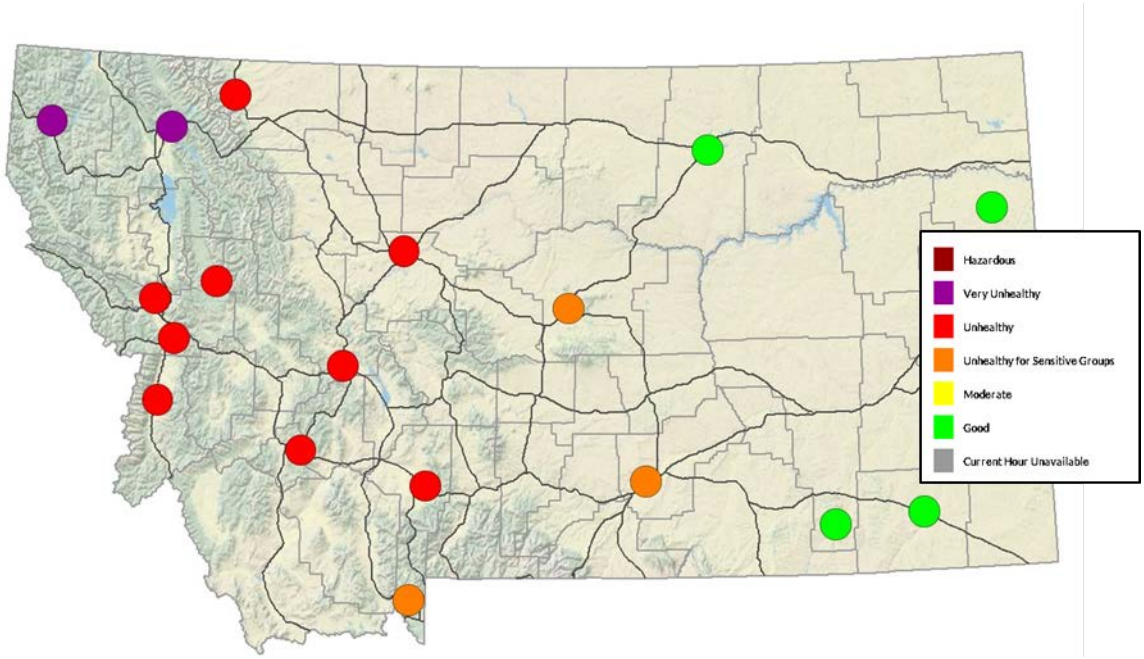
About Today's Air



DEQ
Montana Department
of Environmental Quality

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Introduction

The Today's Air website provides near-real time fine particulate related air quality information to the public on an hourly basis. The website, first launched in 2006, has evolved over time to continually provide more up-to-date information in more user-friendly formats. Currently, the Today's Air website updates at 15 minutes past the hour and provides fine particulate, or particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), concentrations from permanent and temporary monitoring stations running 24 hours a day and 365 days a year.

Representations of health assessment risks within Today's Air are provided as a general advisory, and are not substitutes for individual health awareness and the advice of medical professionals. For more information about $PM_{2.5}$ and the health impacts associated with exposure, click here.

In 2016, Montana DEQ's Air Quality Bureau (DEQ) made further improvements to the Today's Air site to better represent actual air quality conditions and improve comprehension by users. This document provides information on:

- Summary of the 2016 changes to Today's Air
- The NowCast Methodology
- Information on data handling for negative concentrations and significant figures used
- How to compare data to National Ambient Air Quality Standards (NAAQS)
- What Exceptional Events are and how are they are handled
- Wildfire Smoke and Winter Inversion Air Quality Updates
- Specific web page contents
- Reason for changes to Today's Air

This document is meant to be a living document that will develop over time based on feedback from the public. If you have any questions, concerns or recommendations, please use the Contact Form here, and select the "Today's Air" radio button.

