The background of the slide features abstract, overlapping geometric shapes in various shades of blue, ranging from light sky blue to deep navy blue. These shapes are primarily located on the left and right sides of the slide, framing the central text area.

Proposed Minimum Thresholds & Measurable Objectives for Degraded Groundwater Quality & Chronic Lowering of Groundwater Levels

Presented by Georgina King, Montgomery & Associates
Santa Margarita Groundwater Agency
May 28, 2020

Suggested Reading for Sustainable Management Criteria

Sustainable Management Criteria Best Management Practices

https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Sustainable_Management_Criteria_2017-11-06.pdf

- ▶ Pg 4-11: Setting Sustainable Management Criteria
- ▶ Pg 11-12: Chronic Lowering of Groundwater Levels Minimum Threshold
- ▶ Pg 14-15: Degraded Water Quality Minimum Threshold
- ▶ Pg 20: Undesirable Results
- ▶ Pag 27: Measurable Objectives

2

These are Best Management Practices that has DWR has provided to help guide Sustainable Management Criteria development

Outline

- ▶ Proposed Minimum Thresholds & Measurable Objectives for Degraded Groundwater Quality
 - ▶ Board Action Required (5/28/2020)
- ▶ Proposed Minimum Thresholds & Measurable Objectives for Chronic Lowering of Groundwater Levels



Early action on Significant and Unreasonable degraded WQ – coming up quickly



Proposed Minimum Thresholds & Measurable Objectives

Degraded Groundwater Quality

Draft Statement of Significant & Unreasonable Degraded Groundwater Quality

Significant & unreasonable water quality conditions occur if SMGWA projects or management activities **degrade the Basin's groundwater quality such that it** ~~cause an increase in the concentration of constituents in groundwater that~~ leads to adverse impacts on beneficial users or uses of groundwater or surface water ~~because of non-compliance with drinking water standards.~~ Adverse impacts include diminished supply or undue costs for mitigating such negative impacts.

5

This is a track changes version reflecting feedback provided by Board members

Draft Statement of Significant & Unreasonable Degraded Groundwater Quality

Significant & unreasonable water quality conditions occur if SMGWA projects or management activities degrade the Basin's groundwater quality such that it leads to adverse impacts on beneficial users or uses of groundwater or surface water. Adverse impacts include diminished supply or undue costs for mitigating such negative impacts.

DOES THE BOARD HAVE ANY OBJECTIONS?

Unless objections and/or revisions are stated, this will be the draft Statement voted on by the Board

Approach to Setting Groundwater Quality Metrics

- ▶ General sentiment is to ensure groundwater quality remains at current concentrations or better
- ▶ Use State drinking water standards where possible
- ▶ Recognize that nitrate in groundwater impacts nitrate concentrations in the San Lorenzo River and will need to have a lower Minimum Threshold than drinking water standards to ensure that the river's nitrate Total Maximum Daily Load (TMDL) can be achieved

These are criteria discussed at a previous Board meeting and that are used to guide development of the degraded groundwater quality sustainability criteria
SW GW interconnected strongly in the Basin

Approach for Setting Minimum Thresholds

Chemical Constituent	Standard	Minimum Threshold / Drinking Water Standard
TDS	Secondary	1,000 mg/L
Chloride	Secondary	250 mg/L
Nitrate and N	< Primary of 10 mg/L	3 mg/L
Arsenic	Primary	0.01 mg/L
MTBE	Primary	0.013 mg/L
PCE	Primary	0.005 mg/L
TCE	Primary	0.005 mg/L
cis-1,2-DCE	Primary	0.07 mg/L
Chlorobenzene	Primary	0.07 mg/L

Chemical constituents are considered chemicals of concern and will be set SMC if they exceed drinking water standards or are commonly used to assess health of the Basin. We will use State drinking water standards for Minimum Thresholds since exceeding these concentrations will result in adverse impacts to beneficial users.

In an effort to meet the San Lorenzo River TMDL, we recommend using 3 mg/L as the nitrate as N Minimum Threshold instead of the drinking water standard of 10 mg/L. TDS MT is the upper secondary limit that is used County wide. Chloride MT is the recommended level used County-wide.

Iron and manganese are not on this table but are chemicals of concern because they are commonly found above their respective secondary drinking water standards.

Only those chemical constituents found above drinking water standards or are commonly used to assess health of groundwater are included here since it would be excessive both financially and practically to have SMCs for all the constituents tested (hundreds of constituents).

Approach for Setting Measurable Objectives

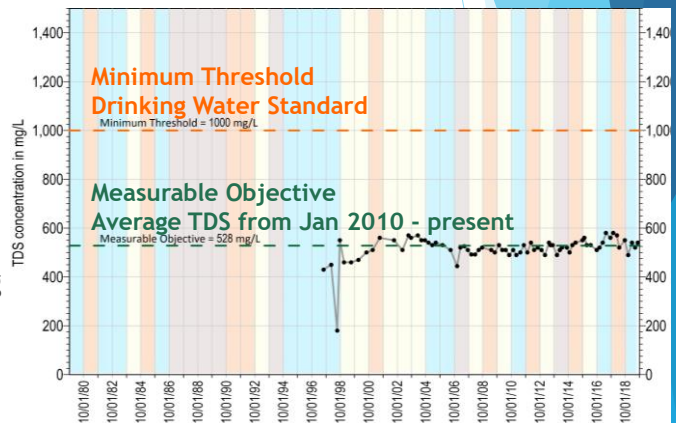
Average groundwater quality over the past 10 years

- ▶ Some wells only get sampled every 3 years
- ▶ Minimum number of samples to include in average must be 3
- ▶ 10 years mostly allows for at least 3 samples to be included in analysis
- ▶ If 3 samples are not in the last 10 years, the last 3 samples taken will be averaged

This slide summarizes the reasons why a 10-year average is recommended to represent current conditions and not a shorter period

What Do Proposed Metrics Look Like Compared to the Data?

