



October 21, 2022

Via Email: Caroline.House@deschutes.org

Caroline House | Senior Planner
Deschutes County Community Development
117 NW Lafayette Ave | Bend, Oregon 97703

RE: ODFW's Comments Regarding the Thornburgh Resort Fish and Wildlife Mitigation Plan Addendum #2 (2022 FWMP), File Number 247-22-000678-MC

Dear Ms. House,

The Oregon Department of Fish and Wildlife (ODFW) appreciates the opportunity to provide comments regarding File Number 247-22-000678-MC, the 2022 Thornburgh Resort Fish and Wildlife Mitigation Plan Addendum #2 (Plan), to Deschutes County (County). It is the policy of the State to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations (ORS 496.012). In accordance with this policy and ODFW's mission, we have reviewed the application and provide the following comments and recommendations to be included in the record for the October 24, 2022, Public Hearing. As the technical experts on fish and wildlife habitat needs in Oregon, ODFW plays a critical role in determining impacts to fish and wildlife resources and recommending means to offset the impacts, if applicable, in accordance with the County Comprehensive Plan and implementing ordinances. Our history of coordination with the applicant and the County have led to the conditions of approval in the Final Master Plan, and we look forward to continued collaboration in protecting Oregon's fish, wildlife, and habitats through this Plan amendment process.

DCC 18.113.070(D) requires “[a]ny negative impact on fish and wildlife resources will be completely mitigated so that there is no net loss or net degradation of the resource.” The applicant has recently been meeting with ODFW in an attempt to ensure the Plan is supported by ODFW as resulting in no net loss or net degradation of the resource. ODFW has reviewed the Plan as submitted to the County and has had several conversations with the applicant to better our understanding of what is proposed. While the overarching concept of the Plan appears to have merit, there is not substantial evidence in the record to determine if DCC 18.113.070(D) standard has been met. ODFW does not have enough information at this time to determine if transferring the location of the impacts to the Thornburgh Resort (Resort) from upstream locations, as proposed in the Plan, would result in no net loss or net degradation of the resource. As such, ODFW has requested additional information from the applicant and anticipate receiving new

information and assessments soon (Note: ODFW received additional information today but will not have time for review prior to the Hearing on Monday.). Due to the complexity of this proposal, substantial changes, and limited time to review additional amendments prior to the October 24 hearing, ODFW requests that the record remain open for at least 30 days to allow for additional review and ODFW's recommendation to the County.

ODFW's Interest in the Deschutes Basin

The proposed development is located in an area with a close hydraulic connection between the regional groundwater aquifer and surface water discharge into the Deschutes River. The effect of groundwater pumping at the Resort is expected to have its greatest impact on spring discharges and Deschutes River flows between Lower Bridge and downstream of Whychus Creek. In addition to resident Redband Trout and Mountain Whitefish, ESA-listed Bull Trout, an experimental population of ESA-listed summer steelhead, and Spring Chinook Salmon are currently present in the Deschutes River from Lake Billy Chinook upstream to Big Falls and in lower Whychus Creek. The distribution of these species overlaps with the impacts of groundwater pumping at the Resort and extends to half a mile below Deep Canyon Creek and one mile below Lower Bridge. The native trout, salmon, and whitefish in the Deschutes basin require consistent sources of cold, clear water to complete their life histories and zones of groundwater discharge provide critically important habitat. Increased groundwater withdrawal for agricultural, residential, and municipal needs has a cumulative negative effect on springs that further degrades fish and wildlife habitat quantity and quality.

ODFW's Fish and Wildlife Mitigation Policy

ODFW recognizes Deschutes County's authority to evaluate this application consistent with County Code provisions. As referenced above, DCC 18.113.070(D) states that "*[a]ny negative impact on fish and wildlife resources will be completely mitigated so that there is no net loss or net degradation of the resource.*" Similarly, to further the Wildlife Policy (ORS 496.012) and Food Fish Management Policy (ORS 506.109), ODFW reviews mitigation proposals utilizing our Fish and Wildlife Habitat Mitigation Policy (OAR 635-415). The Policy was developed as a consistent framework for ODFW staff to utilize when recommending options to avoid, minimize and mitigate impacts of land and water development actions on fish and wildlife habitat. Previous assessments (i.e., the 2008 Addendum) of the Resort's impacts to fish and wildlife habitat resulted in a Habitat Category 2 designation, meaning the impacted habitat is essential and limited for a fish or wildlife species, population, or unique assemblage of species. Under the Policy, the mitigation goal for Habitat Category 2 is no net loss of either habitat quantity or quality and to provide a net benefit of habitat quantity or quality, which is similar to the County's no net loss or net degradation of the resource standard. For the purposes of this comment letter, ODFW has reviewed the Plan for consistency with meeting the DCC 18.113.070(D) standard, as well as providing mitigation recommendations as directed in the ODFW Fish and Wildlife Habitat Mitigation Policy. In addition, it is important to note measures other than those presented in the Plan that rely on existing water law and Oregon Water Resources Department's (OWRD) processes, some of which are outlined below, might be necessary to meet the County standard.

