California Department of Pesticide Regulation
Environmental Monitoring Branch

SWPP Monitoring Prioritization Model User Manual

(Version 3.0)

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1 OVERVIEW

A major goal of the California Department of Pesticide Regulation's (CDPR) Surface Water Protection Program (SWPP) is to characterize pesticide residues in surface water for both agricultural and urban areas of the state. This is done primarily through surface water monitoring to assess concentrations of high priority chemicals and their spatial and temporal distributions in high-use or problem areas. The SWPP Prioritization Workgroup has been developing a methodology and computer implementation to prioritize pesticides for surface water monitoring. The developed criteria and schemes are used to integrate and facilitate the automation of updating the monitoring priority lists in agricultural and urban areas of California. Details of the model development and validation have been documented in the technical reports (Luo et al., 2013; 2014; Luo and Deng, 2015). In summary, two processes (phases) are incorporated in the prioritization: [1] pesticide ranking according to their use amounts and toxicity data, and [2] pesticide screening based on historical monitoring results, physiochemical properties, and registered use sites and application methods. The pesticide ranking process generates a preliminary priority list of pesticides in the domain of interest (use patterns, years, months, counties, and/or watersheds); and the pesticide screening process refines the priority list by identifying pesticides with relatively high risks (labelled with a "True") to surface water quality. The top prioritized pesticides with "True" monitoring recommendations are candidates to be considered in surface water monitoring studies. In addition, modeling options are provided to improve prioritization results according to the scope and objectives of a monitoring project.

The methodology was implemented in a computer model with graphical user interface (GUI). The purpose of this document is to provide instructions on how to use the model. This user's manual includes the following sections:

- Model availability and installation (section 2)
- Overview of the model GUI (section 3)
- PUR data preparation (section 4)
- Functions and options in the model (section 5)
- Modeling results and interpretations (section 6)

2 MODEL AVAILABILITY AND INSTALLATION

The model is available on the CDPR internal share drive, \\dprhq01\SurfaceWater\ Monitoring Priority\[*version number*], including two files "Prioritization.exe" (the executable file) and "data.dat" (supporting database). Please copy the two files from the shared drive to a local hard disk on your computer. Figure 1 shows an example of the model files on a local computer at C:\prioritization. Double click "Prioritization.exe" to start the model.

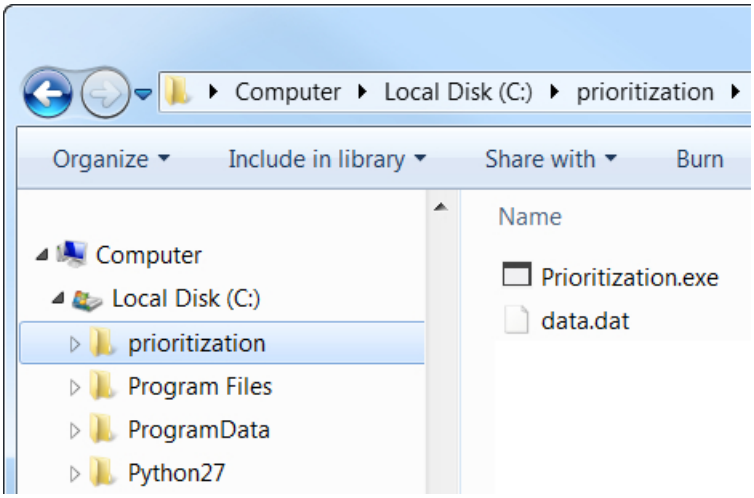
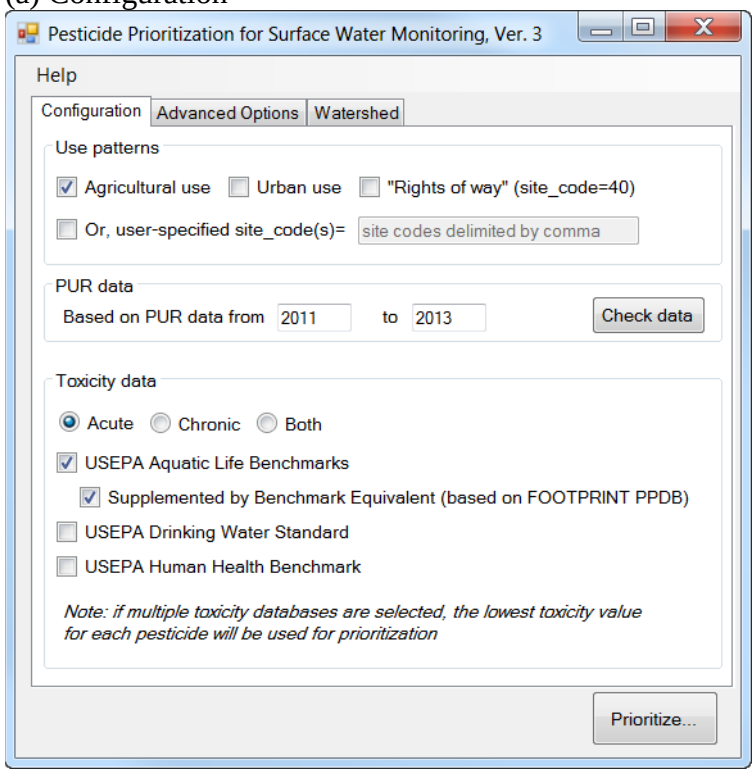


