Melrose DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

Updated: 9-25-2024

Introduction

This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Melrose Drinking Water Supply Management Area (DWSMA), public well nitrate-nitrogen levels, and nitrogen management information. Also included is a summary of the MDA's analysis of nitrogen loss below cropland within this DWSMA. This summary provides the detail the MDA considered to determine whether the proposed list of nitrogen fertilizer best management practices (BMPs) and Alternative Management Tools (AMTs) will be protective of groundwater.

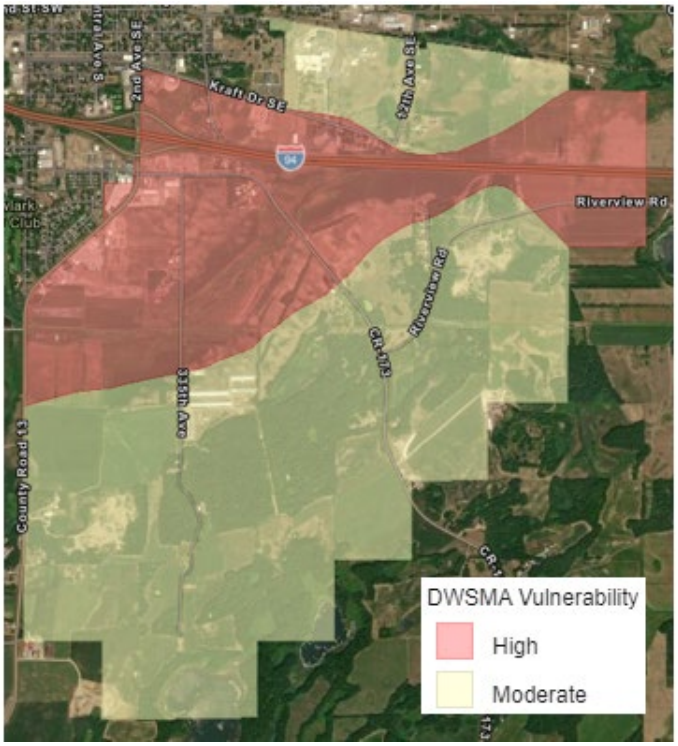

Figure 1. Melrose DWSMA Vulnerability Designated by the MDH.

DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary defined by the Minnesota Department of Health (MDH) for the City of Melrose public wells includes 1,877 acres. The MDH defines the groundwater below this DWSMA as high to moderate vulnerability (Figure 1). Of the 1,877 acres in the DWSMA, 1,006 acres meet the definition of cropland in the Groundwater Protection Rule (GPR). The GPR applies to the 1,006 acres of cropland within this DWSMA.

The MDA relies on the water quality data provided by the MDH to evaluate nitrate-nitrogen levels in the public water supply. Nitrate-nitrogen levels have exceeded 8 mg/L in one of the Melrose public wells within the past ten years (Figure 2). There are four additional public wells in Melrose where nitrate levels have not exceeded 5.4 mg/L within the past ten years. See Table 1 for specific well information.

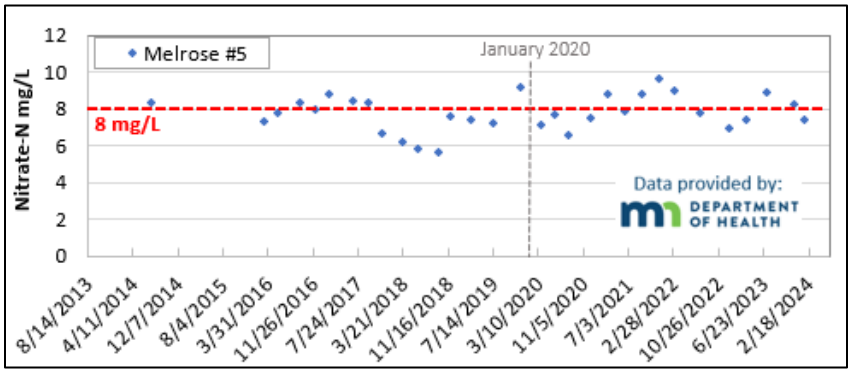

Figure 2. Melrose public well nitrate data through January 2024. See Table 8 for more information.

Table 1. City of Melrose public well information.

