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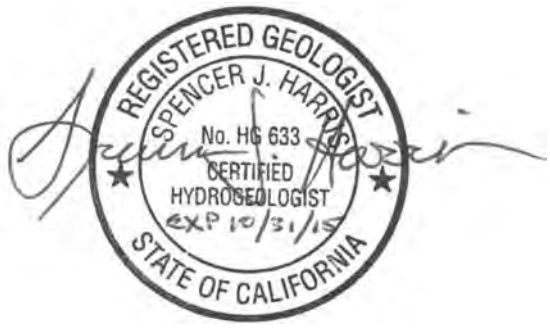
Technical Memorandum



Date: December 9, 2013

From: Spencer Harris, HG 633

To: Ray Dienzo, P.E., County of San Luis Obispo Public Works

SUBJECT: Antidegradation Analysis for Landscape Irrigation Permit, Los Osos Wastewater Project.

This memorandum presents an antidegradation analysis of proposed recycled water reuse for urban landscape irrigation in the Los Osos Valley groundwater basin. The purpose of the analysis is to demonstrate that salt/nutrient-loading from landscape irrigation using recycled water will use less than 10 percent of the available assimilative capacity of the groundwater basin.

BACKGROUND

The County of San Luis Obispo Public Works Department is applying to the State Water Resources Control Board for a permit to use recycled water from the proposed Los Osos Water Recycling Facility for urban landscape irrigation in the Los Osos Valley groundwater basin (Department of Water Resources groundwater basin number 3-8). State Water Resources Control Board Recycled Water Policy paragraph 9d(2) states:

> A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the Regional Water Board by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20 percent of the available assimilative capacity as estimated by the project proponent in a groundwater basin).

This antidegradation analysis has been prepared to demonstrate the above requirement for limited use of basin assimilative capacity. The analysis is specific to Urban Reuse Areas identified as Disposal Area 4 in Attachment B to the Los Osos Water Recycling Facility's Waste Discharge/Recycled Water Requirements (WDR) Order No. R3-2011-0001.

ANTIDEGRADATION ANALYSIS

The Central Coast Regional Water Quality Control Board (CCRWQCB) defines assimilative capacity as:

> The capacity of a natural body of water to receive (a) wastewaters, without deleterious effects, (b) toxic materials, without damage to aquatic life or humans who consume the water, (c) BOD, within prescribed dissolved oxygen limits.

Based on the above definition, the assimilative capacity of a groundwater basin to receive recycled water would be the difference between ambient concentrations of a selected water quality constituent in groundwater and the maximum concentration (or water quality objective, if specified) of the constituent that would preclude deleterious effects. Assimilative capacity for salt loading has been evaluated using Total Dissolved Solids (TDS) concentrations, and nutrient loading has been evaluated using dissolved nitrate as nitrogen (N) concentrations.

The CCRWQCB 2011 Basin Plan lists median groundwater objectives for the following sub-basin/sub-areas of the Estero Bay planning area: Santa Rosa, Chorro, San Luis Obispo, and Arroyo Grande. The existing Estero Bay groundwater objectives for TDS ranges from 700 milligrams per liter (mg/l) for Santa Rosa to 1,000 mg/l for Chorro, and existing groundwater objectives for N range from 5 mg/l for Santa Rosa, San Luis Obispo, and Chorro, to 10 mg/l for Arroyo Grande. The Los Osos Valley groundwater basin is in the Estero Bay planning area but is not hydraulically connected to the sub-basin/sub-areas with median groundwater objectives listed in the Basin Plan.

Ambient Water Quality

The Los Osos Valley groundwater basin has two main water supply aquifers which serve beneficial municipal and agricultural uses, the upper aquifer and the lower aquifer. Available recent TDS and N water quality data for the upper and lower aquifers have been compiled (Appendix A). The average TDS concentration in groundwater collected from 28 upper aquifer, perched and alluvial aquifer groundwater wells is 400 mg/l and the average N concentration is 13.9 mg/l. The average TDS concentration in groundwater collected from sixteen lower aquifer wells was 470 mg/l and the average N concentration was 1.4 mg/l.

The volume of water in the upper aquifer is estimated at 65,000 acre-feet. The volume of freshwater in the lower aquifer inland of the seawater intrusion front is estimated at 140,000 acre-feet (Los Osos Water Purveyors, 2013). Based on these volumes at the constituent concentrations listed above, the average TDS concentration in the groundwater basin is estimated at 450 mg/l and average N concentration is estimated at 5.4 mg/l (calculations in Appendix B).