2016 Changes to Today's Air

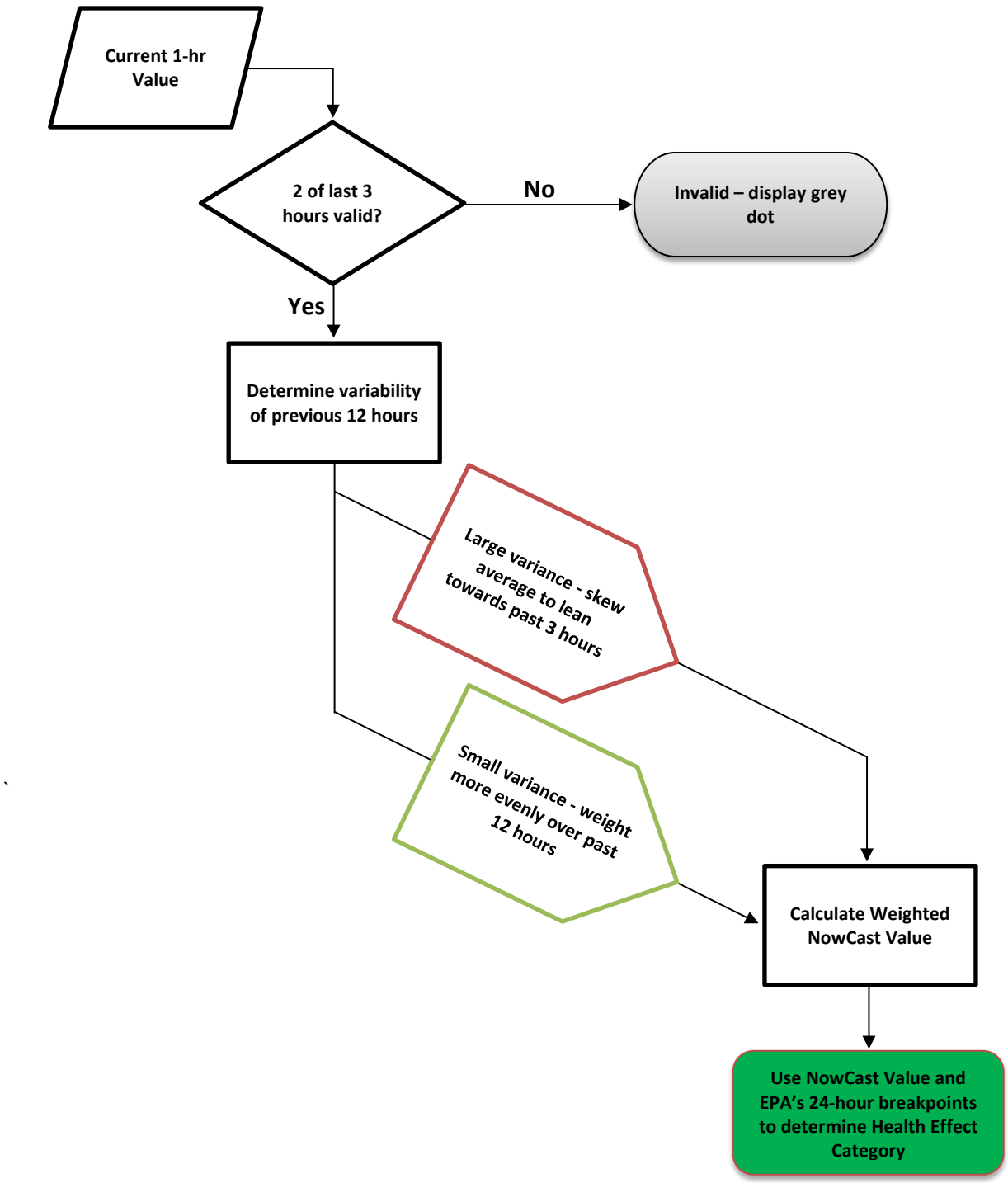
Due to concerns over how air quality conditions are represented on the Today's Air website, DEQ selected an alternate approach for assessing air quality and providing the resulting health effects messaging to the public. The goal is always to deliver representative and responsive information to the public so that Today's Air users can make the most informed decisions possible when planning their activities.

The Environmental Protection Agency's (EPA) NowCast was selected as the best method for presenting air quality related messaging to the public. This methodology better represents actual and cumulative exposure conditions as well as changing conditions more accurately. NowCast was also designed to match the health category for the midnight-to-midnight 24-hour average as well as breakpoints designed around the current NAAQS (National Ambient Air Quality Standard). With this transition the 1-hour and 8-hour breakpoints, associated with the previous Today's Air, were eliminated as the NowCast only requires 24-hour breakpoint comparison

NowCast Methodology

The EPA's NowCast method looks at the last 12 hours and calculates a weighted average of those hours: when air quality conditions are stable weight to each concentration is more evenly distributed, and as more variation is detected in the concentrations (more unstable) weight is shifted toward the most recent hours, allowing it to account for both.

The EPA NowCast looks at the $PM_{2.5}$ concentration for the last 12 hours and calculates a weighted average of those hours as graphically depicted below.



NowCast Equation and Data Analysis

This section describes the NowCast logic mathematically and walks through the calculation to determine the health effect category for given $PM_{2.5}$ concentrations.

C_i = Valid $PM_{2.5}$ concentration from i hours ago, i.e. most recent hour is C_0, concentration from previous hour is C_1, two hours ago, C_2, etc.

To compute a valid NowCast value, two out of the most recent three hours must be valid (*any* two concentrations out of C_0, C_1, and C_2).