Local Well ID	MDH Status	Casing Diameter (in)	Casing Depth (ft)	Well Depth (ft)	Date Constructed
Well #4	Primary	16	98	128	1967
Well #5	Primary	16	62	87	1981
Well #7	Primary	16	83	105	1991
Well #8	Primary	16	75	100	1998
Well #9	Primary	16	67	85	1998

DWSMA Land Use and Potential Nitrate-Nitrogen Point Source Consideration

The MDA conducted a detailed review of potential contaminant sources to determine whether a point source of nitrogen could be the cause of the public well exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Melrose DWSMA, the MDA review did not identify a point source for nitrate-nitrogen. With nitrate levels exceeding 8.0 mg/L within the past ten years and without a point source contribution, this DWSMA was designated at Mitigation Level 2 under Part 2 of the Groundwater Protection Rule in January 2020 (Minnesota Statute 1573.0040, Subp. 7, C, 2).

Part 2 of the Groundwater Protection Rule responds to DWSMAs which have elevated nitrate. The goal is to take action to reduce nitrate in groundwater before a public well exceeds the health standard for nitrate, 10 mg/L. For DWSMAs, like Melrose designated at Level 2, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on agricultural practices that can reduce nitrate levels in groundwater.

The Groundwater Protection Rule defines cropland as land used primarily for the production or harvest of annual or perennial field, forage, food, fiber, or energy crops including pasture but excludes forestland. The evaluation of BMP adoption to determine if a mitigation level change is needed excludes soybean acres (Minnesota Statute 1573.0040, Subp. 7, A).

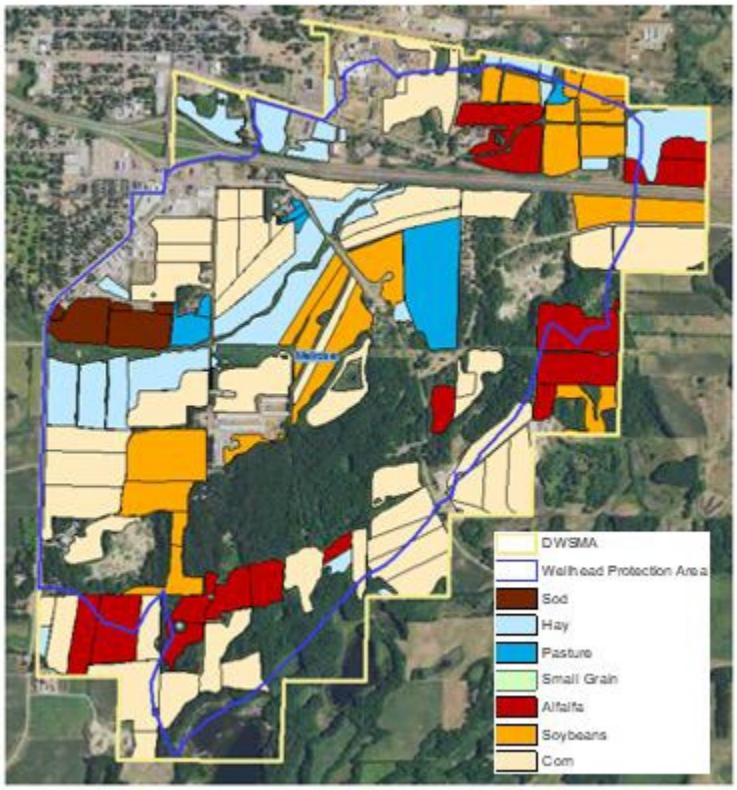

Figure 3. 2021 Cropland within the Melrose DWSMA based on the USDA Cropland Data Layer

A review of the publicly available USDA Cropland Data Layer (hosted on Crop Scape, nass.usda.gov/Research_and_Science/Cropland/Release/index.php) in the Melrose DWSMA shows that the land use here is predominately cropland. Data illustrated in Figure 3 is from the Feb 2022 data release.

In addition to review of cropping history, the MDA also surveyed agronomists and farmers to understand the nitrogen fertilizer management practices used in the Melrose area. The MDA was able to obtain farming information for most of the cropland acres across the DWSMA. Having current and accurate nitrogen fertilizer management data is critical to the discussion of protective agricultural management practices (i.e. BMPs and AMTs) appropriate for this DWSMA. With computer modeling tools, the MDA compares nitrogen leaching loss below current nitrogen fertilizer management and under management changes proposed to protect groundwater. The farming practice information collected includes crop planting, harvest, tillage, and nitrogen fertilizer use data.

