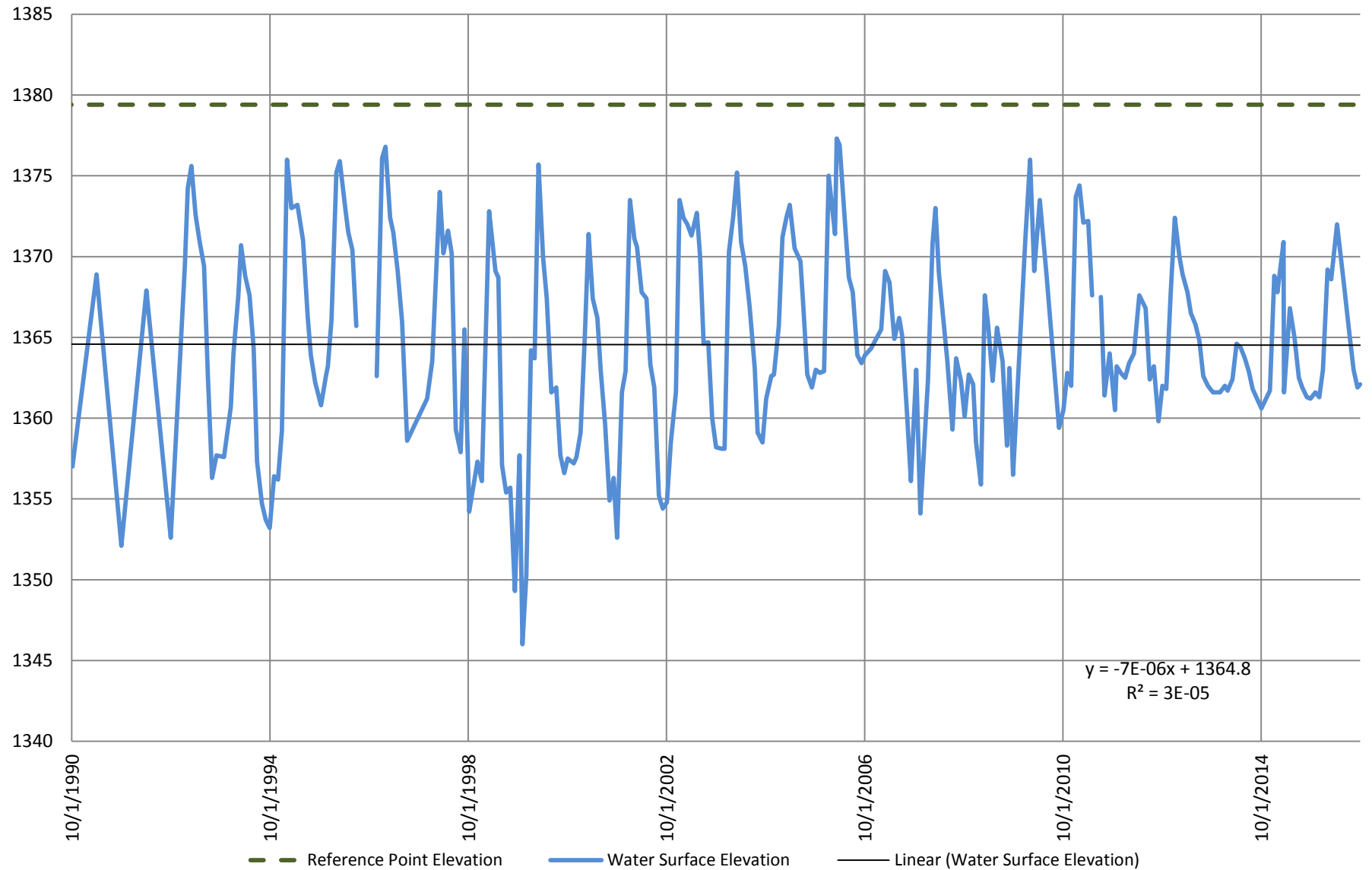
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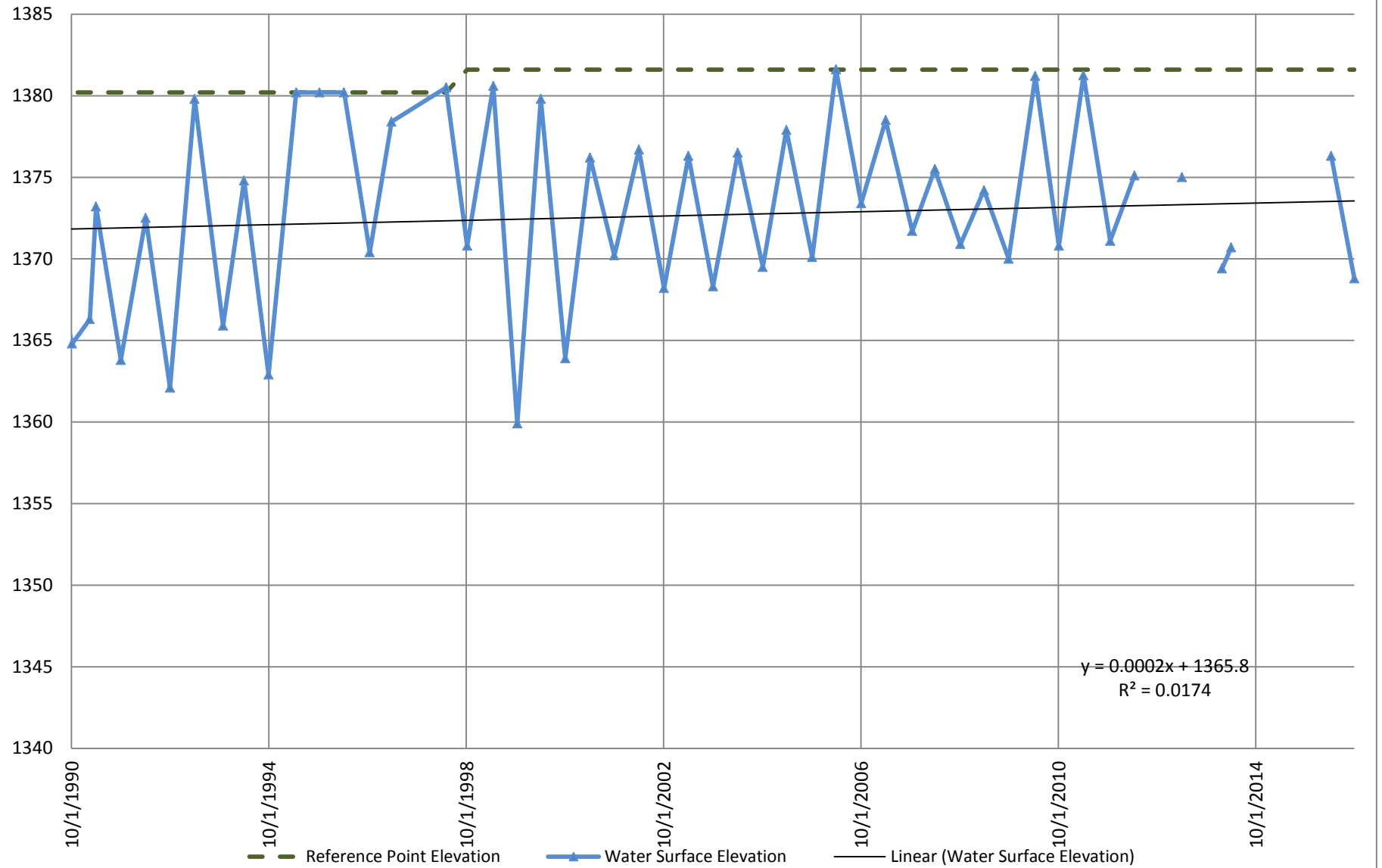
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