Weight factor, w, is determined by the variability in the last 12 concentrations (C_0-C_{11}):

$$w = 1 - \frac{C_{max} - C_{min}}{C_{max}} = \frac{C_{min}}{C_{max}}$$

$$C_{min} = \min\{C_0 \dots C_{11}\}$$

$$C_{max} = \max\{C_0 \dots C_{11}\}$$

w is constrained to be between 0.5 and 1:

$$if\ w < 0.5 \rightarrow w = 0.5$$
$$if\ w > 1 \rightarrow w = 1$$

Then calculate the **NowCast** concentration, which is defined as:

$$NowCast = \frac{\sum_{i=0}^{11} C_i w^i}{\sum_{i=0}^{11} w^i}$$

The displayed color is the NowCast concentration placed in the appropriate category based on these breakpoints:

Figure 1 – NowCast Breakpoints

Health Effects Category	NowCast $PM_{2.5}$ Concentration[1] ($\mu g/m^3$)
Good	0 – 12.0
Moderate	12.1 – 35.4
Unhealthy for Sensitive Groups	35.5 – 55.4
Unhealthy	55.5 – 150.4
Very Unhealthy	150.5 – 250.4
Hazardous	>250.4

[1] Breakpoint concentrations defined within 40 CFR, Part 58; Appendix G

Data Analysis and Handling

Invalid Data:

If there are invalid concentrations, then those hours are eliminated from the numerator and denominator in the calculation:

$$NowCast = \frac{C_0 w^0 + C_1 w^1 + C_2 w^2 + \cancel{C_3 w^3} + C_4 w^4 + C_5 w^5 + C_6 w^6 + \cancel{C_7 w^7} + C_8 w^8 + \cdots}{w^0 + w^1 + w^2 + \cancel{w^3} + w^4 + w^5 + w^6 + \cancel{w^7} + w^8 + \cdots}$$

To compute a valid NowCast value, you must have at least two of the most recent 3 hours of $PM_{2.5}$ concentration data available.

Negative Concentrations:

Montana DEQ uses EPA approved monitors to measure particulate matter across the state. During times of very clean air quality, the monitors may produce negative concentration readings due to normal instrument fluctuations. The EPA considers negative concentrations to be valid down to -10 μg/m^3. The DEQ treats negative values in the NowCast calculation as followed:

- Valid negative concentrations are included in the NowCast calculation
- A NowCast value is valid if it is greater than or equal to -5 μg/m^3. If it is negative but greater than -5 μg/m^3, the NowCast value is set to 0 and placed in appropriate category (green).
- If a NowCast value is less than -5 μg/m^3, then the hour is invalid and no color is calculated (grey).

As noted above, a $PM_{2.5}$ concentration down to -10 μg/m^3 is considered valid, reported to the EPA, and is used (unmodified) in a 24-hour average. However, negative concentrations are not physically possible and give little additional value to the current air quality (for example -2 μg/m^3 can't really be considered "cleaner" air than -4 μg/m^3).

To provide a more conservative estimate of the current day and 24-hour value, we will zero out any negative concentrations before calculating an average to compare to the NAAQS. This will not be a 'true' comparison to the NAAQS but will provide less confusion to the public and is more conservative for regulators and users. Please see the following section about other nuances when using the NAAQS comparison functions.

Significant Figures and Truncation:

In the updated Today's Air, the concentration is displayed out to the tenths place, with additional digits truncated (not rounded) in order to be consistent with how the data is reported to EPA. When computing the 24-hour average, those truncated values are all averaged, *then* that average is truncated to the tenths. Retaining the tenths place also eliminates discrepancy when the comparison is made to the health effect category breakpoints, since the breakpoint resolution is to that decimal place.

Comparison to National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set NAAQS (40 CFR part 50) for pollutants considered harmful to public health and the environment. Currently, the EPA has set air quality standards for six principal pollutants, called "criteria" air pollutants. $PM_{2.5}$ being one of those six criteria pollutants. These standards set specific pollutant limits to protect public health, including the health of at-risk populations such as people with pre-existing heart or lung disease (e.g. asthmatics), children, and older adults as well as to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings

For informational purposes, Today's Air provides a comparison the air quality standard for $PM_{2.5}$ to allow users an opportunity to examine past days 24-hour average values to help assess long-term cumulative exposure potentials.

The 24-hour average $PM_{2.5}$ concentrations and comparisons is displayed on the site-specific pages of Today's Air. The idea is to display the midnight-to-midnight 24-hour average (i.e., the 24 values that are at hours beginning 00:00 – 23:00) for NAAQS comparison purposes. This mid-night-to-mid-night average is how data is handled in EPA's reporting system for calculating design values to determine compliance with the standards. One subtle difference is that during daylight savings, Today's Air will be one hour off of the "official" MST time zone, so the 24-hour average displayed on Today's Air will be different than that day's "official" 24-hour average for that part of the year.