Maximum assimilative capacity

Assimilative capacity has been calculated using the maximum groundwater objective for TDS (1,000 mg/l) and N (10 mg/l) in accordance with Maximum Contaminant Levels for drinking water in Title 22 of the California Code of Regulations. The maximum assimilative capacity of the Los Osos Valley groundwater basin is estimated at 550 mg/l TDS pickup and 4.6 mg/l N pickup, based on the difference between average basin ambient quality and maximum groundwater objectives. Pickup refers to the increase over ambient concentrations of a constituent due to salt/nutrient loading.

In order to use 10 percent of the maximum assimilative capacity, salt/nutrient loading activities would need to increase the TDS of basin groundwater by 55 mg/l, and the N concentration of basin groundwater by 0.46 mg/l. This would require permanently adding 15,330 tons of TDS to the existing salt load in the basin, and permanently adding 130 tons of dissolved N to the existing nutrient load in the basin (calculations in Appendix B).

Landscape irrigation activities

Recycled water reuse for landscape irrigation will be applied to 34 acres of turf at various sites in Los Osos. Calculations for salt and nutrient loading from the recycled water applications have been estimated by San luis Obispo County staff at 4,806 pounds of TDS per acre per year and 54.3 pounds of N per acre per year. The resulting salt/nutrient loads being applied by landscape irrigation are estimated at 82 tons of TDS per year and 0.9 tons of N per year (calculations in Appendix B). These annual salt/nutrient loads are over two orders of magnitude less than 10 percent of the maximum assimilative capacity of the groundwater basin.

Discussion

The final concentration of salt/nutrient in groundwater following an annual cycle of inflow and outflow to the groundwater basin may be summarized by the following mass balance equation:

$$\text{Final concentration} = \frac{(Vt*Ct) + (Vi*Ci) - (Vo*Co)}{(Vt+Vi-Vo)}$$

Where:
Vt = total starting basin groundwater volume
Ct = average concentration of total starting volume
Vi = basin inflow volume
Ci = average concentration of inflow volume
Vo = basin outflow volume
Co = average concentration of outflow volume

To increase the average concentrations of TDS or N in the basin, there must be more salt/nutrient mass entering the system than leaving the system. In the above equation, the following must be true for salt/nutrient loading to occur:

$(Vi*Ci) > (Vo*Co)$

When isolating salt/nutrient loading due to irrigation, the inflow volume (Vi) from irrigation return flow is significantly less then outflow volume (Vo) from pumping. Therefore, inflow concentration (Ci) must be proportionately greater than outflow concentration (Co) to effectively increase the basin salt load. Furthermore, when attributing salt/nutrient loading to irrigation with recycled water, defining the point of basin groundwater outflow concentration is critical, as explained below.

Salt/nutrient loading occurs during the domestic use cycle, not at the water recycling plant. Therefore, if the basin outflow concentration is measured at the pump (prior to distribution), then all the salt loading from the domestic use cycle will be attributable the recycled water reuse activities. If, however, the basin outflow concentration is measured at the treatment plant inflow point (raw effluent), then no salt loading is attributable to recycled water reuse, and nutrient loading is significantly reduced.

Another way of looking at the potential salt loading from recycled water reuse is to consider the pertinent basin inflow concentrations. The Los Osos community is currently on septic systems, which percolates septic-treated effluent to groundwater as return flow. Septic systems can reduce nutrient loading, but not salt loading. When the raw effluent is collected and redirected to the water recycling facility, the nutrient load will also be reduced, but not the salt load. The water recycling facility provides a more effective reduction in nutrient loading but will not significantly change the salt loading, compared to septic discharges.

Therefore, as a project, recycled water reuse for landscape irrigation in the Los Osos Valley groundwater basin will not use any of the existing assimilative capacity of the groundwater basin. The project, through agronomic applications of recycled water on turf, can increase the basin assimilative capacity for N by promoting the uptake of nutrients by turf that could otherwise have percolated to groundwater via septic systems. Recycled water reuse will also offset well pumping, and thereby help to mitigate salt loading related to sea water intrusion.

SUMMARY AND CONCLUSIONS

An antidegradation analysis is required by State Water Resources Control Board recycled water policy to demonstrate that recycled water use for landscape irrigation will use less than 10 percent of the available assimilative capacity of the Los Osos valley groundwater basin. In order to use 10 percent of the maximum assimilative capacity, salt/nutrient loading activities would need increase the existing salt/nutrient load in the basin by an estimated 15,330 tons of TDS and 130 tons of dissolved N.