ODFW's Initial Review of the Plan

The 2008 Fish and Wildlife Mitigation Plan Addendum was based on offsetting water quality and quantity impacts from the Resort utilizing mitigation from mostly surface water rights, some of which were to be legally converted to instream water rights. The new proposed Plan is focused not necessarily on "mitigation", but rather mostly transferring existing groundwater rights to the Resort property, which does not require mitigation from OWRD. ODFW's review of the 2022 Plan was conducted considering this being a new mitigation proposal for a revised proposed use (i.e., Thornburgh is reducing its total water needs from 2,129 AF to 1,460 AF) and in consideration of climate and habitat conditions today, not

what they were in 2008, as fish and wildlife habitat quality and quantity has continued to degrade over time. Groundwater levels have continued to decline in the Deschutes basin, particularly in the vicinity of the proposed new use, leading to less discharge to surface water and further impairment of habitat (*see Thoma et al. 2021*). As such, ODFW has adapted recommendations over time to best protect Oregon's fish, wildlife, and habitats.

Based on our current understanding of the 2022 Mitigation Proposal, it is yet unclear if the Plan will result in outcomes that meet the County's standard in DCC 18.113.070(D), including actions that fully mitigate the Habitat Category 2 impact through in-kind, in-proximity mitigation. The proposed Plan is lacking the detail to provide substantial evidence for stated claims. In addition, the proposed Plan is challenging to understand, so ODFW can only recommend additional caveats for the County's consideration that could make the Plan more durable to meet the applicable standards and help ensure the intended outcomes are realized should the County move forward in accepting the Plan. ODFW offers the following general concerns and recommendations:

- Seeps and springs that contribute cold water to the Deschutes basin are vital to salmonid survival in the basin. Studies have shown that the Resort's impacts are concentrated in areas of the basin known to discharge cold water. As such, ODFW identified the impacted area as Habitat Category 2 (essential and limited habitat) per the ODFW Fish and Wildlife Habitat Mitigation Policy. The 2008 Addendum provided the unique possibility to replace the impacted habitat with a comparable source of cold water (e.g., Deep Canyon Creek) in close proximity to the proposed development, but similar claimed benefits of the new proposed Plan are yet unsubstantiated. The 2022 Plan alleges the actions will contribute to cooling surface water equivalent to or greater than the initial Deep Canyon Creek and other mitigation outlined in the 2008 Plan (e.g., "changing the mitigation source from 13-degree surface water that flows into the Deschutes River from Deep Canyon Creek to 11-degree groundwater discharging directly into the river will serve to lower the temperature of the river and provide additional benefits over those assumed in the FWMP"), but this claim is yet unsupported. As the 2022 Plan no longer utilizes the Deep Canyon Creek water rights as mitigation (and instead transfers the rights to the Resort), there is not enough evidence in the record to determine if the impacts are being offset by similar sources of cold water. ODFW will review additional reports from the applicant when they are available to better understand the benefits of the Plan.
- The Plan outlines benefits to the basin through discontinuing use of groundwater and surface water at numerous locations upstream of the Resort, some of which allegedly provide benefits to the basin for over 100 miles. The benefits claimed for this distance are unsubstantiated and unlikely to be realized for this distance. That said, the Plan may provide localized benefits, but ODFW will need to review additional reports from the applicant when they are available to better assess the benefits and their ability to offset the impacts.
- Discontinuation of groundwater use does not necessarily result in an equal amount of surface flow, nor does it discharge during the same period or at same location. No information is provided about discharge of groundwater near the Point of Appropriation of the transferred rights, so it remains unclear if discontinuation of use of the groundwater rights proposed for transfer (acre feet of pumped water) translates to a particular quantity (cubic feet per second) of surface water instream or how much and for what distance it may lower stream temperature. ODFW is interested in documented improvements in habitat quality and quantity (the claimed outcome of the transfers), not just the transfer process and cessation of use identified.
- The applicant has provided ODFW some initial modeled data that alleges to support the Plan benefits. However, this model incorporated only one year (2016) of data, which was stated to be an average water year. To fully assess changes resulting from the Plan, ODFW would like to see the model results for a wet, dry, and average water year, ideally utilizing the same years modeled in the Deschutes River Basin Habitat Conservation Plan. We have also requested the model be run for the "worst case scenario," showing the Resort impacts without the alleged Plan benefits

resulting from the transfers. This information has not been provided to ODFW to date, so we recommend the County also request this information and carefully assess any supporting information provided to ensure the data represents the range of potential outcomes. ODFW will also need to review additional reports from the applicant when they are available to better assess the benefits and their ability to offset the impacts.