As discussed in the Data Analysis and Handling section, the other discrepancy with this 24-hour calculation is that negative concentrations (above -10 $\mu g/m^3$) are included for official purposes, but on Today's Air these negative concentrations are set to 0 for display and for calculating the 24-hour average. This can result in Today's Air reporting a slightly higher 24-hour average than the official 24-hour average used for NAAQS purposes.

Health assessment for a given 24-hour averaging period are assigned at the end of the 24-hour averaging period. In other words, the current day will only display the rolling average from midnight where the previous day's value will be assigned a health category based on the breakpoints as provided in Figure 1.

Exceptional Events

Exceptional Events are defined as events that affect air quality and are not reasonably controllable or preventable to attain or maintain the NAAQS. DEQ is responsible for tracking, logging, and documenting these events to EPA. Air quality data collected during exceptional events may be excluded for NAAQS compliance determinations if EPA concurs with DEQ documentation. In Montana, wildfires are the most frequently occurring exceptional events and a considerable portion of the $PM_{2.5}$ data collected during these events are flagged and documented accordingly. This should be a consideration when comparing the 24-hour average $PM_{2.5}$ concentration to the NAAQS, as Today's Air is used for health assessment determinations all valid monitored $PM_{2.5}$ concentrations are included. For more information about exceptional events, see EPA's website.

Wildfire Smoke and Winter Air Quality Updates

The DEQ provides daily updates during times when air quality impacts are occurring across the state. These updates are divided into two categories: 1) wildfire smoke updates and 2) winter air quality updates. Wildfire smoke updates outline the cause of wildfire smoke in the state as well as a forecast for upcoming days. The winter air quality updates report on wintertime inversion formation in western Montana valleys. When a current update is available, a link will appear above the Today's Air map or in the Air Quality Links drop down of a mobile device. Updates will not be available during times when air quality is good across the state, most commonly in springtime. Archived information can be found at the following links:

Wildfire Smoke Archive: http://svc.mt.gov/deq/todaysair/smokereport/smokelist.aspx
Winter Air Quality Archive: http://svc.mt.gov/deq/todaysair/aqreport/aqlist.aspx

Today's Air Website Contents

The DEQ maintains a core set of ambient air $PM_{2.5}$ monitoring stations which are continuously accounted for on the Today's Air web page. These core stations are sited in accordance with regulatory obligations or have been installed at the discretion of the DEQ to represent a significant population area. On occasion the DEQ will place temporary monitors in response to an episodic event, typically to address wildfire impacts, or for special impact studies. Depending upon the nature and duration of a monitoring event a temporary station may be represented on the Today's Air web page.

The near-real time hourly $PM_{2.5}$ concentrations (arithmetic 1-hour mean) collected from DEQ's ambient monitoring network provides the basis on which the NowCast average is calculated. The 1-hour average concentrations are posted at 15 minutes after the top of the hour for the previous hour (e.g. the 7:00 am through 8:00 am hourly average concentration is posted to Today's Air at 8:15 am). This delay is provided to allow the automated data validation process to assess the integrity of the present data set and remove erroneous or unrepresentative data due to various reasons (i.e. power failures, equipment malfunctions, scheduled quality checks, maintenance, etc.). The data on Today's Air is raw data and is not considered as official until a thorough data validation occurs; however, the automatic validation process has proven reliable and is very effective in removing invalid data.

Intent is to provide a description of the data and information delivered via Today's Air. Website is configured to work with mobile applications, including phone and tablets; as such, many of the functions described here will adjust to fit the device used in viewing the page. Many functions are converted and accessed through drop down menus.

Representations of health assessment risks provided on Today's Air are general advisories, and not a substitute for individual health awareness and the advice of medical professionals.

Today's Air Front Page Display:

Today's Air main page provides a snap shot of air quality across the state from each monitoring station, depicted by a dot on the map. The color of the dot indicates the air quality condition for a particular site based on the NowCast concentration value and corresponding health effects categorization, calculated for the most recent hour.

Mouse over a particular site, or dot, to reveal the city name where the monitor is located. Clicking on a site, or selecting from the drop down menu, will take you to the station page where additional monitoring data is provided for a particular site. Additionally, the front page provides multiple web links to other information relevant to the Today's Air site.

See Figure 2 for specific description and content for the front page.

Today's Air Monitoring Station Page Display:

In selecting a specific air monitoring station from the front page of Today's Air, either by actively clicking a dot on the map or the selecting from the list of site names, the current day's air monitoring data from that particular station is displayed. Daily data presented is on a mid-night-to-midnight basis.

Main elements displayed within each station page includes; a line graph which presents the hourly NowCast concentrations overlaying the respective health effects categories, the daily NAAQS comparison, and the hourly data table which presents the actual hourly $PM_{2.5}$ concentrations alongside the calculated NowCast value. In addition to the current day's air quality conditions, historic $PM_{2.5}$ data and health effect assessments are available for each station.

