STAFF REPORT
VALLEY WATER MANAGEMENT COMPANY
MCKITTRICK 1 & 1-3 FACILITY

KERN COUNTY

INTRODUCTION

Valley Water Management Company (Valley Water) owns and operates oil field produced wastewater disposal pond systems named the McKittrick 1 ponds and McKittrick 1-3 ponds. The systems are interconnected, regulated as one facility, and collectively referred to herein as the "McKittrick 1 & 1-3 Facility" or "Facility." The Facility is approximately 8.7 miles west of the community of Buttonwillow, as shown on Attachment A.

Oil field produced wastewater from various operators has been discharged to the Facility's approximately 163 acres of ponds for disposal by percolation and evaporation since the late 1950s. Produced wastewater comes from the South Belridge, Cymric, and McKittrick oil fields and is high in salinity and boron. The Facility is not within an established oil field (Attachment B).

Discharges to the ponds are regulated under Resolution No. 69-199 (Permit) and Monitoring and Reporting Program R5-2018-0808 (MRP). The Permit was adopted by the Central Valley Water Board (Board) on 14 February 1969 and regulates Valley Water discharges in the Belgian Anticline, Cymric, and McKittrick Oil Fields. The MRP was issued by the Central Valley Water Board's Executive Officer on 4 April 2018 to require monitoring of Facility discharges and expansion of Valley Water's groundwater monitoring network. The Permit prohibits the discharges from creating pollution or nuisance. "Pollution," by definition, occurs when there are unreasonable impacts to designated beneficial uses in groundwater or surface water. The *Water Quality Control Plan for the Tulare Lake Basin, Third Edition, Revised May 2018* (Basin Plan) designates beneficial uses, establishes water quality objectives, contains implementation plans and policies for protecting waters of the basin, including plans and policies specific to oilfield discharges, and incorporates by reference plans and policies adopted by the State Water Board.

In 2002, at the request of Board staff, Valley Water began to voluntarily investigate groundwater downstructure of its Facility. In June 2010, at the request of Board staff, Valley Water began voluntarily monitoring its discharge and groundwater down structure of the Facility. As discussed in detail below, the groundwater monitoring revealed the presence of a highly saline produced wastewater plume originating from the Facility ponds and migrating to the northeast beyond the Valley Water groundwater monitoring well network. MRP R5-2018-0808 requires the submission and implementation of a Monitoring Well Installation and Sampling Plan (MWISP) that provides for the installation of an appropriate number of upgradient/up-structure groundwater monitoring wells to identify background water quality and an appropriate number of downgradient/down-structure wells to fully delineate the produced wastewater plume.

On 5 April 2018, the Board adopted Resolution No. R5-2018-0015, which directed Staff to determine whether Valley Water's discharge may be regulated under *Order R5-2017-0035 Waste Discharge Requirements General Order* for *Oil Field Discharges to Land General Order Number Two (Oil Field General Order Two)*, *Order R5-2017-0036 Waste Discharge Requirements General Order for Oil Field Discharges to Land General Order Number Three (Oil*

Field General Order Three), or whether Valley Water should be directed to submit for a report of waste discharge for individual waste discharge requirements. Oil Field General Order Two and Oil Field General Order Three are hereafter referred to collectively as "Oil Field General Orders." The determination process was to take approximately one year. The one-year time frame was selected so that Staff could evaluate two additional and complete semiannual monitoring reports, which were to include groundwater data from an expanded groundwater monitoring network. As of January 2019, no additional monitoring wells have been installed to delineate the plume.

The Facility discharge exceeds Basin Plan oil field effluent limits for salt and boron, state drinking water standards for salinity, agricultural water quality objectives for salinity and boron. The plume and groundwater affected by the plume exceeds water quality objectives for Basin Plan designated beneficial uses of Municipal and Domestic Supply (MUN) and Agricultural Supply (AGR).

This Staff Report describes why regulatory coverage under one of the Oil Field General Orders is inappropriate and why coverage under individual WDRs would only be appropriate with significant Facility modifications. It also describes why a Board issued Cease and Desist Order (CDO) is appropriate. Specifically, this Staff Report describes the Facility, the discharges to the Facility, the local geology and hydrogeology, the results of groundwater monitoring conducted to date, and why additional monitoring is necessary to define the extent of the impacts. In preparing this Staff Report, Board staff reviewed the Board files for the Facility, including, but not limited to, those documents listed in Attachment C.

FACILITY

The Facility is constructed on alluvial fan deposits just east of the Cymric and Monument Junction oil fields as shown on Attachment B. These fan deposits are discussed in more detail below but are generally considered to be coarse grained and highly permeable. Structurally, the sediments dip from the southwest to the northeast. Similarly, topography in the area slopes at about 30-feet-per-mile from the west-southwest to the east-northeast, as shown by the surface water channels depicted on Attachment D. The Clean Harbors Buttonwillow, LLC, Class I waste facility (Clean Harbors) is about 1.7 miles to the east-northeast, as shown on Attachment D, and sits at an elevation that is about 100 feet lower than the Facility.

Table 1 below presents the range of analytical results for various constituents associated with samples of produced wastewater discharged to the ponds from November 2002 through November 2018. These analytical results are from samples collected by Board staff during field inspections or submitted by, or on behalf of, Valley Water.

Table 1. *Range of Select Constituents in McKittrick 1 & 1-3 Ponds*

Parameter (units)	**Concentration range**	**State MCL[5]**
Electrical Conductivity (EC) @ 25°C[1] (µS/cm[2])	11,000 - 41,000	1,600/2,200[6]
Total Dissolved Solids (TDS) (mg/L)	11,000 - 26,000	1,000/1,500[6]
Chloride (mg/L)	3,600 - 11,000	500/600[6]
Boron (mg/L)	53 - 94	
Benzene (µg/L[3])	0.46 - 400[4]	1.0[7]
Toluene (µg/L)	0.31 - 1000[4]	100[7]
Ethylbenzene (µg/L)	0.75 - 120[4]	300[7]
Xylenes (µg/L)	1.2 - 550[4]	1750[7]

1. °C = Celsius.
2. µS/cm = microsiemens per centimeter which is equivalent to micromhos per centimeter.
3. µg/L = micrograms per liter.
4. Includes data from samples collected by Board staff during field inspections.
5. State of California drinking water Maximum Contaminant Level (MCL)
6. Secondary MCL, upper limit/short term limit.
7. Primary MCL.

The State drinking water Maximum Contaminant Levels (MCLs) are presented for comparison purposes. Oil field produced wastewater discharged to the Facility is from the more saline marine diatomite formations and the relatively less saline, non-marine Tulare Formation. The large range in produced wastewater constituent concentrations discharging to the ponds depends on the number of wells producing and the corresponding zone of production. The electrical conductivity (EC), chloride, and boron concentrations in the produced wastewater greatly exceed the numerical limits set for oil field discharges to land in the Basin Plan of 1,000 umhos/cm, 200 mg/L, and 1.0 mg/L, respectively. The discharges to the ponds also greatly exceed the MCL for EC, TDS, chloride, benzene, toluene, ethylbenzene, and xylenes. *Water Quality for Agriculture, FAO Irrigation and Drainage Paper 29 Revision 1* (Ayers and Westcot) indicates that severe restrictions on irrigation may occur when the applied irrigation water exceeds an EC of 3000 umhos/cm, a TDS of 2000 mg/L, the chloride exceeds about 350 mg/L (surface irrigation; much less for sprinkler irrigation), and boron exceeds about 3 mg/L. The discharge exceeds these agricultural criteria by orders of magnitude.