- Past proceedings have resulted in the County not requiring “wet water” (e.g., actual use) to meet the no net loss standard. ODFW recommends that this be reconsidered, as “paper water” (e.g., the maximum rate and duty specified in the permit/certificate) as mitigation may not be realized as demonstrated instream flow that benefits both temperature and water quantity as intended and may potentially result in a net loss to the resource. For example, the Deep Canyon Creek water rights identified in the 2008 Addendum were to be transferred instream to provide actual measurable water quantity and quality benefits. The groundwater rights identified in the new Plan currently have no verified past use and do not yet provide these same clear benefits. Relying on OWRD’s administrative processes may not adequately offset water quality and quantity impacts to fish habitat, as the process alone may not completely lead to the intended/necessary outcome.
- Water rights proposed for mitigation or are alleged to provide benefits must represent valid and reliable replacement sources of water. Basin-specific hydrologic conditions, any history of regulation, and past use determine the reliability of a water right. ODFW recommends that surface water rights used for mitigation or claimed benefits demonstrate 100% reliability at the full rate for the past 8 out of 10 years and groundwater rights demonstrate use for the past 8 out of 10 years. This means that any water right that is regulated off on a frequent basis or cannot be/has not been reliably used will not be sufficient mitigation. As such, suitable mitigation will generally need to be in the form of a senior water right that has historically proven reliable as “wet water” for the permitted use. ODFW recommends the County request additional information for each water right proposed for transfer, including the reliability of the rights, season of use, and actual historical use. This information is needed to assess if the proposal provides paper water vs. wet water, which is an important distinction for ODFW.
- The 2008 Mitigation Plan included legal protection of mitigation water through the transfer to instream water rights (particularly the Deep Canyon Creek rights), a requirement that ODFW has continued to support. Discontinuing use and/or cancellation of a water right with the intent of leaving “cool water in the stream” or “in the ground,” as proposed in the 2022 Plan, provides no legal protection for the mitigation water. If not regulated, the water may be withdrawn by other water users, resulting in a potential net loss of the resource.
- The 2022 Proposal states “OWRD mitigation must be in the form of legally protected water for instream use which can be accomplished in different ways acceptable to OWRD, including: i) transferring existing surface water rights for irrigation use into protected instream use; and ii) voluntary cancellation of either surface or groundwater permits in lieu of mitigation. Each method results in the full amount of pumped water allowed under the certificate to be protected permanently instream.” ODFW contends that voluntary cancellations, commitment of non-use, submittal of a transfer application to OWRD, and other such actions in lieu of mitigation do not legally and permanently protect water instream. As a positive outcome of any application is not guaranteed, the County should require additional assurances for code compliance to ensure benefits claimed for surface water quality and quantity are realized. The applicant has many water rights in various stages of approval, and it is unknown at this time what combination of rights will eventually be utilized to offset impacts from the Resort. ODFW recommends that, prior to pumping at the Resort, the County ensure that a clear, final plan is implemented. At a minimum, ODFW recommends approval of the Plan be contingent upon approval of all applicable Final Orders from OWRD.
- “Additional water use” is proposed to be mitigated solely through OWRD’s Groundwater Mitigation Program, which does not account for all impacts to the resource (e.g., water quality

impairment is not directly addressed). ODFW recommends that the County ensure all potential impacts (e.g., both water quality and quantity) are adequately mitigated, when warranted.

- ODFW is concerned with the lack of information regarding how compliance will be ensured over time. It is our understanding that compliance (or noncompliance) with the mitigation measures will be established by annual reporting required by FMP Condition 38, but it is unclear who reviews the reports, who has access to the reports, what repercussions are in place for non-compliance, and if/how ODFW would be engaged in habitat protection. OWRD administrative processes will only address part of the compliance necessary, and sole reliance on OWRD well and streamflow monitoring data is unlikely to be at the appropriate scale and locations to track compliance. ODFW recommends the County ensure surface water quality and quantity is being replaced in perpetuity or for the life of the project as intended.
- Although identified as “excess mitigation,” it is unclear how the applicant is claiming the 1.51 cfs of water being left instream at the Three Sisters Irrigation District diversion or how the portion of the season left instream will be determined. The Final Orders associated with this amount currently allow only 1.2 cfs to be transferred to an instream water right as a result of an Allocation of Conserved Water piping project. The remaining 0.31 cfs, barring any unknown agreements with the applicant, can still be utilized to irrigate new lands. This is one example of the vagueness of the Plan that could use more explanation.
- If this Plan is not implemented in the next 5 years, ODFW will need to reassess the claims and intended outcomes based on any updated information or change in habitat conditions.

We appreciate the County’s continued coordination in protection of Oregon’s fish, wildlife, and habitats. We are happy to answer any questions regarding our concerns and recommendations and plan to be present at the Hearing scheduled for Monday, October 24th. At this time, we ask that the record remain open for a minimum of 30 days to give us time to fully assess new information received from the applicant and provide any updated recommendations to the County.

Sincerely,



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Cc: Jerry George, Corey Heath, and Andrew Walch, ODFW Deschutes Watershed District (via email)
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Water Resources Department
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MEMORANDUM

DATE: August 30, 2021

TO: Deschutes Basin Water Collaborative Groundwater Mitigation Technical Committee

FROM: Michael Thoma, Hydrogeologist
Aurora Bouchier, Hydrogeologist
Justin Iverson, Groundwater Section Manager
Harmony Burrigh, Planning Coordinator

SUBJECT: Response to Technical Assistance Request: Groundwater Mitigation Program purpose in relation to observed groundwater level trends

This memo was prepared in response to a technical assistance request from the Groundwater Mitigation Technical Committee of the Deschutes Basin Water Collaborative, as captured in a technical assistance request form dated 4/30/2021. This memo is intended to help the Technical Committee gain a common understanding of groundwater level conditions in a populated portion of the Deschutes Basin, including an overview of groundwater levels, where and why groundwater levels are declining, and what is being done or could be done to address groundwater level declines. This memo is also intended to describe the current relationship between the Deschutes Groundwater Mitigation Program and groundwater management more broadly. This information is for planning purposes only. It may be used to inform the future scope and approach of the Groundwater Mitigation Technical Committee or the Deschutes Basin Water Collaboratively more generally as they work to develop a basin-wide integrated plan.