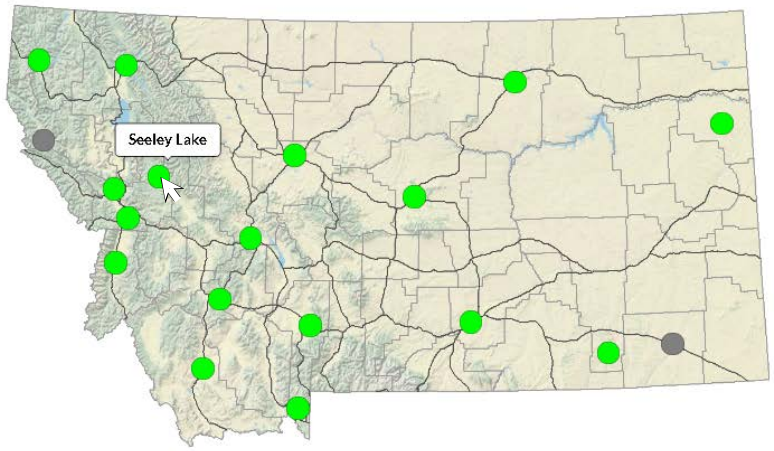
See Figure 3 for specific description and content for each monitoring station page.

Figure 2 – Today's Air Main Page

Link to the statewide air quality discussion and forecast (Available during wildfire & winter seasons only)

Air Quality Forecast

Health Effects Category by Air Monitoring Station
Based on the EPA NowCast Averaging Method.
For 3:00 PM MST to 4:00 PM MST on 12/2/2016



Each dot on the map represents an air monitoring station, click on a dot for station specific data. The color of the dot is determined by the current local air quality and comparison to the health effects category table.

Health Effects Categories

- Hazardous
- Very Unhealthy
- Unhealthy
- Unhealthy for Sensitive Groups
- Moderate
- Good
- Data Unavailable

Explanation of Categories: Breakpoints and Associated Visibility for Particulate Concentrations.

Featured Links:
About Today's Air
County Air Quality Programs
Outdoor Activity Recommendations

Link to page that provides contact information for county's with air quality programs

Breakpoints and Associated Visibility for Particulate Concentrations

Health Effect Categories	Visibility[1] (miles)	NowCast Concentration[2] (µg/m³)	Health Effect	Cautionary Statement
Hazardous	< 1.3	>250.4	Serious aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES. serious risk of respiratory effects in general population.	Everyone should avoid all physical activity outdoors: people with heart or lung disease, older adults, children, and people of lower SES should remain indoors and keep activity levels low.
Very Unhealthy	2.1 - 1.3	150.5 - 250.4	Significant aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES. significant increase in respiratory effects in general population.	People with heart or lung disease, older adults, children, and people of lower SES should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
Unhealthy	5.0 - 2.2	55.5 - 150.4	Increased aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES.increased respiratory effects in general population.	People with heart or lung disease, older adults, children, and people of lower SES should avoid prolonged or heavy exertion; everyone else should reduce prolonged or heavy exertion.
Unhealthy for Sensitive Groups	8.7 - 5.1	35.5 - 55.4	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES.	People with heart or lung disease, older adults, children, and people of lower SES should reduce prolonged or heavy exertion.
Moderate	13.3 - 8.8	12.1 - 35.4	Respiratory symptoms possible in unusually sensitive individuals, possible aggravation of heart or lung disease in people with cardiopulmonary disease and older adults.	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Good	> 13.4 +	0.0 - 12.0	None	None

SES = socioeconomic status

Recommendations for Outdoor Activities Based on Air Quality for Schools and Child Care Facilities

Health Effect Category	Good	Moderate	Unhealthy for sensitive groups*	Unhealthy	Very Unhealthy/ Hazardous
Visibility (miles)	13+	9-13	5-9	2-5	Less than 2
NowCast Concentration (µg/m³)	≤ 12	12 - 35	35 - 55	55 - 150	150 +
Recess or Other Outdoor Activity (15 minutes)	No limitations	No limitations	Make indoor space available for all children to be active, especially young children. If outdoors, limit vigorous activities and people with chronic conditions should be medically managing their condition.	Keep all children indoors.	Keep all children indoors.
Physical Education Class (1 hour)	No limitations	Monitor sensitive groups and limit their vigorous activities.	Make indoor space available for all children to be active, especially young children. If outdoors, limit vigorous activities and people with chronic conditions should be medically managing their condition.	Conduct P.E. indoors. If outdoors, only allow light activities for all participants. People with chronic conditions should be medically managing their condition.	Conduct P.E. in a safe (good air quality) indoor environment.
Athletic Practice, Training (2-4 hours)	No limitations	Monitor sensitive groups and limit their vigorous activities.	People with chronic conditions should be medically managing their condition. Increase rest periods and substitutions for all participants to lower breathing rates.	Conduct practice and trainings indoors. If outdoors, allow only light activities for all participants. Add rest breaks or substitutions to lower breathing rates. People with chronic conditions should be medically managing their condition.	Conduct practice and trainings in a safe (good air quality) indoor environment.
Scheduled Sporting Events (2-4 hours)	No limitations	Monitor sensitive groups and limit their vigorous activities.	People with chronic conditions should be medically managing their condition. Increase rest periods and substitutions for all participants to lower breathing rates.	Consider rescheduling or relocating event. If outdoor event is held, have emergency medical support immediately available. Add rest breaks or substitutions to lower breathing rates. People with chronic conditions should be medically managing their condition.	Reschedule or relocate event.
Examples of light activities: Walking slowly on level ground; Carrying school books; Hanging out with friends			Examples of moderate activities: Skateboarding; Slow pitch softball; Shooting basketballs	Examples of vigorous activities: Running, jogging; Playing football, soccer, and basketball	Please note that the intensity of an activity can vary by person and ability

