FOTC Suggested Refinements to the 2018 GWMA Nitrogen Availability Assessment

The Washington State Department of Agriculture (WSDA) and Yakima County have written a Nitrogen Availability Assessment (NAA) that forms a starting point for further analyses of nitrate pollution of groundwater in the Lower Yakima Valley. The purpose was "to provide a scientific baseline estimate of the potential amount of nitrogen available for transport from different nitrogen sources within the GWMA boundaries."

WSDA/Yakima County Summary statements utilize two tables that describe the amounts of available nitrogen from multiple sources:

Table 1. Estimated nitrogen available for transport from all sources in tons/year and % of total

Source		Scenario A (low)		Scenario B (medium)		Scenario C (high)	
		Tons N/year	% of total N	Tons N/year	% of total N	Tons N/year	% of total N
Irrigated agriculture		298	47	2,595	63	7,452	73
CAFO	Pens	70	11	502	12	935	9
	Lagoons	142	22	781	19	1,421	14
RCIM	All septic (ROSS, LOSS, COSS)	47	7	83	2	135	1
	Residential fertilizer	10	2	26	1	41	0
	Small scale farms	4	1	11	0	18	0
Atmospheric deposition		67	11	89	2	268	3

Table 2. Estimated nitrogen available for transport per acre from all sources

Source		Area (acres)	Scenario A (low) (lb/acre-year)	Scenario B (medium) (lb/acre-year)	Scenario C (high) (lb/acre-year)
Irrigated agriculture		85,775	0-58	0-148	0-284
CAFO	Pens	2,096	67	480	892
	Lagoons	210	1,354	7,448	13,542
RCIM	ROSS	398	223	403	662
	LOSS	3	195	209	225
	COSS	30	163	173	183
	Residential fertilizer	4,381	4.7	11.7	18.6
	Small scale farms	2,096	4.3	10.7	17.1
Atmospheric deposition		87,082	1.53	2.05	6.15

The Friends of Toppenish Creek believe that certain refinements will improve the reliability and utility of this baseline estimate for the LYV GWMA.

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Add composting yards

Deduct acreage for synthetically lined lagoons, make mathematical corrections

Add Bio-solids

Add Waste Water Spray-fields

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Estimate nitrogen for the 10,000 plus acres with minor crops

Calculate atmospheric deposition for the entire 175,161 acres in the GWMA and make appropriate deductions from agricultural parcels.

Assume that at least half of residential fertilizer is taken up by plants

Rationale and Explanation:

1. The WSDA performed in-depth analyses for the 15 major crops in the GWMA target area. These 15 crops cover about 87% of the irrigated agriculture acreage in the area or 85,775

acres. (WSDA, 2018) Other minor crops cover about 13% of the irrigated acreage or approximately 10,000 acres. In order to estimate nitrogen availability for this subset, FOTC calculated nitrogen available per acre in low, medium and high scenarios for the major crops and multiplied these numbers by the acreage in minor crops.

2. Add composting yards: WSDA calculates 536 acres of manure composting in the GWMA target area. In 2015 WSDA commissioned local people to perform deep soil sampling in pens, corrals and compost yards from the area. Here are the results:

Table 7. Results of DSS in Pens & Corrals

Depth in pen (ft)	0	1	2	3	4	5	6
Minimum (mg/Kg NO_3-N)	22.6	21.8	10.6	8.3	6.1	6.5	3.8
Maximum (mg/Kg NO_3-N)	962.6	409.7	199.2	186.5	109.6	93.4	124.7
Average (mg/Kg NO_3-N)	273.3	165.9	98.5	71.2	45.7	36.7	36.4
Median (mg/Kg NO_3-N)	118.6	153.8	89.9	63.6	38	29.6	17.1
Standard Deviation (mg/Kg NO_3-N)	308.6	115.3	54.5	45.9	31.1	26.4	36.8

(From *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*)