Background:

Surface water throughout the Deschutes Basin is fully allocated or over-allocated most months of the year, and surface water is generally not available for appropriation of new out-of-stream uses or new storage. A joint study by the Oregon Water Resources Department (Department) and U.S. Geological Survey (USGS) of groundwater resources of the Deschutes Basin¹ established that there is a hydraulic connection between groundwater and surface water across the Deschutes Ground Water Study Area. Based on the conclusions of the study, the Department has determined that groundwater appropriations within the Deschutes Ground Water Study Area have the potential for substantial interference with surface water as described in OAR 690-0009, and will measurably reduce scenic waterway flows as defined in ORS 390.835, unless mitigation is provided pursuant to the rules in OAR 690-505.

Rulemaking conducted by the Department in 2002 (OAR 690-505-0500 -0630 Deschutes Mitigation Rules and OAR 690-550 Mitigation Banks) established the Deschutes Basin Groundwater Mitigation Program to mitigate the impact of groundwater development in the Deschutes Groundwater Study Area on the Deschutes State Scenic Waterway. This program allows for limited, additional groundwater development using mitigation to offset the impacts to the State Scenic Waterways and specific instream rights. The program was not designed to mitigate for other potential impacts of groundwater development such as groundwater level declines, capture of groundwater otherwise flowing to local springs or other groundwater dependent ecosystems, or hydraulic interference with other groundwater users. In addition to the Deschutes Groundwater Mitigation Program, there are other laws and policies that affect the allocation and management of groundwater that we will briefly touch on in this memo.

Observed Groundwater Level Trends

Figure 1 shows the boundary of the Deschutes Groundwater Study Area and general groundwater level elevations contours, highlighting groundwater elevations across the region (see Gannett et al., 2001¹ for further information on the regional groundwater flow system). The spatial pattern of groundwater levels shows that groundwater elevations are highest near the Cascade Mountains in the west and Newberry Volcano in the south, and decrease to the northeast and north towards the confluence of the Deschutes and Crooked rivers. Groundwater elevation differences drive groundwater to flow from areas of high recharge (e.g., Cascades, Newberry Volcano) to areas where groundwater discharges back to the land surface as springs, or baseflow for streams². In addition to the regional flow pattern, groundwater levels in the central part of the Deschutes Basin are several feet to several-hundred feet below land surface, indicating that stream reaches in the central part of the basin (e.g., Deschutes River and Whychus Creek) are separated from the regional groundwater flow system by an unsaturated zone. Groundwater levels become coincident with surface level elevations near the confluence of the Crooked and Deschutes River, where large amounts of groundwater discharge back to the surface, either as springs or direct discharge to the riverbed.

Long-term groundwater level records in the central part of the Deschutes Basin have shown that some areas are experiencing persistent groundwater level declines (Figure 2), particularly in an area extending from the vicinity of Bend, north toward Lake Billy Chinook, and northeast toward Redmond and Powell Butte (Figure 3). Long-term groundwater level records from select wells in this and the surrounding region were normalized to Spring-1995 levels (Figure 4). This analysis shows water level changes since Spring-1995 vary spatially and highlights different trends in different sub-areas. Table 1 lists the observed changes and rate of change for each sub-area based on least-squares fits of water level changes since Spring-2006 and Table 2 presents the total observed water level decline for those same wells. Spring-2006 was used to estimate a current rate of decline because there is an apparent change in slope in groundwater level trends around that time that appears to be consistent with the present trends.

Another collaborative OWRD-USGS study (Gannett and Lite, 2013³) looked at measured groundwater level changes from 1997 to 2008 and used an existing groundwater flow model⁴ to simulate those changes and estimate the individual influence of major controlling hydrologic factors on observed

groundwater level trends throughout the basin (trends related to those shown in Figure 2 and Figure 4). This work estimated that groundwater level changes in each of the sub-areas are due to, in order of impact, 1) climate influences (i.e., changes in precipitation and recharge), 2) increased groundwater pumping, and 3) reduced recharge through canals due to canal lining. The simulation results for each sub-area are presented in Table 1.

Hydrologic trends show a shift towards drier conditions since the later 1990s that has accompanied a warming trend in the basin (Frankson et al, 2017⁵; Mote et al, 2018; . Observed changes in precipitation and snowpack due to climate change have already been shown to impact groundwater levels in the region³ and expected changes to the climate in the future have a high likelihood of exacerbating existing groundwater level declines. Further groundwater development, specifically in areas of large population growth, is also likely to contribute to groundwater level declines. Finally, irrigation canals have been a significant source of groundwater recharge to this region for several decades and continued lining and piping of canals (which helps to conserve surface water) is also likely to exacerbate groundwater level declines.

Implications and Recommendations

While the Deschutes Groundwater Mitigation Program has helped to maintain State Scenic Waterway flows in the Deschutes River, the program is not intended to mitigate for the impacts of groundwater development on groundwater levels. The basis for the mitigation program is that groundwater and surface water are strongly connected within the Deschutes Basin and that impacts of groundwater development on surface water at specific areas (i.e., along State Scenic Waterway reaches) can be mitigated for. Persistent, long-term groundwater level declines along groundwater flowpaths that discharge to the Deschutes and Crooked Rivers, as are observed in the central part of the Deschutes Basin, will eventually impact groundwater discharge to springs and streams, and surface water flows that rely on this groundwater discharge.