Farmers within this DWSMA use both commercial nitrogen and manure to fertilize corn. Table 2 is an estimate of total nitrogen applied annually including both commercial nitrogen and manure. Due to the small number of operators farming within this DWSMA, more detailed farming practice information cannot be included in this document. The state statute on Agricultural Data (Minnesota Statute 13.643 Subd. 7) protects the identities and location of producers who are cooperating with the MDA in an assessment of farm practices. If farm practice information could identify an individual, it is considered private information and cannot be shared by the MDA.

Table 2. Melrose DWSMA Cropland Nitrogen Rates

Crop Rotation (2012-2021)	Acres	Total Nitrogen Applied (lbs. N/acre)
Corn-Corn	228	100 - 137
Corn-Soybean	192	100 - 128
Corn-Alfalfa	318	0 to 135
Grass Hay	191	0
Pasture	48	0
Sod	29	unknown

The MDA was not able to collect detailed nitrogen management information on all cropland acres that receive manure within this DWSMA. On these acres estimates were made based on discussion with local farmers, agronomists, and resource conservation professionals. Based on the detailed commercial nitrogen fertilizer use information the MDA was able to collect within this DWSMA; nitrogen rates are within University of Minnesota guidelines, all nitrogen sources are accounted for, and nitrogen credits from previous legume crops and manure are taken. Except for split nitrogen applications, the BMPs recommended by the University of MN for the cropping rotation and soil types present within this DWSMA are currently being used.

Within the Melrose DWSMA the crops grown in 2021 included alfalfa, grass hay, pasture, sod, corn, and soybeans. Small grains have also been grown in the DWSMA in nine of the last ten years. In 2021, there were 380 acres of perennial crops (alfalfa, pasture, grass hay, and sod) accounting for 38% of the cropland area. The remaining 62% of cropland acres in 2021 included 453 acres of corn and 174 acres of soybeans (Table 3).

Table 3. 2021 Melrose DWSMA Cropland Cover

Crop Type	Acres	% of Cropland (1,006 acres total)
Alfalfa	144	14%
Pasture	48	5%
Grass Hay	158	16%
Sod	29	3%
Corn	453	45%
Soybean	174	17%

The MDA has also reviewed the USDA Cropland Data Layer[1] over the past ten years in Melrose's DWSMA. During this time, the perennial cover on cropland, excluding soybeans, has ranged between 40-52% of the cropland area (Table 4).

Table 4. Melrose DWSMA cropland crop history excluding soybeans.

Year	Perennial Cover (Alfalfa, Pasture, Grass Hay & Sod) Acres	Perennial Cover (Alfalfa, Pasture, Grass Hay & Sod) % of Cropland	Corn Acres	Corn % of Cropland	Small Grains Acres	Small Grains % of Cropland
2012	506	52%	428	44%	31	3%
2013	464	47%	479	49%	35	4%
2014	439	48%	414	45%	59	6%
2015	422	45%	483	52%	26	3%
2016	406	43%	467	50%	62	7%
2017	378	42%	481	53%	49	5%
2018	390	44%	465	53%	21	2%
2019	387	47%	426	51%	18	2%
2020	362	40%	469	52%	76	8%
2021	380	46%	453	54%	-	-

The crop rotations shifting between corn-soybeans and alfalfa-corn are the reason that perennial cover varies from 40-52% within the Melrose DWSMA. When soybeans are planted and excluded from the calculation, the denominator is reduced and the percentage of perennial cover during those years is accordingly higher. Alfalfa acres have also declined in the DWSMA while annual crop acres have increased (Figure 4).