See the back of this document for suggestions on how to use particulate concentration measurements and visibility guidelines to make a decision about poor outdoor air quality and your event. Visit www.todaysair.mt.gov for more information.

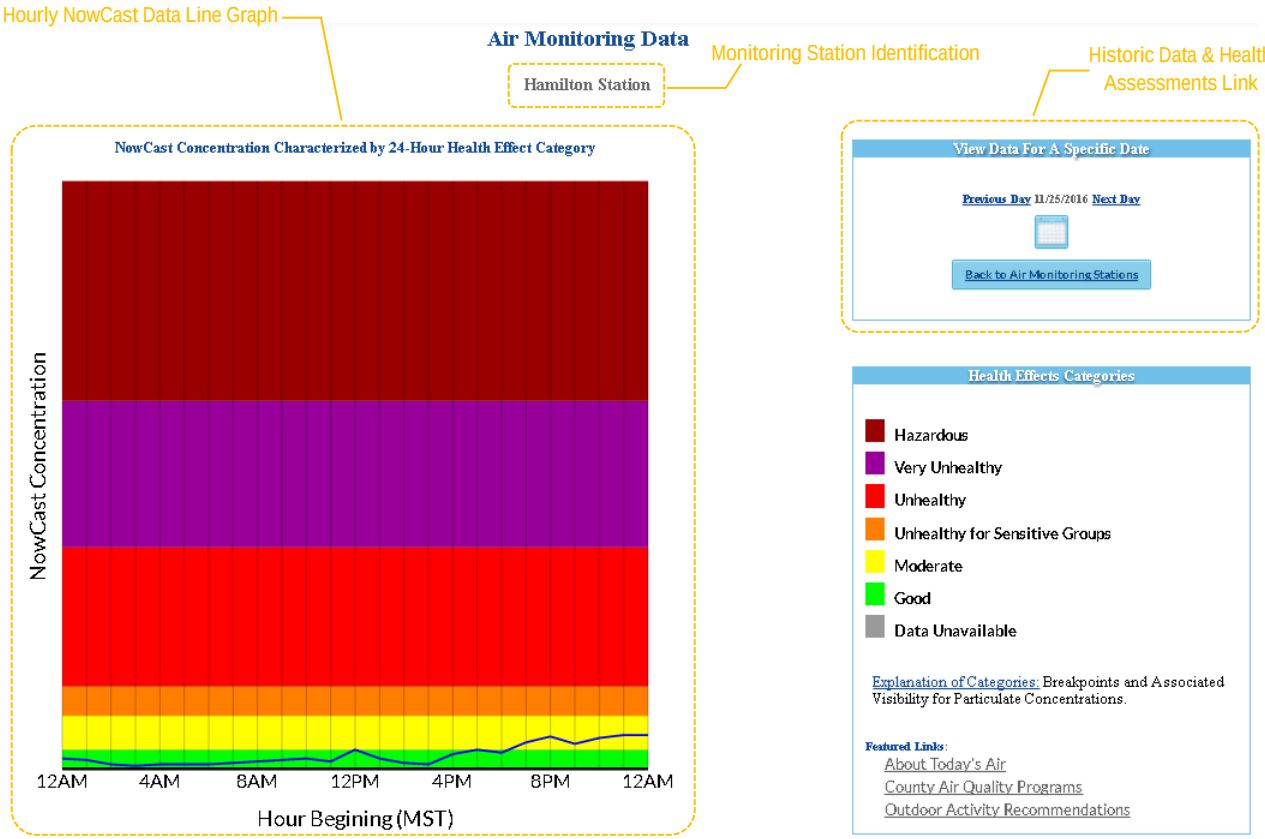
* For the purpose of this document, sensitive groups include:

