# PWC PrepTool User's Guide

**Revision:** 20220813d

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# Introduction

The USEPA's Pesticide in Water Calculator (PWC) simulates pesticide applications to land surfaces and the subsequent transport to and fate in surface water bodies and simple ground aquifers.[1] The PWC model was designed for regulatory applications as applied by the Office of Pesticide Programs (OPP) and uses the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM). PWC requires the user to parameterize the modeling scenario(s) by specifying pesticide physical-chemical properties, environmental fate, and application parameters.

## Need and Objective

Pesticides are typically labeled for a variety of uses, with application instructions and restrictions often differing for each use site *(e.g.*, crop and region). Comprehensive simulation of potential environmental exposure for all use sites and market regions for an active ingredient (AI) can potentially result in hundreds of PWC runs (simulations) that require individual parameterization. Fortunately, to accommodate many runs the PWC model accepts a batch file for input; however, manually parameterizing these runs is time-prohibitive and error prone. Specifically, defining application information (*i.e.*, application dates, application rates, etc.) is cumbersome due to the multitude of permutations that can result from crop management timing (*i.e.*, emergence and harvest dates) and use restrictions that are unique to each use site and region.

There exists a substantial need for a tool that can, for any AI, correctly and efficiently automate the assignment of label-specific application information for each PWC run across all use sites and regions. The PWC-PREP Tool (PWC-PT) is designed to fulfill this need.

## Complexity of Modeling Pesticide Uses

Pesticide labels provide detailed instructions for use of a product, and agronomic practices that vary by region such as typical emergence and harvest dates must also be considered when attempting to model pesticide uses. To draw factual conclusions from the modeling results, it is critical that the pesticide exposure modeling accurately reflects these factors. Satisfying these restrictions can be challenging due to the complex interaction of label instructions and regional variables.

Pesticide labels typically include several types of restrictions, including:

- The number of applications in a year must not exceed the maximum annual number of applications on the label.
- The total amount of pesticide applied in a year must not exceed the maximum annual application amount allowed on the label.
- Interval specific (*e.g.*, pre-emergence or post-emergence) number of applications and amounts applied must not exceed what is allowed on the label.
- Some uses allow for various application rates but limit the number of applications at a given rate.
- The pre-harvest interval (PHI) and minimum reapplication interval (MRI) must also be respected.

Furthermore, it is possible that specific application rates can only be made during certain times of the year. For example, application restrictions may permit the use of a higher application rate during the month prior to harvest, or in the two weeks following emergence. Satisfying all these conditions and ensuring that the model is conservative (see following section) can require complex logic, and the PWC-PT attempts to account for all these restrictions when assigning application dates and rates.

[1] USEPA 2022. *PWC (Pesticide in Water Calculator)*. https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#PWC

## What is the PWC PrepTool?

The PWC PrepTool (PWC-PT) is a program that facilitates the parameterization and generation of a PWC batch input file (.csv) for use in pesticide exposure modeling. The PWC-PT uses a user-friendly graphical user interface (GUI) that enables efficient parameterization of PWC model runs and generation of a batch input file by implementing an algorithm that assigns application dates and rates based on use site and region-specific agronomic practices (label restrictions). This ensures PWC simulations are compliant with the product label while maximizing conservatism.

## PWC PrepTool Conservatism

For conservatism when modeling pesticide uses, EPA typically implements the following conventions when parameterizing the PWC model:

- Application simulations should maximize application rates and number of applications to the extent possible without violating label instructions;
- Applications should be made as close together as possible without violating the minimum reapplication interval (MRI); and,
- For ESA modeling, applications should be made in the wettest month(s) allowed by the label. For example, if the pesticide can be applied to a crop only during post-emergence, then the wettest month in the post-emergence interval should be used (which may not be the wettest month overall in the year).

To the maximum extent possible, the PWC-PT attempts to implement these conventions when assigning applications.

## Geographical Scope of PWC PrepTool

Currently, the PWC-PT is designed to generate PWC runs for any region and use site within the continental United States. If there is interest, adding functionality allowing the PWC-PT to work with other weather / scenario files will be considered.

## Using the PWC PrepTool

The PWC-PT is highly configurable and can be used to generate PWC batch input files for a wide range of pesticides with unique agronomic practices. Furthermore, the user has flexibility in setting up model runs using parameters like application distance from the water body, application method (*e.g.*, foliar, bare ground, incorporated), transport mechanisms (*e.g.*, runoff/erosion + drift or drift only), drift reduction factors, and water body scenarios (*i.e.*, standard aquatic "bins" used by EPA).

### PWC PrepTool Functions (Use Cases)

The PWC-PREP Tool has two primary functions (use cases):

#### *Use Case #1: Generate a new PWC batch input file*

Use case #1 allows the user to create a new PWC batch input file for a specific AI "from scratch". The structure of the resulting batch file matches the format of Appendix A in the PWC Documentation and can be input directly into the PWC program. To generate a new PWC batch input file using the PWC-PT, the user must parameterize the required input tables (see Step 3. Parameterize the Input Tables) and then use the GUI to execute the tool. For this use case, two output files are generated: The first file is the PWC batch file (.csv), and the second a log file (.log) that details the resulting applications and the parameters used to generate them. For more information regarding the output file for Use Case #1, refer to the **Output Files** section.

#### *Use Case #2: Quality-check an existing batch file*

An auxiliary function of the PWC-PT is to quality check (QC) an existing PWC input batch file to verify that it does not violate the labeled use. The user parameterizes the appropriate input tables and then uses the GUI to QC a batch file. Use Case #2 generates a QC report (.csv) and a log file detailing any label compliance findings. For more information regarding the output file for Use Case #2, refer to the **Output Files** section.

Use Case #2 performs the following checks:

- Annual maximum number of apps is not exceeded
- Annual maximum amount applied is not exceeded
- Pre-Emergence maximum number of apps is not exceeded
- Pre-Emergence maximum amount applied is not exceeded
- Post-Emergence maximum number of apps is not exceeded
- Post-Emergence maximum amount applied is not exceeded
- MRI is adhered to
- PHI is not encroached
- No duplicate application dates are used (*i.e.*, more than one application on the same date)
- "Number of Apps" field is correct (*i.e.*, the number of applications specified in a scenario matches the "Number of Apps" field

Note that Use Case #2 does not ensure the following is true:

- That applications are made during the wettest months of the year
- The highest application rates are prioritized
- The maximum annual number of applications are made
- The maximum annual application amount is reached
- The correct drift reduction values and efficiency factors are used

In other words, the quality checks are intended to ensure that the applications to be simulated are label compliant.

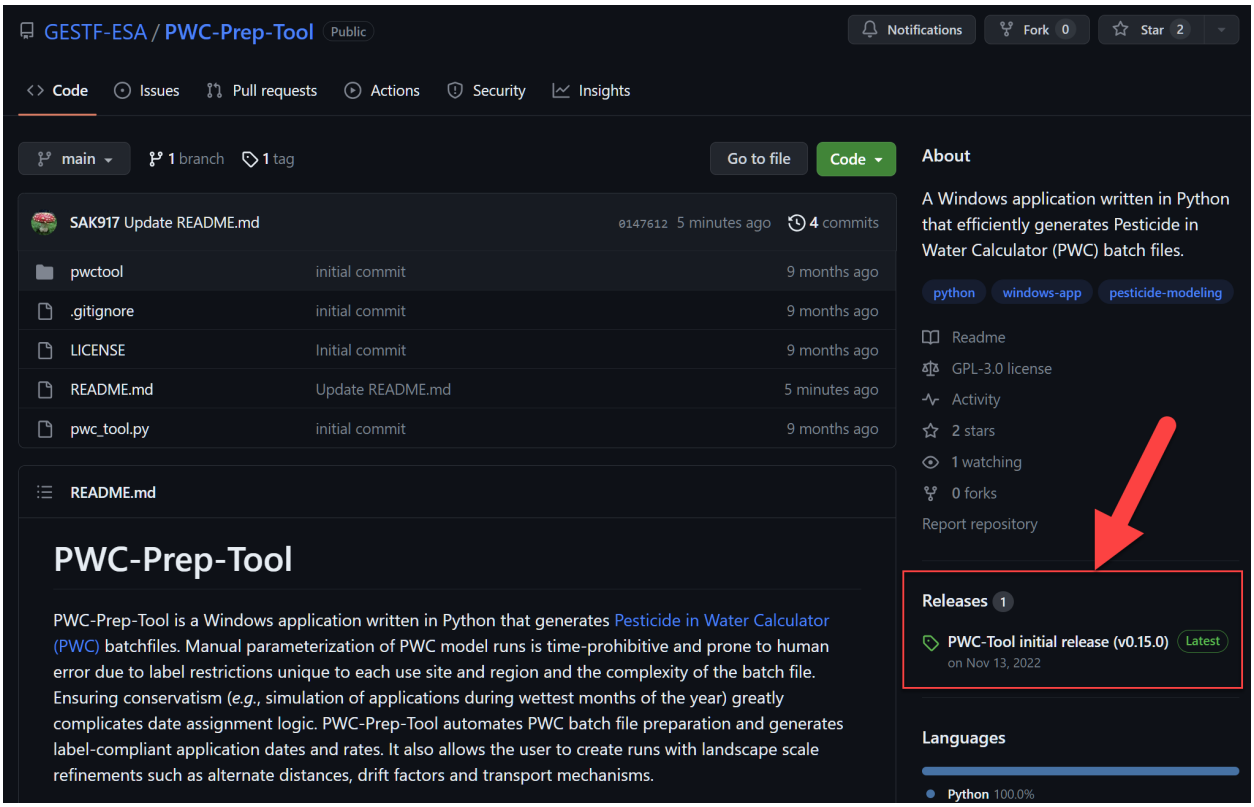
NOTE: The field names in an existing batch file can be anything; however, the columns must be in the same order specified in the official PWC documentation in order to successfully QC the batch file. Also, to QC an existing batch file the user must parameterize the agronomic practices table.

## Downloading and Installing the PWC PrepTool

The current release version of the PWC-PT is available to download from the GESTF GitHub repository:

https://github.com/GESTF-ESA/PWC-Prep-Tool

On the right side of the PWC-Prep-Tool home page is the Releases section. Click on the current release link to download the Windows Installer for the PWC-PT:




Upon downloading the release, run it to install the PWC PrepTool. Note that Python does *not* need to be installed on the computer for the PWC-PT to work. The installation creates an icon under Start > GESTF > PWC Prep Tool as well as a working folder named PWC-PT under the user's Home directory (typically 'C:\Users\[UserName]\PWC-PT').

## Running PWC-PT via the Graphical User Interface

### Step 1. Starting the PWC-PT GUI

After the application is downloaded from GitHub, it may be started by clicking on Start > GESTF > PWC PrepTool. Note that some parameters have default settings, which will be reflected in the GUI when it is first opened (Figure 1):

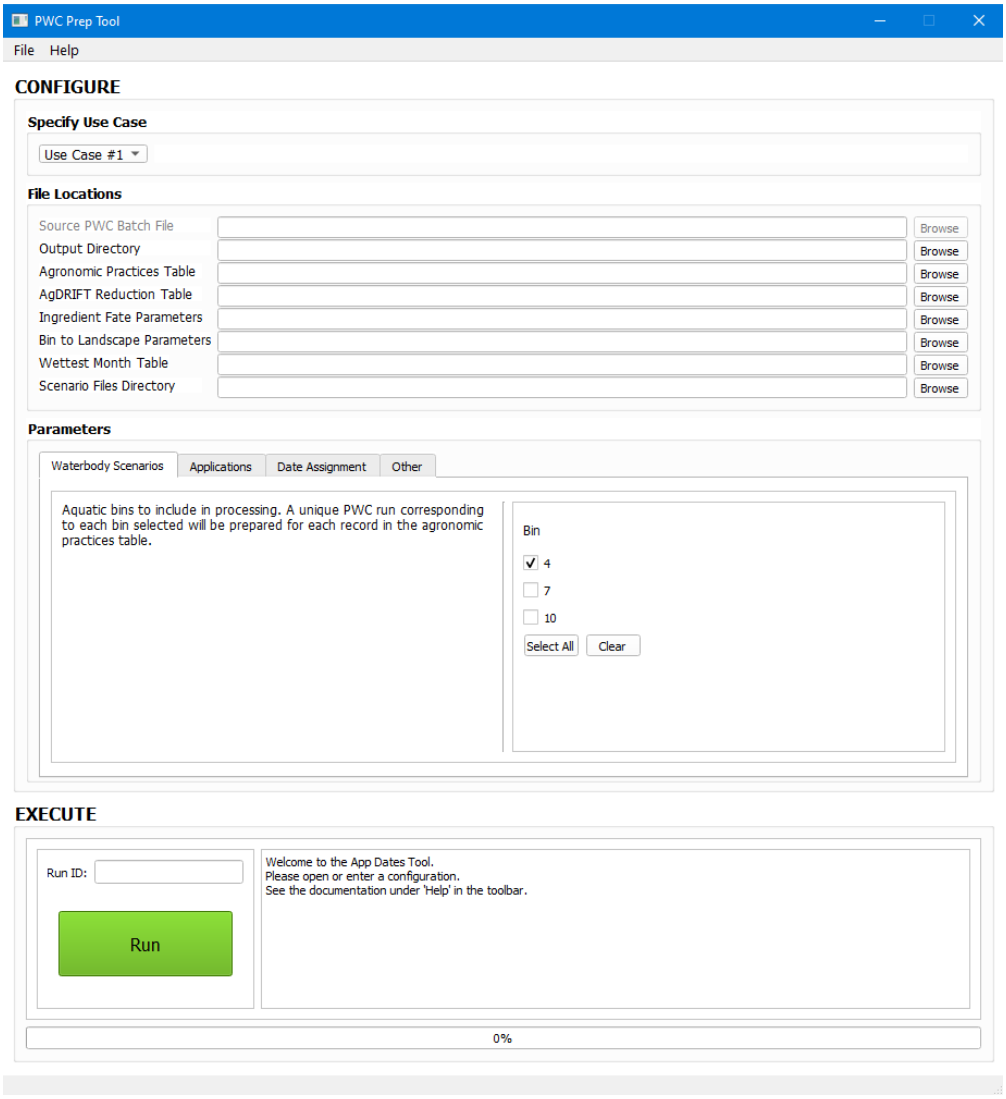



*Figure 1: PWC PrepTool GUI*

### Step 2. Specify the Use Case

In the configure panel, use the drop-down menu to select the appropriate use case based on your objective. Note the textual description of the use case to the right of the drop-down menu. Also note that certain components of the GUI will be greyed-out or disabled based on the use case.