The discharge flows to the McKittrick 1 & 1-3 ponds were not metered until recently. Reported flows and their sources are shown in Attachment E and have ranged from 7000 barrels (bbls) per day (~ 294,000 gallons per day 'gpd') to 115,000 bbls per day (4.83 million gpd). The average of the reported flows is approximately 67,000 bbls per day or 2.8 million gpd. Based on the average flows, the volume of produced water discharged to the ponds from 1960 to 2018 is about 1.4 billion barrels (60 billion gallons).

GENERAL HYDROGEOLOGY AND GROUNDWATER MONITORING RESULTS

Several general studies of the hydrogeology in the area that encompasses the Valley Water facilities that serve the Cymric and Monument Junction Oil Fields have been conducted. At Board staff's request, Valley Water has also conducted hydrogeology studies in the area of the McKittrick 1 & 1-3 ponds and installed a groundwater monitoring network. Similarly, Clean Harbors, has conducted local hydrogeology studies and installed a groundwater monitoring

network for its facility. The following describes the depositional environment of the local sediments and salient information in those reports and studies. As previously mentioned, the reports and studies consulted are listed in Attachment C.

Depositional Environment

Within the Cymric area, the Quaternary stratigraphic depositional environment generally consists of uplifted arid alluvial fan systems underlain by lacustrine (lake deposits) silts, sands, and clays. Alluvial fan systems are formed from the release of water-borne sediments from mountainous catchments into an adjacent valley or basin. Sediments are deposited to the fan by sheet flow and an incised channel that is an extension of the catchment feeder channel. The incised channel will usually end short of the distal portion of the fan. At the end of the channel, flows expand laterally onto the fan surface. Headward-eroding gullies are common on the distal fan either as single channels or as a downward-converging network. These gullies may eventually intersect the incised channel which could result in changing the active portion of the fan to another direction. Alluvial fan systems can transition to an alluvial plain and then on to a lacustrine environment. Alluvial plain deposits are typically well sorted, fine to medium-grained sands. Lacustrine deposits are formed by sedimentation in a lake. These deposits are characterized by well-sorted, fine-grained sediments, such as clays and silts, which formed in a low-energy environment. The edges of lacustrine deposits may have alluvial delta or fluvial deposits.

Stratigraphy

The following describes the general stratigraphy underlying the McKittrick 1 & 1-3 Facility and the Clean Harbors facility. The nomenclature is generally consistent with that provided in Valley Water technical reports and self-monitoring reports. Attachment F.1 and F.2 provide general cross sections.

Alluvium

The first layer underlying the McKittrick 1 & 1-3 Facility is comprised of Holocene age alluvial fans consisting of sediments transported eastward from the Coast Ranges. These sediments are in interbedded layers of poorly sorted relatively coarse-grained, subangular to angular sands with silts and clays. Angular to subangular gravelly sands occasionally occur in the interbedded sequence.

Geomega's report (17 October 2003) documenting the initial hydrogeologic investigation said "Silty clay layers within the shallower alluvial fan sequence act to perch groundwater in the Cymric area. Multi-perched water zones in the alluvial fan sequence encountered in borehole/monitoring wells CYM-17N1 and CYM-19H1 are apparent from air rotary drilling and geophysical log interpretation." The alluvium is saturated to the east and serves as an aquifer for water supply wells.

"Corcoran Clay Equivalent" or basal alluvial clay

Under the alluvium is a silty-clay to clay bed probably deposited in an alluvial plain to lacustrine (lake) environment transition. This bed separates the alluvium from the Tulare Formation. As described in the studies and reports provided by Valley Water, this bed does not act as a

significant aquitard; i.e. it does not act as a significant barrier to the downward migration of produced wastewater discharged from the McKittrick 1 & 1-3 Facility ponds.

Upper Tulare

Below the Corcoran Clay Equivalent (CCE) is what is called the upper Tulare or upper Tulare sand. It consists of Pleistocene age deposits that vary greatly from lacustrine delta deposits to braided stream, and meandering stream deposits. The deposits are comprised of fine-grained sands with interbedded silt and clay layers and gravels. The upper Tulare sand serves as an aquifer to the east that supplies water supply wells.

Regionally extensive clay layer

The upper Tulare sand is separated from what is called the deeper Tulare or deeper Tulare sand by a dense, stiff clay bed approximately 70 feet thick. This is sometimes called the upper Tulare clay.

Deeper Tulare

The deeper Tulare or deeper Tulare sand is composed primarily of fine-grained to medium-grained well-sorted sands. Valley Water documents indicate the deeper Tulare contains the "regional aquifer." The deeper Tulare serves as an aquifer for water supply wells to the east.

Effects of Depositional Environment on Stratigraphy

Potentially significant consequences of the stratigraphy and above described depositional environment include:

1. What may appear to be homogenous (uniform) and isotropic (similar in all directions) deposits in cross-section may actually be heterogeneous (varied) in nature due to fluvial channel cutting and deposition of higher energy (coarser) sediments deposited during higher energy storm events.

2. What may appear to be continuous confining layers in cross section, such as the CCE and the clay layer that separates the upper Tulare from the deeper Tulare may be riddled with more permeable channel deposits that compromise the layers' integrity, preventing them from serving as effective aquitards.

3. Intersecting the more permeable channel deposits with monitoring wells is difficult without detailed subsurface information. Groundwater typically flows preferentially much faster through channel deposits.

Groundwater Monitoring Networks and Results

The locations of the Valley Water McKittrick 1 & 1-3 Facility groundwater monitoring wells and select Clean Harbors facility groundwater monitoring wells are shown in Attachment F.1. Valley Water's groundwater monitoring well network does not have any upgradient or up-structure wells.

As part of the initial hydrogeologic investigation in 2002, Valley Water installed monitoring wells

CYM-19H1 and CYM-17N1 in the upper Tulare and monitoring well CYM-21D1 in the deeper Tulare. The borings for the monitoring wells were drilled using air rotary drilling until groundwater was encountered. At that point, the drilling method was switched to mud rotary.

Analysis of groundwater samples obtained in 2002 contained elevated concentrations of EC, TDS, chloride, and boron. Valley Water's consultant Geomega, Inc., concluded in its September 2003 report titled *Hydrogeologic Characterization Report Valley Waste Disposal Company, Cymric Field Study* (Phase I Study) that produced wastewater from the ponds had infiltrated the upper Tulare at least as far as 0.75 miles from the Facility. The Phase I Study also concluded that groundwater samples from well CYM-21D1 indicated that produced wastewater had not reached groundwater in the deeper Tulare at that point at that time.

In 2006, Valley Water completed monitoring wells CYM-17K1, CYM-17M1, and CYM-17Q1 in an unsaturated portion of the upper Tulare down-structure from the wells installed in 2002. The well locations are also shown in Attachment F.1. These wells were positioned as "sentinel wells" that would indicate whether and when the plume of produced water reached those points in the upper Tulare downgradient from the ponds. Geomega, Inc., submitted an April 2007 report titled *Phase II Hydrogeologic Characterization Report Valley Waste Disposal Company, Cymric Field Study* (Phase II Study) including results from samples obtained in 2006. The Phase II Study concluded that produced wastewater was present in the upper Tulare, but the sentinel wells were dry. Well CYM-21D1, in the deeper Tulare, reportedly did not show any indication of a produced wastewater impact at the time of sampling.

Borehole/Monitoring well details are presented in Table 2 below.

Table 2. *Valley Water McKittrick 1 & 1-3 Groundwater Monitoring Well Information*.