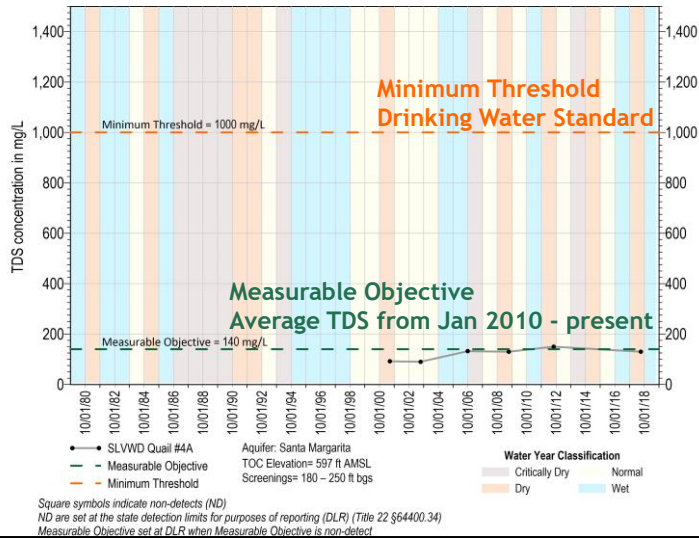
- ▶ Use a chemograph
 - ▶ Plots concentration (vertical) over time (horizontal)
 - ▶ Horizontal lines representing proposed **Minimum Threshold** and **Measurable Objective**
- ▶ Chemographs for all Representative Monitoring Points and chemical constituents of concern are provided in meeting packet



Description of what a chemograph is, how it can be used, and the different lines representing Minimum Thresholds and Measurable Objectives

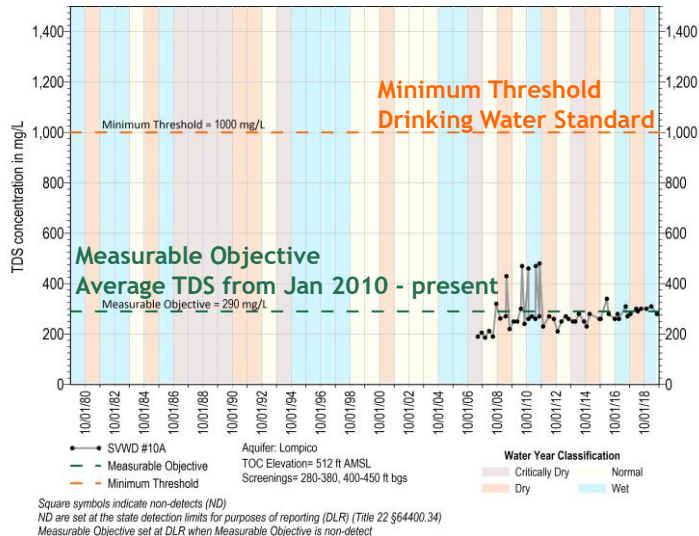
We will go through all 9 slides to point out how the concentration data for different chemical constituents look like against the MT and MO and will take questions after that.

Total Dissolved Solids (TDS) Santa Margarita Aquifer SLVWD Quail Hollow #4A



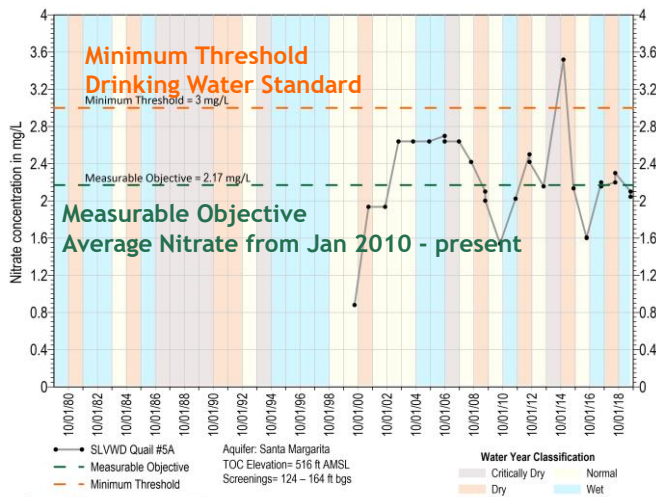
This Santa Margarita aquifer well is sampled every 3 years as represented by the dots on the chemograph.

Total Dissolved Solids (TDS) Lompico Aquifer SVWD #10A



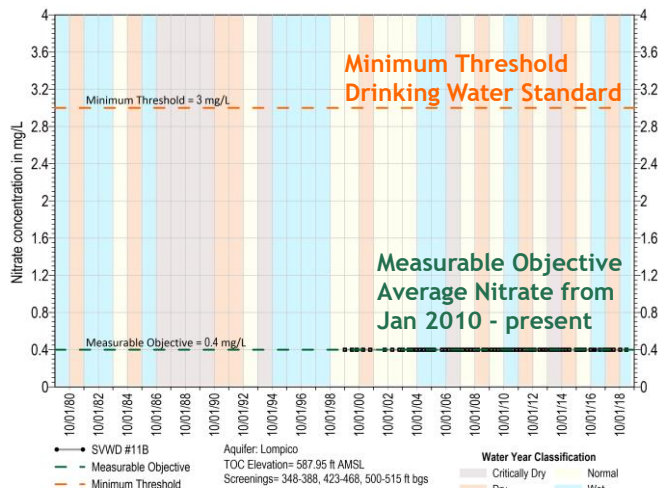
The Lompico aquifer has slightly higher TDS concentrations than the Santa Margarita aquifer but still well below the secondary drinking water standard (minimum threshold on this chart)

Nitrate as N (Santa Margarita Aquifer) SLVWD Quail Hollow #5A



The elevated nitrate observed here is typical of nitrate concentrations in the Santa Margarita aquifer where it is impacted by septic systems. Most of the wells are well below the drinking water standard (or minimum threshold on this chart). Since the slightly elevated concentrations are a pre-existing condition that is not related to the SMGWA, fluctuations above the minimum threshold would need to be caused by SMGWA projects and management actions for there to be undesirable degraded water quality. For example, if a GSP project causes a plume of nitrate to move towards this well and nitrate concentrations increase to always be above the minimum threshold – this would be considered undesirable.