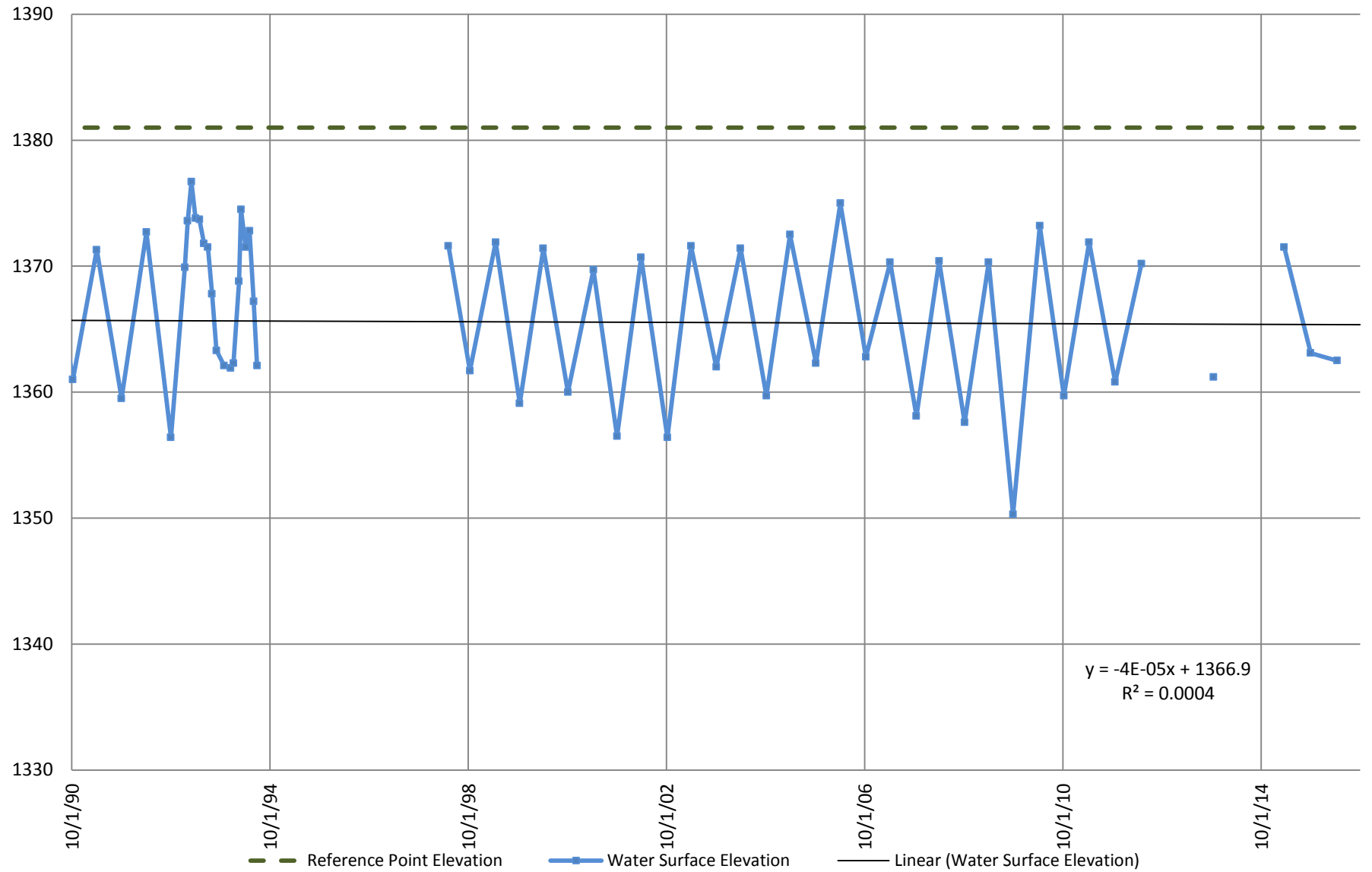
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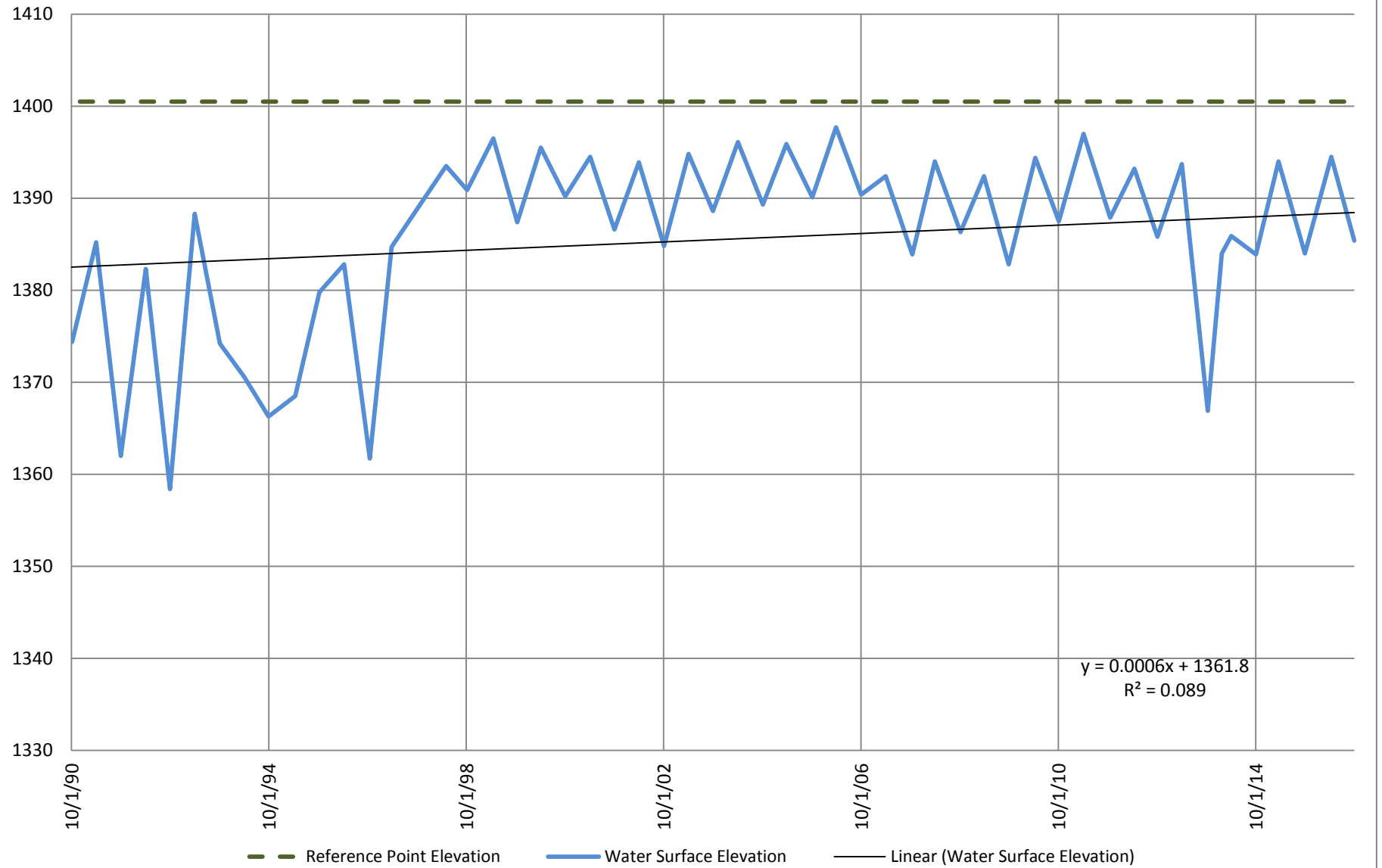
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