Well	Distance to VWMC[1] ponds	Well total depth (ft bgs[2])	Surface Elevation (ft AMSL[3])	Screen interval (ft AMSL[3])	Screen interval (ft bgs)	11/12/2018 Water elevation (ft AMSL[3])
CYM-19H1	1,500 feet (0.28 miles)	245	469.2	354-314	115-155	346.78
CYM-17N1	3,300 feet (0.62 miles)	240	451.5	347-287	105-165	321.60
CYM-17M1	4,300 feet (0.81 miles)	197	446.5	292-262	155-185	278.30
CYM-17Q1	5,438 feet (1.03 miles)	208	437.6	278-238	160-200	238.802
CYM-17K1	5,861 feet (1.11 miles)	210	427.9	278-228	150-200	272.48
CYM-21D1	6,700 feet (1.27 miles)	300	427.1	274-294	274-294	148.24

[1] VWMC = Valley Water Management Company
[2] ft bgs = feet below ground surface
[3] AMSL = feet above mean sea level

In June 2014, Valley Water submitted a self-monitoring report titled *Valley Water Disposal Company, 2010 Semi-Annual Sampling and Analysis Report, McKittrick 1 & 1-3 Ponds Cymric Area* prepared on its behalf by Schlumberger Water Services. The report indicates that sentinel wells CYM-17K1, CYM-17M1, CYM-17Q1 contained a significant amount of water, but Valley Water did not sample the wells. Subsequent reports state that sentinel well soundings are provided in field notes, but the reports do not contain field notes for the sentinel wells.

In March 2015, Valley Water submitted a self-monitoring report titled *Valley Water Management Company, 2014 Second Semi-Annual Sampling and Analysis Report, McKittrick 1 & 1-3 Ponds Cymric Area* prepared by Schlumberger Water Services and summarizing data collected in November 2014. The report indicates that CYM-17M1 had 26.56 feet of water, CYM-17K1 had 48.99 feet of water, CYM-17Q1 had 6.93 feet of water at the time of sampling demonstrating that produced wastewater was present in the sentinel wells (CYM-17K1, CYM-17M1, and CYM-17Q1), and that these wells were hydraulically downgradient from the wells installed in 2002. The report also concluded that there were no indications of a produced water impact on the groundwater monitored by well CYM-21D1 in the deeper Tulare, even though chemical constituent concentrations associated with produced wastewater (e.g. TDS, chloride, and boron) had been increasing in well CYM-21D1 since about 2002, and more significantly since 2010, as shown in Attachment G.

In October 2017, Valley Water submitted a technical report entitled *Valley Water Management Company, Cymric Area Sampling and Analysis Report, First Semi-Annual 2017* (October 2017 Report). The report was prepared by WSP USA on behalf of Valley Water and includes data from Valley Water's June 2017 monitoring event including sampling results from the Facility ponds and groundwater monitoring wells. Samples from each of the Valley Water wells in the upper Tulare were chemically similar to the produced wastewater in the ponds. Monitoring well CYM-21D1 in the deeper Tulare showed indications of produced water impacts. The report states, "The overall trend of increasing concentrations of chloride, magnesium, sodium, and boron at VWMC Deeper Tulare Sand well CYM-21D1 continued with the June 2017 sampling event with concentrations of chloride of 2,400 mg/L and TDS of 8,500 mg/L. The boron concentration in June 2017 was 22 mg/L. These concentrations are the highest recorded and indicate influence from produced water mixing with native groundwater." The data submitted in self-monitoring reports by Valley Water also indicate that from 2002 to 2018 the TDS concentrations in CYM-21D1 have increased from about 1,200 mg/L to about 8,000 mg/L, and the chloride concentrations have increased from 334 mg/L to about 2,700 mg/L. Table 3 summarizes the Valley Water groundwater monitoring data. As previously mentioned, the TDS, chloride, and boron trends are presented in Attachment G. This information along with the increasing water levels in CYM-21D1 indicates the mound of produced wastewater emanating from the Facility ponds is continuing to expand. Attachments H1 and H.2 present salient water level data. The direction of groundwater flow is predominantly to the northeast as shown on Attachment I.

Table 3. *Valley Water McKittrick 1 & 1-3 Facility Groundwater Monitoring Well Water Quality.*

Well ID	**Distance from ponds** (ft[1])	**No. of results &** (date range)	**EC** (umhos/cm[2])	**TDS** (mg/L[3])	**Boron** (mg/L[3])	**Chloride** (mg/L[3])
CYM-19H1	1,500	20 (2002 – 2018)	8,500 – 23,000	10,500 – 14,000	30 – 41	4,120 – 5,700
CYM-17N1	3,500	20 (2002 – 2018)	10,900 – 33,000	7,450 – 18,000	20 – 76	2,700 – 8,000
CYM-17M1	4,400	11 (2014 – 2018)	15,840 24,350	12,000 – 16,000	40 – 55	4,900 – 7,000
CYM-17Q1	5,300	11 (2014 – 2018)	13,000 – 22,600	13,000 – 16,000	45 - 60	4,800 – 5,900
CYM-17K1	5,900	11 (2014 – 2018)	18,000 – 28,000	16,000 – 18,000	55 - 68	6,000 – 8,000
CYM-21D1	6,850	20 (2002 – 2018)	1,970 – 11,000	1,200 – 10,000	2.5 - 22	334 - 2,900

[1] ft = feet.
[2] umhos/cm = micromhos per centimeter.
[3] mg/L = milligram per liter.

Table 4. *Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) Concentrations in Valley Water Facility Groundwater Monitoring Wells.*

Well ID	BTEX (µg/L)			
	Benzene	Toluene	Ethylbenzene	Xylenes
CYM-19HI	0.65-0.79	ND[1]	ND	ND
CYM-17N1	0.53	ND	ND	ND
CYM-17K1	ND	ND	ND	ND
CYM-17M1	0.27	ND	ND	ND
CYM-17Q1	ND	ND	ND	ND
CYM-21D1	0.62	ND	ND	ND
MCLs[2]	1	150	300	1750

1. ND = not detected above laboratory reporting limit. Prior to 2018, reporting limits for benzene, toluene, ethylbenzene, and total xylenes (BTEX) was 2.0 ug/L. Subsequently, reporting limit has been 0.5 ug/L.
2. MCLs = maximum contaminant level. The MCL's for benzene, toluene, ethylbenzene, and total xylenes (BTEX) are Primary MCLs.

Groundwater sample results from Valley Water's monitoring wells for BTEX constituents have generally been not detected. Where there have been detections, the results have been below the State drinking water MCLs.

Central Valley Water Board staff have reviewed the self-monitoring reports for the Clean Harbors Class I landfill facility. As described previously, the Clean Harbors facility is about 1.7 miles to the east-northeast, as shown on Attachment B. The Clean Harbors facility is also down structure and down gradient of the McKittrick 1 & 1-3 Facility ponds. In its hydrogeological

investigations, Clean Harbors has differentiated three zones that contain groundwater: 1. Perched zone, 2. Intermediate zone, and 3. Lower zone. These zones generally correspond to the Alluvium, upper Tulare, and deeper Tulare.

Valley Water obtained split samples during the May 2017 sampling of the Clean Harbors groundwater monitoring wells. In part, the samples were analyzed for general minerals and stable isotopes of oxygen and hydrogen. Generally, the native groundwater in the Cymric area is enriched in sodium, calcium, and sulfate, likely due to the abundance of gypsum present throughout the sediments of the Tulare formation. In contrast, the produced wastewater discharged to Valley Water's ponds are marine waters from deeper zones that occur with petroleum and, as such, are enriched with sodium and chloride.