Nitrate as N (Lompico Aquifer) SVWD #11B

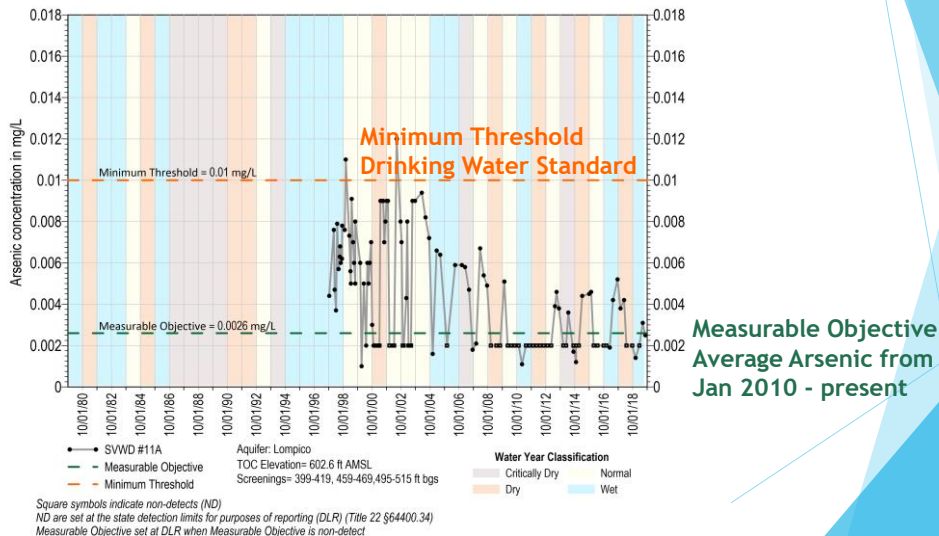


A non-detect means the lab was not able to detect the chemical at the analysis method

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The Lompico aquifer typically has non-detects because of its protected location beneath the Santa Margarita and Monterey Formation. There are many representative monitoring points that have predominantly or only non-detects of nitrate. This chart shows what non-detects look like when plotted on the chart (squares) and that the measurable objective is set at that non-detect level since the method of testing is only required by the state to detect to that non-detect concentration

Arsenic SVWD #11A

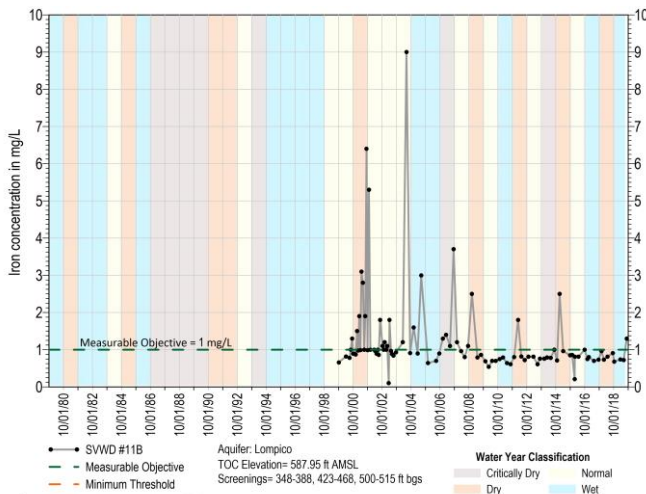


15

Arsenic is a naturally occurring chemical constituent that may have an increase in concentration when imported water is injected into groundwater. This can cause a reaction with the naturally occurring arsenic in groundwater that increases the arsenic concentration. Since this well has exceeded the minimum threshold in the past, an argument could be made that concentrations exceeding the minimum threshold are not undesirable. The decline in arsenic concentrations in this well might be attributable to its sustained pumping and it is possible that a long break in pumping may result in the higher concentrations seen when the well was first put in operation. If concentrations increased significantly from historical data for this well in response to a GSP project or management action, that would be considered undesirable.

Iron SVWD #11B

Minimum Threshold
= 0.3 mg/L
Naturally exceeded
so it cannot be an
Undesirable Result



Measurable Objective
Average Iron from
Jan 2010 - present

Square symbols indicate non-detects (ND)
ND are set at the state detection limits for purposes of reporting (DLR) (Title 22 §64400.34)
Measurable Objective set at DLR when Measurable Objective is non-detect

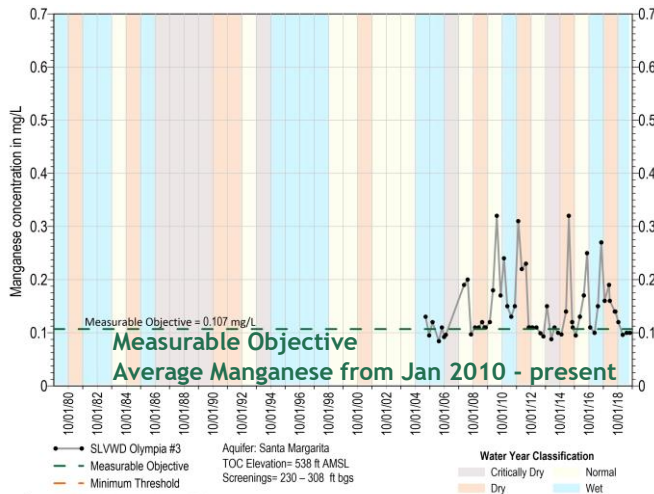
16

Iron is naturally occurring in the Basin and large fluctuates are typical. Natural concentrations exceed the secondary drinking water standard used as the minimum threshold for this chemical constituent. It is therefore not an undesirable result to have exceedances of the minimum threshold. If concentrations increased significantly from historical data for this well in response to a GSP project or management action, that would be considered undesirable.