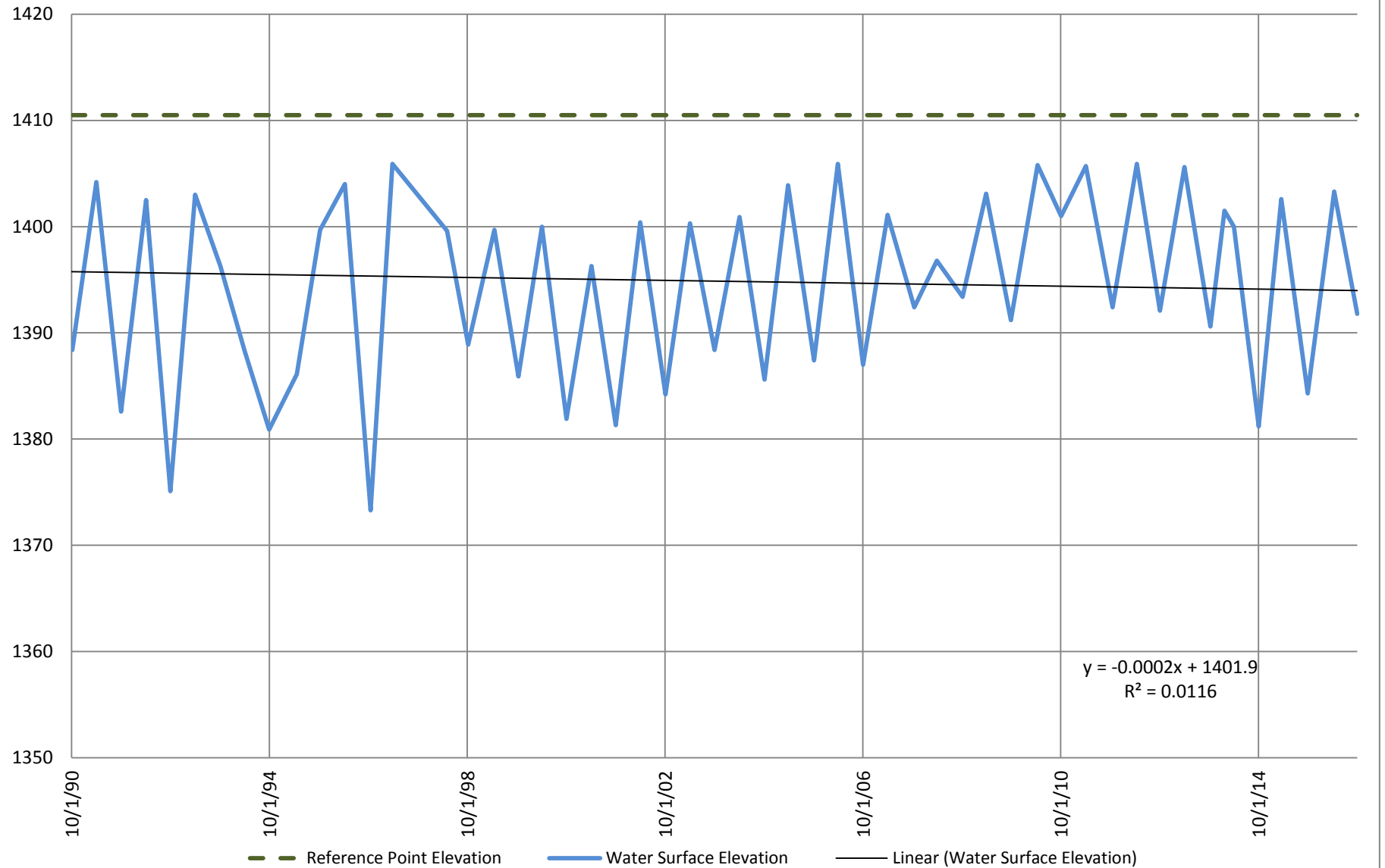
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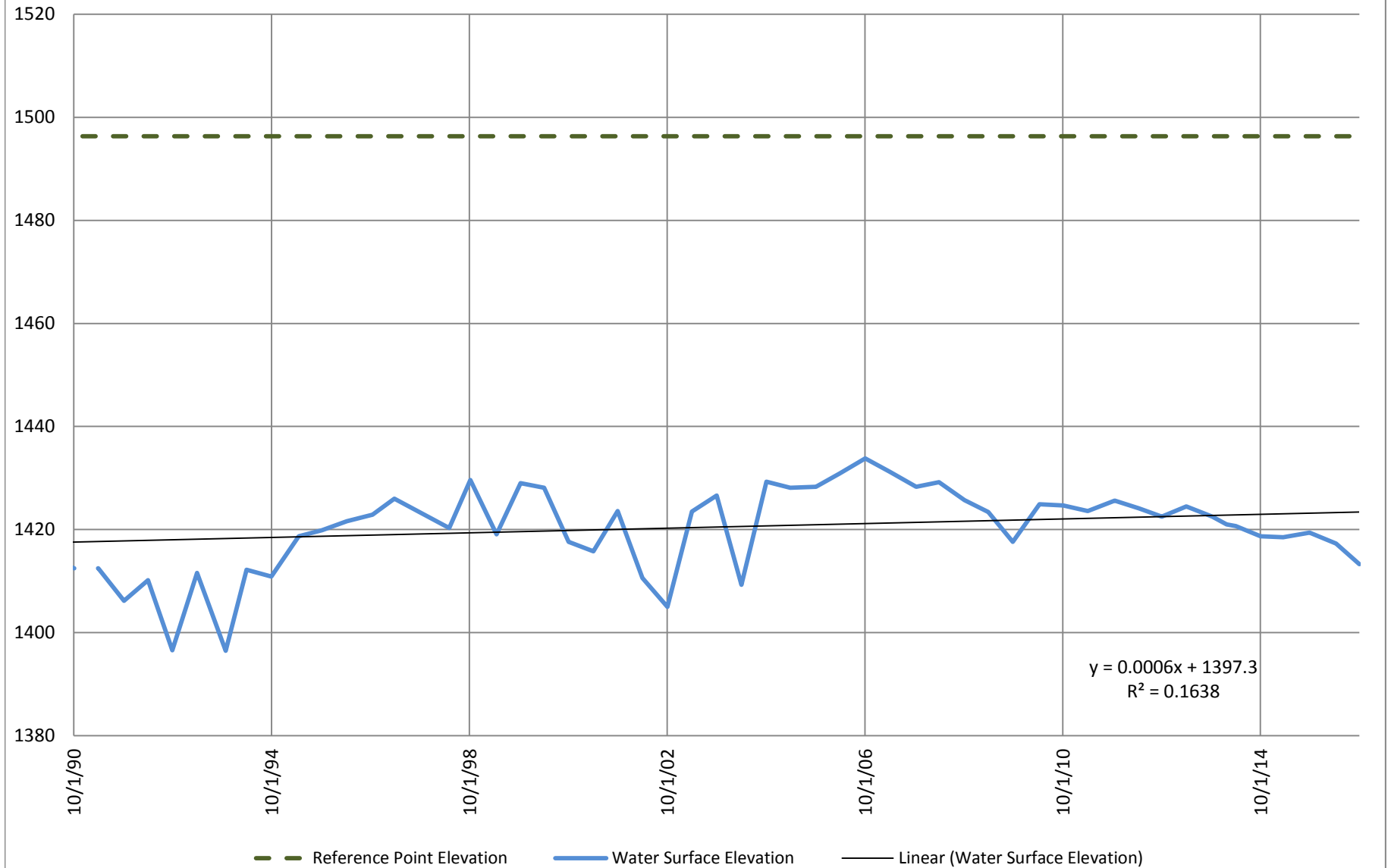


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