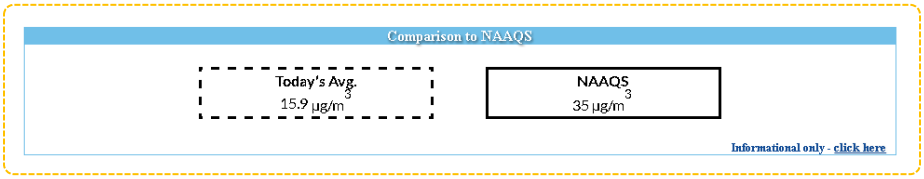
- Young children (ages 0-5 years). Young children may be more sensitive to air pollution as their lungs are still developing and they may have an unknown underlying health condition.
- People who have a chronic condition, such as asthma or another respiratory disease, or cardiovascular disease. People with these conditions may be more sensitive to air pollution and should talk with their primary healthcare provider about managing their condition.

Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.

Mouse over a health effect category to read the associated activity recommendation for that category

Figure 3 - Today's Air Monitoring Station Page





Mid-night-to-Mid-night comparison to EPA's ambient standards (see NAAQS comparison discussion within this document for more detail)

Hourly Data Table Interpretation

Health Effects Categories are based on 24-hour average particulate levels, adjusted to a time-weighted NowCast to provide a real time assessment of current air quality. More Information about the NowCast method can be found here.

Hourly Data

Previous Day 12/6/2016 Next Day

Hour	1-Hour Avg	NowCast Concentration
0:00-1:00	23.8	25.0
1:00-2:00	23.8	24.4
2:00-3:00	20.1	22.2
3:00-4:00	14.1	18.1
4:00-5:00	8.7	13.4
5:00-6:00	18.4	15.9
6:00-7:00	25.1	20.5
7:00-8:00	10.6	15.5
8:00-9:00	11.4	13.4
9:00-10:00	31.7	22.5
10:00-11:00	15.1	18.8
11:00-12:00	5.8	12.3
12:00-13:00	7.7	10.0
13:00-14:00	7.2	8.6

All data in µg/m3
DU = Data Unavailable

Hourly PM2.5 concentration in micrograms per cubic meter aside the calculated NowCast concentration value and corresponding health impact assessment

Reason for Change: Original Today's Air Discussion

The original logic for determining the "health effect" dot color on the Today's Air front map was as follows. The 1-hour, 8-hour, and 24-hour rolling average was compared to the defined breakpoint table and the worst of the three averaging times were displayed, unless the 1-hour concentration is less than 15 $\mu g/m^3$, in which case it shows green (Good) regardless of cumulative exposure. The original health effect breakpoints are shown below:

Original Today's Air Website Breakpoints

Health Effect Categories	24-Hour Avg. (µg/m3)	8-Hour Avg. (µg/m³)	1-Hour Conc. (µg/m³)
Hazardous	>135.4	> 237.0	> 338.5
Very Unhealthy	80.5 - 135.4	140.8 - 237.0	201.1 - 338.5
Unhealthy	35.5 - 80.4	62.1 - 140.7	88.6 - 201.0
Unhealthy for Sensitive Groups	20.5 - 35.4	35.8- 62.0	51.1 - 88.5
Moderate	13.5 - 20.4	23.6 - 35.7	33.6 - 51.0
Good	0.0 - 13.4	0.0 - 23.5	0.0 - 33.5

The Today's Air website is accessed by the public most during wildfire season (June – Oct). During this time, air quality conditions can change quickly (in either direction). While the original method was successful in many instances, there were situations when it misrepresented the current air quality situation relayed to the public on the front "Today's Air" map.

Figure 1 presents data from two separate days during the 2015 wildfire season to illustrate concerns of the original Today's Air methodology.

