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MEMORANDUM

TO: Water Resources Commission

FROM: Jason Spriet, East Region Manager
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SUBJECT: Agenda Item D, December 13, 2024
Water Resources Commission

Harney Basin Groundwater Update

I. Introduction

During this agenda item, staff will brief the Commission on the latest developments in the Harney Basin rulemaking effort to designate a Critical Groundwater Area (CGWA). Discussions will include updates on the process to define groundwater management scenarios, management elements tested with the model, interpretation of modeling results, and key takeaways from modeling results. *This is an informational report.*

II. Integrated Water Resources Strategy Recommended Action

- 1. A-C – Understanding water resources today
- 9. C – Partner with federal agencies, Tribes, and neighboring states in long-term water resources management
- 10. F – Provide an adequate presence in the field
- 11. E – Develop additional groundwater protections

III. Background

As part of the Harney Basin Groundwater Study, USGS and Department staff collaborated on the development of a numerical groundwater flow model which was published in early 2024. A summary of the Harney Basin Groundwater Model (HBGM) is included as Attachment 1 and provides details about the model's design, inputs, outputs, and limitations. The Department is using the HBGM to simulate outcomes of different groundwater management scenarios to inform the rulemaking process and to test whether the management scenario will achieve the target water level trend of no decline. The HBGM is used to evaluate changes in groundwater use to simulate changes to groundwater levels, groundwater storage, natural discharge, dry wells, and other factors in the management scenarios.

Over the last several Rules Advisory Committee (RAC) meetings, the Department has been working with the Division 512 RAC to develop management scenarios to be simulated using the HBGM. The Department has also participated in a robust public engagement process facilitated by Oregon Consensus in the form of discussion groups. Discussion groups are open to all members of the public and provide the opportunity for all participants to share their thoughts and local knowledge related to the rulemaking process. Input from the discussion groups related to management scenarios was brought to the October RAC meeting and was used to inform the three management scenarios proposed by the RAC. The Department also proposed and received input from the RAC on two additional management scenarios for a total of five proposed management scenarios.

IV. Discussion

By defining a range of scenarios to test, different management element’s effects on outcomes can be assessed and quantified. This information can then be used to understand the tradeoffs of different decisions. The following management elements are discussed in this report:

1. Spatial extent
2. Success metric
3. Timeline for achieving success
4. Timeline for phasing in reductions
5. Adaptive management

To gain further insight into the effects of different management elements on outcomes, Department staff built an optimization program for the flow model. This program integrates with the HBGM to identify optimal groundwater pumpage based on a set of parameters. The program takes parameters such as the length of time for phasing in pumpage reductions, the number of years by which the goal must be met, and the statistical methods for measuring success. Using these guiding parameters the program runs the HBGM, evaluates the results, and if needed changes the allowed pumpage, and then runs the HBGM again. The program repeats this process until the specified goal is met within the specified timeline. The optimization program has enabled Department staff to better understand the impacts of different sized subareas for management and the impacts of using different statistical thresholds for measuring success. The modeling results have provided the following insights into the effects of each management element on final outcomes.

<u>Spatial extent:</u>
Three different options for boundaries within the CGWA have been proposed by the Department and the RAC. These options include one, six, and 15 subareas for management. Model results indicate that more subareas in a scenario leads to less variability in water level trends within each subarea while fewer subareas result in larger variability. This outcome is intuitive since subareas were drawn using criteria designed to group together wells with similar behavior and the more subareas that are delineated, the more specific they can be in grouping wells. Because the targeted nature of more subareas, model results also indicate that more subareas in a scenario lead to less differences between the amounts of pumpage reduction needed for success under

each possible success metric. Initial evaluation shows that using the Department's proposed 15 subareas for management allows for strategic reductions in areas of severe decline, making the success metric less influential on required reductions. In some situations, this may allow for less pumpage reduction while still achieving the goal. Conversely, with fewer subareas (six or one), reductions are spread across larger areas creating larger variation across success measures which results in more pumpage reduction being needed to achieve the same outcome.

Success metric:

The Department's position is that the goal for the CGWA should be to achieve a target water level trend of zero decline. Said another way, the goal is to stabilize water levels in the basin. The success metric is the value by which progress toward the goal is evaluated. The Department has discussed three possible options for success metric with the RAC:

1. Median (50th percentile) – success would be achieved when half of all wells are showing zero decline or a positive water level trend. This metric also means that half of all wells in the area could still be declining.
2. Median plus an individual maximum decline rate threshold – success would be achieved when half of all wells are showing zero decline or a positive water level trend and no individual well within an area has a decline rate greater than a set value. An example would be the median must be achieved and no individual well can be declining at greater than one foot per year.
3. 80th percentile – success would be achieved when 80% of all wells are showing zero decline or a positive water level trend. This metric also means that 20% of wells in the area could still be declining.