### Step 3. Parameterize the Input Tables

If executing Use Case #1 (generating a new PWC batch input file), several input tables must first be created. These include the **Agronomic Practices Table (APT)**, the **AgDRIFT Reduction Table**, and the **Ingredient Fate Parameters** table. While changes to the AgDRIFT Reduction Table are typically not required, the APT is label specific and the Ingredient Fate Parameters table is compound specific and typically need to be created for the specific product and uses being modeled. These input tables are described in more detail in the **File Locations Pane** section.

### Step 4. Specify File Locations

In the "File Locations" section of the Configure panel, select file or directory names by clicking the appropriate browse button to open the file dialog and navigate to the appropriate file or directory and specify the corresponding file path. Alternatively, enter the file or directory path directly into the text box. Each of these files/directories are discussed in more detail in the **File Locations Pane** section below.

## Step 5. Specify Parameters and Options

There are additional parameters that give the user more control and flexibility when generating model runs. In the parameters section, you will see the following tabs:

### *Waterbody Scenarios*

Specify the waterbody scenario(s) (*i.e.*, aquatic bins) to model. PWC model runs will be parameterized for each aquatic bin selected. Landscape parameters that correspond to each bin can be configured or modified in the **Bin to Landscape Parameters** input table.

NOTE: The PWC-PT currently simulates the ESA version of the Index Reservoir, which is slightly different from the FIFRA version. A new version of PWC-PT will be released that allows the user to select the FIFRA or ESA version to be modeled.

### *Applications*

Specify which application methods should be modeled, with available application methods described in Table 1. The user must specify the application method for each use to be modeled in the Agronomic Practices Table (see **Agronomic Practices Table** section). After the appropriate sheet from the Agronomic Practices (Excel workbook) is specified in the "Other" tab (see below), the appropriate application method panes will be enabled in the GUI. That is, application method tabs are greyed out (disabled) if that method is not found in the Agronomic Practices Table.

*Table 1: PWC application methods available in the PWC-PT*

| Application Method | Method ID in Batch Input File | Description (from PWC Documentation) |
|---|---|---|
| Bare Ground (Below Crop) | 1 | Distributes pesticide under the canopy into the soil with distribution inversely proportional with depth to 4cm. |
| Foliar (Above Crop) | 2 | Pesticide is intercepted by foliage in proportion to the foliage aerial coverage at the time of application. Pesticide that is not intercepted is treated as a ground application and is distributed in the ground to a depth of 4cm. |
| Incorporated Uniform | 3 | Pesticide is uniformly distributed from the surface to a user-specified depth. |
| Incorporated Entirely at Depth | 4 | Pesticide is placed entirely at a specific depth. Note that placement of pesticide below the runoff extraction depth (R-depth on *Runoff Tab*) will result in no pesticide being transported in runoff. |
| T-Band Split | 5 | Pesticide is distributed to a depth specified by the incorporation depth, with a specified fraction (see T-Band Split below) placed into the top 2cm. |
| Incorporated Linearly Increased with Depth | 6 | Pesticide mass is distributed in the soil linearly increasing with depth down to the depth specified by the user. |
| Incorporated Linearly Decreased with Depth | 7 | Pesticide is distributed in the soil linearly decreasing with depth down to the depth specified by the user. |

### *Drift Setback Distance*

The user can simulate different drift setback distances from the waterbody, with PWC model runs parameterized for each distance selected. These distances correspond to drift factors listed in the **AgDRIFT Reduction Table** and are used to simulate application sites that are not directly adjacent to a water body by reducing the amount of spray drift based on the setback distance[2]. If running standard "edge of waterbody" scenarios specify the "000m" distance only, or alternatively you can select any combination of distances up to 150 meters.

### *Date Assignment*

There are three parameters in the date assignment tab:

- App Date Prioritization allows the user to specify how to prioritize the application dates (see the **Date Assignment Parameters** section for more information).
- Random Start Dates allows the user to turn on or off random date assignments, and the Random Seed enables reproducibility (see the **Random Start Dates and Random Seed** section for more information).

### *Profiles*

When conducting "what-if" scenarios, it can be helpful to have multiple sheets in the APT (e.g., evaluating the effects of possible changes to the label) and/or the AgDRIFT Reduction Table (e.g., evaluating the effects of different setback distances) that represent the scenarios being evaluated. There are several parameters in the profiles tab that indicate the specific scenarios of the APT and DRT that are used to generate the model runs:

- The Ag Practices Scenario is a drop-down list in which the user selects the name of the worksheet to use in the **Agronomic Practices Table** (APT).
- The AgDRIFT Reduction Scenario uses the same concept but for the **AgDRIFT Reduction Table**, allowing the user to simulate different drift reduction scenarios or even use different drift models.
- The Residential Adjustment Factor is the EEC adjustment factor for Residential use site run, and accounts for the fact that not all residential land cover is a potential application site. The US-EPA has typically used a value of 0.587 which is the default value used by PWC-PT.

## Step 6. Executing the PWC-PT

Below the Configure pane, the Execute pane is where the user executes the PWC-PT. The user should first specify a unique run identifier. This is used for naming the output files, so it is recommended to use conventional characters allowed in file names, and to use a standardized naming convention. For example, if the run identifier was "Test_Run_v1", the output files would be "Test_Run_v1_new_batch_file.csv" and "Test_Run_v2.log".

The diagnostic window presents processing status and feedback as the tool runs, and the progress bar indicates the amount of processing completed and remaining.

## Step 7. Reviewing the Output

The PWC-PT writes output files to the output directory, as specified in the File Locations pane. Learn more about in the **Output Files** section.

[2] US-EPA, 2013. Guidance on Modeling Offsite Deposition of Pesticides Via Spray Drift for Ecological and Drinking Water Risk Assessments.

### Saving, Opening, and Editing Configurations

The current state of the GUI (*i.e.*, the parameters that are set or selected) is termed a "configuration", and the configuration can be saved and used again as needed. To save, open, or create a new configuration, use the "File" menu. Configurations are stored as human-readable YAML files (.yml) and the user can edit these YAML files directly, but they rely on specific formatting, so it is recommended to only edit a configuration file by using the PWC-PT GUI to make the changes desired and then using the Save option to save the changes and update the YAML configuration file.

## File Locations Pane

### Source PWC Batch file

The source PWC Batch file is used in use case #2, where the PWC runs are checked for label compliance.

### Output Directory

The output directory is the location where the output files will be written. Either use the browse button to specify the output directory or copy and paste the folder path into the text box. You must specify the output directory for both use cases.

### Agronomic Practices Table

The Agronomic Practices Table (APT) contains the application instructions for each labeled use to be modeled. The APT is based upon and consistent with and builds upon EPA's "Master Use Summary Table" used in biological evaluations. The APT is designed to capture the application information necessary to implement PWC modeling and accommodate special cases such as rates for specific pests or regionally specific instructions such as "East/West of the Rocky Mountains" or "California only". The APT also accommodates timing restrictions such as "do not apply to corn before tasseling" or "do not make more than two applications in pre-emergence".

The APT is an Excel (.xlsx) file and Table 2 shows the fields in the APT. The user must create a unique APT for each active ingredient, and can generate different versions (unique Excel sheets in the same workbook) of the APT to model "what-if" scenarios or permutations of labeled uses if desired. An example APT is presented in **Appendix 1: Input File Examples**. When creating or modifying an APT, please ensure that the field names match Table 2 (or the default APT that is provided with the PWC-PREP Tool).

*Table 2: Agronomic Practices Table (APT) field definitions*

| Field Name | Type | Description |
|---|---|---|
| *RunDescriptor* | String | A PWC run descriptor that matches the source PWC batch file. Must be unique in the APT. |
| *LabeledUse* | String | The labeled use that this run represents, also known as the use site. It is recommended to use the appropriate use site as displayed in the "AgCensus Crop List" sheet in the default APT. This will ensure that runs are only generated for HUCs that overlap states where the crop is actually grown. Learn more about assignment of states to uses in the **Census of Agriculture Crop to State Lookup Table** section. |
| *ApplicationMethod* | String | The method of application to simulate. Must be one of: 1, 2, 3, 4, 5, 6, 7. See **Applications** section for more details. |
| *DriftProfile* | String | Drift profile identifier indicating the spray drift profile to use for this run. Corresponds to "Profile" column in the **AgDRIFT Reduction Table**. |
| *Scenario* | String | EPA scenario file name to use for the run. |
| *States* | Variable | The states (*e.g.*, "AZ, CA") or regions (*e.g.*, "West of the Rockies") the use is allowed. See **States Field Convention** in **Appendix 1: Input File Examples** for more information. |

| Field Name | Type | Description |
|---|---|---|
| *MaxAnnAmt* | Float | The maximum annual amount of AI that can be applied in lbs. / acre. This value is converted to kg / ha for use in the PWC batch file. |
| *MaxAnnNumApps* | Integer | The maximum annual number of applications that can be made for this use. |
| *PHI* | Integer | The Pre-Harvest Interval representing the number of days preceding harvest in which applications are not allowed. |
| *PreEmergence_MaxAmt* | Float | The maximum amount of AI that can be applied within the pre-emergence interval. The PWC-PT defines pre-emergence as the time period after the harvest date and before the emergence date specified in the Scenario file for the use. |
| *PreEmergence_MaxNumApps* | Integer | The maximum number of applications that can be made within the pre-emergence interval. |
| *PostEmergence_MaxAmt* | Float | The maximum amount of AI that can be applied within the post-emergence interval in lbs. / acre. The PWC-PT defines post-emergence as the time period after the emergence date and before the harvest date specified in the Scenario file for the use. |
| *PostEmergence_MaxNumApps* | Integer | The maximum number of applications that can be made within the post-emergence interval. |
| *Rate1_MaxAppRate* | Float | The maximum application rate for Rate1. All rows in the APT are required to have a value for this field. |
| *Rate1_MaxAppNumApps* | Integer | The maximum number of applications that can be made at Rate1_MaxAppRate. May be left blank and will be calculated based on the Max Application Rate, the Annual Max Amount and the Annual Max Number of Applications. |
| *Rate1_PreEmergenceMRI* | Integer | The Minimum Reapplication Interval (MRI) for Rate1 pre-emergence applications. A value in this field indicates that pre-emergence applications at this rate are valid. May be left blank to indicate pre-emergence applications are not permitted on the label. |
| *Rate1_PostEmergenceMRI* | Integer | The post-emergence interval MRI for Rate1. A value in this field indicates that post-emergence applications at this rate are valid. May be left blank to indicate post-emergence applications are not permitted on the label. |
| *Rate1_Instructions* | String | Special instructions for Rate1. More information about rate-specific instructions can be found in **Appendix 2: Rate Specific Instructions Convention**. |
| *RateX_ …* | … | Remaining fields for rates two through four. |

The PWC-PT supports a maximum of four distinct application regimens per modeled use, with corresponding restrictions for each regimen. The ability to parameterize multiple rates accounts for more complex label instructions such as “make up to two applications at a rate of 0.25 - 1 lb. per acre pre-emergence, and/or three applications at a rate of 0.25 - 0.5 lbs. per acre post-emergence, not to exceed a total of 1.5 lbs. per acre per year”.

**IMPORTANT**: The PWC-PT date assignment algorithm currently relies on application rates being listed from highest (Rate1) to lowest (Rate4) to ensure conservatism. When specifying the rate-specific parameters, please be sure to enter rates from highest to lowest application rates (*i.e.*, *Rate1_MaxAppRate* should always be greater than or equal to *Rate2_MaxAppRate*, etc.)

### AgDRIFT Reduction Table

The AgDRIFT Reduction table is a lookup table that maps a drift profile to corresponding drift reduction and efficiency values[3]. The drift reduction value depends on the waterbody scenario (bin), application method, and application setback distance. An example AgDRIFT Reduction Table can be found in the **AgDRIFT Reduction Table** section of **Appendix 1: Input File Examples**.