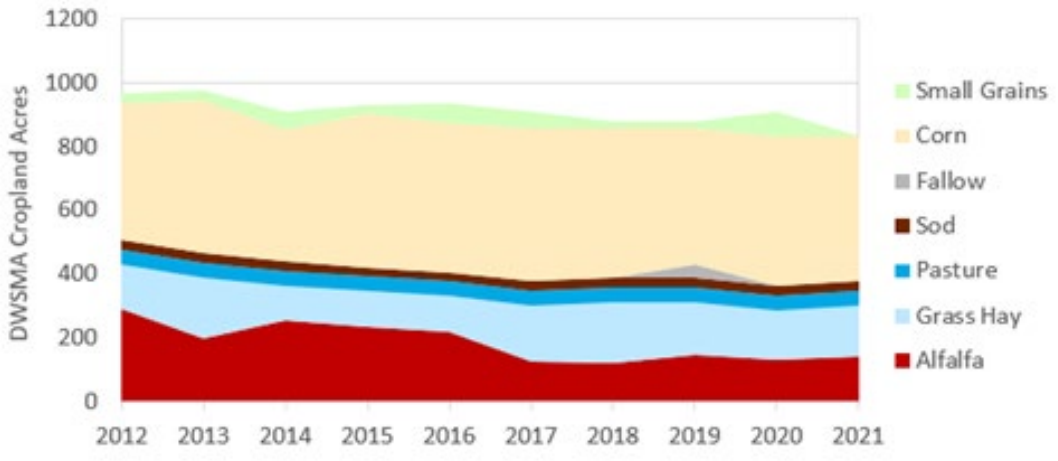

Figure 4. Melrose DWSMA Cropland Cover 2021. Perennial cover in the Melrose DWSMA has averaged 46% of the cropland acres (excluding the acres in soybeans). See Table 9 for more information.

DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a crop and soil computer simulation model called the Environmental Policy Integrated Climate model (EPIC) (https://epicapex.tamu.edu/epic/) the MDA has estimated the nitrogen loss below the root zone in the Melrose DWSMA comparing the nitrogen management practices used in the recent past with the nitrogen loss below alternative nitrogen management practices. The table below shows the modeled nitrogen loss below current nitrogen management practices. The model estimates an area weighted average of 14.1 lbs. N/acre are lost below the rootzone of all cropland within the DWSMA (Table 5).

Table 5. Melrose DWSMA nitrate-nitrogen loss estimates below cropland. Modeled nitrogen loss below cropland following current nitrogen management practices.

Crop Rotation	2021 Acres Within the DWSMA	Fraction of DWSMA Cropland	Area Weighted Average Nitrogen Leaching (lbs. N/ac)
Corn-Corn (C-C)	229	0.23	**24.4**
Corn-Soybean (C-SB)	193	0.19	**14.5**
Alfalfa for 3 years followed by 3 years of corn (AAA-CCC)	318	0.32	**11.8**
Grass Hay	191	0.19	**5.8**
Pasture	47	0.05	**11.4**
Total for all crops listed above	978	0.98	**14.1**

The model estimates that by adding split applications of nitrogen to acres where this nitrogen fertilizer BMP is not already adopted a 0.2% reduction in nitrogen loss on an annual basis is possible. The use of a urea/ESN blend or urea with a nitrification inhibitor at preplant results in a 0.3% and a 0.6% annual reduction in nitrogen loss (Table 6). The modeling in this DWSMA indicates that these three BMPs are equivalent from a groundwater protection standpoint. As such, any one of these practices could be used interchangeably to protect groundwater in this DWSMA.

Table 6. Melrose DWSMA modeled nitrate-nitrogen loss below nitrogen best management practices (BMPs). The nitrogen loss reductions are based on the adoption of the listed BMP where split application is not already adopted. ESN and use of a nitrification inhibitor at preplant are alternatives to the split application of nitrogen.

Nitrogen Best Management Practices	Additional Acres within DWSMA	Nitrogen Loss Reduction	Notes
Split apply nitrogen on all C-C and C-SB acres	219	0.2%	219 additional C-C and C-SB acres splitting nitrogen. Currently there are 68 acres of C-SB that split nitrogen applications.
Urea/ESN (60/40 blend) applied at preplant on C-C and C-SB acres	152	0.3%	152 additional C-C and C-SB acres using preplant Urea/ESN blend. Currently there are 134 acres of C-C and C-SB that apply urea/ESN at preplant.
Nitrification inhibitor on urea applied preplant on C-C and C-SB acres	152	0.6%	152 additional C-C and C-SB acres that are not already using ESN at preplant.