Manganese SLVWD Olympia #3

Minimum Threshold
= 0.05 mg/L

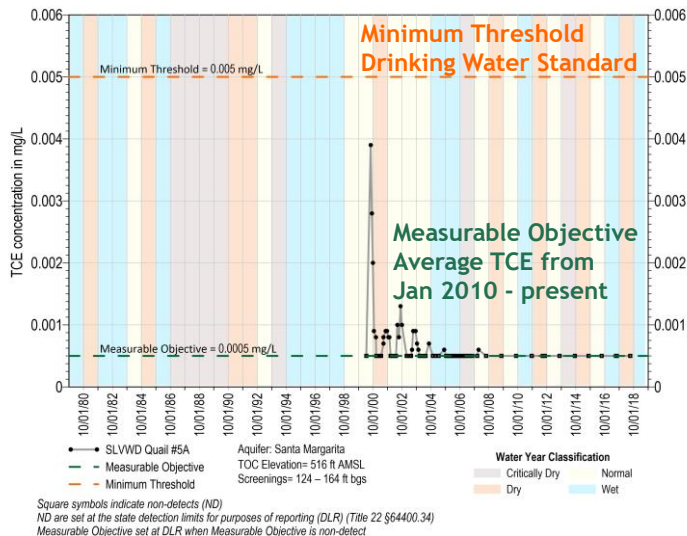
Naturally exceeded
so it cannot be an
Undesirable Result



17

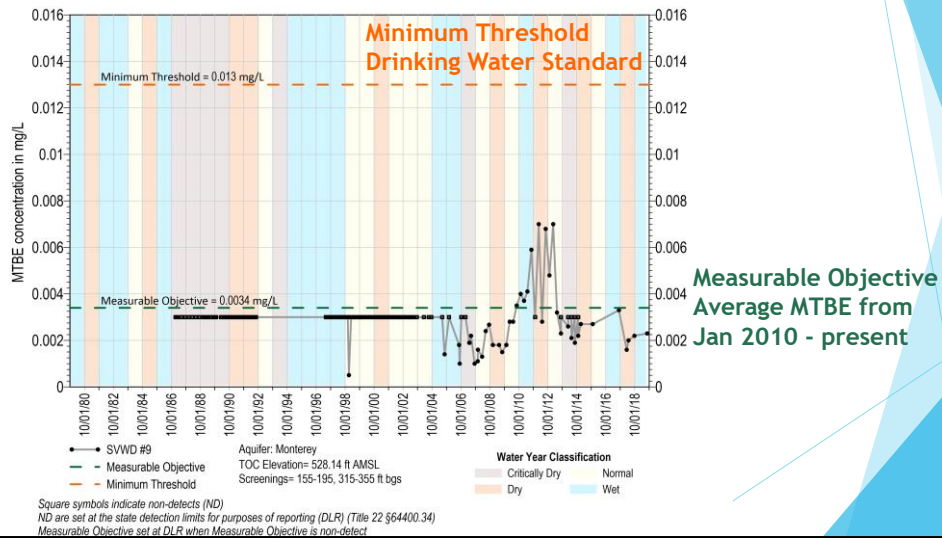
Manganese is naturally occurring in the Basin and large fluctuates are typical. Natural concentrations exceed the secondary drinking water standard used as the minimum threshold for this chemical constituent. It is therefore not an undesirable result to have exceedances of the minimum threshold. If concentrations increased significantly from historical data for this well in response to a GSP project or management action, that would be considered undesirable.

Trichloroethylene (TCE) SLVWD Quail Hollow #5A



Volatile organic compounds (VOCs) have been detected in a few Basin public water supply wells. None of the concentrations exceeded drinking water standards. This is an example of one of the wells in the Santa Margarita Quail Hollow area that had some detects in the early 2000s. The other chemographs for VOC that have detects look similar to this. Most wells have only non-detects.

Methyl tertiary-butyl ether (MTBE) SVWD #9



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This well that is no longer used for water supply shows the past impact of MTBE. Although it was detected, it was never above the drinking water standard (minimum threshold on this chart).

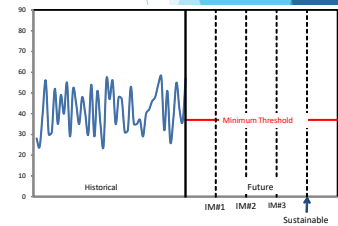
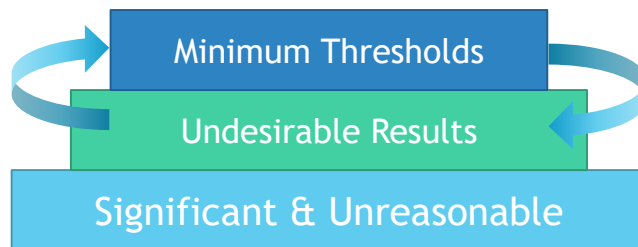
Summary tables of proposed Minimum Thresholds and Measurable Objectives by Representative Monitoring Point and chemical constituent is included with packet of chemographs

Total Dissolved Solids (TDS)			
Representative Monitoring Point	Aquifer	Minimum Threshold, mg/L	Measurable Objective, mg/L
Mount Hermon #2	Lompico	1,000	110
Mount Hermon #3	Lompico	1,000	330
SLVWD Olympia #2	Santa Margarita	1,000	457
SLVWD Olympia #3	Santa Margarita	1,000	573
SLVWD Pasatiempo #5A	Lompico	1,000	110
SLVWD Pasatiempo #6	Lompico	1,000	155
SLVWD Pasatiempo #7	Lompico	1,000	143
SLVWD Quail #4A	Santa Margarita	1,000	140
SLVWD Quail #5A	Santa Margarita	1,000	123
SVWD #10	Lompico	1,000	371
SVWD #10A	Lompico	1,000	290
SVWD #11A	Lompico	1,000	525
SVWD #11B	Lompico	1,000	367
SVWD #3B	Lompico/Butano	1,000	563
SVWD #9	Monterey	1,000	839
Orchard Well	Lompico/Butano	1,000	450

To get the actual proposed Minimum Thresholds and Measurable Objectives for each Representative Monitoring Point, summary tables for each chemical constituent are provided before each chemical constituents' sets of chemographs.

Relationship between Minimum Thresholds and Undesirable Results

- ▶ Minimum Threshold and Undesirable Results area related to each other

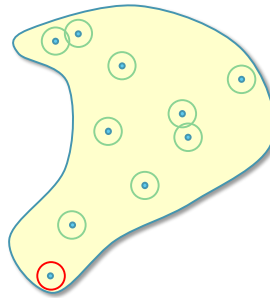


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For determining sustainability in a basin, minimum thresholds on their own are not the measure used. SGMA has mandated that we define Undesirable Results for each sustainability indicator that rely on minimum thresholds.

Undesirable Results are a Combination of Minimum Thresholds

Example: An undesirable result occurs when more than 10% of the Representative Monitoring Points have Minimum Threshold exceedances for any chemical constituent



How you define Undesirable Results is
how you can accommodate flexibility

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This slide provides an example of how a combination of minimum threshold exceedances could be worded. These combinations provide for the flexibility to sometimes exceed minimum thresholds without causing undesirable results.