Figure 1. Monitoring prioritization model on a local computer

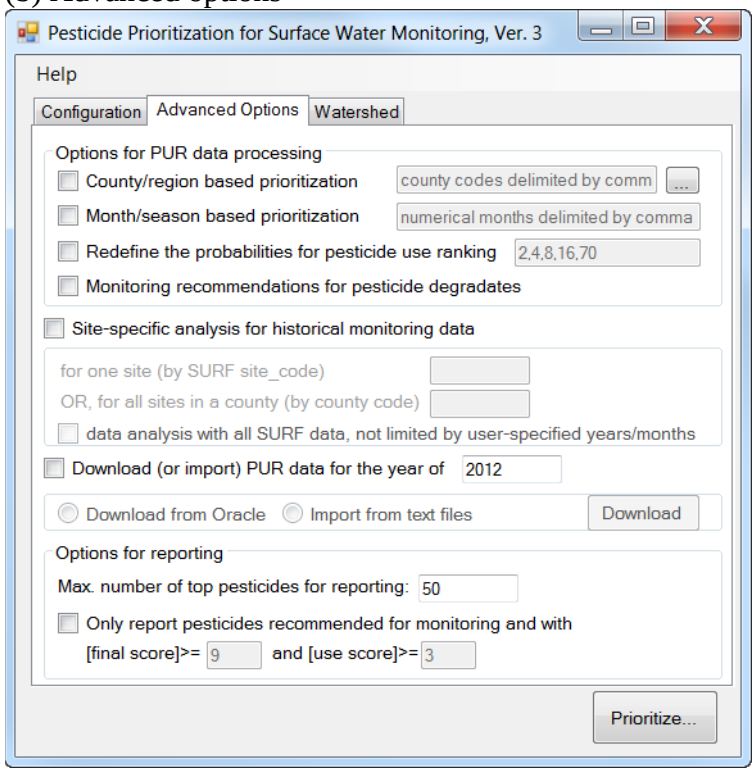
3 OVERVIEW OF THE MODEL GUI (GRAPHICAL USER INTERFACE

The model includes a "Help" menu, three panels selected by pressing the appropriate tab, and a "Prioritize" button (Figure 2). The "Configuration" panel specifies basic settings for prioritization, including pesticide use pattern, years of PUR, and toxicity data sources. The basic settings can be refined with the "Advanced Options" panel according to the specific objectives of a monitoring study. The "Watershed" panel provides options for monitoring prioritization at the spatial scale of watershed.