### Ingredient Fate Parameters

The ingredient fate parameters (*LUT_Chemical Parameters.csv*) is a lookup table that specifies fate and transport parameters for the active ingredient. This needs to be generated and customized based on the properties of the AI. An example Ingredient Fate Parameters Table is presented in **Table 3** below**.**

*Table 3: Example Ingredient Fate Parameters Table*

| Parameter | Value |
|---|---|
| SorptionCoefficient (mL/g) | 46 |
| kocflag | TRUE |
| WaterColumnMetabolismHalflife (day) | 6.2 |
| WaterReferenceTemperature (C) | 20 |
| BenthicMetabolismHalflife (day) | 39 |
| BenthicReferenceTemperature (C) | 20 |
| AqueousPhotolysisHalflife (day) | 50 |
| PhotolysisReferenceLatitude (degrees) | 40 |
| HydrolysisHalflife (days) | 266 |
| SoilHalflife (days) | 30.42 |
| SoilReferencerTemperature (C) | 25 |
| FoliarHalflife (day) | 3 |
| MolecularWeight (g/mol) | 162.2 |
| VaporPressure (torr) | 5.20E-06 |
| Solubility (mg/L) | 5.50E+04 |
| Henry's Constant (unitless) | 0 |
| Air Diffusion (cm3/d) | 0.01 |
| Heat of Henry (J/mol) | 0.001 |

### Bin (Water Body) Parameters

The Bin Parameters Table (*LUT_BinParameters.csv)* specifies waterbody parameters used by PWC to represent the aquatic bin. Parameters for Bins 4, 7 and 10 found in the default landscape parameters table are presented in **Table 4**:

*Table 4: Bin Parameters Table*

| Bin | FlowAvgTime | Field Size ($m^2$) | Waterbody Area ($m^2$) | Init Depth (m) | Max Depth (m) | HL (m) | PUA | Baseflow |
|---|---|---|---|---|---|---|---|---|
| 4 | 1 | 1.73E+06 | 5.26E+04 | 2.74 | 2.74 | 6.00E+02 | 1 | 0 |
| 7 | 0 | 1.00E+05 | 1.00E+04 | 2 | 2 | 3.57E+02 | 1 | 0 |
| 10 | 1 | 1.00E+05 | 1.00E+04 | 0.15 | 0.15 | 3.57E+02 | 1 | 0 |

[3] US-EPA, 2013. Guidance on Modeling Offsite Deposition of Pesticides Via Spray Drift for Ecological and Drinking Water Risk Assessments.

### Wettest Month Table

The Wettest Month Table (*LUT_WettestMonths.csv*) lists the months (January – December) in order from wettest to driest for each level 2 hydraulic unit (HUC2). The default Wettest Month Table provided with the PWC-PT release is presented in **Table 5**. Each row represents a HUC2 region, and the columns are wettest months for that HUC2 ranked from wettest to driest. The values correspond to the month number (*e.g.*, January = 1, February = 2, etc.). For example, Table 5 indicates that the 5$^{th}$ wettest month in HUC 10a is August (month 8). This table was developed using standard weather files for each HUC using the methodology used by EPA in its Biological Evaluation for the carbamates.

*Table 5: Wettest Month Table*

| HUC2 | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 11 | 5 | 4 | 9 | 12 | 6 | 8 | 3 | 10 | 2 | 1 | 7 |
| **2** | 7 | 5 | 10 | 8 | 6 | 3 | 2 | 9 | 11 | 12 | 4 | 1 |
| **3** | 3 | 2 | 7 | 1 | 4 | 12 | 5 | 11 | 6 | 8 | 9 | 10 |
| **4** | 4 | 8 | 9 | 7 | 6 | 5 | 3 | 11 | 10 | 12 | 2 | 1 |
| **5** | 5 | 3 | 7 | 6 | 4 | 11 | 8 | 12 | 2 | 9 | 10 | 1 |
| **6** | 3 | 7 | 12 | 2 | 1 | 5 | 6 | 11 | 4 | 9 | 8 | 10 |
| **7** | 6 | 8 | 7 | 5 | 9 | 4 | 10 | 3 | 11 | 12 | 2 | 1 |
| **8** | 7 | 2 | 8 | 4 | 12 | 9 | 1 | 5 | 3 | 6 | 11 | 10 |
| **9** | 6 | 7 | 5 | 8 | 9 | 4 | 10 | 3 | 11 | 1 | 12 | 2 |
| **10a** | 6 | 5 | 9 | 7 | 8 | 4 | 3 | 10 | 11 | 2 | 12 | 1 |
| **10b** | 5 | 6 | 4 | 9 | 10 | 3 | 7 | 11 | 8 | 1 | 12 | 2 |
| **11a** | 5 | 11 | 4 | 3 | 10 | 6 | 9 | 12 | 7 | 8 | 2 | 1 |
| **11b** | 6 | 8 | 7 | 5 | 9 | 10 | 4 | 3 | 11 | 2 | 1 | 12 |
| **12a** | 5 | 4 | 10 | 9 | 6 | 3 | 2 | 11 | 7 | 8 | 12 | 1 |
| **12b** | 9 | 5 | 6 | 8 | 10 | 7 | 4 | 11 | 3 | 2 | 12 | 1 |
| **13** | 9 | 8 | 7 | 10 | 6 | 12 | 2 | 11 | 1 | 3 | 5 | 4 |
| **14** | 5 | 4 | 9 | 6 | 7 | 3 | 8 | 10 | 2 | 11 | 12 | 1 |
| **15a** | 7 | 8 | 3 | 12 | 2 | 9 | 1 | 11 | 10 | 4 | 5 | 6 |
| **15b** | 12 | 8 | 9 | 3 | 7 | 2 | 11 | 1 | 10 | 4 | 6 | 5 |
| **16a** | 4 | 3 | 5 | 10 | 12 | 2 | 11 | 9 | 1 | 6 | 8 | 7 |
| **16b** | 11 | 6 | 12 | 4 | 5 | 3 | 1 | 2 | 10 | 8 | 9 | 7 |
| **17a** | 12 | 11 | 1 | 2 | 3 | 10 | 4 | 5 | 9 | 6 | 8 | 7 |
| **17b** | 5 | 3 | 4 | 11 | 12 | 6 | 1 | 2 | 10 | 9 | 8 | 7 |
| **18a** | 1 | 2 | 11 | 3 | 12 | 4 | 10 | 9 | 5 | 6 | 8 | 7 |
| **18b** | 1 | 3 | 2 | 12 | 11 | 4 | 10 | 9 | 5 | 8 | 6 | 7 |
| **19a** | 7 | 6 | 8 | 9 | 5 | 10 | 11 | 12 | 1 | 2 | 4 | 3 |
| **19b** | 8 | 9 | 7 | 10 | 6 | 12 | 11 | 4 | 5 | 2 | 3 | 1 |
| **20a** | 4 | 11 | 3 | 12 | 2 | 5 | 1 | 7 | 10 | 8 | 9 | 6 |
| **20b** | 12 | 1 | 11 | 2 | 10 | 3 | 4 | 5 | 9 | 7 | 6 | 8 |
| **21** | 11 | 5 | 10 | 9 | 8 | 12 | 7 | 6 | 4 | 1 | 2 | 3 |

### Scenario Files Directory

The scenario files directory contains the standard EPA scenario files representing use sites and weather files based on HUC2 regions.

NOTE: Version 1.0 of the PWC-PT uses EPA's Ecological Risk scenario and weather files that were used for ESA assessments prior to April 28, 2023. A new version of the tool that works with the new (v2) scenario and weather files being (PWC Scenarios and Weather Files for Surface Water Assessments v4) is currently being developed.

# The Application Date Assignment Algorithm

## Overview

A large part of the PWC-PREP Tool is the application assignment algorithm that, for a given PWC model run, assigns application dates and corresponding application rates that comply with label instructions. Manually determining the application dates and rates is often complicated due to complex label restrictions. For example, the maximum annual number of applications must not be exceeded, and the applications must be made during the appropriate interval (*e.g.*, post-emergence) without violating MRI and PHI restrictions. Additionally, implementing required conservatism introduces further complexity that makes efficient manual parameterization of many PWC runs virtually impossible.

To address this complexity, the PWC-PT implements a date assignment algorithm consisting of a sequence of logical decisions. This section describes the user-controlled parameters that influence the algorithm's behavior and details the algorithm's logic. Then, examples of the application assignment algorithm are presented.

## Conservatism

When modeling for pesticide risk assessment, EPA typically implements certain conservative assumptions to ensure that a "worst-case" scenario is represented. For example, uses are typically modeled by applying the maximum annual amount possible at the maximum rate using the maximum number of applications. Conservatism may also include simulating applications made during the wettest months of the year when runoff/erosion are expected to be most significant.

The PWC-PT application date assignment algorithm is designed to ensure that these conservative assumptions are maximized. That is, the algorithm will make the highest number of applications at the highest application rate permitted based on the labeled use restrictions specified by the user. Applications during wettest months may also be prioritized.

## Date Assignment Parameters

The user has some ability to configure the date assignment process. This flexibility takes the form of three parameters.

### Application Date Prioritization

In some uncommon cases, the maximum application rate and the wettest months cannot both be prioritized to the fullest degree of conservatism. For example, the maximum application rate allowed for a use may only be made post-emergence, but the wettest months fall within the pre-emergence interval. Therefore, the user must either prioritize the maximum application rate or applying in the wettest months as doing both is mutually exclusive. This decision is made by setting the App. Date Prioritization parameter to either "Max. App. Rate" or "Wettest Month". An example of the significance of the "App. Date Prioritization" parameter is presented in **Example 2 – Interval Limits and Prioritization.**

### Random Start Dates and Random Seed

By default, the first valid date of the month is utilized as the start date in a series of applications. If the random start dates box is checked, a randomly selected day within the month will be used as the start date. Note that label restrictions are still complied with regardless of whether this parameter is enabled or disabled.

If "Random Start Dates" is selected, the user can specify a random number "seed" (this can be an integer or a string) to allow reproducibility of results. In other words, specifying the same random number seed on subsequent runs (assuming all other settings are also the same) will result in the same sequence of days being selected for application despite the first day being randomly selected. In this way, the results of a run with a random number seed can be reproduced independently as long as the same seed is specified.

## Algorithm Logic

### High Level Overview

Iterate through each day (date) in the year, from wettest to driest month (first to last day in month)

- Prepare the first application in a series
  - Get the starting application date
  - Get the starting application rate
- Make applications if the following conditions are true, otherwise return to outer loop
  - *Date is valid*
  - *Rate is valid*
  - *Annual limits are not exceeded*
- After first valid start date, prepare the next application in a series
  - Get the next application date
  - Get the next application rate

### Iterate through each date in a year

The outer loop of the algorithm uses a list of potential application dates comprised of all dates within the year sorted by wettest month. For example, if February is the first wettest month, and December is the second wettest month, the first potential application dates would be Feb 1st, Feb 2nd, Feb 3rd, …, Feb 28th, Dec 1st, Dec 2nd, Dec 3rd, etc. The same pattern is repeated for the remaining months of the year. This iteration serves as an outer loop for the algorithm. The algorithm will return to this outer loop anytime that another application date in a series is not valid, but applications can still be made.

### Prepare the first application in a series

#### *Get the starting application date*

Application dates are assigned by first defining a start date, then defining the remaining applications of a series. There may be one or more series of applications that comprise all applications modeled within a given year (PWC run). The first application in a series is the start date, which is the first valid date identified in the outer loop iteration.

#### *Get the starting application rate*

For each application, there must be an application rate. The PWC-PT allows the user to specify up to four unique rates for each run descriptor (*RunDescriptor* field in the APT). The application rate for the starting application will be the highest rate allowable for that date.

### Make applications if the following conditions are true

If the following conditions are met, then an application can be made; otherwise, the algorithm returns to the outer loop:

#### *Application Date is Valid*

An application date is valid if the following conditions are met:

1. The interval (*i.e.*, pre-emergence or post-emergence) the proposed application date falls within is a valid interval for applications at the given rate;
2. The limits (maximum number of applications and maximum amount applied) for the interval have not been exceeded;
3. The rate-specific instructions are satisfied;
4. The application date is not within the MRI; and,
5. The pre-harvest interval (PHI) is not encroached.

#### *Application Rate is Valid*

An application rate is valid if the rate-specific number of applications is not exhausted. If all rates are exhausted, then no more applications can be made.

#### *Annual Limits are not Exceeded*

Applications can be made if the annual limits are not exceeded. That is, the maximum number of applications are not exceeded, and the maximum annual amount is not exceeded.

### Determine the next application date in a series

Following a valid start date, a series of applications is initiated and each subsequent application in a series is tested for validity. Subsequent applications are made until no more applications can be made.

#### *Assign the next application date in a series*

The algorithm will first try to forward assign the next possible application date in a series based on the MRI. For example, if the start date is June 15$^{th}$ and the MRI is 10 days, the next date in a series will be June 15$^{th}$ plus 10 days or June 25$^{th}$. This date is checked for validity using the same criteria as the start date to ensure that it complies with the label.

If the date is valid, it is assigned as the next application in the sequence. If it is not valid, then the algorithm will attempt to "reverse assign" by calculating the next application date to be the start date minus the MRI. If the resulting date is also not valid, but the annual limits have not been exceeded, the algorithm will continue with the outer iteration and determine a new start date for an application series.

#### *Assign the next application rate in a series*

The application rate corresponding to the next application date in a series is determined the same way as the rate corresponding to the starting application rate.

## Algorithm Examples

The following examples demonstrate how the algorithm manages different situations. Each example highlights a unique component of the application assignment logic.

### Example 1 – Annual Limits

This relatively straightforward example illustrates the annual limits as a limiting factor. As previously stated, the algorithm will only generate applications that comply with the annual limits. Specifically, the label-specified maximum annual number of applications and maximum annual amount allowable for a use will not be exceeded. The agronomic restrictions set for the example use are shown below in Table 6, and represents a transposed row (use) in the APT.