The salt/nutrient loads that would be applied by using recycled water for landscape irrigation are estimated at 82 tons of TDS per year and 0.9 tons of N per year. These annual salt/nutrient loads are over two orders of magnitude less than 10 percent of the maximum assimilative capacity of the groundwater basin.

When accounting for the current fate of salt/nutrient loading from domestic water use in the groundwater basin, recycled water reuse for landscape irrigation will not use any of the existing assimilative capacity of the groundwater basin. The project, through agronomic applications of recycled water on turf, can actually increase the basin assimilative capacity for N by promoting the uptake of nutrients by turf that could otherwise have percolated to groundwater via septic systems. Recycled water reuse will also offset well pumping, and thereby help to mitigate salt loading related to sea water intrusion.

Landscape irrigation with recycled water will use less than 10 percent of the available assimilative capacity of the Los Osos Valley groundwater basin. The project meets the antidegradation analysis requirements of recycled water policy.

REFERENCES

Central Coast Regional Water Quality Control Board, 2011, Los Osos Water Recycling Facility Waste Discharge/Recycled Water Requirements (WDR) Order No. R3-2011-0001.

County of San Luis Obispo Public Works, 2013, Calculation of Agronomic Rates for Landscape Irrigation of Recycled Water at Urban Landscaped Areas by Los Osos Water Recycling Facility, November 26, 2013.

Los Osos Purveyors, 2013, Basin Plan for the Los Osos Groundwater Basin, Public Review Draft, August 1, 2013.

State Water Resources Control Board Recycled Water Policy, Resolution 2013-003, January 22, 2013. http://www.swrcb.ca.gov/water_issues/programs/water_recycling_policy/

APPENDIX A

Ambient Groundwater Quality

Table 1
Ambient Water Quality - Lower Aquifer
Los Osos Valley Groundwater Basin

Station ID	Source	Sample Date	TDS	N
			mg/l	mg/l
30S/10E-12J1	a	11/20/2009	732	0
30S/10E-13J4	a	1/14/2010	435	1.6
30S/10E-13L4	a	11/20/2009	979	2.3
30S/10E-13N	a	11/19/2009	267	6.1
30S/10E-24C1	a	11/20/2009	347	4.1
30S/11E-7Q3	a	11/19/2009	465	0.1
30S/11E-17E7	a	11/19/2009	427	1.4
30S/11E-17E8	a	11/20/2009	255	4.3
30S/11E-17N10	a	11/20/2009	357	0.5
30S/11E-18K8	a	11/20/2009	378	0
30S/11E-18K9	a	11/20/2009	307	1
30S/11E-18L2	a	11/19/2009	890	0.4
30S/11E-18L6	a	12/9/2009	528	0
30S/11E-19H2	b	1/14/2005	330	0
30S/11E-20Aa	b	2/1/2005	380	0.7
30S/11E-20La	b	1/12/2005	510	0
AVERAGE			**470**	**1.4**

TDS = Total Dissolved Solids
N = Nitrate as Nitrogen
mg/l = milligrams per liter
Not detected entered as zero N for averaging (detection limit 0.1 mg/l)
a = Cleath Harris Geologists, 2010, Water Quality Monitoring Results Summary, 2009-2010, Los Osos Valley Gerioundwater Basin, April 26, 2010.

b = Cleath & Associates, 2005, Sea Water Intrusion Assessment and Lower Aquifer Source Investigation of the Los Osos Valley Groundwater Basin, San Luis Obispo County, California, October 2005.

Table 2
Ambient Water Quality - Upper/Perched/Alluvial Aquifers
Los Osos Valley Groundwater Basin

Station ID	Source	Sample Date	TDS	N
			mg/l	mg/l
30S/10E-13G	c	6/12/2013	290	9.7
30S/10E-13H	c	6/19/2013	110	2.2
30S/10E-13L5	c	6/12/2013	540	16
30S/10E-13Q1	c	6/12/2013	650	25.7
30S/10E-24A	c	6/12/2013	310	15.9
30S/11E-7K3	c	6/17/2013	600	17.3
30S/11E-7L3	c	6/13/2013	430	18.7
30S/11E-7N1	c	6/19/2013	190	5.2
30S/11E-7Q1	c	6/19/2013	500	18.4
30S/11E-7R1	c	6/13/2013	480	16.3
30S/11E-8Ma	c	6/19/2013	190	2.8
30S/11E-8Mb	d	8/14/2012	790	32
30S/11E-8N2	c	6/14/2013	70	2.8
30S/11E-17D	c	6/18/2013	400	19.8
30S/11E-17E9	c	6/17/2013	370	15.5
30S/11E-17F4	c	6/18/2013	390	0.3
30S/11E-18A	c	6/18/2013	380	13.1
30S/11E-18B1	c	6/20/2013	460	11.7
30S/11E-18C1	c	6/13/2013	520	17.3
30S/11E-18E1	c	6/17/2013	290	9.9
30S/11E-18J6	c	6/19/2013	380	3.6
30S/11E-18L3	c	6/13/2013	200	5
30S/11E-18L4	c	6/13/2013	490	27.4
30S/11E-18N1	c	6/12/2013	440	27.9
30S/11E-18R1	c	6/18/2013	360	20
30S/11E-20A2	b	1/6/2005	360	0
30S/11E-20B7	b	1/6/2005	210	1.99
30S/11E-21D13	b	1/6/2005	880	31.6
AVERAGE			**400**	**13.9**