Under Oregon water law, “all water within this state from all sources of water supply belong to the public”⁷. The Department is tasked with ensuring that appropriation of groundwater is “within the capacity of available resources,” assuring “adequate and safe supplies of groundwater for human consumption while conserving maximum supplies of ground water for [...] other beneficial uses” and determining and maintaining “reasonably stable groundwater levels”⁷. Where there is “impairment of or interference with existing rights to appropriate surface water” or where “groundwater levels are declining,” the Department encourages voluntary joint action, but is directed to act under its other authorities in the event that “voluntary joint action is not taken or is ineffective”⁷. As groundwater levels in the central part of the basin approach 50 ft of total decline from the highest-know water levels (50 feet being one of the thresholds in the current statewide definition of “excessively declined” in OAR 690-008), the Department may enforce stricter control on future groundwater allocation. This may take the form of denying new groundwater appropriation even where State Scenic Waterway mitigation credits are available, restrictively classifying new groundwater uses, or establishing a Critical Groundwater Area.

The Deschutes Basin Collaborative has the opportunity to assist in assuring sustainable water supplies for current and future needs while maintaining reasonably stable groundwater levels by proactively addressing groundwater level declines. Some options include:

- Work with the Department to better understand the expected long-term impacts of climate change, canal lining, and groundwater development on future groundwater supplies and surface water flows.
- Advise the Department regarding future basin program rules to address groundwater development where it is expected to contribute to groundwater level declines or impact other groundwater or surface water users.
- Incorporate actions to address current and expected future groundwater level declines into a comprehensive basin plan.
- Consider the effects of any proposed actions on groundwater levels.
- Work with groundwater users to pursue and implement voluntary agreements as described in ORS 537.745.
- Examine the effects of groundwater level declines on groundwater dependent ecosystems, such as springs.

¹ Gannett, M. W., Lite Jr, K. E., Morgan, D. S., and Collins, C. A., 2001, Ground-Water Hydrology of the Upper Deschutes Basin, Oregon, USGS Water-Resources Investigations Report 00-4162, 74 p., <https://pubs.usgs.gov/wri/wri004162/pdf/WRIR004162.pdf>

² Lite, K. E. and Gannett, M. W., 2002, Geologic Framework of the Regional Ground-Water Flow System in the Upper Deschutes Basin, Oregon, USGS Water-Resources Investigation Report 02-4015, 44 p., <https://pubs.er.usgs.gov/publication/wri024015>

³ Gannett, M.W., and Lite, K.E., Jr., 2013, Analysis of 1997-2008 groundwater level changes in the upper Deschutes Basin, Central Oregon, USGS Scientific Investigations Report 2013-5092, 34 p., <http://pubs.usgs.gov/sir/2013/5092>.

⁴ Gannett, M. W. and Lite, K. E., 2004, Simulation of Regional Ground-Water Flow in the Upper Deschutes Basin, Oregon, USGS Water Resources Investigation Report 2003-4195, 84 p., <https://pubs.er.usgs.gov/publication/wri034195>

⁵ Frankson, R., K. Kunkel, S. Champion, L. Stevens, D. Easterling, K. Dello, M. Dalton, and D. Sharp, 2017, Oregon State Climate Summary, NOAA Technical Report NESDIS 149-OR, 4 pp., <https://statesummaries.ncics.org/chapter/or/>

⁶ Mote, Philip W., Sihan Li, Dennis P. Lettenmaier, Mu Xiao, and Ruth Engel, 2018, Dramatic declines in snowpack in the western US, Nature Partner Journals: Climate and Atmospheric Science, Volume 1, 2.

⁷ [ORS 537.525](#).

Figure 1: Map of the Deschutes Groundwater Study Area boundary and generalized groundwater level elevation contours (from Gannett et al., 2017: Page 10, Figure 4)