Clean Harbors' groundwater monitoring wells MW-148I and MW-102RL are on the upgradient side of the Class I facility (i.e., the side closest to the McKittrick 1 & 1-3 Facility) (Attachment F.1). MW-148I is screened in the upper Tulare and MW-102RL is screened in the deeper Tulare. Groundwater sample analyses from monitoring well MW-148I and MW-102RL indicate that TDS and chloride concentrations in these wells has been increasing from as early as 2007, as shown on Attachments J.1 and J.2. From 2011 to 2018, the TDS in MW-148I has increased from about 2,340 mg/L to 6,600 mg/L, from 2009 to 2018 the chloride concentration has increased from about 246 mg/L to 1,800 mg/L, and from 2015 to 2018 the boron in MW-148I has increased from about 4.9 mg/L to 9.5 mg/L. From 2013 to 2018, the TDS in MW-102RL has increased from about 3,040 mg/L to about 4,000 mg/L (high of 4,300 in Q1 2018, 3,800 for Q4 2018), and from 2007 to 2018 the chloride concentration has increased from about 450 mg/L to about 750 to 780 mg/L. The data suggest that groundwater at the Clean Harbors location has been adversely impacted by produced wastewater.

Stable isotopes of oxygen and hydrogen can be used to help differentiate between wastewaters discharged to ponds and native groundwaters, or a combination thereof. The ratios of H^2 to H^1 and O^{18} to O^{16} are measured in each sample and are expressed as parts-per-thousand differences from that of Vienna Standard Mean Ocean Water. They are then plotted with δ^2H on the y-axis and $\delta^{18}O$ on the x-axis, as shown on Attachment K. The plotted points are compared to the Global Meteoric Water Line or a Local Meteoric Water Line (LMWL). Native groundwater that has not been significantly evaporated plots below, but near the LMWL, as shown on Attachment K. Wastewater that has been subject to significant evaporation in ponds plots farther to the right side of the graph, and farther from the LMWL. Mixtures plot in between the two, with those containing more pond water plotting farther to the right than those containing less pond water.

Attachment K shows isotopic results for water sampled from Clean Harbors MW-170L and Kern County Water Well 23. These wells are below and slightly to the right of the LMWL, and probably do not represent groundwater that has been mixed with any significant volume of produced wastewater from ponds. There are only single sample results for Clean Harbors MW-102RL and MW-148I, but these wells plot farther from the LMWL indicating possible mixing with produced wastewater from the McKittrick 1 & 1-3 ponds. MW-148I plots still farther to the right of the LMWL. From 2006 to 2018, data for CYM-21D1 shows consistent movement away from the LMWL and towards the data associated with the Valley Water McKittrick 1 & 1-3 upper Tulare wells CYM-19H1, CYM-17N1, CYM-17K1, CYM-17M1, and CYM-17Q1. The quality of groundwater in these wells reflects primarily the quality of produced wastewater discharged to the McKittrick 1 & 1-3 Facility ponds. Isotope data for the produced wastewater from the

McKittrick 1 & 1-3 Facility ponds is included in Attachment K for reference. As expected, it is generally farther to the right and away from the LMWL. The isotope results of the groundwater samples CYM-21D1 and from Clean Harbors' wells MW-102RL, MW-148I, and MW-149I show that produced wastewater is mixing with groundwater in the upper Tulare and deeper Tulare, at least as far down gradient as the Clean Harbors facility.

The ionic composition of the minerals dissolved in a water (wastewater, unaffected groundwater, or a combination of both) can be used to classify the water based on the dominant dissolved anions (negatively charged) and cations (positively charged). The ionic composition of the water is expressed in milliequivalents per liter (meq/L). A milliequivalent is a measurement of the molar concentration of the ion, normalized by the ionic charge of the ion. The dominant dissolved ion must be greater than 50 percent of the total. For example, water classified as a sodium-bicarbonate-type water contains more than 50 percent of the total cation milliequivalents as sodium and more than 50 percent of the total anion milliequivalents as bicarbonate. If no cation or anion is dominant (greater than 50 percent), the water is classified as mixed and the two most common cations or anions in decreasing order of abundance are used to describe the water type. For example, a water containing 45 percent sodium, 35 percent calcium, and 20 percent magnesium, and 55 percent bicarbonate, 30 percent sulfate, and 15 percent chloride would be classified as a sodium-calcium-bicarbonate-type water. Stiff and Piper diagrams can be used to illustrate the ionic composition of water samples (e.g., wastewater, unaffected groundwater, or a combination of both.) and, with sufficient data, how the composition changes over time.

Stiff diagrams provide a graphical representation of geochemical data and are often used when qualitative comparison of many analyses is needed. A polygonal shape is created by plotting major cation and anion concentrations in milliequivalents on parallel horizontal lines with anions plotted to the right of a vertical zero line and cations plotted to the left.

Stiff diagrams presented on Attachments L.1 – L.4 show recent water quality of the Facility produced wastewater, water quality of wells that appear to be unaffected by the produced wastewater (which is date dependent), and water quality in Valley Water and Clean Harbors groundwater monitoring wells that have been impacted by produced wastewater. The Stiff diagrams indicate that the Valley Water monitoring wells between the Facility ponds and the Clean Harbors groundwater monitoring wells have been affected by produced wastewater when compared to the unaffected water quality. Well CYM-21D1 (Attachment L.4) has shown a steady increase in some cations and anions and primarily sodium and chloride, indicative of increasing impacts over time from produced wastewater. Significant impacts are also appearing in some of the Clean Harbors facility monitoring wells down gradient of the Valley Water groundwater monitoring well network. The primary source of produced wastewater appears to be discharges from the Facility ponds.

For the attached Piper diagrams, cation and anion concentrations for each of the produced wastewater and groundwater samples have been converted to total milliequivalents of solute per liter of solution (meq/L) and plotted as percentages of their respective totals in two triangles (Attachments M.1-M.4). The cation and anion relative percentages in each triangle are then projected into a quadrilateral polygon that describes the water type. The attached Piper diagrams provide graphical representations of the major cations and anions for Valley Water's produced wastewater ponds, waters that appear to be unaffected by infiltrated produced wastewater, and waters that have been impacted by produced wastewater over time appear to

show a progressive mixing over time between the two types (CYM-21D1).

These diagrams show that the Valley Water produced wastewater is dominated by sodium and chloride (Attachment M.1). Better quality water that appears to be largely unaffected by the produced wastewater is more sulfate-rich, consistent with groundwater typical of the west side of the San Joaquin Valley, and here represented by wells MW-170L, MW-149I, Belridge 16, and CYM-21D [in 2006] on Attachment M.2. Piper diagrams for several wells show mixing of produced wastewater with better quality water (Attachment M.3), or in the case of well CYM-21D1, increasing impacts over time from produced wastewater (Attachment M.4), which clearly shows a shift from a sulfate type water to a chloride type water with time.

Notwithstanding the above, the October 2017 Report concludes that Valley Water's discharges from its McKittrick 1 & 1-3 Facility ponds have not impacted groundwater in Clean Harbors' upgradient monitoring wells and proffers the following arguments:

- Groundwater levels in the Clean Harbors' wells have been decreasing while levels in the Valley Water wells are increasing. The report states, therefore, the wells are not hydraulically connected.

- Boron concentrations have been increasing in the Valley Water monitoring wells and show no trends in Clean Harbors' wells.

- The calculated groundwater flow velocity shows that the produced water constituents could not have reached the Clean Harbors' wells at this time.

- The pH of the water from the Valley Water monitoring well CYM-21D1 is more acidic (6.6 to 6.8) than the groundwater from the nearest Clean Harbors groundwater monitoring wells, which are more alkaline (7.5 to 8.1). The report states, therefore, the wells are not hydraulically connected.

The arguments posited by WSP USA on Valley Water's behalf are not persuasive. Valley Water has provided no evidence of a geologic structure that would impede or isolate the produced wastewater discharged into and from the McKittrick 1 & 1-3 Facility ponds from the Clean Harbors' facility monitoring wells. Further, the Clean Harbors' facility is down structure from and much closer to large areas of irrigated agriculture than the McKittrick 1 & 1-3 Facility ponds. The decrease in the Clean Harbors' groundwater monitoring well water levels is likely due to increased pumping of groundwater for irrigation during the recent drought conditions. The increases in the groundwater levels in the Valley Water monitoring wells are probably due to continued discharge to the Facility ponds and the large volume of percolated produced wastewater that is moving through the formations tapped by the groundwater monitoring wells.