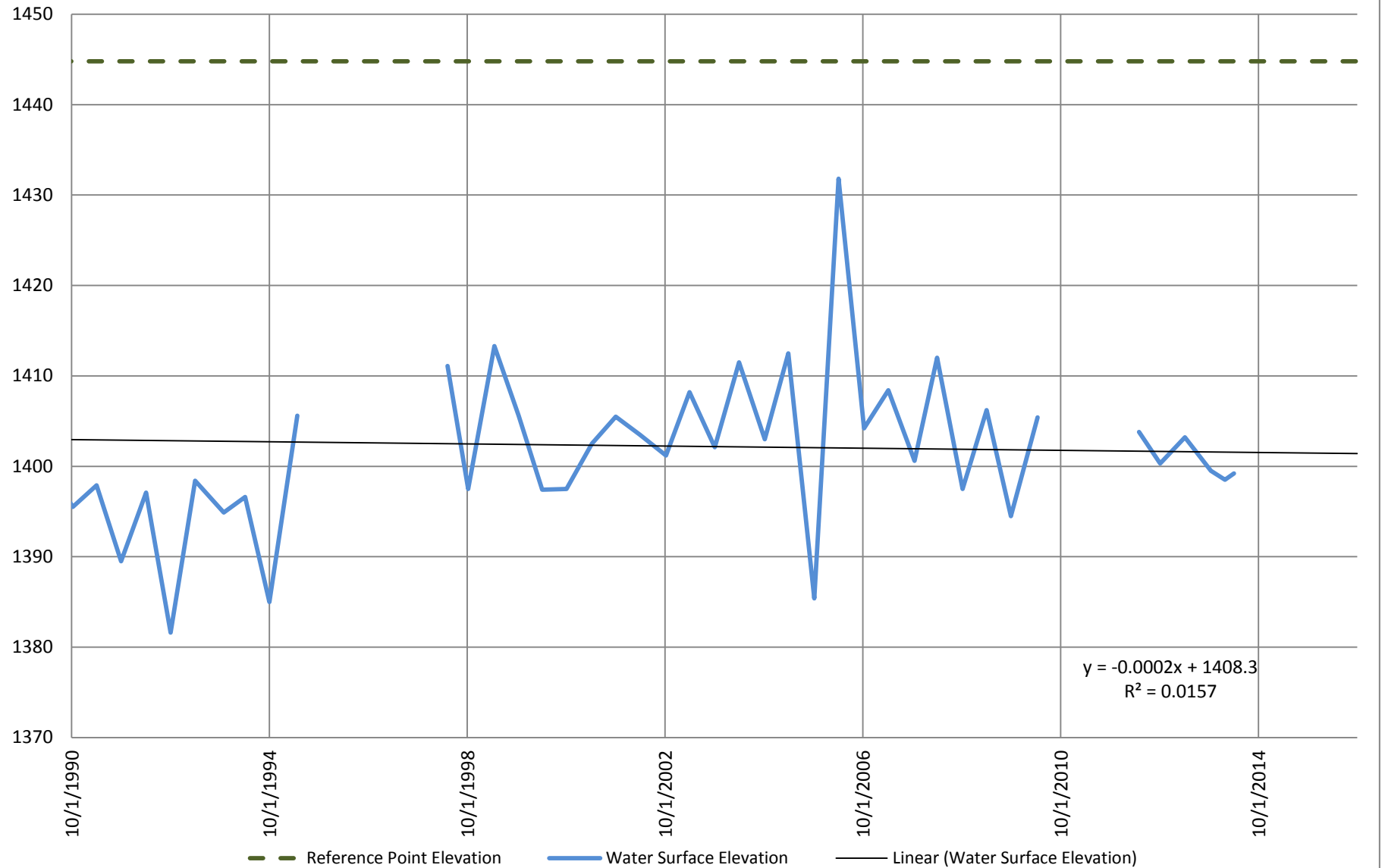


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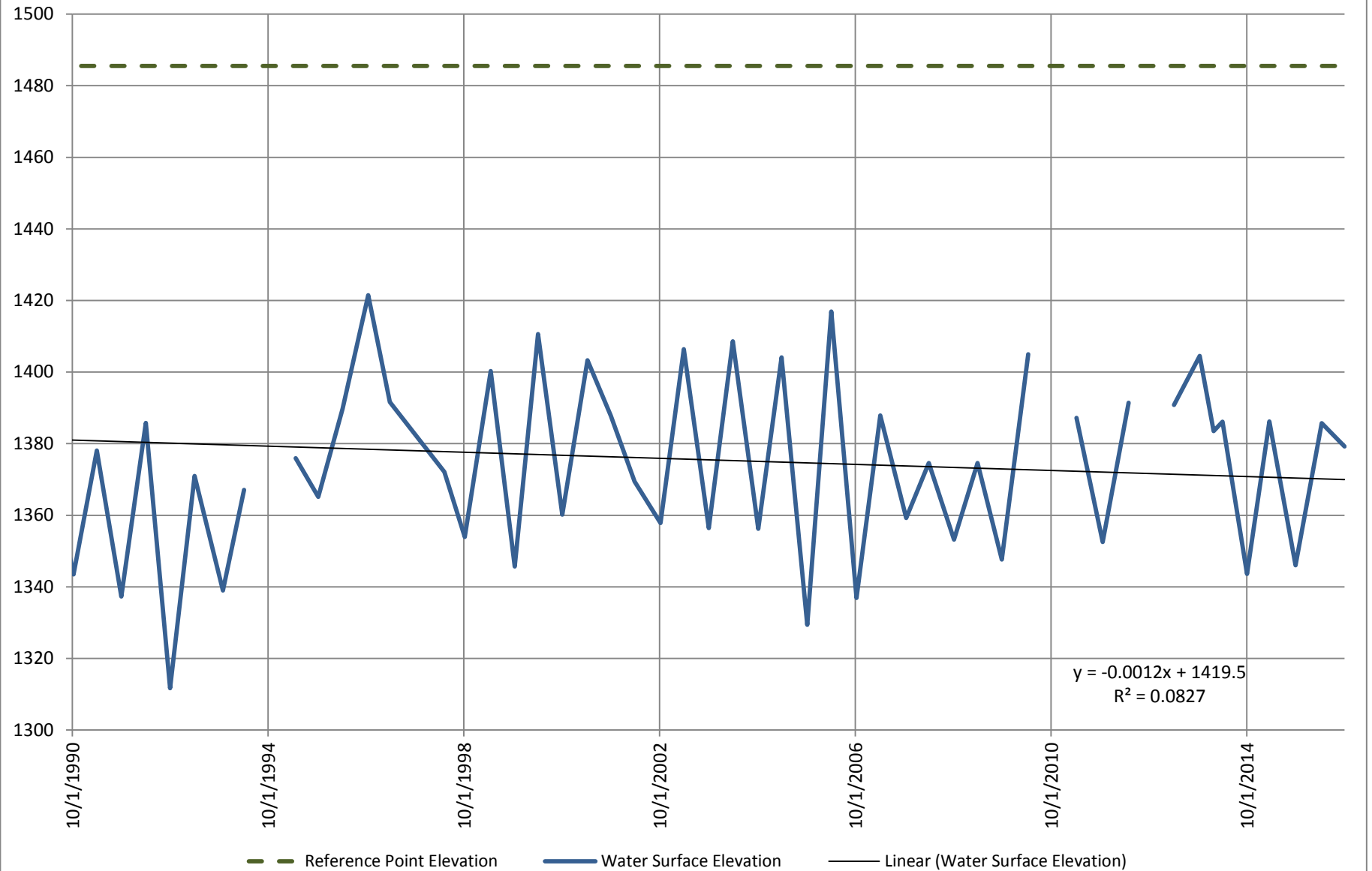
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