TDS = Total Dissolved Solids
N = Nitrate as Nitrogen
mg/l = milligrams per liter
Not detected entered as zero N for averaging (detection limit 0.1 mg/l)

b = Cleath & Associates, 2005, Sea Water Intrusion Assessment and Lower Aquifer Source Investigation of the Los Osos Valley Groundwater Basin, San Luis Obispo County, California, October 2005.

c = Cleath-Harris Geologists, 2013, Los Osos Water Recycling Facility, Baseline Groundwater Quality Monitoring, June 2013.

d = Cleath-Harris Geologists, 2012, Los Osos Water Recycling Facility, Baseline Groundwater Quality Monitoring, August 2012.

APPENDIX B

Salt/Nutrient Loading Calculations

WATER QUALITY CALCULATIONS - AMBIENT CONCENTRATIONS

Antidegradation Analysis - Landscape Irrigation Permit

conversion factors 1 mg/l = 2.719362 lbs/af

1 ton = 2,000 lbs

TOTAL DISSOLVED SOLIDS (TDS)

Upper Aquifer	400	mg/l	concentration
	1087.7	lbs/af	concentration
	65000	acre-feet	volume of water
	70700500	lbs	TDS mass
	35350	tons	TDS mass
Lower Aquifer	470	mg/l	concentration
	1278.1	lbs/af	concentration
	140000	acre-feet	volume of water
	178934000	lbs	TDS mass
	89467	tons	TDS mass
Basin	205000	acre-feet	volume of water
	124817	tons	TDS mass
	249634000	lbs	TDS mass
	1217.7	lbs/af	concentration
	450	**mg/l**	concentration

NITRATE AS NITROGEN (N)

Upper Aquifer	13.9	mg/l	concentration
	37.8	lbs/af	concentration
	65000	acre-feet	volume of water
	2457000	lbs	N mass
	1229	tons	N mass
Lower Aquifer	1.4	mg/l	concentration
	3.8	lbs/af	concentration
	140000	acre-feet	volume of water
	532000	lbs	N mass
	266	tons	N mass
Basin	205000	acre-feet	volume of water
	1495	tons	N mass
	2990000	lbs	N mass
	14.6	lbs/af	concentration
	5.4	**mg/l**	concentration

WATER QUALITY CALCULATIONS - ASSIMILATIVE CAPACITY

Antidegradation Analysis - Landscape Irrigation Permit

conversion factors 1 mg/l = 2.719362 lbs/af

1 ton = 2,000 lbs

TOTAL DISSOLVED SOLIDS (TDS)

Basin	450	mg/l	concentration
	1000	mg/l	maximum objective
	550	mg/l	maximum assimilative capacity
	1495.6	lbs/af	maximum assimilative capacity
	205000	acre-feet	volume of water
	306598000	lbs	TDS mass in assimilative capacity
	153299	tons	TDS mass in assimilative capacity
	15330	tons	10 percent of maximum available capacity

NITRATE AS NITROGEN (N)

Basin	5.4	mg/l	concentration
	10	mg/l	maximum objective
	4.6	mg/l	maximum assimilative capacity
	12.5	lbs/af	maximum assimilative capacity
	205000	acre-feet	volume of water
	2562500	lbs	N mass in assimilative capacity
	1281	tons	N mass in assimilative capacity
	128	tons	10 percent of maximum available capacity

RECYCLED WATER APPLICATIONS

4806	lbs/ac/yr	TDS
54.3	lbs/ac/yr	N
34	acres	Turf
163404	lbs/yr	TDS
82	tons/yr	TDS
1846.2	lbs/yr	N
0.9	tons/yr	N