For this example use, the maximum annual amount is 3.5 lb./acre, and the maximum annual number of applications is 4. There are no interval restrictions (note they are blank). There is only one application rate specified, which is Rate1 at 0.9 lbs./acre. This rate is only valid in the post-emergence interval as denoted by the "Rate1_PostEmergenceMRI" field specified as 5. There are no restrictions on the number of applications for this rate and no rate-specific restrictions.

*Table 6: Agronomic practices information, algorithm example 1*

| | |
|---|---|
| **RunDescriptor** | example |
| **LabeledUse** | example |
| **ApplicationMethod** | Aerial |
| **Scenario** | example |
| **States** | OR, SD, NY |
| **DriftProfile** | A-F-M |
| **MaxAnnAmt** | 3.5 lb./acre (3.9 kg/ha) |
| **MaxAnnNumApps** | 4 |
| **PHI** | 7 |
| **PreEmergence_MaxAmt** | |
| **PreEmergence_MaxNumApps** | |
| **PostEmergence_MaxAmt** | |

| | |
|---|---|
| **PostEmergence_MaxNumApps** | |
| **Rate1_MaxAppRate** | 0.9 lb./acre (1.0 kg/ha) |
| **Rate1_MaxNumApps** | |
| **Rate1_PreEmergenceMRI** | |
| **Rate1_PostEmergenceMRI** | 5 |
| **Rate1_Instructions** | |
| **Rate2_MaxAppRate** | |
| **Rate2_MaxNumApps** | |
| **Rate2_PreEmergenceMRI** | |
| **Rate2_PostEmergenceMRI** | |
| **Rate2_Instructions** | |
| **Rate3_MaxAppRate** | |
| **Rate3_MaxNumApps** | |
| **Rate3_PreEmergenceMRI** | |
| **Rate3_PostEmergenceMRI** | |
| **Rate3_Instructions** | |
| **Rate4_MaxAppRate** | |
| **Rate4_MaxNumApps** | |
| **Rate4_PreEmergenceMRI** | |
| **Rate4_PostEmergenceMRI** | |
| **Rate4_Instructions** | |

Additional run parameters derived from the agronomic restrictions (Table 7) include the HUC2 that corresponds to the state(s) specified, the emergence and harvest date for the scenario, and the rate specific information. Note the HUC2 for this example is 10a. This is one of several HUC2s that were processed for this run based on the states entered by the user (OR, SD, and NY). All relevant information utilized for each run is written to the output log file.

*Table 7: Information derived from the agronomic practices table, algorithm example 1*

| | |
|---|---|
| HUC2 | 10a |
| Emergence | 6/1/2021 |
| Harvest | 8/30/2021 |
| Rate1_ValidIntervals | Post-Emergence |
| Rate1_instr_startdate | |
| Rate1_instr_enddate | |
| Rate1_instr_timeframe | |
| Rate2_ValidIntervals | |
| Rate2_instr_startdate | |
| Rate2_instr_enddate | |
| Rate2_instr_timeframe | |
| Rate3_ValidIntervals | |
| Rate3_instr_startdate | |
| Rate3_instr_enddate | |
| Rate3_instr_timeframe | |
| Rate4_ValidIntervals | |
| Rate4_instr_startdate | |
| Rate4_instr_enddate | |
| Rate4_instr_timeframe | |

Table 8 presents the wettest month table for HUC 10a, with June the wettest month and January the driest month.

*Table 8: Wettest month table for HUC 10a, algorithm example 1*

| Wettest Month Rank | Month |
|---|---|
| 1st | 6 |
| 2nd | 5 |
| 3rd | 9 |
| 4th | 7 |
| 5th | 8 |
| 6th | 4 |
| 7th | 3 |
| 8th | 10 |
| 9th | 11 |
| 10th | 2 |
| 11th | 12 |
| 12th | 1 |

The algorithm starts by listing all potential application dates in order of wettest to driest month. In this example, the list starts with June 1st and continues until June 30th. Then, it continues to each day in the next wettest month (in this case May). The list of all potential application dates includes all days in the year. Next, it iterates through each date until a valid date that meets all label requirements is found.

*Table 9: Application dates and rates for algorithm example 1*

| Application Date | Amount Applied |
|---|---|
| 06-01 | 0.9 lb./acre (1.0 kg/ha) |
| 06-06 | 0.9 lb./acre (1.0 kg/ha) |
| 06-11 | 0.9 lb./acre (1.0 kg/ha) |
| 06-16 | 0.8 lb./acre (0.9 kg/ha) |

Rate one is the only valid rate and is only permitted in the post-emergence interval. Therefore, the first date in the post-emergence interval is a valid application date and serves as the start date in the series. In this case, June 1st is the first post-emergence date (note the post-emergence interval is inclusive of the emergence date and harvest date minus PHI). The subsequent applications in the series are forward-assigned (Table 9) based on the MRI (which is 5) until any of the maximum annual restrictions are reached. Note that in this example, the application rate for the last application is adjusted so as to equal but not exceed the annual maximum application amount. With application #4 the maximum annual amount (3.9 kg/ha) as well as the maximum number of applications (4) are reached, so no more applications can be made.

Table 10 shows the total number of applications and amount applied for the year, each interval, and each rate. There were 4 total applications made, all within the post-emergence interval and all using Rate1.

*Table 10: Application results for algorithm example 1*

| Category | Number of Apps | Amount Applied |
|---|---|---|
| Annual | 4 | 3.5 lb./acre (3.9 kg/ha) |
| Pre-Emergence | 0 | 0 |
| Post-Emergence | 4 | 3.5 lb./acre (3.9 kg/ha) |
| Rate1 | 4 | 3.5 lb./acre (3.9 kg/ha) |
| Rate2 | 0 | 0 |
| Rate3 | 0 | 0 |
| Rate4 | 0 | 0 |

### Example 2 – Interval Limits and Prioritization

This example highlights the restrictions of interval limits and date assignment prioritization. Interval limits such as "pre-emergence maximum number of applications" cannot be exceeded. To satisfy these restrictions, prioritizing date assignments (controlled via the "App Date Prioritization" parameter in the GUI) can have a significant impact on the results, as demonstrated in this example.

This example implements two valid application rates for the use (Table 11). Rate1 is 3 lb./acre and valid only within the post-emergence interval, and rate two is 2 lb./acre valid only within the pre-emergence interval. This use also has both annual and interval limits, with only two applications allowed pre-emergence, while a maximum of 4 lbs./acre may be applied post-emergence.

*Table 11: Agronomic practices information, algorithm example 2*

| | |
|---|---|
| **RunDescriptor** | Example |
| **LabeledUse** | Example |
| **ApplicationMethod** | Ground |
| **Scenario** | Annual Example |
| **States** | Example |
| **DriftProfile** | G-LB-F-MC |
| **MaxAnnAmt** | 10 lb./acre (11.2 kg/ha) |
| **MaxAnnNumApps** | 5 |
| **PHI** | 3 |
| **PreEmergence_MaxAmt** | |
| **PreEmergence_MaxNumApps** | 2 |
| **PostEmergence_MaxAmt** | 4 lb./acre (4.5 kg/ha) |
| **PostEmergence_MaxNumApps** | |
| **Rate1_MaxAppRate** | 3 lb./acre (3.4 kg/ha) |
| **Rate1_MaxNumApps** | |
| **Rate1_PreEmergenceMRI** | |
| **Rate1_PostEmergenceMRI** | 10 |
| **Rate1_Instructions** | |
| **Rate2_MaxAppRate** | 2 lb./acre (2.2 kg/ha) |
| **Rate2_MaxNumApps** | |
| **Rate2_PreEmergenceMRI** | 5 |
| **Rate2_PostEmergenceMRI** | |
| **Rate2_Instructions** | |
| **Rate3_MaxAppRate** | |
| **Rate3_MaxNumApps** | |
| **Rate3_PreEmergenceMRI** | |
| **Rate3_PostEmergenceMRI** | |
| **Rate3_Instructions** | |
| **Rate4_MaxAppRate** | |
| **Rate4_MaxNumApps** | |
| **Rate4_PreEmergenceMRI** | |
| **Rate4_PostEmergenceMRI** | |
| **Rate4_Instructions** | |

The derived information (Table 12) indicates the HUC2 is 17a and the scenario uses an emergence date of April 15th and a harvest date of August 15th.

*Table 12: Information derived from the agronomic practices table, algorithm example 2*

| | |
|---|---|
| **HUC2** | 17a |
| **Emergence** | 4/15/2021 |
| **Harvest** | 8/15/2021 |
| **Rate1_ValidIntervals** | Post-Emergence |
| **Rate1_instr_startdate** | |
| **Rate1_instr_enddate** | |
| **Rate1_instr_timeframe** | |
| **Rate2_ValidIntervals** | Pre-Emergence |
| **Rate2_instr_startdate** | |
| **Rate2_instr_enddate** | |
| **Rate2_instr_timeframe** | |
| **Rate3_ValidIntervals** | |
| **Rate3_instr_startdate** | |
| **Rate3_instr_enddate** | |
| **Rate3_instr_timeframe** | |
| **Rate4_ValidIntervals** | |
| **Rate4_instr_startdate** | |
| **Rate4_instr_enddate** | |
| **Rate4_instr_timeframe** | |

Table 13 presents the wettest month table for HUC 17a, with December the wettest month and July the driest month.

*Table 13: Wettest month table or HUC 10a, algorithm example 2*

| Wettest Month Rank | Month |
|---|---|
| 1st | 12 |
| 2nd | 11 |
| 3rd | 1 |
| 4th | 2 |
| 5th | 3 |
| 6th | 10 |
| 7th | 4 |
| 8th | 5 |
| 9th | 9 |
| 10th | 6 |
| 11th | 8 |
| 12th | 7 |

This example demonstrates both date prioritization scenarios (*i.e.*, wettest month and maximum application rate). In both cases, the list of potential application dates begins with December 1st and follows the sorting of the wettest month table.

When the wettest month is prioritized, the first two applications are made in December (falling in the pre-emergence interval) using Rate2 (Table 14). At this point, the pre-emergence interval is exhausted because there can be only two applications made in the pre-emergence interval. However, two more applications are made in the post-emergence interval (April 15th and April 25th) using Rate1, which is valid in the post-emergence interval. Note that the rate for the final application is reduced from 3 lb./acre to 1 lb./acre to not exceed the post-emergence interval maximum amount of 4 lb./acre.

*Table 14: Application dates and rates for algorithm example 2, wettest month prioritization*

| Date | Amount Applied |
|---|---|
| 12-01 | 2 lb./acre (2.2 kg /ha) |
| 12-06 | 2 lb./acre (2.2 kg /ha) |
| 04-15 | 3 lb./acre (3.3 kg/ha) |
| 04-25 | 1 lb./acre (1.1 kg /ha) |

When prioritizing the maximum application rate, the highest application rate (in this case rate one) is prioritized (Table 15). Rate1 is valid only during the post-emergence interval, and April 15th is the first post-emergence date. A subsequent application 10 days later (Rate1 MRI) is then assigned. Because the post-emergence interval maximum amount is now reached, two additional applications are made using Rate2 which falls within the pre-emergence interval. These two applications were made on April 5th and March 31st due to reverse date assignment from the series start date of April 15th. Reverse assignment is implemented when the next forward date is invalid, and is used to ensure consecutive applications as close to the MRI as possible are modeled.

*Table 15: Application dates and rates for algorithm example 2, maximum application rate prioritization*

| Date | Amount Applied |
|---|---|
| 04-15 | 3 lb./acre (3.3 kg/ha) |
| 04-25 | 1 lb./acre (1.1 kg /ha) |
| 04-05 | 2 lb./acre (2.2 kg /ha) |
| 03-31 | 2 lb./acre (2.2 kg /ha) |

The number of applications and amount applied for both scenarios are shown in Table 16 and Table 17. The total amount applied and total number of applications are the same, even though the application dates themselves are different. Notice that in both cases, due to the label restrictions the annual limits were not actually reached. If this occurs, the PWC-PT will present a warning in the diagnostic window and the log file.

*Table 16: Application results for algorithm example 2, wettest month prioritization*

| Category | Number of Apps | Amount Applied |
|---|---|---|
| Annual | 4 | 8 lb./acre (9.0 kg/ha) |
| Pre-Emergence | 2 | 4 lb./acre (4.5 kg/ha) |
| Post-Emergence | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate1 | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate2 | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate3 | 0 | 0 |
| Rate4 | 0 | 0 |

*Table 17: Application results for algorithm example 2, maximum application rate prioritization*

| Category | Number of Apps | Amount Applied |
|---|---|---|
| Annual | 4 | 8 lb./acre (9.0 kg/ha) |
| Pre-Emergence | 2 | 4 lb./acre (4.5 kg/ha) |
| Post-Emergence | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate1 | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate2 | 2 | 4 lb./acre (4.5 kg/ha) |
| Rate3 | 0 | 0 |
| Rate4 | 0 | 0 |

### Example 3 – Rate Limits and Rate Special Instructions

This example highlights rate-specific limits and special instructions. Often a label will specify more than one potential application rate for a use, each with its own maximum number of applications. Rate-specific special instructions such as using a specific rate "only within 30 days of harvest" can also be provided for the use.

In this case there are three unique potential application rates of 5, 4, and 3 lbs./acre (Table 18). However, Rate1 (5 lb./acre) and Rate2 (4 lb./acre) also have a specified maximum number of applications and unique special instructions. The special instructions for rate one are denoted as "Y_E-30", which means applications at this rate can only be made 30 days prior to emergence. Similarly, Rate2 special instructions are Y_E+30, meaning applications at this rate can only be made in the 30 days post-emergence. See **Appendix 2: Rate-Specific Instructions Convention** for more information about how to specify rate-specific special instructions.