Relatively stable boron concentrations in samples from the Clean Harbors' groundwater monitoring well MW-102RL are not unexpected. Boron tends to be mobile in sands and gravels but can adsorb to finer grained soils such as silts and clays. The ability of boron in a plume to migrate through the subsurface at rates similar to or slower than TDS and chloride depends on many factors, including but not limited to, the pH and the salinity of the discharge, the pH of the groundwater with which the discharge is mixing; and the pH, buffering capacity, and composition of the soils through which the discharge/groundwater mixture is migrating. Therefore, the boron front of a plume can move slower through the subsurface than more

conservative constituents, such as chloride. As shown in Attachment J.1, boron is increasing in MW-148I.

The groundwater flow velocity calculations presented in the October 2017 Report, and more recently in the February 2019 monitoring report submitted by Golder Associates Inc., likely underestimate the actual groundwater flow velocities as they assume a consistent flow gradient, employ a hydraulic conductivity value derived from the analysis of one fine grained soil sample, and use an assumed effective porosity. The report gives no consideration to the heterogeneous nature of the local hydrogeology. For example, produced wastewater that finds its way into a subterranean channel comprised of coarse sand or gravel will travel much faster than calculated.

Lastly, regarding pH, the pH in CYM-21D1 has ranged from 7.10 to 10.4 pH units. The pH in the Clean Harbors wells historically ranged from 7.5 to 8.2 pH units. The pH range for CYM-21D1 overlaps the pH range reported for the Clean Harbors wells, which contradicts the assertion made in the October 2017 Report.

Downgradient Groundwater Quality and Beneficial Uses

The beneficial uses of groundwater in the Cymric area designated by the Basin Plan are: Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), and Industrial Service Supply (IND). In many instances, the quality of groundwater to the east of the McKittrick 1 & 1-3 Facility ponds is of sufficient quality to meet water quality objectives for MUN, AGR, and IND.

Attachment N shows the locations of select Clean Harbors monitoring wells and existing water supply wells, mostly agricultural wells, downgradient of the McKittrick 1 & 1-3 ponds. Attachment P also shows TDS concentrations in the wells. As described above, TDS and chloride concentrations in MW-148I and MW-102RL have increased over time. The historical quality in MW-148I was suitable for MUN and AGR. It now appears to be unsuitable for both.

Attachment N shows several agricultural wells operated primarily by Starrh Family Farms, LP (Starrh Farms) to the north of the McKittrick 1 & 1-3 Facility and the Clean Harbors facility. Starrh Farms well Belridge 7 had a TDS of 2,700 mg/L in 2013 when it was last sampled by AMEC, Foster, Wheeler. The sampling notes indicate that at the time of sample collection the well was actively pumping, and presumably irrigating crops. Other agricultural wells in the area have TDS values ranging from 2,300 mg/L to 6,800 mg/L. The agricultural well closest to the Valley Water Facility had a TDS of 18,000 mg/L. The better quality wells contain TDS and chloride concentrations that do not require dilution prior to use on salt-tolerant crops. The wells with higher TDS concentrations can be blended with higher quality surface water to irrigate a variety of crops. On 26 January 2018, Starrh Farms communicated to Board staff that these wells are very important to its operations when surface water allocations are short.

Attachment N also shows that to the east McKittrick 1 & 1-3 Facility and Clean Harbors, groundwater from agricultural wells in the area have had TDS values ranging from 391 mg/L to 5,952 mg/L. Data for these wells is old, but do demonstrate that high quality groundwater has existed, and presumably exists today, down gradient of the McKittrick 1 & 1-3 Facility.

Additional Groundwater Monitoring Well Work Plans

On November 2014, Kennedy/Jenks Consultants and Schlumberger Water Services, on behalf of Valley Water submitted a report titled, *Monitoring Well Installation Work Plan for the McKittrick Ponds, Cymric Oil Field, California* (2014 Work Plan). Kennedy/Jenks then met with Board staff on 6 January 2015 to discuss the Work Plan. On January 2015, Kennedy/Jenks submitted a proposed modification to the Work Plan. The Work Plan proposed to drill three to four borings and install at least two, and possibly four monitoring wells to further characterize the vadose zone and groundwater. The work plan proposed to drill in two phases. In the first phase, two wells would be drilled "soon" (CYM-19H2 and CYM-21D2) and two borings (CYM-17H1 and CYM-17H2) would be drilled later because they were proposed in an area of protected species habitat. CYM-19H2 would be installed as a deep groundwater monitoring well. CYM-21D2 would be installed as a shallow monitoring well or if water was not encountered, as a sentinel well. If groundwater quality changed in the CYM-21D1 well (CYM-21D1 is now impacted), then CYM-17H2 would be installed as a deep groundwater monitoring well.

On January 2015, Board staff issued a letter to Valley Water generally concurring with the Work Plan. Staff requested a second monitoring well be installed above the Upper Tulare Clay, and that CYM-17H1 be installed.

On April 2016, Valley Water submitted a report titled *Biological Report for the Valley Water Management Cymric Water Monitoring Well Projec*t (Biological Report). The Biological Report concluded that well 17H1 and well 17H2 could be installed but that the other proposed wells were in endangered species habitat. It also stated that there is enough room near a Clean Harbors monitoring well location for a drilling rig. Further, the Biological Report stated, "As for the other monitoring wells that were proposed near the McKittrick pond facility, it appears that we will have to obtain a "take" in permit prior to the installation of those wells. A "take" permit currently requires at least six months and more likely one year to obtain a permit."

As of February 2019, Valley Water has not implemented the proposed 2014 Work Plan, nor has Valley Water provided a formal update on whether it sought or acquired a "take" permit (or whether one was denied) for the installation of CYM-19H2 and CYM-21D2 monitoring wells. Wells 17H1 and 17H2 have not been installed, as proposed in the 2014 Work Plan and approved in the January 2015 Board staff letter.

In June 2018, Kennedy/Jenks Consultants, on behalf of Valley Water submitted a report titled, *Monitoring Well Installation and Sampling Plan for the Valley Water Management Company*

McKittrick Ponds Facility, Cymric Oil Field (2018 Work Plan). The Monitoring Well Installation and Sampling Plan (MWISP or Work Plan) was submitted in response to the requirements of Monitoring and Reporting Program Order R5-2018-0808. The Work plan proposed the installation of six additional monitoring wells to extend the existing groundwater monitoring network and delineate the plume of produced wastewater emanating from the Facility ponds.

On 27 July 2018, Board staff issued a letter to Valley Water conditionally concurring with the 2018 Work Plan. Staff requested Valley Water incorporate three recommendations into a revised MWISP: 1. Monitoring well CYM-17A1 be installed whether or not well CYM-17H1 is completed in unsaturated sediments; 2. All new monitoring wells are logged using geophysical methods; and 3. The process for determining the screened interval for a well is included in the MWISP.

In August 2018, Kennedy/Jenks Consultants, on behalf of Valley Water submitted a report titled, *Revised Monitoring Well Installation and Sampling Plan for the Valley Water Management Company McKittrick Ponds Facility, Cymric Oil Field* (Revised 2018 Work Plan). The Revised 2018 Work Plan did not contain an implementation schedule with specific dates for any proposed activities, but rather stated that, "No site work will be scheduled until habitat and endangered species restrictions for well locations have been satisfactorily addressed." The Revised 2018 Work Plan did not include a proposed date for the initiation of site biological review and/or assessment, any documentation of efforts Valley Water had taken to date, and when site work was expected to commence.