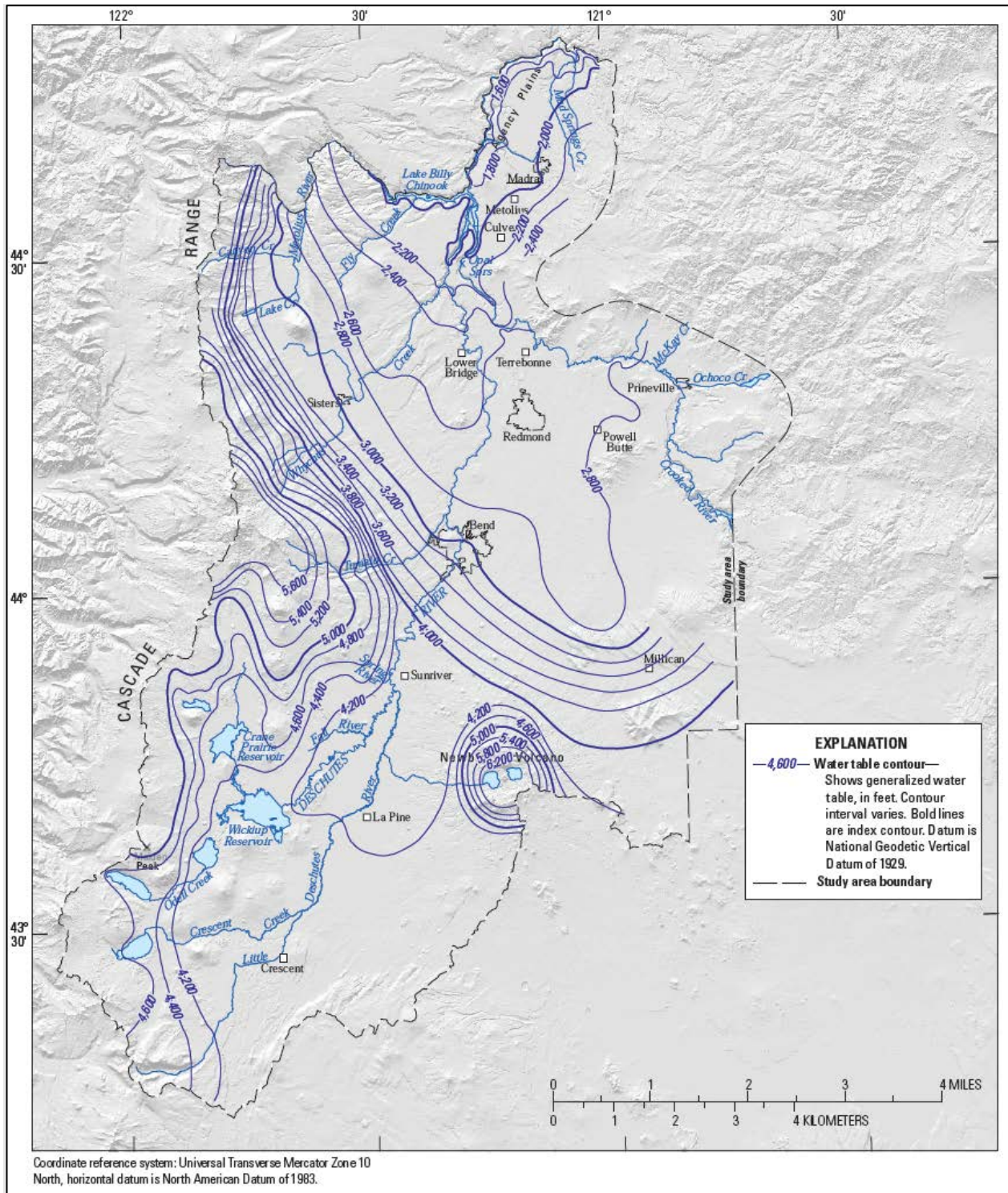


Figure 2: Hydrographs of select wells in the central part of the Deschutes Basin shown on shared elevation axis (left pane) and on individual axis (right pane); see Figure 3 for well locations.