In general, modeling results indicate that option 3 will likely require a larger reduction in pumpage to achieve the goal than option 2 which will likely require larger pumpage reductions than option 1. However, option three will also likely result in higher final water levels across the basin than either option one or two. In short, the more stringent the success metric, the more pumpage reduction necessary and the higher the final water levels in the basin.

Timeline for achieving success:

The timeline for achieving success is the length of time by which success should be achieved. Feedback from the RAC has included suggestions for this value in the range of 10 to 60 plus years with many RAC members supporting 30 years. Model results indicate that a shorter timeline for achieving success will require greater pumpage reduction to achieve the goal and will result in higher final water levels across the basin (less decline before achieving stability). Conversely, a longer timeline requires less pumpage reduction and results in lower final water levels across the basin (more decline).

Timeline for phasing in reductions:

The timeline for phasing in reductions is the period of time over which reductions will be implemented. The longer the timeline for phasing in reductions, the larger the reductions in pumpage will need to be to achieve the goal on the same timeline. Conversely, a shorter timeline for phasing in reductions results in less reduction in pumpage being necessary to achieve the goal.

<u>Adaptive Management:</u>
Many members of the RAC have also advocated for the Department to adaptively manage the basin. While further conversation is needed with the RAC to clearly define adaptive management, the RAC seems to be advocating for a process by which the Department implements management actions in the basin in the form of pumpage reductions over a period of time, the success of those management actions are monitored for a period of time, and then additional action is taken if necessary. The goal being to prevent the Department from implementing more pumpage reductions than are necessary to achieve the stated goal of a target water level trend of zero decline. Members of the RAC have also advocated for certainty related to management actions the Department intends to take in the basin. Certainty allows for water users in the basin to make business decisions based on assured regulatory actions that will not change.

The Department views adaptive management and certainty as existing on opposite ends of a spectrum. The more certainty there is in a management scenario, the less adaptive management can be in that scenario. Conversely, a highly adaptive management scenario will result in substantially less certainty for water users. Adaptive management is also affected by the timeline for achieving success and the timeline for phasing in reductions. The longer these timelines are, the more time there is for measuring success and adapting management actions. Shorter timelines limit the options for adapting management. However, as noted previously, longer timelines likely result in lower final water levels across the basin (more decline).

Another consideration for adaptive management is the responsiveness of the groundwater system to changes in management. The Department is still evaluating model results to better understand the responsiveness of the groundwater system to reductions in pumpage to identify the appropriate frequency of adaption. Ideally the frequency at which management can be adapted should be longer than the time it takes for the effects of management to be measured in the groundwater system. The frequency at which success is evaluated and management actions are adapted will continue to be an ongoing topic with the RAC.

V. Conclusion

Out of the five management scenarios tested, only one scenario achieved the target water level trend goal of zero decline. The successful scenario simulated an immediate return to the volume of groundwater pumped in 1990, which is a reduction of 59% from the quantity pumped in 2018. The remaining four scenarios would require greater pumpage reductions than proposed to achieve the target water level trend goal. Department staff also optimized each of the three proposed spatial extents for management. Using a 10-year phase-in period for reductions and a 30-year target for groundwater stabilization, optimization results suggest reductions of 28% to 40% from 2018 levels will achieve the goal. The range of reduction is influenced directly by the spatial extent used and the success metric chosen. When only one management area is used, pumpage reductions must be greater than with six or 15 subareas, regardless of the success metric used. A more stringent success metric results in more pumpage reductions being necessary to achieve the goal regardless of the spatial extent used. However, when using the median as the success metric, pumpage reductions are nearly equivalent between the six-subarea scenario and the 15-subarea scenario.

The Department will continue conversations with the RAC about the different management elements and their impact on the outcomes of management scenarios. Going forward, the Department will be soliciting feedback from the RAC on the following questions:

- What is a reasonable timeframe for achieving the goal of a target water level trend of zero decline?
- Should pumpage reductions be phased-in to allow time for economic adjustment? If so, how long should that phase-in period be?
- What size of subareas should be used to manage the basin? Considerations for this question include how subarea size affects the ability to form voluntary agreements and water right transfers and how important it is to strictly follow prior appropriation.
- What success metric (median, 80th percentile, etc.) should be used to define success? Said another way, how many wells should be allowed to continue declining and still call the results success?
- How should impacts to natural discharge, groundwater storage, domestic wells, and the economy be considered when optimizing a management scenario?