On 13 September 2018, Board staff issued to Valley Water an Order pursuant to Water Code section 13267 (September 13267 Order). The September 13267 Order stated the number of proposed monitoring wells that would be added to the six existing wells would likely be inadequate to define the lateral and vertical extent of wastewater constituents in the groundwater. However, in the interest of moving forward expeditiously, September 13267 Order conditionally approved the Revised MWISP contingent upon Valley Water:

1. Installing proposed monitoring well CYM-17A1 in first encountered groundwater regardless of whether well CYM-17H1 is completed in unsaturated sediments. The July 13267 Order noted Valley Water could move CYM-17A1 north towards Delfern Road to minimize disturbance to habitat during installation and monitoring;

2. Installing a shallow well at the proposed site of CYM-25B1 if the geophysical logging of the well showed the presence of perched water in the upper Tulare sands;

3. Providing with each monitoring report a demonstration that specific low-flow pumping and sampling method parameters are stable, recorded, and reported each time;

4. Sampling and analyzing the selected Clean Harbors monitoring wells MW-148I, MW-149RI, MW-102RL, MW-170L, and MW-PRL as part of its obligations to comply with Order No. R5-2018-0808; and

5. Proceeding forthwith with the installation of all proposed wells that are at existing well sites and that do not need additional biological review for endangered species issues.

To address the vagueness of the schedule proposed in the MWISPs, the July 13267 Order required Valley Water Management Company to provide technical and monitoring reports as follows:

Item	Description	Due Date
1.	Updated Biological assessment report of proposed monitoring well locations.	3 October 2018
2.	Demonstration that monitoring well drilling has begun for clear monitoring well locations.	28 November 2018
3.	Monitoring well installation report for new wells.	90 days after monitoring well installation
4.	A demonstration that additional biological assessment has begun for proposed monitoring well sites that require it. A time schedule that includes obtaining required "take" permits where necessary.	28 November 2018
5.	Monthly biological review activities progress reports.	By the 10th day of each month
6.	Technical Report of monitoring well installation, completion, and sampling as required by MRP.	1 March 2019

On 3 October 2018, Valley Water submitted a report prepared by McCormick Biological, Inc., and titled *Biological Evaluation for Proposed Valley Water Management Cymric Well Locations, Kern County, California* (Updated Biological Assessment Report). The report stated that all Revised 2018 Work Plan proposed monitoring well locations required further Biological assessment and that installation of monitoring wells could not begin. It stated that a complete Biological Assessment for the Blunt Nose Leopard Lizard was necessary and that it would take approximately one year to complete (by 15 September 2019). McCormick Biological, Inc., recommended that "Valley Water Management should consider pursuing take authorization/permitting under the state and federal Endangered Species Acts with the CDFW and the USFWS for this project."

During a conference call on 10 December 2018, Board staff and Valley Water's representatives stated that two additional monitoring wells (CYM-17E1 and CYM-20A1) could potentially be installed without additional biological assessment. Board staff replied that Valley Water that the two proposed well locations were within the extent of the plume, and that Board staff would also like to see monitoring wells between the existing Valley Water and the Clean Harbors monitoring wells. Board staff directed Valley Water to continue to address biological and access issues and to install upgradient and additional downgradient monitoring wells. Board staff advised Valley Water to collect as much data as feasible from all additional monitoring wells and for selected Clean Harbors monitoring wells.

As of February 2019, no additional monitoring wells have been installed, nor have any of the selected Clean Harbors monitoring wells been added to Valley Water's monitoring network.

Groundwater Modeling

Valley Water contracted with Catalyst Environmental (Consultant) to use MODFLOW-SURFACT modeling software to model the subsurface migration of the produced wastewater plume from the Facility. Staff met with Valley Water and its Consultant on 9 October 2017 and

10 January 2018 to discuss the various data inputs in the model, the assumptions of the model, and the preliminary results. The modeling effort assumes that, beginning in the late 1950's, the plume migrated to the northeast and that by 2014 it reached the three sentinel wells approximately one mile down gradient from the Facility ponds. Another assumption is that infiltrated wastewater is restricted to migration in sands in the upper Tulare interval and that no wastewater is leaking through the underlying upper Tulare clay. Two key general assumptions for the model are that the sediments are homogeneous and isotropic.

Two scenarios were proposed for the modeling effort. Both scenarios assumed that Valley Water ceases discharge to the Facility ponds in 2050. The first scenario (Scenario 1) ramps up the discharge rate to 45,000 barrels per day from 1957 to 1992 and then employs a steady 45,000 barrel per day discharge rate to 2050. The second scenario (Scenario 2) ramps up the discharge rate to 75,000 barrels per day from 1957 to 2002 and then employs a steady 75,000 barrel per day discharge rate to 2050. The model was run for both scenarios to year 2117 to allow for plume expansion after the cessation in discharge.

Staff has not evaluated the model and any results because Valley Water has not presented the model and results in a technical report. However, preliminary results for the two scenarios were provided at the 10 January 2018 meeting with Staff. Valley Water indicated that by 2050 the plume would migrate nearly ¾ mile to the northeast of well CYM-17K1; and that by 2117 the plume would reach its maximum downgradient extent at approximately 1-mile northeast of well CYM-17K1, which is to the west of the northwestern corner of the Clean Harbors facility. Valley Water indicated for Scenario 2 that by 2050 the plume would migrate approximately 1.1 miles to the northeast of well CYM-17K1; and that by 2117 the plume would reach its maximum downgradient extent at approximately 1.5 miles northeast of well CYM-17K1, which is about ½ mile to the north of the northwestern corner of the Clean Harbors facility with the leading edge of the plume near to and south of the Belridge 7 irrigation supply well (See Attachment N).

The Consultant presented some model results at the 4/6 April 2018 Board hearing for Resolution R5-2018-0015. The Consultant stated that initial model results indicate that over the next 30 years the plume would migrate another ¾ mile downgradient (this appears to be Scenario 1 in 2050). Not mentioned by the Consultant is that the plume will continue to migrate further downgradient even after wastewater discharge ceases in 2050 (the second part of Scenario 1). Also, not mentioned were the results for Scenario 2 discussed above.

Board staff expressed its concerns with the modeling effort during its meetings with Valley Water and its Consultant. The primary concerns were that: 1. The model assumes the sediments are homogenous and isotropic whereas site sediments are heterogenous and anisotropic, 2. The model does not address potential preferential flow pathways, and 3. The model does not address fluid migration in the deeper Tulare.

Board staff concerns have not been adequately addressed, and the predictive ability of the model is questionable given that contemporary groundwater monitoring data indicates that the plume has already migrated past the terminal downgradient edge predicted by the Scenario 1 model result for the year 2117.

Groundwater Monitoring Conclusions

Several pieces of information, including but not limited to the following, support the conclusion

produced wastewater from the Valley Water McKittrick 1 & 1-3 ponds has migrated and continues to migrate down-structure through the sediments of the upper Tulare and has also impacted groundwater quality in the regional aquifer in the deeper Tulare:

1. Valley Water has discharged large volumes of poor-quality produced wastewater to the Facility Ponds since the late 1950s, estimated at 60,000,000,000 gallons.

2. Valley Water's Facility ponds sit upgradient and upstructure of agricultural land and the Clean Harbors facility, which is 2.2 miles northeast of the ponds.

3. Groundwater elevation data and contour maps provided by Valley Water indicate that the groundwater direction of flow and gradient is to the northeast towards the agricultural land and the Clean Harbors facility.

4. Valley Water's technical reports and self-monitoring reports have acknowledged that there is a plume of poor-quality produced wastewater migrating from the ponds to the east, and the plume has migrated beyond its sentinel wells and CYM-21DI, about 1.11 and 1.27 miles downgradient, respectively.