(a) Configuration



(b) Advanced options



(c) Watershed

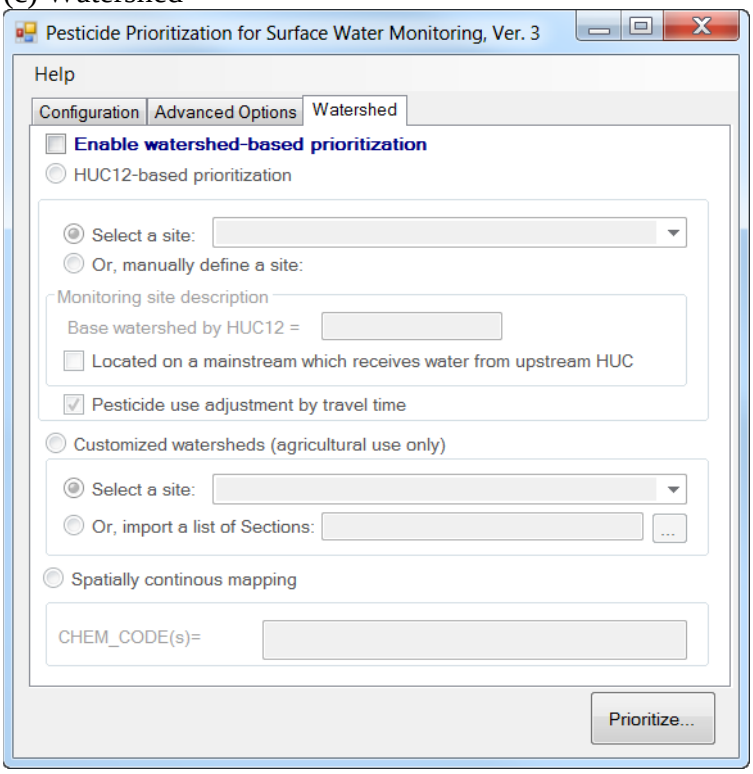


Figure 2. Graphical user interface for the prioritization model including tabs to make selections for (a) configuration, (b) advanced options, and (c) watershed

4 PUR DATA PREPARATION

4.1 CHECKING PUR DATA IN THE SUPPORTING DATABASE

Monitoring prioritization is based on downloaded PUR data in the supporting database ("data.dat") (Figure 1). One should check data availability before conducting prioritization. By clicking the "check data" button in the "configuration" panel, the model will report all PUR data available in the supporting database (Figure 3). If a year of PUR data that will be used in the prioritization is not already downloaded, the missing data can be prepared by *importing* from online PUR data in text format or *downloading* from the CDPR internal database, as described in the following sub-sections.