To consider additional opportunities the MDA modeled additional practices and Alternative Management Tools (AMTs) that go above and beyond BMPs to further reduce nitrogen loss below the root zone (Table 7a and 7b). If AMTs were adopted the model estimates that nitrogen leaching below the rootzone within this DWSMA could be reduced by the percentages shown in the table. These are voluntary practices. Working with local farmers, this list will be promoted widely, and funding will be identified to support adoption of these practices.

Table 7a. Melrose DWSMA modeled nitrogen loss below additional practices considered by the Melrose LAT.

Management Change	Additional Acres within DWSMA	Nitrogen Loss Reduction	Notes
AAA-CC in place of AAA-CCC	258	10%	Converting 258 acres currently in a AAA-CCC rotation to a AAA-CC rotation. Growing 2 years of corn instead of 3. Currently there are 318 acres in a AAA-CCC rotation. If all 318 acres were converted the modeled reduction is 12%.
C-SB in place of C-C (rotations receiving only commercial fertilizer)	94	3%	94 additional acres in a C-SB rotation. This replaces all the existing C-C acres that receive only commercial fertilizer.
C-SB in place of C-C (rotations receiving manure)	134	10%	134 additional acres in a C-SB rotation. This replaces all the existing C-C acres that receive manure.
Incorporate manure within 12 hrs instead of within 12-96 hrs of application (C-C acres)	135	7.5%	Incorporating manure within 12hrs increases plant available nitrogen (PAN). This reduces the total amount of manure needed to apply the same rate of PAN. This would be a change on all 135 acres of C-C that receive manure.

Table 7b. Melrose DWSMA modeled nitrogen loss below AMTs considered by the Melrose LAT.

Management Change	Additional Acres within DWSMA	Nitrogen Loss Reduction	Notes
AAA-CCC in place of C-C	109	10%	109 additional acres in an alfalfa-corn rotation (A-A-A-C-C-C) in place of existing corn-corn acres.
Perennial grass in place of C-C	62	10%	62 acres of new perennial grass (i.e. CRP) planted in place of existing corn acres.
Grass hay in place of C-SB	97	10%	97 additional acres of grass hay in place of existing C-SB acres. Currently there are 125 acres of dryland C-SB acres in the DWSMA.
Cover crop after SB on all fields in C-SB rotation	193	5%	This is an average of 96 additional acres of cover crop planted annually. Currently there are no cover crops grown within the DWSMA.

MDA Recommended Nitrogen Fertilizer Best Management Practices for the Melrose DWSMA

In consultation with the local advisory team that includes farmers and agronomists managing cropland within the DWSMA, the MDA has developed the following list of BMPs to protect groundwater. A more detailed list of these BMPs is available on the MDA's Melrose DWSMA webpage (www.mda.state.mn.us/melrose-dwsma).

- Maintain the existing perennial cover on cropland.
- Apply nitrogen to dryland corn in a corn-corn rotation at or below the 0.15 Maximum Return to Nitrogen (MRTN) in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to dryland corn in a corn-soybean rotation at or below the 0.15 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to irrigated corn in a corn-soybean rotation at or below the 0.2 MRTN in the University of Minnesota's nitrogen fertilizer application guidelines.
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- Split applications of nitrogen fertilizer on fine textured soils.
- Split application of nitrogen fertilizer or the use of urea/ESN blend or urea with a nitrification inhibitor at preplant on coarse textured soils.
- On coarse textured soils use nitrogen stabilizer on labeled crops when applying at early sidedress.
- For all other crops grown within the DWSMA, nitrogen rates must follow the current University of Minnesota guidance applicable to that crop.

The MDA will conduct an evaluation in this Level 2 DWSMA to determine whether these nitrogen fertilizer BMPs have been implemented on 80% of the cropland, excluding soybeans. The evaluation will occur no sooner than three growing seasons after the BMP list is published.

Conclusion

In the Melrose DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, modeled nitrogen loading estimates below existing nitrogen fertilizer management practice and alternative practices.

The cropland in perennial cover including grass hay, alfalfa, and pasture accounts for a substantial amount of cropland within this DWSMA. Over the past ten years, the percentage of cropland in perennial cover ranged from 40-52% when soybeans are not counted in the calculation.