5. Groundwater levels continue to increase in in Valley Water's downgradient groundwater monitoring wells.

6. TDS, chloride, and boron concentrations continue to increase in Valley Water's CYM-21D1 and Valley Water's consultants have stated, in multiple reports, that this is due to mixing with produced wastewater.

7. TDS, chloride, and boron concentrations continue to increase in Clean Harbors' MW-148I.

8. TDS and chloride concentrations continue to increase in Clean Harbors' MW-102RL.

9. Isotope data analyses indicate that the groundwater in Valley Water's CYM-21D1 is continuing to mix with produced wastewater and move closer to the isotopic signature of water in Valley Water's ponds. The isotope results of the groundwater samples CYM-21D1 and from Clean Harbors' wells MW-102RL, MW-148I, and MW-149I show that produced wastewater is mixing with groundwater in the upper Tulare and deeper Tulare, at least as far down gradient as Clean Harbors.

10. Stiff diagrams show that Well CYM-21D1 has shown a steady increase in sodium and chloride, indicative of increasing impacts over time from produced wastewater. Significant impacts are also appearing in some of the Clean Harbors facility monitoring wells down gradient of the Valley Water groundwater monitoring well network. The primary source of produced wastewater is discharges from the Facility ponds.

11. Piper diagrams for several wells show mixing of produced wastewater with better quality water, or in the case of well CYM-21D1, increasing impacts over time from produced wastewater, which clearly shows a shift from a sulfate type water to a chloride type water with time.

This information indicates the waste constituents have migrated at least 2.2 miles (to well MW-148I) downgradient from the Facility in the upper Tulare and 1.9 miles (to well MW-102RL) down gradient in the deeper Tulare, which is part of the regional aquifer.

MONITORING AND REPORTING PROGRAMS (MRP) R5-2018-0808

Water Code section 13267 authorizes the Central Valley Water Board to require monitoring and technical reports as necessary to investigate the impact of a waste discharge on waters of the State.

Pursuant to Water Code section 13267, on 4 April 2018, and under authority delegated to the Executive Officer by the Board, the Executive Officer issued to Valley Water MRP Order R5-2018-0808 which requirements include: Facility inspections, maintenance requirements, effluent monitoring, and groundwater monitoring. The MRP requires Valley Water to report on the quantity and quality of produced wastewater before it is discharged to the ponds, the quality of produced wastewater while it resides in the ponds, and the quality of monitoring well water.

The MRP requires Valley Water to install additional monitoring wells to delineate the vertical and lateral extent of the produced wastewater plume to help to ensure the protection of designated beneficial uses of groundwater.

The MRP requires wastes (solids, liquid, and semi-solids) and groundwater to be analyzed for a wide range of constituents that are defined in MRP Table 1. Monitoring reports are required to include full laboratory reports.

Some of the more important MRP requirements are outlined below:

- The submittal of information regarding the use of all chemicals used during well drilling, installation, operation, and maintenance activities associated with each well generating waste materials (liquids and solids) that are discharged to the McKittrick 1 & 1-3 Facility ponds.

- The submittal of a Monitoring Well Installation and Sampling Plan (MWISP) within 60 days of MRP issuance. The MWISP would provide for the installation of an appropriate number of upgradient/up-structure dip groundwater monitoring wells to identify background water quality and an appropriate number of downgradient/down-structure and cross gradient/cross-structure dip wells to delineate the plume of produced wastewater emanating from the Facility ponds in both the shallow and deep groundwater zones.

- The submittal of a Monitoring Well Installation Completion Report (MWICR) within 90 days of installation of a groundwater monitoring well(s).

- The submittal of Quarterly monitoring reports whether or not there is a discharge.

The MRP issued on 4 April 2018 is very similar to those in Oil Field General Order One and Oil Field General Order Two. With respect to Water Code section 13267(b)(1) requirements, Valley Water owns and operates the Facility. Facility discharges have migrated and continue to migrate to the northeast and are adversely affecting groundwater in the regional aquifer, which is

designated for MUN, AGR, and IND, and is used nearby for AGR. The monitoring requirements contained in the MRP are necessary to fully characterize the discharge and the lateral and vertical extent of the groundwater plume emanating from the Facility and inform an effective strategy to protect water quality. The related costs are similar to those carried by other dischargers under Oil Field General Order One and Oil Field General Order Two and are reasonable considering the magnitude of known and potentially ongoing impacts to water quality.

As of February 2019, Valley Water has failed to install additional monitoring wells proposed and approved to date and as far back as October 2014 and January 2015 respectively. Valley Water has failed to delineate the vertical and lateral extent of the produced wastewater plume generated by discharges to the Facility through the installation and sampling of additional monitoring wells to help ensure the protection of designated beneficial uses of groundwater as required by MRP R5-2018-0808.

RESOLUTION R5-2018-0015

As described above, on 5 April 2018, the Board adopted Resolution R5-2018-0015 Central Valley Water Board staff to take appropriate action to determine whether Valley Water's discharge may be regulated under Oil Field General Order Two or Oil Field General Order Three, or whether Valley Water should be directed submit for the Board's consideration a report of waste discharge to be regulated under an updated set of individual waste discharge requirements.

The following evaluation is based on an extensive amount of historic hydrogeologic and monitoring information provided by Valley Water, Clean Harbors' groundwater monitoring data, information compiled by Board staff, and other information related to oil field operations. The evaluation also included the relatively small amount of new information collected and submitted by Valley Water since the April 2018 meeting of the Board

Regulation under Oil Field General Orders

Valley Water has suggested the Facility discharge could be covered under Oil Field General Order Three. Oil Field General Order Three does not require groundwater monitoring. This Order requires dischargers to either demonstrate that there is no groundwater beneath the discharge areas, that produced wastewater will not migrate into areas with groundwater with designated beneficial uses, or if there is groundwater underlying the discharge location, demonstrate that the current Basin Plan groundwater beneficial uses are eligible for de-designation.

The groundwater directly under the Facility appears to be primarily produced water from the Facility ponds and possibly other Valley Water facilities. This groundwater may be suitable for dedesignation. However, this water is migrating to the northeast into areas where groundwater not suitable for dedesignation, because it is of higher quality and is being beneficially used.

Oil Field General Order Three also includes Groundwater Limitations that proscribe discharges from causing groundwater to contain constituents in concentrations that adversely affect beneficial uses. Valley Water's monitoring reports indicate that its discharges are polluting groundwater in the first encountered groundwater (MW-148I) and the deeper regional aquifer

(CYM-21D1 and MW-102RL), both of which have active beneficial uses of AGR. Additionally, the produced wastewater has migrated to the northeast and beyond the Facility groundwater monitoring well network. To date, the extent of plume migration has not been fully characterized, but given the local hydrogeology, it is expected to remain uncontained and continue to migrate northeastward. Therefore, the discharge cannot comply with Oil Field General Order Three.

Like Oil Field General Order Three, Oil Field General Order Two proscribes discharges from causing groundwater to contain constituents in concentrations that adversely affect beneficial uses. Therefore, it would seem that regulating the facility under Oil Field General Order Two would likewise be inappropriate. In addition, Oil Field General Order Two requires that the discharges from the regulated facility comply with State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (*State Antidegradation Policy*). The *State Antidegradation Policy* requires, among other things, that the discharger employ best practicable treatment or control (BPTC) to minimize degradation; and that any degradation be consistent with the maximum benefit to the people of the State. Given the high salinity of the discharge, the large volume of the discharge, the location of the discharge upgradient and upstructure of groundwater that is beneficially used for AGR, the evidence demonstrating that the discharge is migrating downgradient and down structure to the northeast and adversely impacting groundwater beneficially used for AGR, it is may be unreasonable to conclude that the discharge should be considered BPTC and that the degradation inheres to the maximum benefit to the people of the state.