Potential Undesirable Results for Degraded Water Quality

Example 1

Less Flexible
More Protective



Any Representative
Monitoring Point
Exceeds any Minimum
Threshold

Example 2

More Flexible
Less Protective



More than <X%> of
Representative
Monitoring Points
Exceed any of their
Minimum Thresholds
over <time period>

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These are examples of two different approaches that could be taken to define Undesirable Results. The first example is less forgiving or flexible, while the second allows more flexibility. The next slide provides more details on the second example's variables shown between < >

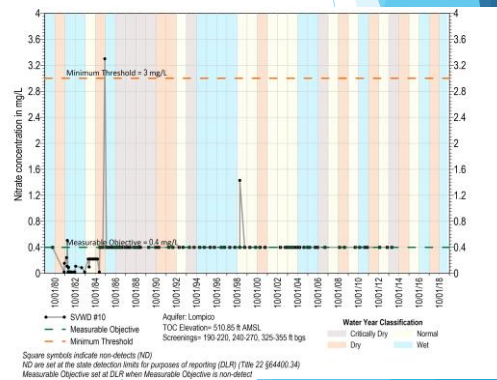
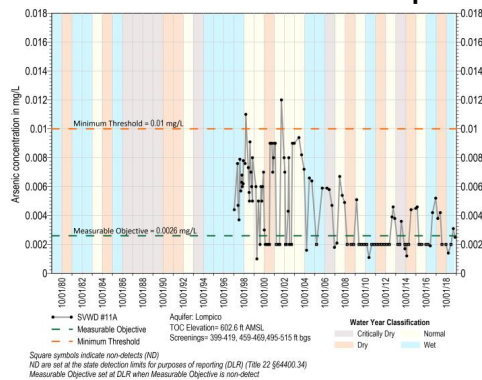
We will also need to include in the definition of Undesirable Results that those chemical constituents that are already exceeding Minimum Thresholds are not undesirable because they are naturally occurring and not caused by SMGWA activities.

Example 2 could include the use of a moving average to compare against Minimum Thresholds to determine if there is undesirable groundwater degradation.

Undesirable Results Variables

More than <X%> of Representative Monitoring Points Exceed any of their Minimum Thresholds over <time period>

Some chemical constituents fluctuate but without permanent exceedances



These two chemographs show examples of where minimum thresholds have been exceeded previously. The Basin should not be considered unsustainable because of a few data spikes that may possibly be sampling or lab error. Definition of undesirable results should take these possibilities into account by providing for some flexibility in how often exceedances may occur without causing significant and unreasonable impacts.

Degraded Groundwater Quality Sustainable Management Criteria

- ▶ Final Board Questions/Comments
- ▶ Public Comment

- ▶ Board Action on Preliminary Degraded Groundwater Quality:
 - ▶ Minimum Thresholds
 - ▶ Measurable Objectives
 - ▶ ~~Undesirable Results~~

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Board Chair to lead Action:

Are there any objections to accept the proposed methodology for setting Minimum Thresholds based on State Drinking Water Standards (except nitrate) & Measurable Objectives based on average concentrations over 10 years, or at least 3 points for degraded groundwater quality.



Proposed Minimum Thresholds & Measurable Objectives

Chronic Lowering of Groundwater Levels

Draft Statement of Significant & Unreasonable Chronic Lowering of Groundwater Levels

Groundwater levels declining below measured historical low levels that impair groundwater supply availability or cause undue financial burden for any of the Basin's beneficial users or uses

Note: this statement may change slightly once we factor in groundwater dependent ecosystems

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This statement was drafted by staff based on input received both verbally during the April Board meeting and by email after the meeting.

This is supposed to be a very general statement – more details are provided in the description of what undesirable results would look like, e.g., “Groundwater levels lower than historical low levels that decline at rate greater than X feet over Y consecutive years”

Considerations for Setting Groundwater Level Metrics

- ▶ Groundwater levels should not be allowed to get worse than they have been historically
- ▶ Protect against dewatering of the Santa Margarita aquifer
- ▶ Protect Groundwater Dependent Ecosystems (not yet factored in the approach presented tonight)
- ▶ Build in wording to indicate maximum rate of decline over time
- ▶ Levels in some part of the basin may need to increase relative to recent conditions
- ▶ Metrics to be developed for each aquifer
- ▶ If Measurable Objectives are set to increase levels, these must consider cost

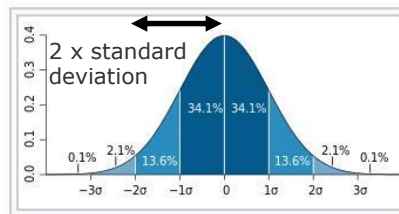
These are considerations discussed at previous Board meetings or provided as Director comments in emails after the April Board meeting. These have been used to guide development of the degraded groundwater level sustainability criteria