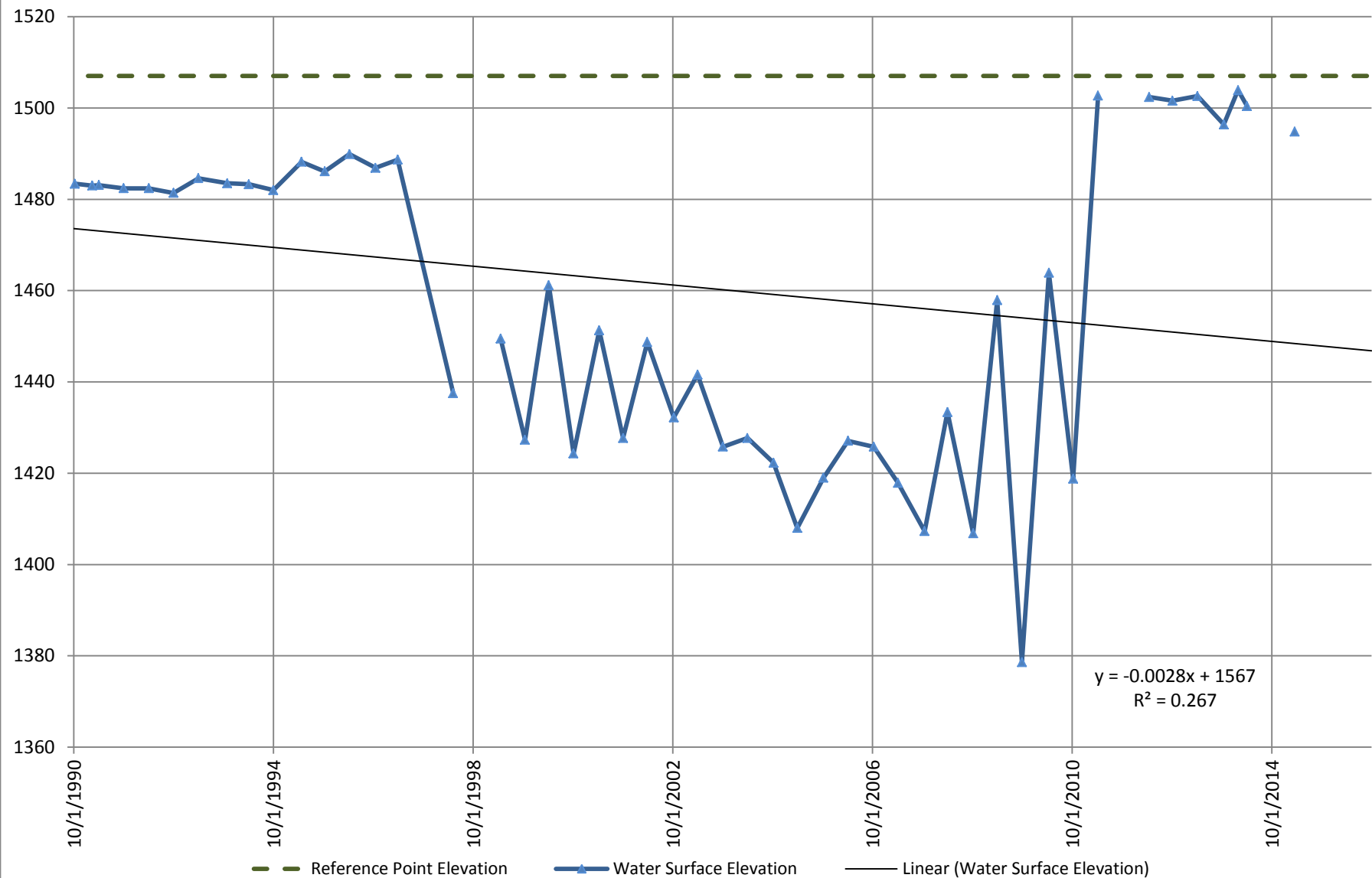
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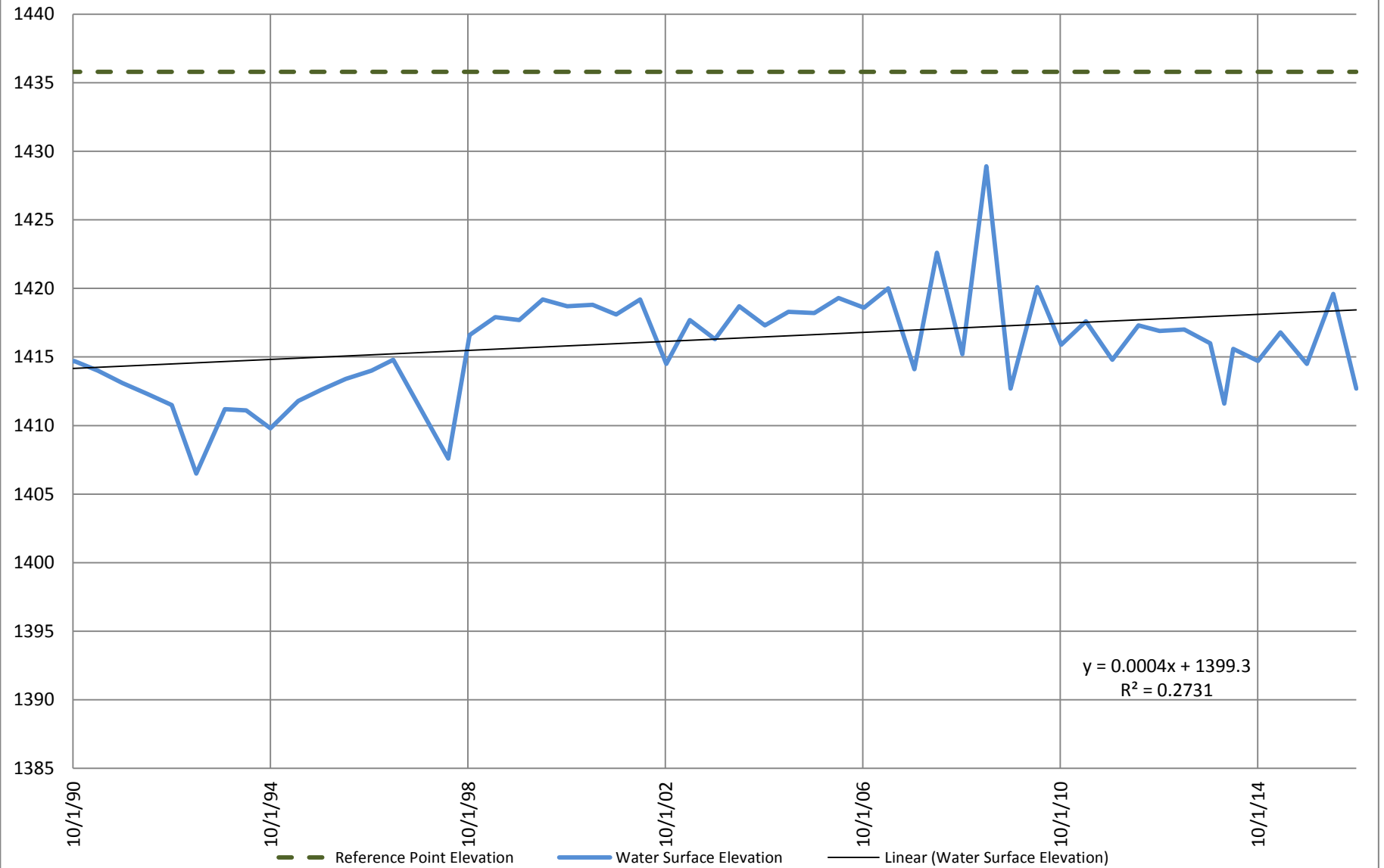
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