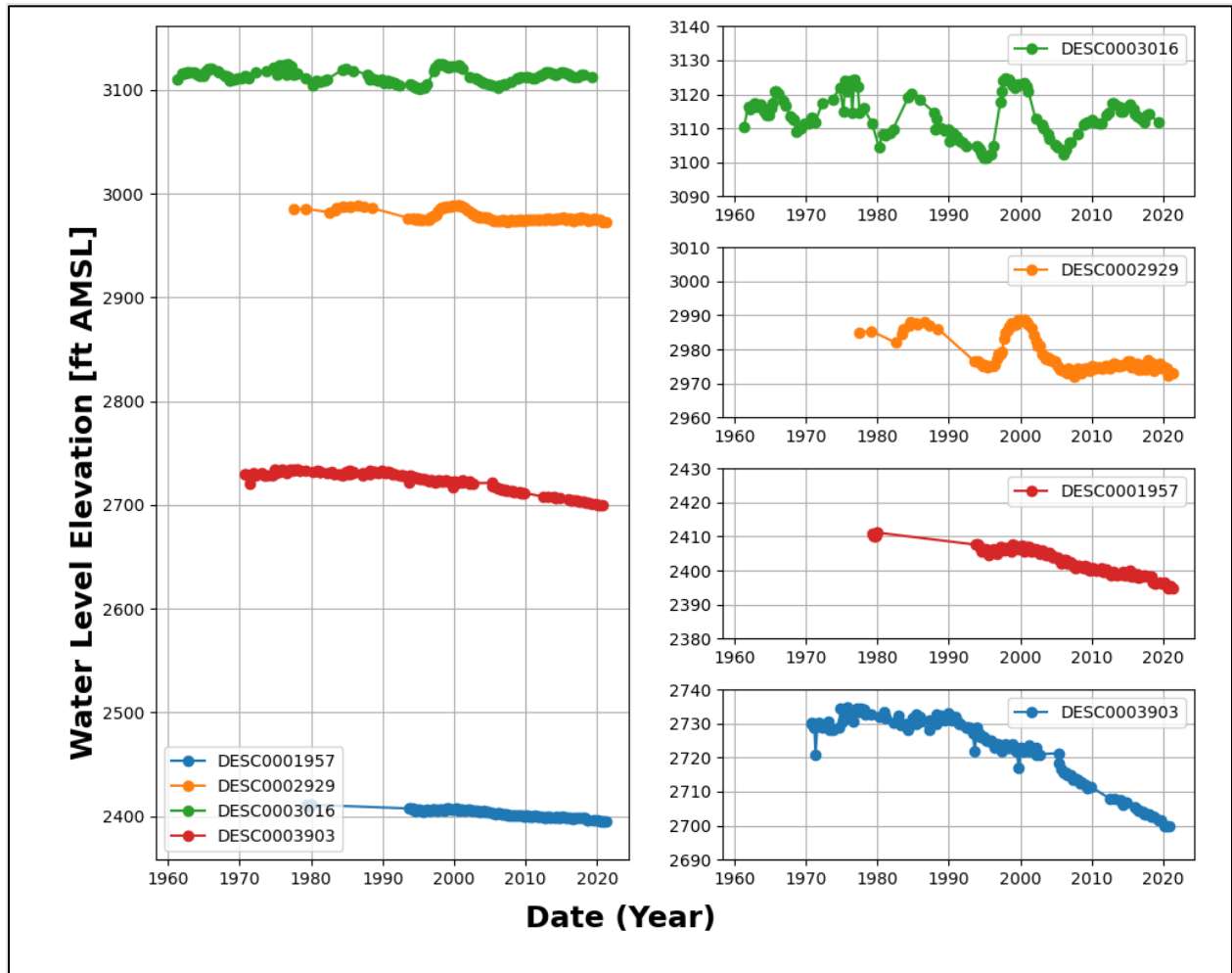


Figure 3: Map showing select wells with long-term groundwater level records, color-coded by the observed rate of decline; inset map shows Deschutes Groundwater Study Area boundary and extent of larger map.

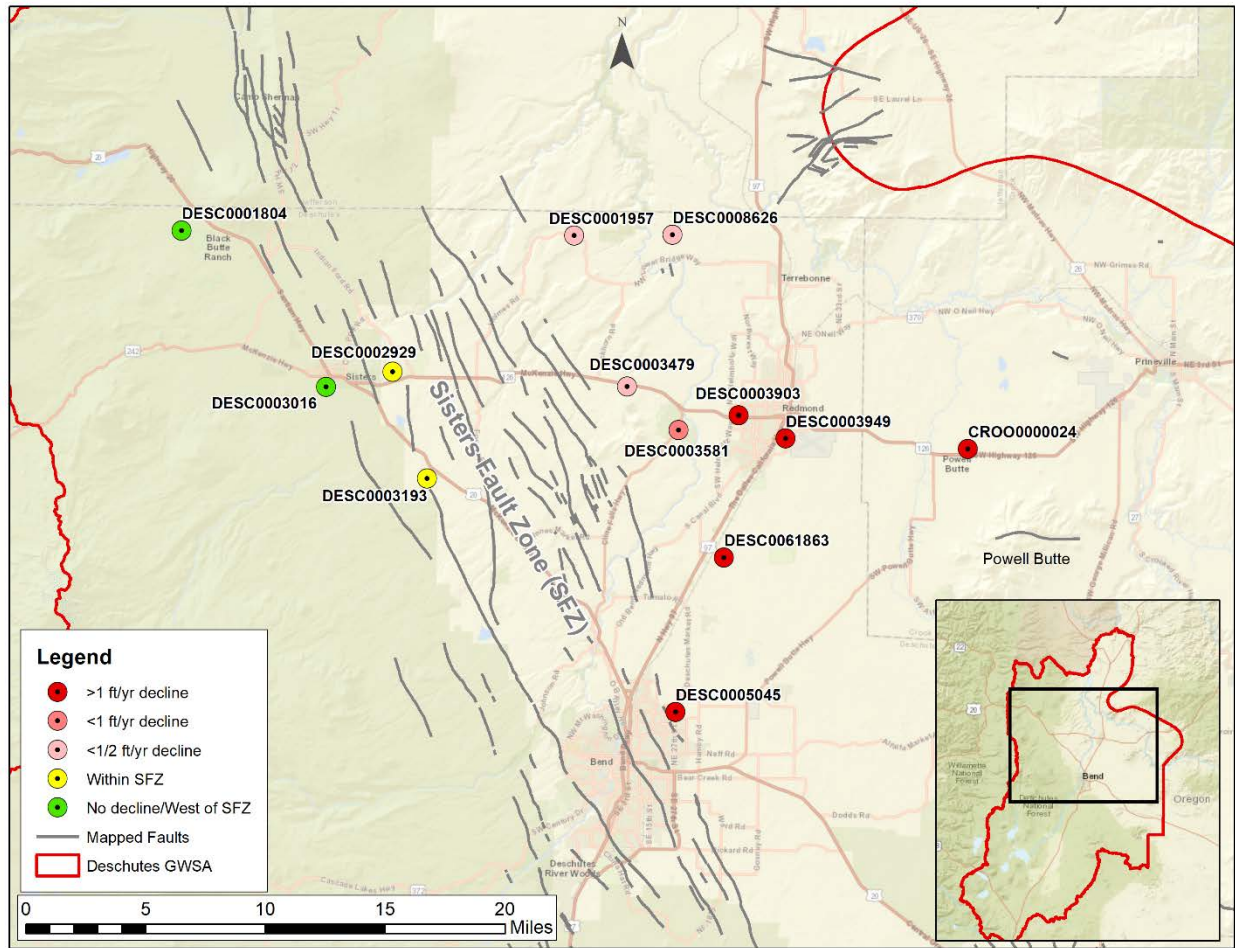


Figure 4: Groundwater level changes since Spring-1995 for wells shown in Figure 3 (excludes DESC0061863 which has an intermittent period of record)