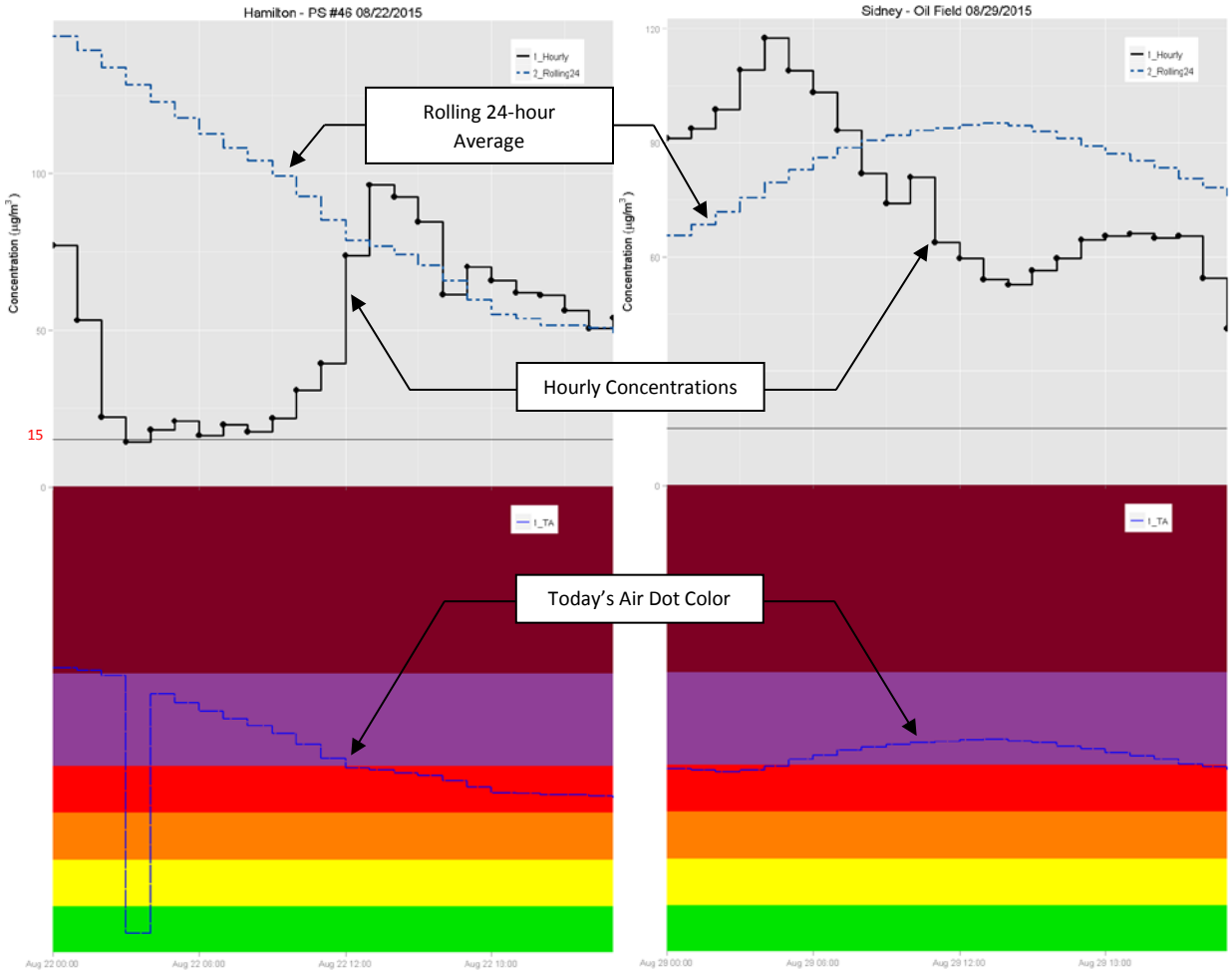
The first graph on the left is from Hamilton in August 2015;

- The hourly concentrations (top left – solid black line) decrease to 15 $\mu g/m^3$ for one hour early in the day, then remain low but slightly above 15 $\mu g/m^3$ for several hours before increasing in the afternoon.
- The rolling 24-hour average concentration (top left – dashed blue line) is elevated from the previous day, starting out much higher than the morning hourly concentrations.
- The Today's Air dot color (bottom left – solid blue line) is controlled by the 24-hour average for almost all hours of the day. The dip below 15 $\mu g/m^3$ for one hour causes the dot color to jump between good and very unhealthy over the course of three hours. When hourly concentrations increase (air quality worsens) in the afternoon, the 24-hour average and dot color do not show the change and instead show improvement.

The second graph on the right is from Sidney in August 2015;

- The hourly concentrations (top right – solid black line) are high in the morning, then decrease in the afternoon
- The 24-hour average concentration (top right – dashed blue line) starts out lower than the hourly concentrations in the morning, then increases in the afternoon.
- The Today's Air dot color (bottom right – solid blue line) is controlled by the 24-hour average concentrations throughout the day. Due to the lag in the 24-hour value, the dot color is very unhealthy air quality when concentrations are best.

Figure 1 – Current Today's Air



Both examples highlight some of the confusion perceived by a user of Today's Air:

- The 15 µg/m^3 breakpoint often causes abrupt jumps spanning multiple health categories. If the concentrations are near this threshold for several hours, this can cause the dot to jump back and forth between green (good) and an elevated category.
- When air quality is bad, the Today's Air algorithm is usually controlled by the 24-hour rolling average, which is very slow to respond to 1-hour concentration changes. In the left plot, in which the previous day had several very elevated concentrations, the dot color is slow to respond to the relatively low concentrations in the morning, and still doesn't respond appropriately to the elevated concentrations in the afternoon.
- The Sidney plot (right) is showing somewhat of an opposite effect as the left, where the hourly concentrations start off elevated and then improve, and then the dot color "catches up" in the afternoon, when the concentrations are near their lowest.

Figure 2 – Today's Air using NowCast