*Table 18: Agronomic practices information, algorithm example 3*

| **RunDescriptor** | Example |
|---|---|
| **LabeledUse** | Example |
| **ApplicationMethod** | Ground |
| **Scenario** | Overwinter Example |
| **States** | Example |
| **DriftProfile** | G-LB-F-MC |
| **MaxAnnAmt** | 20 lb./acre (22.4 kg/ha) |
| **MaxAnnNumApps** | 5 |
| **PHI** | 3 |
| **PreEmergence_MaxAmt** | |
| **PreEmergence_MaxNumApps** | |
| **PostEmergence_MaxAmt** | |
| **PostEmergence_MaxNumApps** | |
| **Rate1_MaxAppRate** | 5 lb./acre (5.6 kg/ha) |
| **Rate1_MaxNumApps** | 1 |
| **Rate1_PreEmergenceMRI** | 5 |
| **Rate1_PostEmergenceMRI** | |
| **Rate1_Instructions** | Y_E-30 |
| **Rate2_MaxAppRate** | 4 lb./acre (4.5 kg/ha) |
| **Rate2_MaxNumApps** | 2 |
| **Rate2_PreEmergenceMRI** | |
| **Rate2_PostEmergenceMRI** | 10 |
| **Rate2_Instructions** | Y_E+30 |
| **Rate3_MaxAppRate** | 3 lb./acre (3.4 kg/ha) |
| **Rate3_MaxNumApps** | |
| **Rate3_PreEmergenceMRI** | 5 |
| **Rate3_PostEmergenceMRI** | 5 |
| **Rate3_Instructions** | |
| **Rate4_MaxAppRate** | |
| **Rate4_MaxNumApps** | |
| **Rate4_PreEmergenceMRI** | |
| **Rate4_PostEmergenceMRI** | |
| **Rate4_Instructions** | |

Table 19 shows the derived information. The rate-specific restriction intervals are included.

*Table 19: Information derived from the agronomic practices table, algorithm example 3*

| | |
|---|---|
| **HUC2** | 17a |
| **Emergence** | 10/15 |
| **Harvest** | 7/15 |
| **Rate1_ValidIntervals** | Pre-Emergence |
| **Rate1_instr_startdate** | 9/15 |
| **Rate1_instr_enddate** | 10/15 |
| **Rate1_instr_timeframe** | Y |
| **Rate2_ValidIntervals** | Post-Emergence |
| **Rate2_instr_startdate** | 10/15 |
| **Rate2_instr_enddate** | 11/14 |
| **Rate2_instr_timeframe** | Y |
| **Rate3_ValidIntervals** | Pre-Emergence, Post-Emergence |
| **Rate3_instr_startdate** | |
| **Rate3_instr_enddate** | |
| **Rate3_instr_timeframe** | |
| **Rate4_ValidIntervals** | |
| **Rate4_instr_startdate** | |
| **Rate4_instr_enddate** | |
| **Rate4_instr_timeframe** | |

*Table 20: Wettest month table for HUC 17a, algorithm example 3*

| Wettest Month Rank | Month |
|---|---|
| 1st | 12 |
| 2nd | 11 |
| 3rd | 1 |
| 4th | 2 |
| 5th | 3 |
| 6th | 10 |
| 7th | 4 |
| 8th | 5 |
| 9th | 9 |
| 10th | 6 |
| 11th | 8 |
| 12th | 7 |

As in example 2, there is a different outcome depending on whether wettest months or maximum application rate is prioritized (Table 21 and Table 22). When wettest months are prioritized, only Rate3 is used as it is valid for the first potential application date (Dec 1$^{st}$). Rate2 (4 lbs./acre) is also valid for the post-emergence interval, but the rate-specific restrictions limit the use of this rate to between 10/15 and 11/14 (Table 19), so it is not valid on December 1$^{st}$. Rate three is therefore used for the remaining applications until the maximum annual number of applications is reached.

*Table 21: Application results for algorithm example 3, wettest month prioritization*

| Date | Amount Applied |
|---|---|
| 12-01 | 3 lb./ac (3.4 kg/ha) |
| 12-06 | 3 lb./ac (3.4 kg/ha) |
| 12-11 | 3 lb./ac (3.4 kg/ha) |
| 12-16 | 3 lb./ac (3.4 kg/ha) |
| 12-21 | 3 lb./ac (3.4 kg/ha) |

When the maximum application rate is prioritized, the highest rate (Rate1) is utilized first, then Rate2, then finally Rate3. Rate1 is limited to only one application, and Rate2 is limited to two applications.

*Table 22: Application results for algorithm example 3, maximum application rate prioritization*

| Date | Amount Applied |
|---|---|
| 10-01 | 5 lb./ac (5.6 kg/ha) |
| 10-15 | 4 lb./ac (4.5 kg/ha) |
| 10-25 | 4 lb./ac (4.5 kg/ha) |
| 11-04 | 3 lb./ac (3.4 kg/ha) |
| 11-09 | 3 lb./ac (3.4 kg/ha) |

In both cases, the maximum annual number of applications is reached, but the total amount applied is impacted by the prioritization parameter (Table 23, Table 24).

*Table 23: Application results for algorithm example 3, wettest month prioritization*

| Category | Number of Apps | Amount Applied |
|---|---|---|
| Annual | 5 | 15 (16.8 kg/ha) |
| PreEmergence | 0 | 0 |
| PostEmergence | 5 | 15 (16.8 kg/ha) |
| Rate1 | 0 | 0 |
| Rate2 | 0 | 0 |
| Rate3 | 5 | 15 (16.8 kg/ha) |
| Rate4 | 0 | 0 |

*Table 24: Application results for algorithm example 3, maximum application rate prioritization*

| Category | Number of Apps | Amount Applied |
|---|---|---|
| Annual | 5 | 19 lb./acre (21.3 kg/ha) |
| PreEmergence | 1 | 5 lb./acre (5.6 kg/ha) |
| PostEmergence | 4 | 14 lb./acre (15.7 kg/ha) |
| Rate1 | 1 | 5 lb./acre (5.6 kg/ha) |
| Rate2 | 2 | 8 lb./acre (9.0 kg/ha) |
| Rate3 | 2 | 6 lb./acre (6.7 kg/ha) |
| Rate4 | 0 | 0 |

## Output Files

For both Use Case #1 and Use Case #2, two output files are generated. For Use Case #1, a new batch file (.csv) is created along with a log file (.log). For Use Case #2, a QC report (.csv) is generated along with a log file (.log).

### New PWC Batch File

A new PWC Batch file is created for Use Case #1, and can be used directly into PWC as a batch input file. The field order is identical to the order described in the PWC documentation. Descriptions of the first 86 columns of the batch file are provided below:

| Column | Field Name | Type | Description |
|---|---|---|---|
| 1 | Run Descriptor | String | Run Descriptor (unused by PWC) |
| 2 | Run Name | String | Unique run name (arbitrary to PWC) |
| 3 | SorptionCoefficient (mL/g) | Float/In | Sorption Coefficient (mL/g) |
| 4 | Kocflag | Bool | Koc flag (TRUE if Koc, FALSE if Kd) |
| 5 | WaterColumnMetabolismHalflife | Float/In | Water Column Metabolism half-life (day) |
| 6 | WaterReferenceTemperature (C) | Float/In | Water Reference Temperature (ºC) |
| 7 | BenthicMetabolismHalflife (day) | Float/In | Benthic Metabolism half-life (day) |
| 8 | BenthicReferenceTemperature (C) | Float/In | Benthic Reference Temperature (ºC) |
| 9 | AqueousPhotolysisHalflife (day) | Float/In | Aqueous Photolysis Half-life (ºC) |
| 10 | PhotolysisReferenceLatitude (?) | Float/In | Photolysis reference latitude |
| 11 | HydrolysisHalflife (days) | Float/In | Hydrolysis half-life (day) |
| 12 | SoilHalflife (days) | Float/In | Soil half-life (day) |
| 13 | SoilReferencerTemperature (C) | Float/In | Soil reference temperature (ºC) |
| 14 | FoliarHalflife (day) | Float/In | Foliar half-life (day) |
| 15 | MolecularWeight (g/mol) | Float/In | Molecular weight (g/mol) |
| 16 | VaporPressure (torr) | Float/In | Vapor Pressure (torr) |
| 17 | Solubility (mg/L) | Float/In | Solubility (mg/L) |
| 18 | Henry's Constant | Float/In | Henry’s Constant |
| 19 | Air Diffusion | Float/In | Air Diffusion Coefficient ($cm^3/d$) |
| 20 | Heat of Henry | Float/In | Heat of Henry (J/mol) |
| 21 | HUC2 | String | Hydraulic Unit Code level 2 (*e.g.*, 17a) |
| 22 | Scenario | String | Scenario File |
| 23 | Weather overide | String | Alternative weather file (if blank, use default from scenario) |
| 24 | blank 1 | | LEAVE BLANK |
| 25 | blank 2 | | LEAVE BLANK |
| 26 | blank 3 | | LEAVE BLANK |
| 27 | blank 4 | | LEAVE BLANK |
| 28 | blank 5 | | LEAVE BLANK |
| 29 | blank 6 | | LEAVE BLANK |
| 30 | blank 7 | | LEAVE BLANK |
| 31 | blank 8 | | LEAVE BLANK |
| 32 | blank 9 | | LEAVE BLANK |
| 33 | blank 10 | | LEAVE BLANK |
| 34 | blank 11 | | LEAVE BLANK |
| 35 | AquaticBin | Int | Aquatic Bin Number |
| 36 | FlowAvgTime | Float/In | Flow averaging time |
| 37 | Field Size | Float/In | Field size ($m^2$) |
| 38 | Waterbody Area | Float/In | Water body Area ($m^2$) |

| Column | Field Name | Type | Description |
|---|---|---|---|
| 39 | Init Depth | Float/In | Initial Depth (m) |
| 40 | Max Depth | Float/In | Max Depth (m) |
| 41 | HL | Float/In | Hydraulic Length (m) |
| 42 | PUA | | PUA |
| 43 | Baseflow | Float/In | Baseflow ($m^3/s$) |
| 44 | Num_Daysheds | | Number of Daysheds |
| 45 | IRF1 | | Dayshed fraction 1 |
| 46 | IRF2 | | |
| 47 | IRF3 | | |
| 48 | IRF4 | | |
| 49 | IRF5 | | |
| 50 | IRF6 | | |
| 51 | IRF7 | | |
| 52 | IRF8 | | |
| 53 | IRF9 | | |
| 54 | IRF10 | | |
| 55 | IRF11 | | |
| 56 | IRF12 | | |
| 57 | IRF13 | | |
| 58 | IRF14 | | |
| 59 | IRF15 | | |
| 60 | IRF16 | | |
| 61 | IRF17 | | |
| 62 | IRF18 | | |
| 63 | IRF19 | | |
| 64 | IRF20 | | |
| 65 | IRF21 | | |
| 66 | IRF22 | | |
| 67 | IRF23 | | |
| 68 | IRF24 | | |
| 69 | IRF25 | | |
| 70 | IRF26 | | |
| 71 | IRF27 | | |
| 72 | IRF28 | | |
| 73 | IRF29 | | |
| 74 | IRF30 | | |
| 75 | IRF31 | | |
| 76 | NumberofApplications | Int | Number of Applications |
| 77 | Absolute Dates? | Bool | True = Absolute Dates, False = Relative Dates |
| 78 | Relative Dates? | | |
| 79 | Day1 | Int | First application day |
| 80 | Month1 | Int | First application Month |
| 81 | AppRate1 | Float | First application rate (kg/ha) |
| 82 | ApplicationMethod1 | Int | First application method |
| 83 | Depth1 | Float/In | First application depth, if applicable (cm) |
| 84 | T-BandSplit1 | | First application T-split, if applicable |
| 85 | Eff.1 | Float | First application efficiency |
| 86 | Drift1 | Float | First application drift |

### *Run Name Convention*

Convention for the "Run Name" field is "rundescriptor_huc2_scenario_bin_appmethod_driftprofile_distance_transportmechanism_depth_tband_randstartdates_dateprior".

## QC Report

For Use Case #2, a QC report (.csv) is produced (Table 25) in addition to a log file. The QC report indicates APT compliance for each run in a user specified PWC Batch File. See more about Use Case #2 in the **PWC-PREP Tool Functions (Use Cases**) section.