Table 8. Results of DSS in Compost Yards

Site	Surface	1 Ft	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft	7 Ft
1C1	364.0	116.3	95.6	82.6	31.1	15.4	15.6	8.3
1C2	292.7	49.8	24.5	28.6	27.1	21.0	19.8	
5C1	159.0	118.8	133.8	225.0	153.9	116.7	28.0	8.5
2Cl	139.0	1.3	6.3	1.0	3.2	1.9	8.5	
2Cu	649.4	30.0	2.2	36.9	150.0	175.1	151.5	
4C1	48.3	164.5	226.1	216.9	222.5	132.1	59.1	
6C	123.2	73.5	34.7	24.7	17.7	9.1		
Ave.	253.7	79.2	74.7	88.0	86.5	67.3	47.1	8.4
Range	48.3-649.4	1.3-164.5	2.2-226.1	1-216.9	3.2-222.5	1.9-175.1	8.5-151.5	8.3-8.5

(From *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*)

Compare Average Readings for Pens & Corrals to Averages for Composting Yards

Site Average	Surface	1 Ft	2 Ft	3 Ft	4 Ft	5 Ft	6 Ft
Compost	253.7	79.2	74.7	88.0	86.5	67.3	47.1
Pens & Corrals	273.3	165.9	98.5	71.2	45.7	36.7	36.4

For general purposes FOTC believes that the estimates of 67 lbs/acre, 480 lbs/acre and 892 lbs/acre from pens and corrals are appropriate for compost yards. This is certainly closer to reality than estimating 0 lbs per acre.

3. Adjust lagoon surface area:

A. FOTC made an adjustment for a mathematical error in the WSDA calculations. WSDA had assumed that a lagoon with 1:3 side slopes, filled to 43% capacity would have a liquid depth of 4.9 ft. WSDA then calculated the liquid surface area for a square or rectangular lagoon with a depth of 4.9 ft. In fact a square lagoon filed to 43% capacity will have a liquid depth of 6 ft and the associated liquid surface area will be 6% greater than WSDA's calculation.

For this reason FOTC increased the total lagoon acreage by 6% to 222.6 acres

B. WSDA documents that 9% of the lagoons in the GWMA target area have synthetic liners. (WSDA, 2018, page 24). It is likely that the lagoons with liners are larger lagoons so the total lagoon area with synthetic liners is likely to be > 9%. Nevertheless, FOTC used the 9% estimate to reduce the total lagoon area to 202.6 acres.

There are many important variables for lagoons nitrogen measurements. FOTC has only examined two. We note that the lagoon acreage in the GWMA study is about .002 acres per cow, while the lagoon acreage in the California study is about .003 acres per cow.

4. Add Bio-solids: In 2012 the EPA performed a *Nitrogen Loading Screening Analysis* for Yakima County in an attempt to characterize the nitrogen balance. The data gathered by the EPA is valid and appropriate for addition to the GWMA's NAA. See the table below from page 14 of the EPA study:

Table 3: Amount of Biosolids Utilized in Yakima County

	2005	2006	2007	2008	2009
Total Lbs Nitrogen/year applied	58,305	105,669	419,174	175,300	173,667
# acres biosolids applied	346	831	2994	1982	1381
# fields biosolids applied	11	28	63	41	59

FOTC calculated an average of 1,500 acres per year that receive bio-solids in the area. We assumed agronomic application and applied the nitrogen available per acre in low, medium and high scenarios for other fertilizers to this subset of data. (See adjustments in item 1 above)

5. Add Waste Water Spray-fields: FOTC is aware of one waste water spray field in the LYV. There may be more. The Port of Sunnyside has a Waste Water Treatment Plant and a National Pollutant Discharge Elimination System (NPDES) permit, No. WA0052426, that permits the facility to spread up to 432 lbs of nitrogen per acre per year on 398 acres.

Again, we assumed agronomic applications, although 432 lbs of nitrogen per acre seems very high. We applied the nitrogen available per acre in low, medium and high scenarios for other fertilizers to this subset of data.

6. Atmospheric Deposition: Nitrogen from the ambient air falls equally on all areas of the LYV GWMA. By only categorizing nitrogen that falls on non-agricultural areas as Atmospheric Deposition, the WSDA leaves the impression that Atmospheric Deposition is not significant. FOTC has revised the estimates and calculated the input from this source using 175,161 acres, the total GWMA area, and estimates of 1.53, 2.05 and 6.15 lbs/acre. (FOTC believes these estimates are too low). Corresponding amounts of nitrogen per acre were subtracted from irrigated agriculture and from animal agriculture.

7. Residential Fertilizer: It is unreasonable to suggest that all of the nitrogen from fertilizers applied to lawns and gardens is available for leaching. Plant uptake for a flower garden is not much different from uptake for hops. For simplicity FOTC has estimated that about half of the nitrogen from residential fertilizer is available for leaching. We have reduced the Yakima County estimates by 50%.