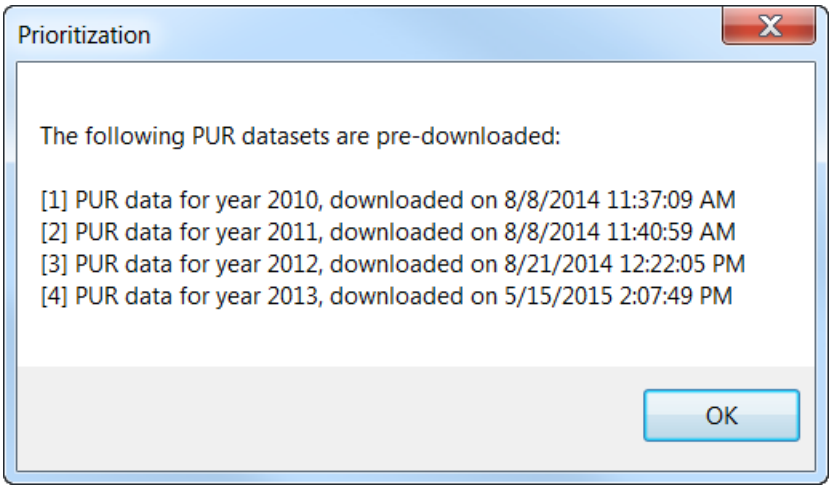


Figure 3. Message box summarizing PUR data existing in the supporting database

4.2 IMPORTING PUR DATA

PUR data can be downloaded from CDPR FTP (File Transfer Protocol) site (ftp://transfer.cdpr.ca.gov/pub/outgoing/pur_archives). Data are provided as .ZIP files for each year; for example, "pur2008.zip" for PUR data of year 2008. By extracting into a folder, the data files are organized by counties as "udc[YY]_[CC].txt" where [YY] is the 2-digit year and [CC] is the 2-digit California county code. Lookup table for the county codes is available at http://www.sos.ca.gov/business/notary/forms/notary-county-codes.pdf.

Once PUR data are downloaded and extracted, they can be imported to the prioritization model by following the steps (Figure 4):

1) Select the option for "Download (or import) PUR data" in the panel for advanced options,
2) Specify the year of PUR to be imported (data will be imported for one year at a time),
3) Select the option for "Import from text files",
4) Click the button "Download" and refer to the folder containing extracted PUR data,
5) Wait until the model presents a message box for completion (Figure 5).
6) The above processes will import PUR data for one year. Repeat these processes for all years to be imported one by one.