*Table 25: QC report field information*

| Field Name | Type | Description |
|---|---|---|
| RunisValid | Bool | Overall indicator if run is label compliant |
| RunDescriptor | String | Run descriptor |
| RunName | String | Run Name |
| HUC | String | HUC2 region |
| Bin | Int | Aquatic bin |
| Scenario | String | Scenario |
| EmergenceDate | Date | Scenario emergence date |
| HarvestDate | Date | Scenario harvest date |
| AppRates(kg/ha) | List [Date] | List of application rates |
| AppDates (sorted) | List [Date] | List of application dates (sorted) |
| Check_Ann_NumApps_NotExceeded | Bool | True if annual number of apps. not exceeded |
| Modeled_Ann_NumApps | Int | Total number of apps. in batch file |
| Label_Ann_NumApps | Int | Total number of apps. on label (APT) |
| Check_Ann_Amt_NotExceeded | Bool | True if annual maximum amt. not exceeded |
| Modeled_Ann_Amt | Float | Total amount in batch file |
| Label_Ann_Amt | Float | Total amount in label (APT) |
| Difference_Ann_Amt | Float | Difference between modeled and label total amount |
| Check_PreE_NumApps_NotExceeded | Bool | True if pre-emergence number of applications not exceeded |
| Modeled_PreE_NumApps | Int | Pre-emergence number of apps. in batch file |
| Label_PreE_NumApps | Int | Pre-emergence max. number of apps. on label |
| Check_PreE_Amt_NotExceeded | Bool | True if pre-emergence amount not exceeded |
| Modeled_PreE_Amt | Float | Pre-emergence max. amount in batch file |
| Label_PreE_Amt | Float | Pre-emergence max. amount on label |
| Difference_PreE_Amt | Float | Difference between modeled and label pre-emergence amt. |
| Check_PostE_NumApps_NotExceeded | Bool | True if post-emergence number of applications not exceeded |
| Modeled_PostE_NumApps | Int | Post-emergence number of apps. in batch file |
| Label_PostE_NumApps | Int | Post-emergence max. number of apps. on label |
| Check_PostE_Amt_NotExceeded | Bool | True if post-emergence amount not exceeded |
| Modeled_PostE_Amt | Float | Post-emergence max. amount in batch file |
| Label_PostE_Amt | Float | Post-emergence max. amount on label |
| Difference_PostE_Amt | Float | Difference between modeled and label post-emergence amt. |
| Check_MRI_NotWithin | Bool | True if the MRI is adhered to for all apps. |
| Modeled_MRIs | List [Int] | List of MRIs in batch file |
| Label_MRI | Int | Label specific MRI (Note: Compared to Rate1 MRI) |
| Check_NoDuplicate_AppDates | Bool | True if there are no duplicate application dates |
| Check_PreHarvInt_NotWithin | Bool | True if no apps. within the pre-harvest interval |
| Label_PreHarvInt | Int | Pre-harvest interval on label |
| Check_NumAppsField_IsCorrect | Bool | True if the "number of applications" field is correct |
| NumAppsField | Int | Value in the number of apps. field in batch file |
| Modeled_NumApps | Int | Actual number of applications in the batch file |

### Log File

For both Use Cases, a log file is produced. The log file contains information about the execution of the PWC-PT, including any warnings, errors, or information the user might find relevant to better understand how the PWC-PT generated the assigned dates and application rates.

## Limitations

Although the PWC-PREP Tool is powerful, there are limitations. The PWC-PREP Tool date assignment algorithm does not account for rain events. For example, a label may state “do not apply x hours before or during a rain event”. The PWC-PREP Tool *does not consider rain events* when assigning application dates, but this is a feature being considered for a future version of the tool.

An additional limitation is the PWC-PT can account for up to four unique crop cycles in the APT by specifying a date range in the rate specific instructions for each rate in the APT; however, there currently is no way to account for more than four crop cycles.

# Appendix 1: Input File Examples

## Agronomic Practices Table (APT)

Table 27 below shows an example of an APT. A default example APT that a user can start with is included with the PWC-PT in the '[UserHome]\PWC-PT\data' folder.

*Table 26: Example Agronomic Practices Table*

(Note this example does not show columns for Rates 2 through 4)

| RunDescriptor | LabeledUse | ApplicationMethod | DriftProfile | Scenario | States | MaxAnnAmt | MaxAnnNumApps | PHI | PreEmergence_MaxAmt | PreEmergence_MaxNumApps | PostEmergence_MaxAmt | PostEmergence_MaxNumApps | Rate1_MaxAppRate | Rate1_MaxNumApps | Rate1_PreEmergenceMRI | Rate1_PostEmergenceMRI | Rate1_Instructions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alfalfa_a | HAY, ALFALFA | 2 | A-F-M | GrasslandESA | All | 13.0 | 18 | 7 | | | 13 | 18 | 0.9 | 18 | | 5 | |
| Bermudagrass_6CC_a | GRASSES & LEGUMES TOTALS | 2 | A-F-M | GrasslandESA | All-AZ | 5.4 | 6 | 3 | | | 5.4 | 6 | 0.9 | 6 | | 31 | |
| Bermudagrass_9CC_a | GRASSES & LEGUMES TOTALS | 2 | A-F-M | GrasslandESA | AZ | 8.1 | 9 | 3 | | | 8.1 | 9 | 0.9 | 9 | | 31 | |
| Corn_a | CORN, GRAIN | 2 | A-F-M | CornESA | All | 2.25 | 5 | 3 | | | 2.25 | 5 | 0.45 | 2 | | 5 | Y_E+14>E+21 |
| Corn_2CC_a | CORN, GRAIN | 2 | A-F-M | CornESA | CA, HI, TX | 4.5 | 10 | 3 | | | 4.5 | 10 | 0.45 | 2 | | 5 | Y_E+14>E+21 |
| Cotton_East_a | COTTON | 2 | A-F-M | CottonESA | East of Rockies | 1.35 | 2 | 15 | | | 1.35 | 2 | 0.675 | 2 | | 5 | |
| Cotton_West_a | COTTON | 2 | A-F-M | CottonESA | West of Rockies | 1.35 | 2 | 15 | | | 1.35 | 2 | 0.675 | 2 | | 3 | |
| Peach_a | PEACHES | 2 | A-F-M | OrchardESA | All | 5.4 | 6 | 4 | 5.4 | 6 | 5.4 | 6 | 0.9 | 6 | 5 | 5 | |
| Pear_a | PEARS | 2 | A-F-M | OrchardESA | CT, DE, NH, NJ, NY, MD, ME, MA, PA, RI, VT | 1.8 | 2 | 7 | 1.8 | 2 | 1.8 | 2 | 0.9 | 2 | 5 | 5 | |
| Citrus_a | CITRUS TOTALS | 2 | A-F-M | CitrusESA | AZ, CA, HI | 2.7 | 3 | 1 | 2.7 | 3 | 2.7 | 3 | 0.9 | 3 | 5 | 5 | |
| Pecan_a | PECANS | 2 | A-F-M | OrchardESA | AL, AR, FL, GA, LA, KY, NC, MS, SC, TN, VA, WV | 6.3 | 7 | 30 | 6.3 | 7 | 6.3 | 7 | 0.9 | 7 | 5 | 5 | |
| Peanut_a | PEANUTS | 2 | A-F-M | OtherRowESA | All | 3.6 | 4 | 21 | | | 3.6 | 4 | 0.9 | 4 | | 5 | |
| Turf_a | Sod Farms | 2 | A-F-M | OtherCropESA | All | 3.6 | 4 | 0 | | | 3.6 | 4 | 0.9 | 4 | | 5 | |
| Sorghum_a | SORGHUM, GRAIN | 2 | A-F-M | OtherGrainESA | All | 0.9 | 2 | 14 | | | 0.9 | 2 | 0.45 | 2 | | 5 | |
| Soybean_a | SOYBEANS | 2 | A-F-M | SoybeanESA | All | 1.35 | 3 | 3 | | | 1.35 | 3 | 0.45 | 3 | | 5 | |
| Soybean_HiRate_a | SOYBEANS | 2 | A-F-M | SoybeanESA | AR, LA | 2.7 | 3 | 3 | | | 2.7 | 3 | 0.9 | 3 | | 5 | |
| Tobacco_a | TOBACCO | 2 | A-F-M | OtherRowESA | All | 2.25 | 5 | 5 | | | 2.25 | 5 | 0.45 | 5 | | 5 | |
| Vegetable_a | VEGETABLE TOTALS | 2 | A-F-M | VegetableESA | All-AZ | 13.0 | 16 | 3 | | | 13 | 16 | 0.9 | 16 | | 2 | |
| Vegetable_AZ_a | VEGETABLE TOTALS | 2 | A-F-M | VegetableESA | AZ | 13.0 | 24 | 3 | | | 13 | 24 | 0.9 | 24 | | 2 | |
| Wheat_a | WHEAT | 2 | A-F-M | WheatESA | ID, OR, WA | 1.8 | 4 | 7 | | | 1.8 | 4 | 0.45 | 4 | | 5 | |
| SugarBeet_a | SUGARBEETS | 2 | A-F-M | OtherRowESA | All | 4.5 | 5 | 21 | | | 4.5 | 5 | 0.9 | 5 | | 5 | |
| Lentils_a | LENTILS | 2 | A-F-M | VegetableESA | All | 0.9 | 1 | 21 | | | 0.9 | 1 | 0.9 | 1 | | 5 | |

### States Field Convention

The "States" field in the APT is used to specify the states for which the labeled use and corresponding restrictions are valid, and the PWC-PT will generate PWC model runs for all HUC2s that intersect the states listed. The "States" field can be specified a variety of ways, as presented in Table 27.

*Table 27: States field convention in APT.*

| Value | Description |
|---|---|
| OR | A single state |
| OR, WA, CA | Multiple states separated by a comma |
| All | All states |
| All – OR, WA, CA | All states excluding a few |
| West of Rockies | All states west of the Rocky Mountains |
| East of Rockies | All states east of the Rocky Mountains |

### Census of Agriculture Crop-to-State Lookup Table

The PWC-PT implements a crop-to-state lookup table to increase the accuracy of modeling labeled uses[4]. Although product labels specify that application may be made to a given crop in "all states", often a particular use is not grown in all states specified by the label. For example, in the sample APT presented above (Table 26), the label does not provide any state restrictions for use on tobacco. However, tobacco is actually grown in only a subset of the states (Table 28). To efficiently address this problem, the PWC-PT generates runs for only the HUC2s that are determined to be relevant to a given use site by using a state to HUC2 lookup table. Using the lookup table, for any specified use site (row in the APT) the PWC-PT can determine which states are specified by the label, and for that specific use considers only those states where the crop is grown. The resulting subset of states is used to determine which HUC2s to generate PWC runs for.

This crop to state lookup table is included as a sheet in the default APT workbook (provided with the PWC-PREP Tool). Users can enter the name of the crop from the lookup table (Table 28) in the "LabeledUse" column in the APT (*e.g.*, Table 26). Alternatively, the user can enter any string they like in the "LabeledUse" column to include all states specified by the label.

*Table 28: Crop to state lookup table derived from USDA Census of Agriculture 2017*

| Crop | States Where Crop is Grown (According to 2017 USDA Census of Agriculture) |
|---|---|
| ALMONDS | AL, AZ, AR, CA, CO, FL, GA, IL, KY, MS, MO, NM, OH, SC, TN, TX, UT, VA, WA |
| APPLES | AL, AK, AZ, AR, CA, CO, CT, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| APRICOTS | AL, AZ, AR, CA, CO, GA, HI, ID, IL, IA, KS, KY, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WA, WV, WI |
| ARONIA BERRIES | CA, IL, IA, KS, KY, MD, MA, MI, MN, MO, MT, NE, NJ, NC, ND, OH, OR, PA, SD, TN, VT, VA, WA, WI |
| ARTICHOKES | AZ, CA, CO, HI, MD, MA, MN, MO, NH, NM, NY, NC, OH, OR, SC, TX, VT, VA, WA, WI |
| ASPARAGUS | AL, AK, AZ, AR, CA, CO, CT, FL, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| AVOCADOS | CA, FL, HI, LA, TX |
| BANANAS | CA, FL, HI, SC, TX |
| BARLEY | AL, AK, AZ, CA, CO, CT, DE, GA, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MO, MT, NE, NV, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |

[4] The state(s) in which a given crop is grown has been determined by using the 2017 Census of Agriculture to identify all states that list production for that crop. It is anticipated that this Crop-to-State LUT will be updated with each new release of the Census of Agriculture.