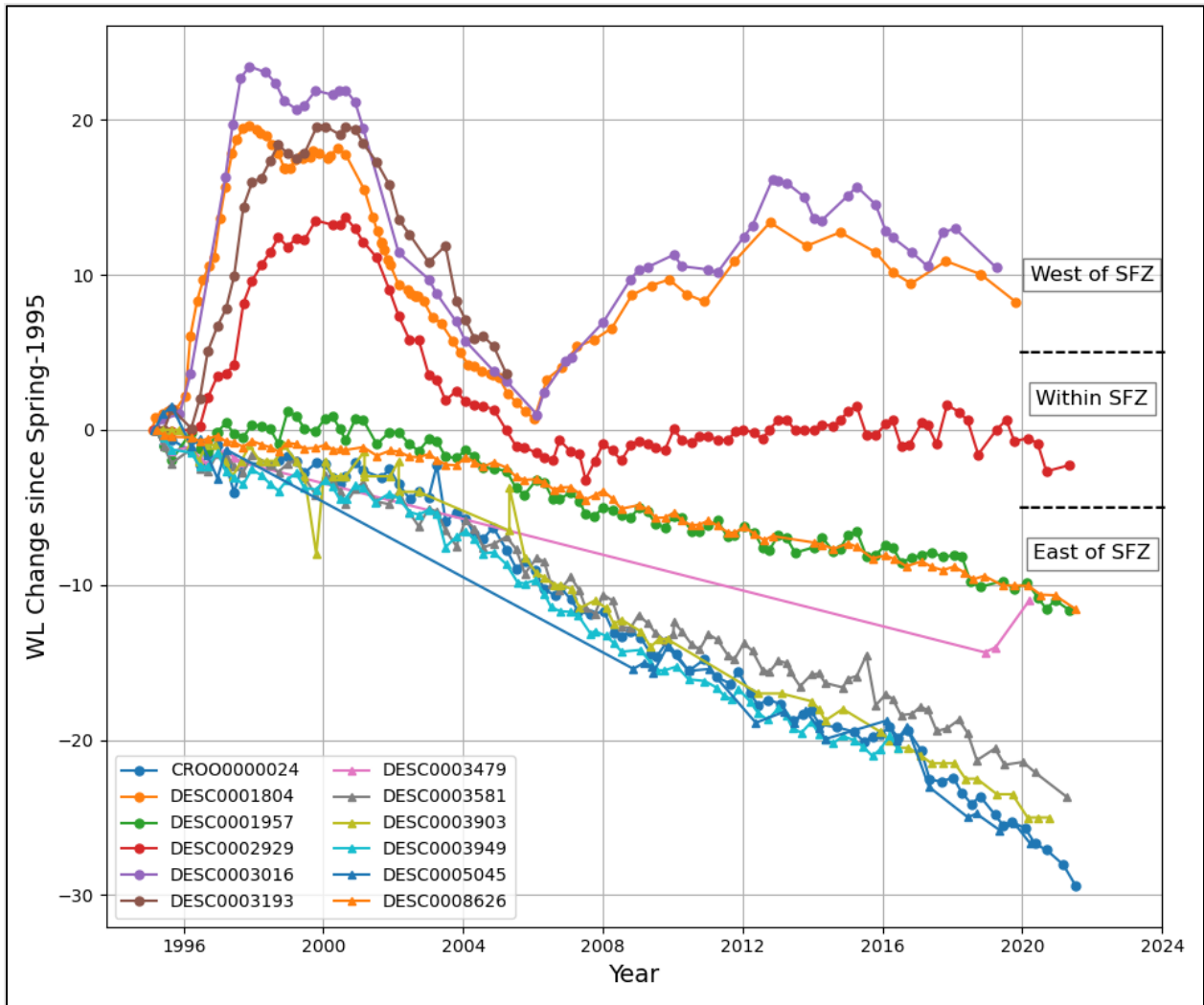


Table 1: Summary of Observed Groundwater Level Declines by Sub-Area

Sub-Area as Described in USGS Report ²	Observed Water Level Change (this memo)		Simulated Decline and Drivers from USGS Report ² for period of record 1997-2008			
	Avg. Decline Since 1995 (feet)	Decline Rate* 2006 - 2020 (ft/yr)	Decline (feet)	Climate Influences (%)	Pumping (%)	Canal Lining (%)
Redmond to Powell Butte: CROO0000024 DESC0003903 DESC0003949 DESC0005045	25.1	1.04	13-14	60-65	25-30	10
Cline Buttes to Redmond: DESC0003581	23.7	0.83	12-14	60-70	20-25	5-10
Lower Bridge: DESC0001957 DESC0003479 DESC0008626	11.1	0.45	5-6	60-70	20-30	10
Sisters: DESC0001804 DESC0002929 DESC0003016 DESC0003193	-	-	22	80	13	7
* Decline rate is the average of the decline rate for all wells in a sub-area						

Table 2: Summary of Observed Water Level Declines by Well

Well	Total Decline	Full Period of Record	Avg. Rate of Decline since 1995	Years to 50 ft Total Decline	Comment
CROO0000024	33.3	1994 - 2020	1.04	16	
DESC0003903	34.8	1975 - 2020	1.04	14	
DESC0003949	29.8	1980 - 2016	1.04	19	well abandoned in 2016
DESC0005045	44.1	1979 - 2020	1.04	6	
DESC0003581	24.8	1994 - 2020	0.83	30	
DESC0001957	16.5	1979 - 2020	0.45	74	
DESC0003479	21.5	1979 - 2019	0.45	63	
DESC0008626	11.6	1994 - 2020	0.45	85	
DESC0001804	--	1993 - 2019	NA		trends with climate
DESC0002929	--	1977 - 2020	NA		trends with climate through 2006
DESC0003016	--	1961 - 2019	NA		trends with climate
DESC0003193	--	1978 - 2005	NA		trends with climate; discontinued in 2005