Attachments:

1. **The Harney Basin Groundwater Model Summary**

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Agenda Item D, Attachment 1

The Harney Basin Groundwater Model (HBGM)

OREGON
WATER RESOURCES DEPARTMENT

Modeling Objective:

Studies show that the Harney Basin has experienced more groundwater withdrawal than what is naturally replenished, resulting in a significant decrease in groundwater levels and storage. The Harney Basin Groundwater Model (HBGM) developed by the United States Geological Survey (USGS) in coordination with the Oregon Water Resources Department (OWRD) provides a better understanding of groundwater movement in the basin which will aid in sustainable management of the resource.

Model Design:

The HBGM is a three-dimensional numerical model that covers the entire Harney Basin and surrounding areas and runs from 1930 through 2018 utilizing 89 years of data. The model divides the area into a grid of 78,064 square cells each covering approximately 2,000 by 2,000 feet. Each cell represents a small part of the landscape, such as terrain, rock units, streams, springs and more. The average value for aquifer properties, such as groundwater flow rates through a given material, are assigned to each cell to describe the groundwater framework. The model consists of 10 vertical layers of varying thickness based on the type of aquifer materials and their hydraulic properties.

Model Inputs:

Hydraulic Properties:

Individual model cells were assigned water movement properties based on the aquifer characteristics of the layer they represent. The thickness of each layer was estimated using previous studies and information from drilling records. These water movement properties describe how efficiently different layers can transmit and store or release water. There's a lot of variation in these properties across the groundwater flow system. In parts of the model with less data, like deeper layers in upland areas, the representation of these properties is more generalized and varies less with depth.

Recharge:

Recharge represents the water that flows into the groundwater system. The primary source of recharge to the Harney Basin in the uplands is infiltration of rainwater and snowmelt. Additionally, recharge from surface-water infiltration where streams enter the lowlands and lose water to the subsurface was also considered and integrated into the model.

Discharge:

Discharge represents the water that flows out of the groundwater system. Groundwater discharge consists of two parts: natural and artificial. Natural discharge happens through evapotranspiration (ET, a process by which the water moves from land to atmosphere via soil surface and vegetation) and flow into streams and springs. Artificial groundwater discharge comes from pumping water from wells. The rates of groundwater pumping for irrigation were estimated using satellite-based ET data and groundwater rights information. Pumping rates for other uses were calculated using reported or publicly available data.

Model Calibration

Model inputs were adjusted through multiple iterations to match both measured and estimated hydrological conditions. This included modifying factors like aquifer properties, ET parameters, and recharge. The model's accuracy was assessed by comparing its predictions to measurements for stream baseflow and groundwater levels. Overall, the model's estimates for basin-wide baseflow were within 5 percent of the most reliable available data. It also showed a good match across the basin's range of groundwater levels, which vary by up to 1,300 ft.

Model Outputs:

Model results show that many of the lowland areas began experiencing substantial declines in groundwater levels after 1990, the period when pumpage began to increase across the basin. The simulated decline by the year 2018 in the Weaver Spring area is greater than 90 ft, in the Northern lowlands is greater than 100 ft, and in the Crane, area is greater than 40 ft. The total volume of pumped groundwater during the model period was supplied relatively equally by decreased lowland ET (35%), decreased spring and stream discharge (32%), and the deficit in lowland groundwater storage represented by groundwater declines (32%).

The model outputs can be used to forecast how groundwater levels, discharge, and storage might change depending on hypothetical future groundwater management scenarios. The HBGM can also show how groundwater flow changes over time due to variations in recharge and groundwater pumping.

Model Limitations:

Numerical models simplify complex natural systems. Every model has some limitations and uncertainties. The model divides the area into cells, averaging conditions within each cell, which can overlook changes at smaller scales. Additionally, the monthly time intervals used for model inputs may not accurately capture shorter-term hydrological changes. The model gives us an idea of how groundwater is changing across a region, but it might not accurately predict how each individual well behaves. The model overpredicts in some areas and underpredicts in others. The model's accuracy is better in places where the data, such as water levels, well records, and pumping rates, are abundant.

While the HBGM isn't perfect for predicting precise groundwater levels at a specific well, it offers insights into the basin's hydrogeologic system and can help compare different water-management strategies at the landscape scale. Despite some limitations, the model is the most realistic, accurate and reliable tool, at present, for understanding the basin's groundwater dynamics.
For more information about the HBGM please refer to the report, published on March 22, 2024, Groundwater Model of the Harney Basin, Southeastern Oregon.