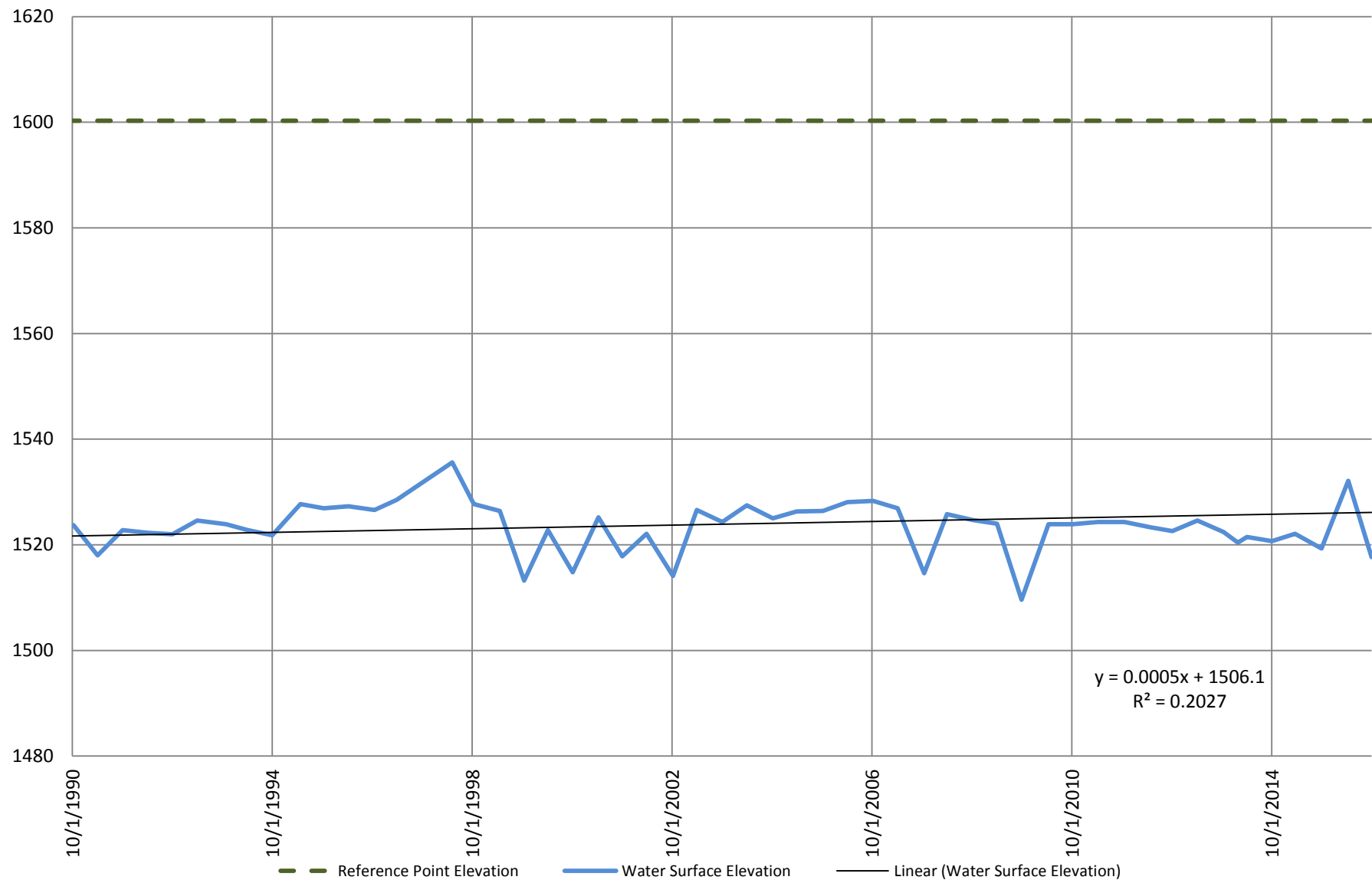
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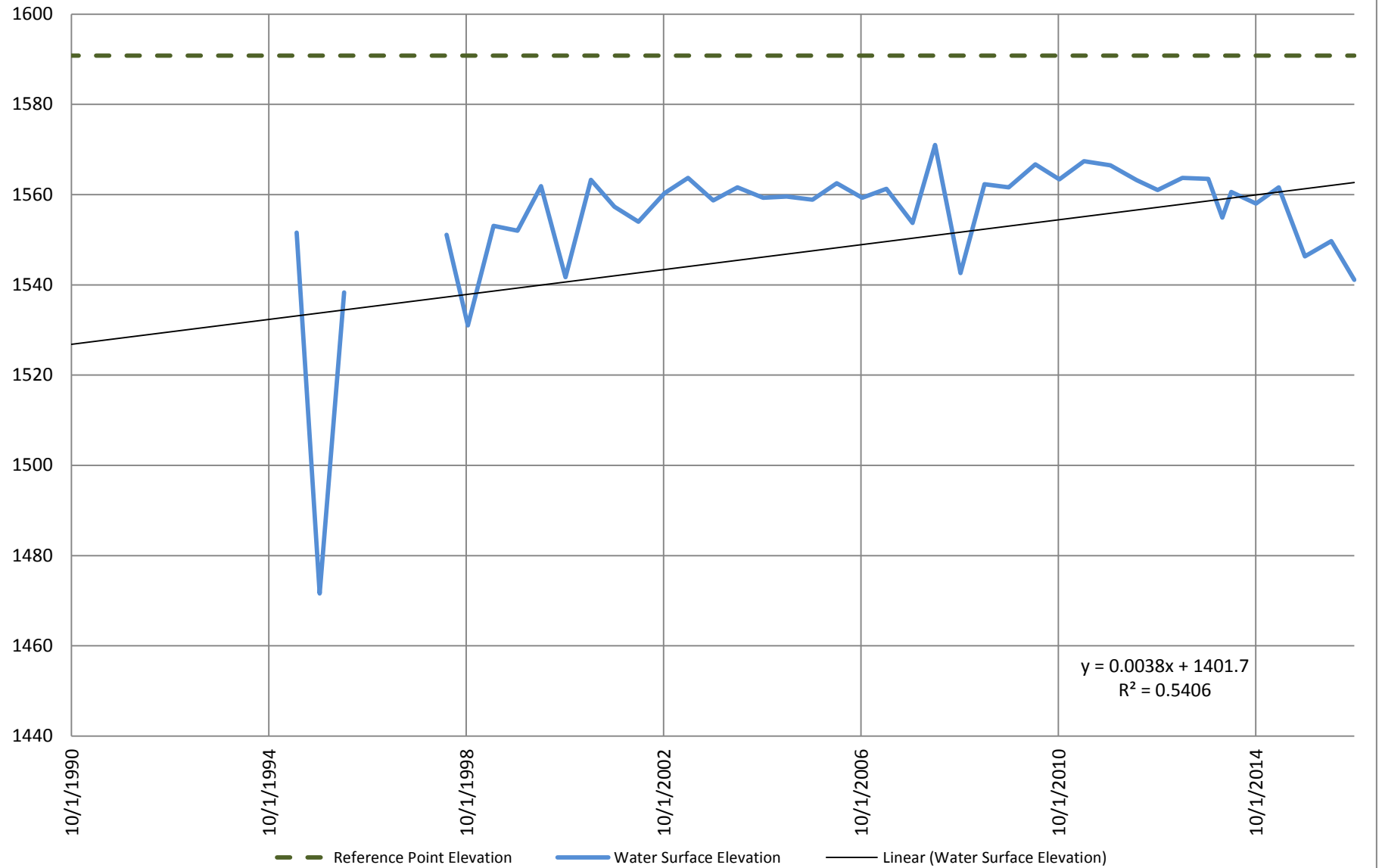
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