Based on our fertilizer dealer survey the current University of Minnesota nitrogen fertilizer BMPs are being followed on most cropland acres within the DWSMA where commercial fertilizer is the only source of nitrogen. On these acres the nitrogen rates applied are below the 0.2 MRTN for irrigated corn following soybeans and below the 0.15 MRTN

for both dryland corn following corn and dryland corn following soybeans. The fertilizer dealership survey indicated that all nitrogen sources are considered, and legume credits counted. Split application of nitrogen is the only University of Minnesota BMP not yet widely adopted across these acres. On cropland acres where manure is applied to corn, reductions in total nitrogen rate may be needed to meet the rates published in the BMP list.

Modeling of nitrogen loss below Alternative Management Tools within this DWSMA illustrate options that can further reduce nitrogen loss below the crop root zone. These options were developed in consultation with the LAT. Specific cropland acres have not been identified for the establishment of these Alternative Management Tools, but the LAT acknowledges the additional groundwater protection that this could provide if adopted. The next steps within this DWSMA are to review these practices with individual landowners and explore possible funding opportunities to establish these practices.

If the percentage of perennial cover within the DWSMA were to be reduced from its current level, additional review of the nitrogen fertilizer BMPs for this DWSMA may be needed and a new list of nitrogen fertilizer BMPs approved. Other examples that could cause such a change include, but are not limited to, changes in the cropping rotation, changes to the MDH groundwater vulnerability designations, and changes to the MDH approved DWSMA boundary.

Based on the understanding and information provided above, the MDA believes that the recommended nitrogen management practices within the Melrose DWSMA are appropriate and that the continued use of these practices over the long-term will prevent nitrate-nitrogen loss below cropland from increasing. Additionally, modeling of nitrogen loss below cropland indicates that further reductions are possible with the establishment of Alternative Management Tools. Promotion and funding to support the establishment of Alternative Management Tools within the Melrose DWSMA will be a priority.

Data Tables for Figure 2 and Figure 4

Table 8. Nitrate-nitrogen levels within Melrose public well #5. This is the only well in the Melrose public well system that has exceeded 8 milligrams per liter within the past ten years.

Collection Date	Well #5 Nitrogen Test Level in mg/L
7/21/2014	8.3
3/8/2016	7.3
5/23/2016	7.8
9/13/2016	8.3
12/8/2016	8
2/21/2017	8.8
6/26/2017	8.4
9/13/2017	8.3
11/27/2017	6.7
3/20/2018	6.2
6/5/2018	5.8
9/20/2018	5.6
11/28/2018	7.6
3/18/2019	7.4
7/10/2019	7.2
12/3/2019	9.2
3/20/2020	7.1
6/4/2020	7.7
8/20/2020	6.6
12/16/2020	7.5
3/10/2021	8.8
6/15/2021	7.9
9/13/2021	8.8
12/14/2021	9.6
3/7/2022	9
7/20/2022	7.8
12/19/2022	6.9
3/22/2023	7.4
7/12/2023	8.9
11/30/2023	8.2
1/24/2024	7.4

Table 9. Crop history within the Melrose DWSMA including the total annual acreage of each crop type grown from 2012 to 2021. Soybean acres are not included. The percent of acres in perennial cover average 46% of the cropland acres in this table. Perennial acres include sod, alfalfa, grass hay, and pasture.

Year	Corn Acres	Small Grain Acres	Fallow Acres	Alfalfa Acres	Grass Hay Acres	Pasture Acres	Sod Acres	Total Acres	Percent of Acres in Perennial Cover
2012	428.2	30.7	0	293.5	134.7	48.4	29.3	964.8	52.4%
2013	478.7	35	0	199.1	187.6	48.4	29.3	978.1	47.5%
2014	413.5	58.6	0	254.7	108.3	46.7	29.3	911.1	48.18%
2015	482.9	25.6	0	235.5	110.3	46.7	29.3	930.3	45.3%
2016	467.3	62	0	222	109.2	45.5	29.3	935.3	43.4%
2017	481.4	49.2	0	128.6	173.3	46.7	29.3	908.5	41.6%
2018	465.3	21	0	122.4	191.4	46.7	29.3	876.1	44.5%
2019	425.7	18.3	44.4	149.8	161.5	46.7	29.3	875.7	44.2%
2020	468.6	76.4	0	132.6	153.1	46.7	29.3	906.7	39.9%
2021	453.1		0	144.2	157.8	48.2	29.3	832.6	45.6%