Approach for Setting Minimum Thresholds

Three Options

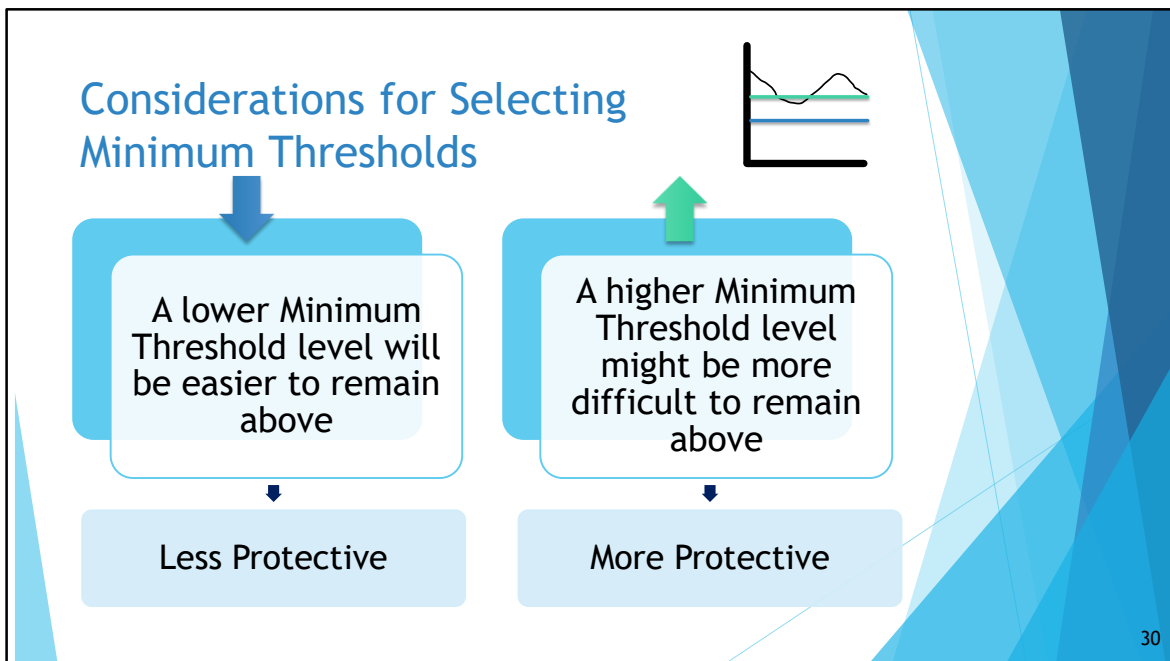
- ▶ Minimum Threshold = 2 x standard deviations** of the average level
- ▶ Minimum Threshold = minimum level
- ▶ Minimum Threshold = 1 x standard deviations of the minimum level

** Standard deviation is a statistic used to tell how water level measurements for a well are spread out from the average



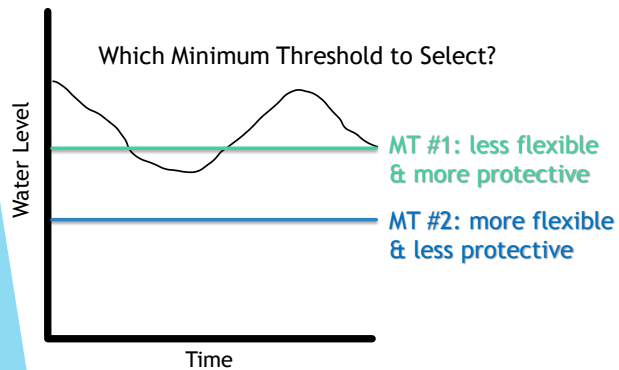
We are looking for a standardized method of determining what the minimum threshold should be for representative monitoring points. We have looked at three options so far. 2x standard deviation should account for 95% of the water levels, or all but 2.5% of the water levels at the low end of the range, making it a good statistical indicator of outlying values below the average. 1 x standard deviation of the minimum level provides for water levels to fall below the historical minimum level by a depth equal to the deviation from average that 68% of levels experience

The standard deviation is like a ruler for judging whether a particular data point is really wacky (or not)



The three different methods give three different results. To put into perspective what the different levels mean: a lower Minimum Threshold level will be easier to remain above but is less protective, while a higher Minimum Threshold level might be more difficult to remain above but is more protective.

Considerations for Selecting Minimum Thresholds taking into Account Undesirable Results



An Undesirable Result is a combination of Minimum Threshold exceedances that cause significant and unreasonable effects

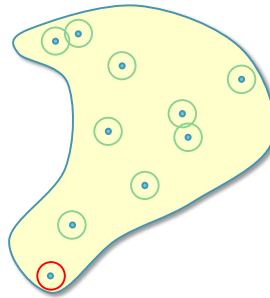
Avoiding Undesirable Results is how you prove sustainability

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We need to consider undesirable results to help in selecting minimum thresholds as they work together.

Undesirable Results are a Combination of Minimum Thresholds

Example: An undesirable result occurs when 20% of groundwater elevations, measured at Representative Monitoring Points, drop below their respective Minimum Thresholds

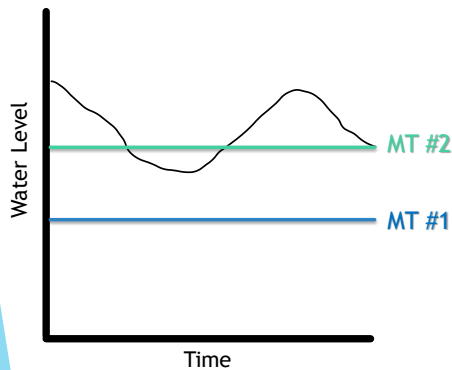


How you define Undesirable Results is
how you can accommodate flexibility

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Refresher slide of what Undesirable Results are

Examples of Different Undesirable Results for Different Minimum Thresholds

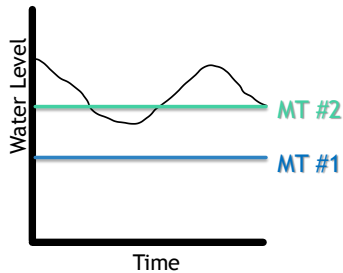


Using MT#1, example
Undesirable Results are:

- ▶ No representative monitoring point can have its groundwater level fall below its Minimum Threshold, or
- ▶ A certain % of representative monitoring points can exceed their Minimum Thresholds

If you select a MT below historical levels it may be easier to remain above it in the future so potentially you could say no wells have exceed their respective MTs. If more flexibility is needed to avoid undesirable results, a certain percentage of representative monitoring points could alternatively be allowed to exceed the MT in a year.

Examples of Different Undesirable Results for Different Minimum Thresholds



Using MT#2, example Undesirable Results are:

- ▶ Groundwater levels in a representative monitoring point are undesirable if levels fall below its Minimum Threshold for more than <3> consecutive years at an average rate greater than <5> feet per year

If the higher MT is selected, you will need to build more flexibility into your undesirable results by allowing for a certain amount of exceedances. These can be based on time and rate.

Approach for Setting Measurable Objectives

Maintain Levels



Use average levels

Recover Levels



Use groundwater model
to Select Achievable
Levels Given PMAs and
Climate Change

Must be Achievable

How measurable objectives are set for each representative monitoring point depends on what changes in groundwater levels are desired. Where the goal is to maintain levels where they are now, an average level is used. If recovery is desired, then an achievable level will be derived from the groundwater model which has the ability to predict groundwater levels while considering climate change, and projects & management actions.