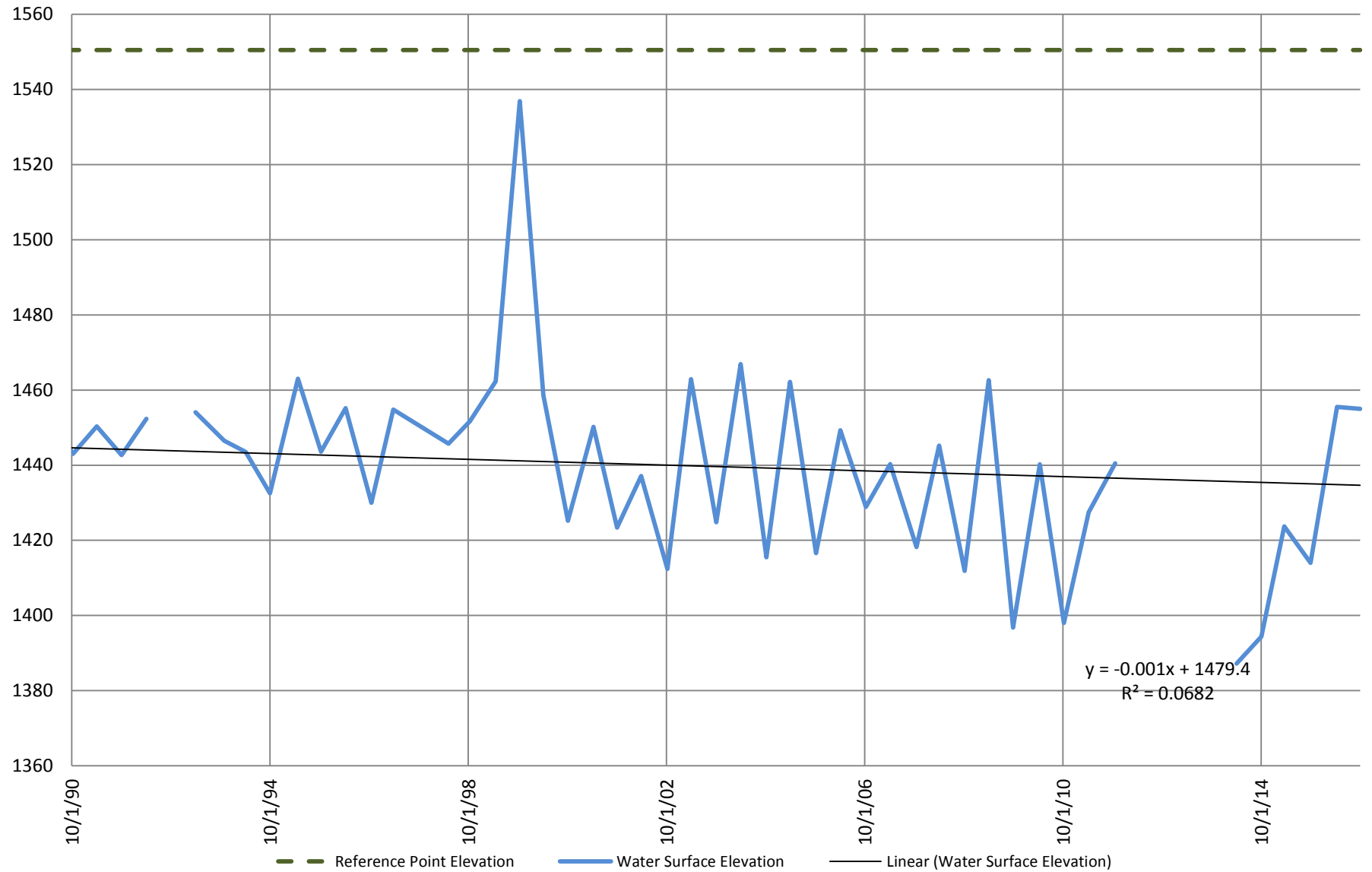
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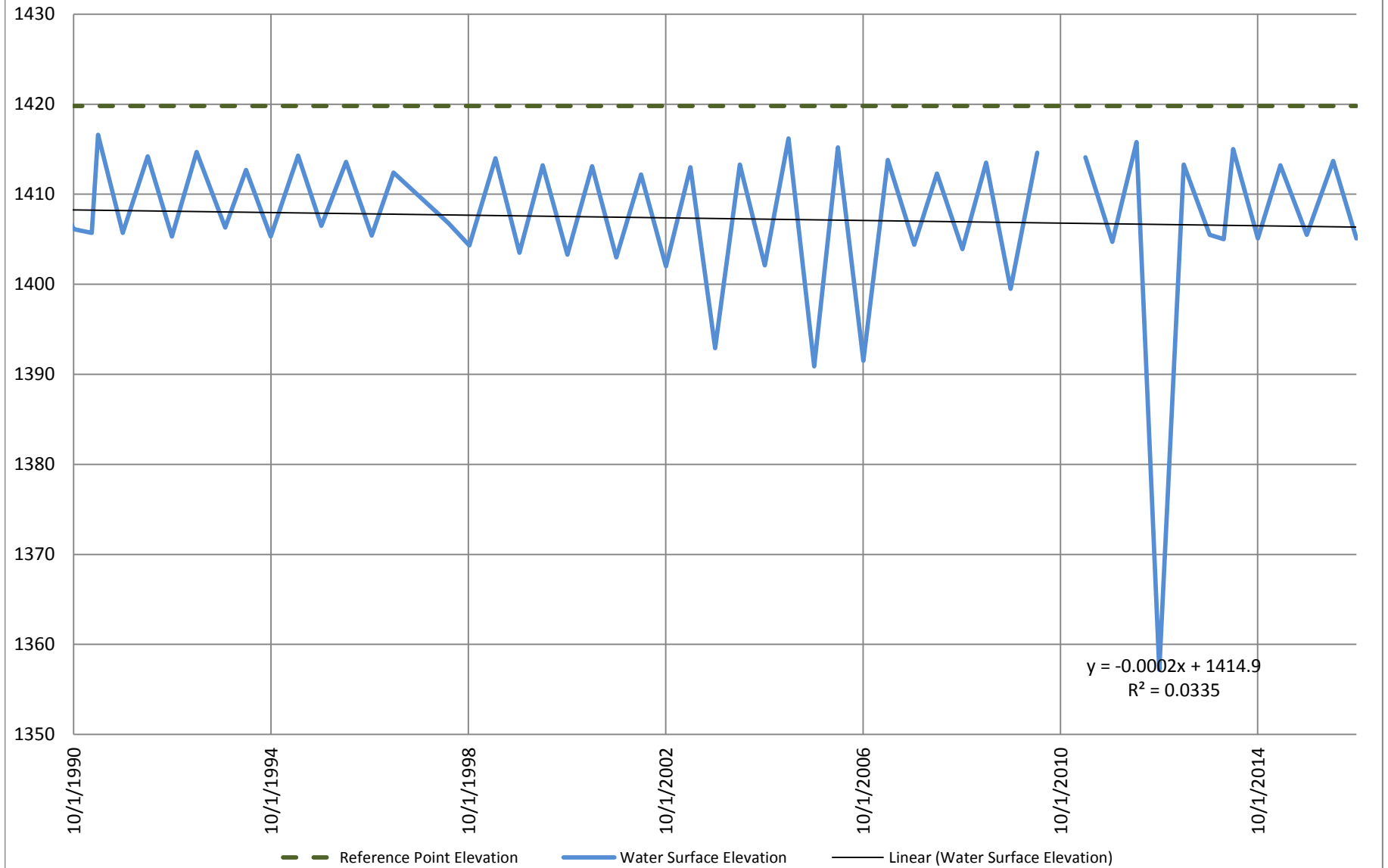
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