| Crop | States Where Crop is Grown (According to 2017 USDA Census of Agriculture) |
|---|---|
| BEANS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| BEANS, DRY EDIBLE, (EXCL. CHICKPEAS & LIMA) | AZ, CA, CO, HI, ID, IL, KS, ME, MA, MI, MN, MT, NE, NV, NM, NY, NC, ND, OH, OK, OR, SD, TX, VT, VA, WA, WI, WY |
| BEETS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| BLACKBERRIES | AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| BLUEBERRIES | AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, OH, OK, OR, PA, RI, SC, SD, TN, TX, VT, VA, WA, WV, WI |
| BOYSENBERRIES | CA, NJ, NY, OR, PA, SC, TN, TX, UT, WA |
| BROCCOLI | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| BRUSSELS SPROUTS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MO, MT, NE, NJ, NM, NY, NC, OH, OR, PA, RI, SC, SD, TN, TX, VT, VA, WV, WI |
| BUCKWHEAT | ID, IL, IA, ME, MI, MN, MO, MT, NE, NJ, NY, ND, OH, OR, PA, SD, WA, WI |
| CABBAGE | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CAMELINA | MS, MT |
| CANOLA | CO, ID, IN, KS, KY, LA, MN, MO, MT, ND, OK, OR, PA, TN, TX, WA |
| CARROTS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CAULIFLOWER | AL, AK, AZ, AR, CA, CO, CT, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| CELERY | AK, AZ, AR, CA, CO, CT, GA, HI, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MO, MT, NE, NH, NJ, NM, NY, NC, OH, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV |
| CHERIMOYAS | CA, HI |
| CHERRIES | AL, AK, AZ, AR, CA, CO, CT, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CHESTNUTS | AL, AR, CA, CT, FL, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MS, MO, NJ, NM, NY, NC, OH, OR, PA, RI, SC, TN, TX, VT, VA, WA, WV, WI |
| CHICKPEAS | AZ, CA, ID, MN, MT, NE, ND, OR, SD, WA, WY |
| CHICORY | CA, CT, IL, KY, LA, ME, MD, MA, MT, NJ, NY, NC, OR, PA, SC, VT, VA, WA, WI |
| CITRUS TOTALS | AL, AZ, CA, FL, GA, HI, LA, SC, TX |
| CITRUS, OTHER | CA, HI, TX |
| COFFEE | HI |
| CORN, GRAIN | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CORN, SILAGE | AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CORN, TRADITIONAL OR INDIAN | AZ, CA, CO, CT, IL, IN, IA, KY, ME, MD, MA, MN, NJ, NM, NY, NC, OH, OR, PA, TN, UT, WA, WI |
| COTTON | AL, AZ, AR, CA, FL, GA, KS, LA, MS, MO, NM, NC, OK, SC, TN, TX, VA |
| CRANBERRIES | ME, MA, MI, NJ, OR, WA, WI |
| CUCUMBERS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| CURRANTS | AK, CA, IL, IN, MD, MA, MI, MN, MT, NH, NJ, NY, ND, OH, OR, PA, SD, UT, VT, WA, WI |
| DAIKON | AZ, CA, CO, CT, FL, GA, HI, IL, IN, IA, KS, LA, ME, MD, MA, MI, MN, MO, MT, NE, NH, NJ, NM, NY, NC, OH, OR, PA, SC, TN, TX, VT, VA, WA, WI |
| DATES | AZ, CA, NM |

| Crop | States Where Crop is Grown (According to 2017 USDA Census of Agriculture) |
|---|---|
| EGGPLANT | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| ELDERBERRIES | AL, CA, CO, CT, FL, GA, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, NE, NH, NJ, NY, NC, OH, OK, OR, PA, SC, SD, TN, TX, VT, VA, WA, WV, WI |
| EMMER & SPELT | IL, IN, KY, ME, MD, MI, MO, MT, NY, ND, OH, PA, WA, WV, WI |
| ESCAROLE & ENDIVE | CA, CO, CT, FL, GA, HI, IL, IN, IA, KY, ME, MD, MA, MI, MN, MO, MT, NH, NJ, NY, NC, OH, OR, PA, TN, VT, VA, WA, WI |
| FIGS | AL, AR, CA, DE, FL, GA, IL, KY, LA, MD, MS, MO, NJ, NM, NY, NC, OK, OR, PA, SC, TN, TX, VA, WA, WV |
| FLAXSEED | ID, MN, MT, ND, OR, SD, WA |
| GARLIC | AL, AK, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NV, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TX, UT, VT, VA, WA, WV, WI, WY |
| GINGER ROOT | AL, AZ, CA, CT, FL, GA, HI, ID, IL, IN, KS, KY, ME, MD, MA, MI, MN, MS, MO, NJ, NY, NC, OR, PA, SC, TN, VT, VA, WI |
| GINSENG | CA, KY, NY, NC, SC, TN, WI |
| GRAPEFRUIT | AL, AZ, CA, FL, HI, LA, TX |
| GRAPES | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| GRASSES & LEGUMES TOTALS | CA, CO, FL, GA, ID, KS, KY, MN, MT, NE, NV, OR, UT, WA, WY |
| GREENS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| GUAR | OK, TX |
| GUAVAS | CA, FL, HI, TX |
| HAY | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAY & HAYLAGE | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAY, (EXCL ALFALFA) | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAY, ALFALFA | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAY, IRRIGATED | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, WA, WI, WY |
| HAYLAGE | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAYLAGE, ALFALFA | AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| HAZELNUTS | AL, AR, CA, CO, CT, FL, GA, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, NE, NJ, NM, NY, NC, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| HERBS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SD, TN, TX, UT, VT, VA, WA, WI, WY |
| HERBS, DRY | AK, CA, CO, CT, GA, HI, KY, ME, MA, MI, MT, NM, NY, NC, OR, PA, SD, TN, TX, VT, VA, WV |
| HOPS | AR, CO, CT, ID, IL, IN, IA, KY, ME, MD, MA, MI, MN, MO, MT, NV, NJ, NM, NY, NC, OH, OR, PA, TN, VT, VA, WA, WI |
| HORSERADISH | AL, AZ, CA, CO, CT, HI, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MO, NE, NH, NJ, NY, NC, OH, PA, SD, TN, VT, VA, WA, WV |
| JOJOBA | AZ, CA |
| KIWIFRUIT | AL, CA, FL, GA, MS, MO, NC, OR, PA, SC, TN, VT, VA, WA, WV |
| KUMQUATS | CA, FL, HI, TX |
| LEGUMES, ALFALFA, SEED | AZ, CA, ID, KS, MT, NE, OR, PA, SD, TX, UT, VA, WA, WY |
| LEMONS | AZ, CA, FL, GA, HI, LA, MS, TX |
| LENTILS | CA, ID, MN, MT, NE, NY, ND, SD, WA |

| Crop | States Where Crop is Grown (According to 2017 USDA Census of Agriculture) |
|---|---|
| LETTUCE | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| LIMES | AL, AZ, CA, FL, GA, HI, LA, MS, TX |
| LOGANBERRIES | CA, FL, MI, NC, OR, TN, WA |
| MACADAMIAS | CA, FL, HI |
| MANGOES | CA, FL, HI, TX |
| MELONS | AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| MINT, OIL | CA, ID, IN, OR, TN, WA, WV, WI |
| MISCANTHUS | MO, NC |
| MUSTARD, SEED | CA, ID, MT, NC, ND, OR, WA |
| NECTARINES | AL, AZ, AR, CA, CO, CT, FL, GA, ID, IL, IN, KS, KY, ME, MD, MA, MI, MS, MO, NH, NJ, NM, NY, NC, OH, OK, OR, PA, SC, TN, TX, UT, WA, WV |
| OATS | AL, AK, AR, CA, CO, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| OKRA | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NJ, NM, NY, NC, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| OLIVES | AZ, CA, GA, IL, OR, TX |
| ONIONS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| ORANGES | AL, AZ, CA, FL, GA, HI, LA, MS, SC, TX |
| ORCHARDS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| PAPAYAS | CA, FL, HI, TX |
| PARSLEY | AL, AK, AR, CA, CO, CT, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MO, MT, NE, NV, NH, NJ, NM, NY, NC, OH, OR, PA, RI, SD, TN, UT, VT, VA, WA, WV, WI |
| PASSION FRUIT | CA, FL, HI |
| PEACHES | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| PEANUTS | AL, AR, CA, FL, GA, HI, LA, MS, NM, NC, OK, SC, TX, VA |
| PEARS | AL, AZ, AR, CA, CO, CT, DE, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| PEAS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| PEAS, AUSTRIAN WINTER | CO, ID, MT, OR, WA |
| PEAS, DRY EDIBLE | CA, CO, ID, IL, IA, KS, MI, MN, MO, MT, NE, NM, NY, ND, OK, OR, SC, SD, TX, WA, WI, WY |
| PECANS | AL, AZ, AR, CA, FL, GA, IL, IN, KS, KY, LA, MD, MI, MS, MO, NE, NV, NM, NY, NC, OH, OK, SC, TN, TX, UT, VA |
| PEPPERS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| PERSIMMONS | AL, AR, CA, CT, FL, GA, HI, IL, IN, IA, KS, KY, LA, MD, MI, MS, MO, NJ, NY, NC, OH, OK, OR, PA, SC, TN, TX, VA, WA, WV, WI |
| PINEAPPLES | HI |
| PISTACHIOS | AZ, CA, NV, NM, TX, UT |
| PLUMS | AL, AZ, AR, CA, CO, CT, ID, IL, IN, IA, KY, LA, ME, MA, MI, MS, MO, MT, NE, NV, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WY |
| POMEGRANATES | AL, AZ, CA, FL, GA, HI, LA, MS, NV, NM, SC, TX, UT |
| POTATOES | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| PRUNES | CA, CO, ID, IL, ME, MA, MI, MO, MT, NM, NY, OH, OR, PA, TN, UT, WA |
| PUMPKINS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |

| Crop | States Where Crop is Grown (According to 2017 USDA Census of Agriculture) |
|---|---|
| RADISHES | AL, AK, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| RAPESEED | ID, MI, NC, OR, PA, SC |
| RASPBERRIES | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| RHUBARB | AL, AK, AR, CO, CT, GA, HI, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, OH, OR, PA, RI, SD, TN, UT, VT, VA, WA, WV, WI, WY |
| RICE | AR, CA, FL, LA, MS, MO, TN, TX |
| RYE | AL, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, ME, MD, MA, MI, MN, MO, MT, NE, NJ, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, VT, VA, WA, WV, WI |
| SAFFLOWER | CA, ID, MT, ND, SD, UT |
| SESAME | FL, KS, OK, TX |
| SORGHUM, GRAIN | AL, AZ, AR, CA, CO, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, MD, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, ND, OH, OK, PA, SC, SD, TN, TX, VA, WV, WI |
| SORGHUM, SILAGE | AL, AZ, AR, CA, CO, FL, GA, ID, IL, IN, IA, KS, KY, LA, MD, MI, MN, MO, NE, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WV, WI, WY |
| SOYBEANS | AL, AR, CO, CT, DE, FL, GA, HI, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, ND, OH, OK, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| SPINACH | AL, AK, AZ, AR, CA, CO, DE, FL, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, OH, OK, OR, PA, RI, SC, SD, TX, UT, VT, VA, WA, WV, WI, WY |
| SQUASH | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| STRAWBERRIES | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| SUGARBEETS | CO, ID, MI, MN, MT, NE, ND, OR, WY |
| SUNFLOWER | AL, CA, CO, FL, GA, IL, IN, IA, KS, KY, MD, MI, MN, MO, MT, NE, NJ, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, VA, WA, WV, WI, WY |
| SWEET CORN | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| SWEET POTATOES | AL, AZ, AR, CA, CO, CT, DE, FL, GA, HI, IL, IN, IA, KS, KY, LA, ME, MD, MA, MN, MS, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI |
| TANGELOS | AL, AZ, CA, FL, HI, TX |
| TANGERINES | AL, AZ, CA, FL, GA, HI, LA, MS, TX |
| TARO | CA, HI, ME, MA |
| TOBACCO | CT, FL, GA, IN, KY, MD, MA, MO, NC, OH, PA, SC, TN, VA, WI |
| TOMATOES | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NV, NH, NJ, NM, NY, NC, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| TRITICALE | CA, CO, ID, IL, IN, IA, KS, MD, MI, MN, MO, MT, NE, NY, NC, ND, OH, OK, OR, PA, SD, TN, TX, UT, VA, WA, WI, WY |
| TURNIPS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, TN, TX, VT, VA, WA, WV, WI, WY |
| VEGETABLE TOTALS | AL, AK, AZ, AR, CA, CO, CT, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| WALNUTS | AL, AZ, AR, CA, CO, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, NE, NV, NJ, NM, NY, NC, OH, OK, OR, PA, RI, SC, TN, TX, UT, VT, VA, WA, WV, WI |
| WATERCRESS | CA, CT, HI, IL, ME, MD, MA, MI, MN, MS, NY, NC, OH, OR, TN, VA, WA, WI |
| WHEAT | AL, AK, AZ, AR, CA, CO, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MI, MN, MS, MO, MT, NE, NV, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY |
| WHEAT, SPRING, DURUM | AZ, CA, CO, ID, MN, MT, NM, NY, ND, OR, SD |
| WHEAT, WINTER | AL, AR, CA, CO, DE, FL, GA, ID, IL, IN, IA, KS, KY, LA, ME, MD, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, ND, OH, OR, PA, SC, SD, TN, TX, UT, VT, VA, WA, WV, WY |
| WILD RICE | CA, MN |

## AgDRIFT Reduction Table

The AgDRIFT Reduction Table maps a drift profile code ("Profile" column) to efficiency and drift factor values based on application distance from the target waterbody. See Table 29: AgDRIFT Reduction Table example.