Note: There are ponds in the southeastern section of the GWMA target are that receive waste water from the City of Grandview. FOTC believes that there is likely discharge to groundwater from these ponds but we lack the resources and time to estimate the contribution to GWMA nitrogen balance from this source.

Here are the revised Table 1 and Table 2, based on the adjustments described above:

Table 1 Revised - Lbs per Year

Source		Scenario A	(Low)	Scenario B	(Medium)	Scenario C	(High)
		#/year	% total N	#/year	% total N	#/year	% total N
Irrigated Agriculture	Calculated for 15 major crops	464,764	34%	5,014,161	55%	14,376,484	71%

Irrigated Agriculture	Estimated for minor crops	54,184	4%	584,571	6%	1,676,069	8%
CAFO	Pens	137,225	10%	1,001,783	11%	1,856,742	8%
	Lagoons	273,953	20%	1,508,281	17%	2,741.857	9%
	Compost	35,026	3%	255,703	3%	473,930	2%
RCIM	All Septic (ROSS, LOSS, COSS)	94,000	7%	166,000	2%	270,000	1%
	Residential Fertilizer	10,000	1%	26,000	0%	41,000	0%
	Small Scale Farms	8,000	1%	22,000	0%	36,000	0%
	Bio-solids	10,350	1%	90,750	1%	260,700	1%
	Waste Spray fields	2,746	0%	24,079	0%	69,172	0%
Atmospheric Deposition		267,996	20%	359,080	4%	1,077,240	5%
Totals -#		1,358,244		9,052,408		20,140,079	

Table 1 Revised – Tons per Year

Source		Scenario A	(Low)	Scenario B	(Medium)	Scenario C	(High)
		Ton/year	% total N	Ton/year	% total N	Ton/year	% total N
Irrigated Agriculture	Calculated for 15 major crops	232.4	34%	2,507.1	55%	7,188.3	71%
Irrigated Agriculture	Estimated for minor crops	27.1	4%	292.3	6%	838	8%
CAFO	Pens	68.6	10%	500.9	11%	928.4	8%
	Lagoons	137	20%	754.1	17%	1,370.9	9%
	Compost	17.5	3%	127.9	3%	237	2%
RCIM	All Septic (ROSS, LOSS, COSS)	47	7%	83	2%	135	1%
	Residential Fertilizer	5	1%	13	0%	20.5	0%
	Small Scale Farms	4	1%	11	0%	18	0%
	Bio-solids	5.2	1%	45.4	1%	130.4	1%
	Waste Spray fields	1.4	0%	12	0%	34.6	0%
Atmospheric Deposition		134	20%	179.5	4%	538.6	5%
Totals -Tons		679.1		4,526.2		10,070.0	

Table 2 Revised

Source		Area (acres)	Scenario A (low) (lbs/acre-year)	Scenario B (medium) (lb/acre-year)	Scenario C (high) (lbs/acre-year)
Irrigated agriculture	Calculated Major Crops	85,775	0-58	0-148	0-284
	Estimated Minor Crops	10,000	6.9	60.5	173.8
CAFO	Pens	2,096	67	480	892
	Lagoons	203	1,354	7,448	13,542
	Compost	535	67	480	892
RCIM	ROSS	398	223	403	662
	LOSS	3	195	209	225
	COSS	30	163	173	183
	Residential Fertilizer	4,281	2.35	5.85	9.3
	Small Scale Farms	2,096	4.3	10.7	17.1
	Bio-solids	1,500*	6.9	60.5	173.8
	Waste Spray Fields	398	6.9	60.5	173.8
Atmospheric Deposition		175,161	1.53	2.05	6.15

In the Medium Scenario the FOTC calculations give the following contributions to nitrogen availability by source:

Irrigated Agriculture: 61% (**55**% + 6%)

Lagoons: 17%

Pens: 11%

Atmospheric Deposition: 4%

Compost 3%

Septics: 2%

Bio-solids: 1%

This is somewhat different from the Contributions described in *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*

Irrigated Agriculture: 64%

Lagoons: 19%

Pens: 12%

Septics: 2%

Atmospheric Deposition: 2%

Residential Fertilizer: 1%