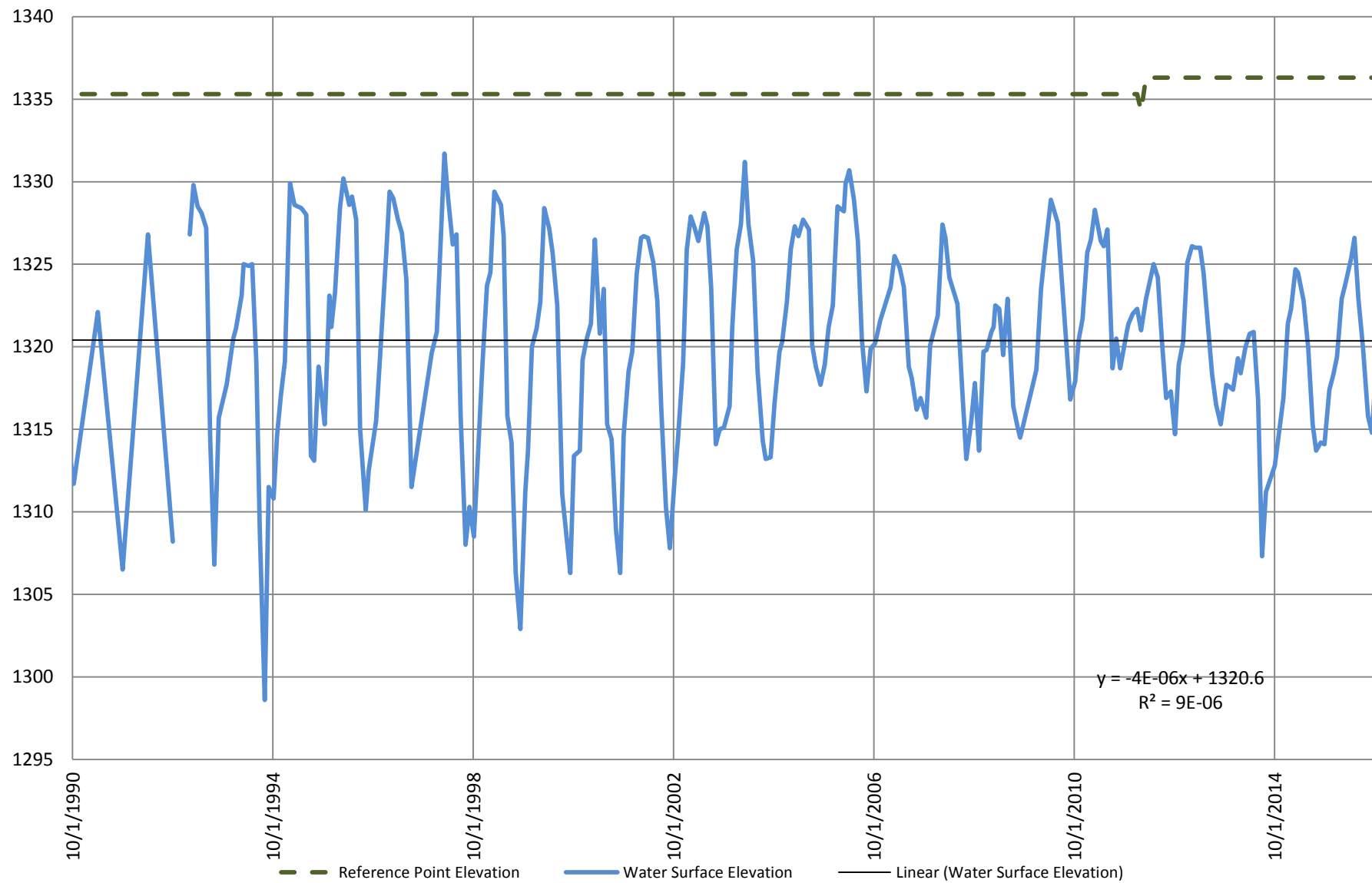
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BIG VALLEY 13N-09W-30A1



BIG VALLEY 14N-09W-32G2



BIG VALLEY 14N-09W-33L3