*Table 29: AgDRIFT Reduction Table example*

| Profile | Description | Efficiency | 000m | 030m | 060m | 090m | 120m | 150m | 300m |
|---|---|---|---|---|---|---|---|---|---|
| 4-A-VF-F | Bin 4 - Aerial (Very Fine to Fine) | 0.95 | 0.25828 | 0.15828 | 0.11262 | 0.08860 | 0.07420 | 0.06454 | 0.04573 |
| 4-A-F-M | **Bin 4 - Aerial (Fine to Medium), EPA Default** | 0.95 | 0.13490 | 0.05608 | 0.03444 | 0.02558 | 0.02070 | 0.01782 | 0.01305 |
| 4-A-M-C | Bin 4 - Aerial (Medium to Coarse) | 0.95 | 0.09654 | 0.03025 | 0.01704 | 0.01196 | 0.00961 | 0.00828 | 0.00591 |
| 4-A-C-VC | Bin 4 - Aerial (Coarse to Very Coarse) | 0.95 | 0.07574 | 0.01888 | 0.01025 | 0.00729 | 0.00585 | 0.00501 | 0.00345 |
| 4-AB-N | Bin 4 - Airblast (Normal; Stone, Pome, Vinyard) | 0.99 | 0.00122 | 0.00037 | 0.00023 | 0.00012 | 0.00010 | 0.00009 | 0.00004 |
| 4-AB-D | Bin 4 - Airblast (Dense; Citrus, Tall Trees) | 0.99 | 0.01653 | 0.00340 | 0.00190 | 0.00138 | 0.00104 | 0.00090 | 0.00056 |
| 4-AB-SP | **Bin 4 - Airblast (Sparse: young, dormant), EPA Default** | 0.99 | 0.04807 | 0.00366 | 0.00115 | 0.00060 | 0.00036 | 0.00023 | 0.00006 |
| 4-AB-VI | Bin 4 - Airblast (Vineyard) | 0.99 | 0.00264 | 0.00038 | 0.00023 | 0.00012 | 0.00009 | 0.00007 | 0.00003 |
| 4-AB-ORC | Bin 4 - Airblast (Orchard) | 0.99 | 0.02495 | 0.00349 | 0.00179 | 0.00117 | 0.00093 | 0.00069 | 0.00045 |
| 4-AB-AP | Bin 4 - Airblast (Apples) | 0.99 | 0.00091 | 0.00037 | 0.00023 | 0.00022 | 0.00012 | 0.00011 | 0.00008 |
| 4-AB-APd | Bin 4 - Airblast (Apples Dormant) | 0.99 | 0.07281 | 0.00295 | 0.00067 | 0.00026 | 0.00012 | 0.00009 | 0.00002 |
| 4-AB-OR | Bin 4 - Airbast (Oranges) | 0.99 | 0.01222 | 0.00157 | 0.00084 | 0.00048 | 0.00036 | 0.00033 | 0.00011 |
| 4-AB-AL | Bin 4 - Airblast (Almond) | 0.99 | 0.00697 | 0.00067 | 0.00025 | 0.00012 | 0.00008 | 0.00006 | 0.00002 |
| 4-AB-GR-W | Bin 4 - Airblast (Grape, wrap around sprayer) | 0.99 | 0.00040 | 0.00012 | 0.00008 | 0.00006 | 0.00005 | 0.00004 | 0.00002 |
| 4-AB-GR | Bin 4 - Airblast (Grape) | 0.99 | 0.00264 | 0.00038 | 0.00023 | 0.00012 | 0.00009 | 0.00007 | 0.00003 |
| 4-AB-P | Bin 4 - Airblast (Pecans) | 0.99 | 0.02443 | 0.00539 | 0.00318 | 0.00231 | 0.00194 | 0.00159 | 0.00111 |
| 4-G-HB-VF-F | **Bin 4 - Ground (high boom, VF to Fine), EPA Default** | 0.99 | 0.06610 | 0.01441 | 0.00855 | 0.00586 | 0.00431 | 0.00335 | 0.00156 |
| 4-G-LB-VF-F | Bin 4 - Ground (Low boom, VF to Fine) | 0.99 | 0.02723 | 0.00604 | 0.00387 | 0.00290 | 0.00230 | 0.00194 | 0.00111 |
| 4-G-HB-F-MC | Bin 4 - Ground (High boom, Fine to M/C)) | 0.99 | 0.01662 | 0.00457 | 0.00315 | 0.00232 | 0.00184 | 0.00149 | 0.00089 |
| 4-G-LB-F-MC | Bin 4 - Ground (Low boom, Fine to M/C) | 0.99 | 0.01082 | 0.00299 | 0.00210 | 0.00162 | 0.00137 | 0.00114 | 0.00067 |
| 7-A-VF-F | Bin 7 - Aerial (Very Fine to Fine) | 0.95 | 0.2421 | 0.1455 | 0.1033 | 0.0812 | 0.0677 | 0.0588 | 0.0394 |
| 7-A-F-M | **Bin 7 - Aerial (Fine to Medium), EPA Default** | 0.95 | 0.1254 | 0.0508 | 0.0318 | 0.0234 | 0.0189 | 0.0162 | 0.0113 |
| 7-A-M-C | Bin 7 - Aerial (Medium to Coarse) | 0.95 | 0.0885 | 0.0274 | 0.0156 | 0.0109 | 0.0087 | 0.0075 | 0.0051 |
| 7-A-C-VC | Bin 7 - Aerial (Coarse to Very Coarse) | 0.95 | 0.0681 | 0.0169 | 0.0094 | 0.0067 | 0.0054 | 0.0045 | 0.0030 |
| 7-AB-N | Bin 7 - Airblast (Normal; Stone, Pome, Vinyard) | 0.99 | 0.0011 | 0.0003 | 0.0002 | 0.0001 | 0.00010 | 0.00008 | 0.00003 |
| 7-AB-D | Bin 7 - Airblast (Dense; Citrus, Tall Trees) | 0.99 | 0.0145 | 0.0030 | 0.0017 | 0.0012 | 0.0010 | 0.0008 | 0.0004 |
| 7-AB-SP | **Bin 7 - Airblast (Sparse: young , dormant), EPA Default** | 0.99 | 0.0416 | 0.0032 | 0.0011 | 0.0005 | 0.00030 | 0.00020 | 0.00004 |
| 7-AB-VI | Bin 7 - Airblast (Vineyard) | 0.99 | 0.0024 | 0.0004 | 0.0002 | 0.0001 | 0.00009 | 0.00007 | 0.00003 |
| 7-AB-ORC | Bin 7 - Airblast (Orchard) | 0.99 | 0.0218 | 0.0031 | 0.0016 | 0.0011 | 0.0008 | 0.0007 | 0.0003 |
| 7-AB-AP | Bin 7 - Airblast (Apples) | 0.99 | 0.0008 | 0.0004 | 0.0002 | 0.0002 | 0.0001 | 0.0001 | 0.00007 |
| 7-AB-APd | Bin 7 - Airblast (Apples Dormant) | 0.99 | 0.0631 | 0.0024 | 0.0006 | 0.0003 | 0.0001 | 0.00008 | 0.00001 |
| 7-AB-OR | Bin 7 - Airbast (Oranges) | 0.99 | 0.0107 | 0.0014 | 0.0007 | 0.0005 | 0.0004 | 0.0003 | 0.0001 |
| 7-AB-AL | Bin 7 - Airblast (Almond) | 0.99 | 0.0061 | 0.0006 | 0.0002 | 0.0001 | 0.00008 | 0.00005 | 0.00002 |
| 7-AB-GR-W | Bin 7 - Airblast (Grape, wrap around sprayer) | 0.99 | 0.0004 | 0.0001 | 0.00008 | 0.00006 | 0.00005 | 0.00004 | 0.00002 |
| 7-AB-GR | Bin 7 - Airblast (Grape) | 0.99 | 0.0024 | 0.0004 | 0.0002 | 0.0001 | 0.00009 | 0.00007 | 0.00003 |
| 7-AB-P | Bin 7 - Airblast (Pecans | 0.99 | 0.0216 | 0.0049 | 0.0029 | 0.0021 | 0.00170 | 0.00150 | 0.00090 |
| 7-G-HB-VF-F | **Bin 7 - Ground (high boom, VF to Fine), EPA Default** | 0.99 | 0.0616 | 0.0131 | 0.00790 | 0.00540 | 0.00400 | 0.00310 | 0.00120 |
| 7-G-LB-VF-F | Bin 7 - Ground (Low boom, VF to Fine) | 0.99 | 0.0268 | 0.0055 | 0.00360 | 0.00270 | 0.00210 | 0.00180 | 0.00090 |
| 7-G-HB-F-MC | Bin 7 - Ground (High boom, Fine to M/C)) | 0.99 | 0.0165 | 0.0042 | 0.0029 | 0.0022 | 0.0017 | 0.0014 | 0.0007 |
| 7-G-LB-F-MC | Bin 7 - Ground (Low boom, Fine to M/C) | 0.99 | 0.0109 | 0.0028 | 0.0019 | 0.0015 | 0.0012 | 0.0010 | 0.0006 |
| 10-A-VF-F | Bin 10 - Aerial (Very Fine to Fine) | 0.95 | 0.2421 | 0.1455 | 0.1033 | 0.0812 | 0.0677 | 0.0588 | 0.0394 |
| 10-A-F-M | **Bin 10 - Aerial (Fine to Medium), EPA Default** | 0.95 | 0.1254 | 0.0508 | 0.0318 | 0.0234 | 0.0189 | 0.0162 | 0.0113 |
| 10-A-M-C | Bin 10 - Aerial (Medium to Coarse) | 0.95 | 0.0885 | 0.0274 | 0.0156 | 0.0109 | 0.0087 | 0.0075 | 0.0051 |
| 10-A-C-VC | Bin 10 - Aerial (Coarse to Very Coarse) | 0.95 | 0.0681 | 0.0169 | 0.0094 | 0.0067 | 0.0054 | 0.0045 | 0.0030 |
| 10-AB-N | Bin 10 - Airblast (Normal; Stone, Pome, Vinyard) | 0.99 | 0.0011 | 0.0003 | 0.0002 | 0.0001 | 0.00010 | 0.00008 | 0.00003 |
| 10-AB-D | Bin 10 - Airblast (Dense; Citrus, Tall Trees) | 0.99 | 0.0145 | 0.0030 | 0.0017 | 0.0012 | 0.0010 | 0.0008 | 0.0004 |
| 10-AB-SP | **Bin 10 - Airblast (Sparse: young , dormant), EPA Default** | 0.99 | 0.0416 | 0.0032 | 0.0011 | 0.0005 | 0.00030 | 0.00020 | 0.00004 |
| 10-AB-VI | Bin 10 - Airblast (Vineyard) | 0.99 | 0.0024 | 0.0004 | 0.0002 | 0.0001 | 0.00009 | 0.00007 | 0.00003 |
| 10-AB-ORC | Bin 10 - Airblast (Orchard) | 0.99 | 0.0218 | 0.0031 | 0.0016 | 0.0011 | 0.0008 | 0.0007 | 0.0003 |
| 10-AB-AP | Bin 10 - Airblast (Apples) | 0.99 | 0.0008 | 0.0004 | 0.0002 | 0.0002 | 0.0001 | 0.0001 | 0.00007 |
| 10-AB-APd | Bin 10 - Airblast (Apples Dormant) | 0.99 | 0.0631 | 0.0024 | 0.0006 | 0.0003 | 0.0001 | 0.00008 | 0.00001 |
| 10-AB-OR | Bin 10 - Airbast (Oranges) | 0.99 | 0.0107 | 0.0014 | 0.0007 | 0.0005 | 0.0004 | 0.0003 | 0.0001 |
| 10-AB-AL | Bin 10 - Airblast (Almond) | 0.99 | 0.0061 | 0.0006 | 0.0002 | 0.0001 | 0.00008 | 0.00005 | 0.00002 |
| 10-AB-GR-W | Bin 10 - Airblast (Grape, wrap around sprayer) | 0.99 | 0.0004 | 0.0001 | 0.00008 | 0.00006 | 0.00005 | 0.00004 | 0.00002 |
| 10-AB-GR | Bin 10 - Airblast (Grape) | 0.99 | 0.0024 | 0.0004 | 0.0002 | 0.0001 | 0.00009 | 0.00007 | 0.00003 |
| 10-AB-P | Bin 10 - Airblast (Pecans | 0.99 | 0.0216 | 0.0049 | 0.0029 | 0.0021 | 0.00170 | 0.00150 | 0.00090 |
| 10-G-HB-VF-F | **Bin 10 - Ground (high boom, VF to Fine), EPA Default** | 0.99 | 0.0616 | 0.0131 | 0.00790 | 0.00540 | 0.00400 | 0.00310 | 0.00120 |
| 10-G-LB-VF-F | Bin 10 - Ground (Low boom, VF to Fine) | 0.99 | 0.0268 | 0.0055 | 0.00360 | 0.00270 | 0.00210 | 0.00180 | 0.00090 |
| 10-G-HB-F-MC | Bin 10 - Ground (High boom, Fine to M/C)) | 0.99 | 0.0165 | 0.0042 | 0.0029 | 0.0022 | 0.0017 | 0.0014 | 0.0007 |
| 10-G-LB-F-MC | Bin 10 - Ground (Low boom, Fine to M/C) | 0.99 | 0.0109 | 0.0028 | 0.0019 | 0.0015 | 0.0012 | 0.0010 | 0.0006 |

# Appendix 2: Rate-Specific Instructions

The rate-specific special instructions are used to define typical label-specified restrictions for individual rates. For example, a rate may only be valid in the 30 days leading up to harvest. See **Example 3 – Rate Limits and Rate Special Instructions** for an example of rate specific special instructions in action.

Rate-specific instructions are specified in the Agronomic Practices Table (APT) using a specific convention. The convention is comprised of two components of a string. The first component is a Boolean indicator ("Y" or "N").

Y: applications for this rate *can only* be made during the instructions window

N: applications for this rate *cannot* be made in the instructions window

The second part of the convention is the instruction window. Specifically, the start and stop dates for the window. The instructions window can be defined in three ways: relative to the emergence / harvest date, a date range, or a date range relative to the emergence / harvest date. The first part (boolean yes/no) and second part (instructions window) are connected by an underscore as illustrated in the examples below (Table 30):

*Table 30: Rate-specific instructions convention examples*

| Instruction | Description |
|---|---|
| Y_H-30 | Applications can only be made in the 30 days preceding the harvest date |
| N_E+05 | Applications cannot be made within 5 days following the emergence date |
| N_0501>0615 | Applications cannot be made between May 1st and June 15th |
| N_1201>0201 | Applications cannot be made between Dec 1st and Feb 1st |
| Y_E+15>H+15 | Applications can only be made between 15 days after emergence and 15 days after harvest |
| Y_E-10>H+00 | Applications can only be made between 10 days before emergence and harvest |

If the rate instructions format is defined incorrectly in the APT, then an error will be presented to the user during execution of the PWC-PT. However, it is up to the user to ensure that the rate instructions entered accurately comply with the label. For example, an error will be indicated for "YH+15" because the underscore between Y and H is missing. However, an error will not be indicated for "Y_H+500".