Individual Waste Discharge Requirements

Another option would be for Board staff to require Valley Water to submit a report of waste discharge supporting an updated set of individual waste discharge requirements (WDRs) pursuant to Water Code section 13263. Individual waste discharge requirements would require Facility discharges to comply with the requirements of the Basin Plan and the *State Antidegradation Policy*. As mentioned above, due to the high salinity and boron of the discharge and local hydrogeology, the existing discharge configuration may not be considered BPTC. Valley Water would need time to modify its treatment and/or control practices to ensure compliance with the Basin Plan. Some potential modifications could include improved treatment to remove salts and boron, the implementation of plume management to contain the plume, or changes in disposal practices, including discharge to underground injection control wells to put the discharge into deeper, unusable aquifers. Underground injection control is widely used in oil field disposal operations, and Valley Water has experience operating UIC wells.

The proposed Cease and Desist Order ultimately requires Valley Water to either submit a report of waste discharge (along with a supporting technical report) that would describe facility improvements needed to comply with all applicable regulatory requirements, or that discharges at the facility cease.

PROPOSED CEASE AND DESIST ORDER

The information above indicates that the Valley Water Facility discharges have violated and/or threatened to violate Resolution 69-1999 by causing a condition of pollution or threatening to cause a condition of pollution.

Water Code section 13301 states in part:

> *When a Regional Board finds that a discharge of waste is taking place or threatening to take place in violation of requirements or discharge prohibitions prescribed by the regional board or the state board, the board may issue an order to cease and desist and direct that those persons not complying with the requirements or discharge prohibitions (a) comply forthwith, (b) comply in accordance with a time schedule set by the board, or (c) in the event of a threatened violation, take appropriate remedial or preventive action. Cease and desist orders may be issued directly by a board, after notice and hearing, or in accordance with the procedure set forth in Section 13302.*

Water Code section 13267(b) of the states, in relevant part:

> *(a) A regional board, in establishing or reviewing any water quality control plan or waste discharge requirements, or in connection with any action relating to any plan or requirements or authorized by this division, may investigate the quality of any waters of the state within this region.*
>
> *(b)(1) In conducting an investigation specified in subdivision (a), the regional board may require that any person who has discharged, discharges, or is suspected of having discharged or discharging, or who proposes to discharge waste within its region … shall furnish, under penalty of perjury, technical or monitoring program reports which the regional board requires. The burden, including costs, of these reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports. In requiring those reports, the regional board shall provide the person with a written explanation with regard to the need for the reports, and shall identify the evidence that supports requiring that person to provide the reports.*

As instructed by Board adopted Resolution R5-2018-0015, Board staff has taken action to determine whether Valley Water's discharge may be regulated under Oil Field General Order Two, Oil Field General Order Three, or individual waste discharge requirements. These actions include rereview of Valley Water and Clean Harbors historic groundwater monitoring data and more recent data collected since April 2018. This review does not include any groundwater monitoring data from new groundwater monitoring wells, as Valley Water has not installed any new wells. Nonetheless, based on the review, staff have determined the following:

1. The Facility discharge does not meet the criteria to obtain coverage under Oil Field General Order Two or Oil Field General Order Three.

2. Valley Water would likely need to significantly modify its discharge to comply with waste discharge requirements implementing the Basin Plan, which would require regulation under an individual order.

If Valley Water could not demonstrate to the Board that it would be able to comply with applicable requirements to be sufficiently protective of groundwater beneficial uses, it lies within the Board's discretion to order that discharges from the Facility cease and desist. Board staff have therefore prepared for Board consideration a Cease and Desist Order pursuant to Water Code section 13301. The Cease and Desist Order requires Valley Water to:

1. Cease and desist from discharging produced wastewater in violation and threatened violation of WDR Resolution No. 69-199 and the *Water Quality Control Plan for the Tulare Lake Basin* according to a specific schedule.

2. Submit by **1 October 2019**, implement work plans already approved by Board staff and to:

    a. complete the ongoing hydrogeological investigation to fully characterize the nature and lateral and vertical extent of the release of the plume;

    b. identify each potential Constituent of Concern in the discharges to the Facility ponds and propose concentration limits in groundwater for each Constituent of Concern; and

    c. identify and sample water supply wells located within 2.5 miles of the Facility and analyze the samples for Constituents of Concern.

3. Submit by **1 January 2020**:

    a. a complete Report of Waste Discharge based on the information acquired during the *Work Plan for the McKittrick 1 & 1-3 Facility* that will ensure that future discharges at the McKittrick 1 & 1-3 Facility will be in compliance with the *Water Quality Control Plan for the Tulare Lake Basin;*

    b. a ***Closure Plan and Closure Time Schedule*** for the wind-down and closure of any portions of the McKittrick 1 & 1-3 Facility that Valley Water Management Company determines are no longer to be used;

    c. a ***McKittrick 1 & 1-3 Facility Remediation Work Plan*** based on the hydrogeological investigation that describes a time schedule under which Valley Water Management Company will conduct groundwater, surface water, and/or soil remediation consistent with the corrective action program requirements of Title 27. This will entail the preparation of an engineering feasibility study followed by a proposed corrective action program.

4. Cease discharge to the McKittrick 1 & 1-3 facility on **1 July 2020** unless those discharges are in full compliance with waste discharge requirements issued by the Central Valley Water Board.

Valley Water owns and operates the Facility. These discharges have degraded/polluted and/or threaten to degrade/pollute groundwater downgradient of the Facility. The reports and actions proposed by the Cease and Desist Order are necessary to define the lateral and vertical extent of the plume migrating from the Facility, to ensure the Discharger complies with the requirements of this Order; and to ensure that Valley Water brings the Facility into compliance with WDRs Resolution No. 69-199, MRP Order R5-2018-808, the Basin Plan and the Water Code to assure protection of waters of the state.

CONCLUSIONS AND RECOMMENDATIONS

Valley Water's McKittrick 1 & 1-3 Facility ponds are the source of a plume of highly saline produced wastewater that exceeds for several constituents water quality objectives necessary to support locally designated beneficial uses of MUN and AGR. AGR is an existing beneficial use in the area, and more importantly, immediately downgradient of the Facility. Staff believes the plume has migrated beyond Valley Water's groundwater monitoring well network and downgradient and down-structure at least 2.2 miles (to well MW-148I) in the upper Tulare and 1.9 miles (to well MW-102RL) in the deeper Tulare. The plume has caused the water in MW-148I to exceed MUN and AGR water quality objectives for TDS and chloride and water in MW-102RL to exceed MUN water quality objectives for chloride. These wells are screened in aquifers that supply local agricultural wells a short distance from the Facility. Staff believes there is a good chance that produced wastewater traveling through channels of course grained materials has migrated from the Valley Water Facility far beyond the Clean Harbors facility, but it has not been detected due to limitations associated with the existing groundwater monitoring network. Progress on the expansion of Valley Water's groundwater monitoring network has not proceeded according to anticipated timeframes, though endangered species issues are partially responsible for the delays.

Given the close proximity of the upstructure of groundwater with an existing AGR beneficial use, the depositional environment of underlying sediments, the high salinity and boron of the produced wastewater, and the unknown limits of the expanse of the plume migrating to the northeast, Board staff do not believe the Facility discharge meets the requirements to be regulated under any of the Oil Field General Orders for Oil Field Discharges to Land. However, discharges from the facility may be permitted under a set of individual waste discharge requirements, provided that Valley Water takes adequate measures to ensure the protection of groundwater beneficial uses. This would likely include the modification and upgrading of Valley Water's wastewater discharge infrastructure. The proposed Cease and Desist Order is necessary to ensure that Valley Water completes the characterization of the plume and modifies its discharge so that it complies with the Water Quality Control Plan for the Tulare Lake Basin and protects the beneficial uses of groundwater downgradient of the Facility.