Approach for Setting Measurable Objectives

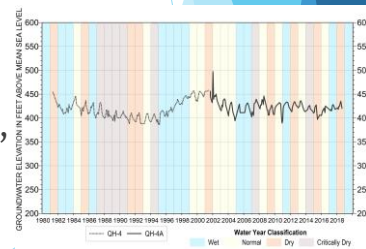
Santa Margarita Aquifer

- ▶ **RECOVER** levels in dewatered Pasatiempo area

⇒ Use groundwater model to determine achievable recovered groundwater levels

- ▶ **MAINTAIN** levels in Quail Hollow, Olympia, & elsewhere

⇒ Use average groundwater levels



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The groundwater level measurable objectives for different areas of Santa Margarita aquifer are to recover in the Pasatiempo area where dewatering has occurred; and to maintain groundwater levels in the rest of the Basin where permanent declines have not occurred.

Approach for Setting Measurable Objectives

Monterey Formation

- ▶ **RECOVER** levels in the Scotts Valley area
 - ⇒ PMAs in the Scotts Valley area will not target this “aquifer” as it is not a reliable aquifer. Its recovery will be incidental to recovery of the Santa Margarita and Lompico aquifers
 - ⇒ Use groundwater model to determine recovered groundwater levels
- ▶ **MAINTAIN** levels elsewhere

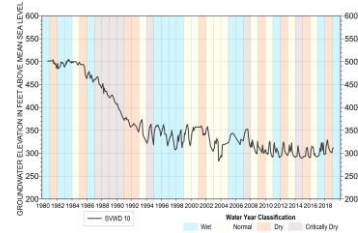


Although there are no wells in which to monitoring groundwater levels in the Monterey Formation, the only well with a long-term record of levels is SVWD #9 that is in the general area where the Santa Margarita aquifer is dewatered. Its groundwater levels will recover coincidentally with recovery of the Santa Margarita and Lompico aquifers in this area. The model will need to be used to determine how much recovery might take place and therefore what the measurable objective could be.

Approach for Setting Measurable Objectives

Lompico Aquifer

- ▶ **RECOVER** levels in
Scotts Valley area
 - ⇒ Use groundwater
model to determine
recovered
groundwater levels
- ▶ **MAINTAIN** levels
elsewhere



In the Scotts Valley area where there has been 150 feet of decline, the Board has indicated that recovery of groundwater levels is desired. How much of a recovery can take place is dependent on cost effective projects and management actions. The model will be used to determine the measurable objectives. There are no other long-term data for groundwater levels in other parts of the Basin and therefore it is assumed that users are okay with the status quo and the objective will be to maintain levels.

Approach for Setting Measurable Objectives

Butano Aquifer

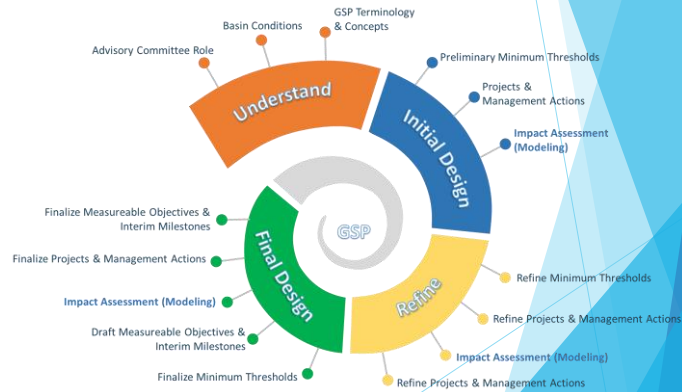
- ▶ **MAINTAIN** levels
 - ⇒ Use average groundwater levels

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The Butano aquifer is not well understood in the area where it is most pumped by SVWD because its extraction wells are screened across both the Lompico and Butano aquifers. The groundwater level data available are therefore a composite of the two aquifers. Until the Butano aquifer is understood more fully with the aid a deep dedicated monitoring well screened only in the Butano aquifer near the municipal Butano extraction wells, the measurable objective will seek to maintain groundwater levels.

Remember that Developing Sustainable Management Criteria is an Iterative Process

- ▶ We will use the groundwater model to predict future groundwater levels taking into account PMAs and climate change
- ▶ May need to adjust these preliminary criteria based on simulated model results
- ▶ During 20 year implementation period, SMC can be revised as more data become available



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There is no correct answer in developing SMCs and we are not expected to get it right at our first attempt

What Do Proposed Metrics Look Like Compared to the Data?

► Use a Hydrograph

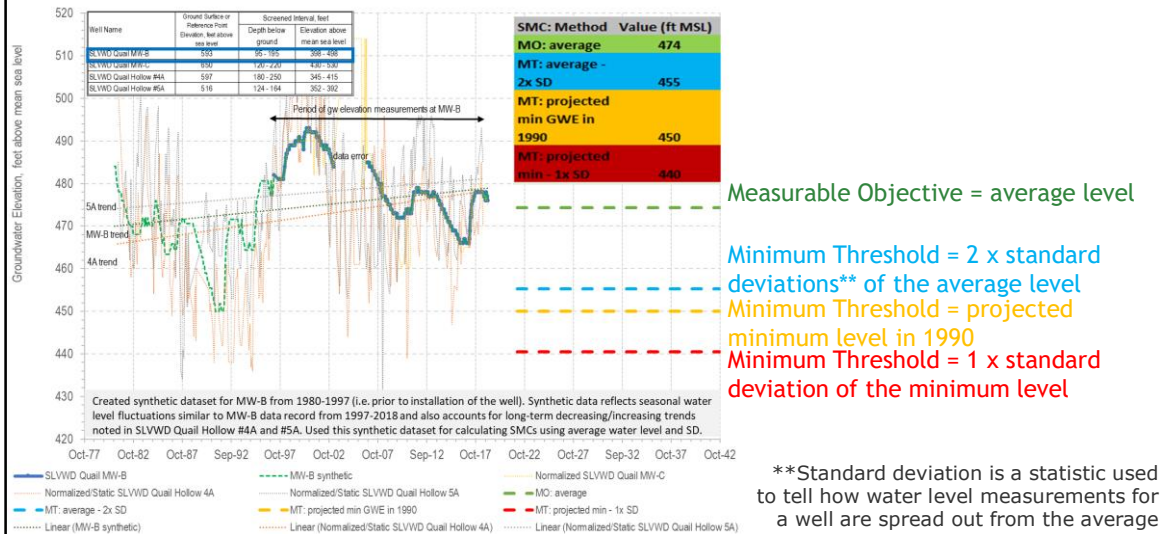
- Plots elevation/depth to water (y-axis/vertical) over time (x-axis/horizontal)
- Horizontal lines representing Minimum Threshold and Measurable Objective

Measurable Objective
Minimum Threshold Option 1
Minimum Threshold Option 2
Minimum Threshold Option 3

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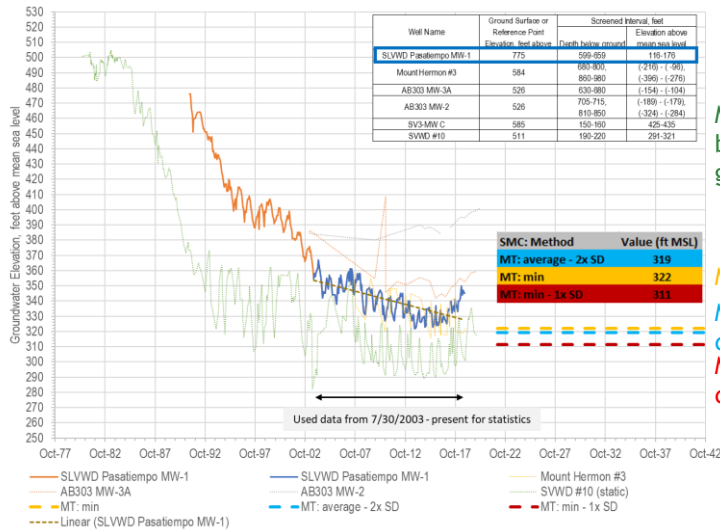
Hydrographs will include lines showing measurable objective and 3 minimum threshold options

Santa Margarita Aquifer - Quail Hollow Area



SLVWD Quail MW-B is selected as a representative monitoring point (RMP) as it represents the groundwater levels of the nearby extraction wells (SLVWD Quail Hollow #4A and #5A). The other hydrographs have been normalized to SLVWD Quail MW-B so they can be compared easier with the RMP. The three different options for minimum thresholds are shown on the hydrograph together with the measurable objective (average groundwater levels over the period of record for the RMP).

Lompico Aquifer - Pasatiempo Area



Measurable Objective to be determined using groundwater model

Minimum Threshold = minimum level

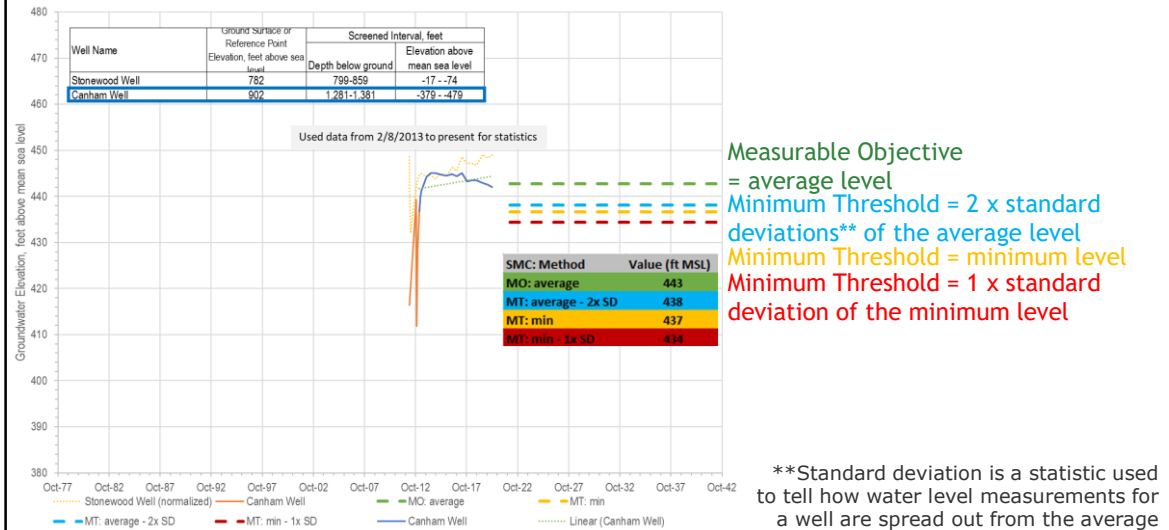
Minimum Threshold = 2 x standard deviations** of the average level

Minimum Threshold = 1 x standard deviation of the minimum level

**Standard deviation is a statistic used to tell how water level measurements for a well are spread out from the average

SLVWD Pasatiempo MW-1 (orange and blue color represent different trend period on the hydrograph) is selected as a representative monitoring point (RMP) as it represents groundwater levels of the nearby wells. The three different options for minimum thresholds are shown on the hydrograph. The measurable objective is not shown as this needs to be determined using the groundwater model.

Butano Aquifer - Northern Scotts Valley



SLVWD Canham is selected as a representative monitoring point (RMP) as it one of the few monitoring well sin the Butano aquifer and is the closest to the production wells SVWD #3B and Orchard Well pumping in the Lompico/Butano aquifers. The Stonewood Well hydrograph is normalized to Canham Well's hydrograph so they can be compared easier. The three different options for minimum thresholds are shown on the hydrograph together with the measurable objective (average groundwater levels over the period of higher levels). The 25 ft increase in levels at the start of the monitoring data don't seem correct so those are excluded from the average.

Minimum Threshold Options

- ▶ Minimum Threshold = 2 x standard deviations of the average level
- ▶ Minimum Threshold = minimum level
- ▶ Minimum Threshold = 1 x standard deviation of the minimum level

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To recap, these are the three minimum threshold options we have presented. It would be preferable to use one option to determine minimum thresholds for all representative monitoring points. However, it may be necessary to use a different option for some wells because the data requires a different approach.

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- ▶ Final Board Questions/Comments
- ▶ Public Comment
- ▶ Staff will take Board comments, during this meeting and by email after the meeting, into account and present recommendations for Minimum Thresholds and Measurable Objectives for all Representative Monitoring Points at a future Board meeting

Thank you for your participation!