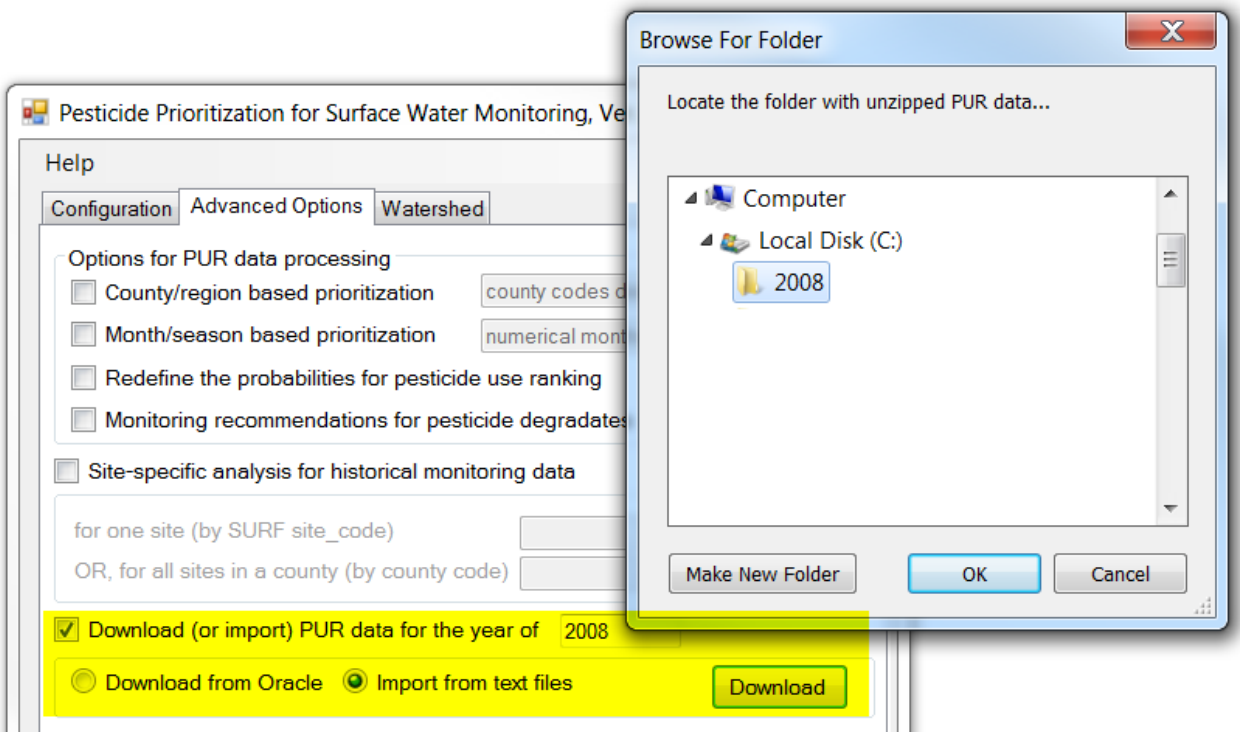


Figure 4. PUR data importing (data for year 2008 as an example, with downloaded and extracted data files in the folder "C:\ 2008")

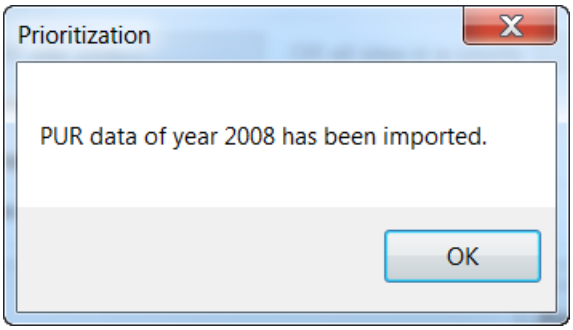


Figure 5. Message box for the completion of PUR data downloading (or importing)

4.3 DOWNLOADING PUR DATA

To download PUR data from CDPR internal database, one should have a direct or VPN (Virtual Private Network) connection to the CDPR's internal network and prepare an Oracle account and ODBC (Open Database Connectivity) configurations. Select the option of "Download from Oracle" on the advanced option panel (Figure 4) for PUR data downloading. Please contact IT help desk if you have questions on the network, Oracle account, or ODBC. Details for ODBC configuration are also provided in the Appendix of this manual.

5 FUNCTIONS AND OPTIONS IN THE MODEL

5.1 PESTICIDE USE PATTERNS

The following use patterns and their combinations can be used for prioritization:

- Predefined use patterns
  - Agricultural uses, defined based on site_code in PUR: "site_code between 150 and 40000 OR site_code=40008" (Luo et al., 2013),
  - Urban uses: site_code=10 ("structural pest control" as defined in PUR) or 30 ("landscape maintenance"),
  - Right-of-way applications: site_code=40 ("rights of way").
- User-defined use patterns, by comma-delimited site_code's.

5.2 YEARS OF PUR DATA

Users are asked to specify the years of PUR data to be used in prioritization. Please make sure the required years of data have been prepared according to the "PUR data preparation" processes. For monitoring study planning, we suggest three years up to the latest available PUR data. For example, PUR data of 2010-2012 were used in DPR monitoring planning for the 2015 sampling season (Deng, 2015).

5.3 TOXICITY DATA TYPE AND SOURCES

Toxicity data (Table 1) in the model are derived from various sources including USEPA aquatic life benchmarks, benchmark equivalents, the IUPAC (International Union of Pure and Applied Chemistry) FOOTPRINT pesticide property database, USEPA drinking water standards, and USEPA human health benchmarks. Data are organized according to their sources and type (acute or chronic), and users can select different datasets and their combinations for prioritization.

Table 1. Available toxicity databases for prioritization

Toxicity data	Notes and flags
USEPA Benchmarks Aquatic life benchmarks maintained by USEPA Office of Pesticide Program (OPP) (USEPA, 2015).The lowest value in the reported benchmarks for fish, invertebrates, nonvascular plants, and vascular plants is used in prioritization, for acute and chronic data, respectively.	Flags: ">" if the toxicity is reported as larger than a certain value; "<" if the toxicity is reported as less than a certain value; Otherwise, no flags
Benchmark Equivalents	If this option is selected, benchmark equivalents will be used to supplement (not

OPP Benchmark Equivalents based on IUPAC FOOTPRINT pesticide property data base (PPDB (FOOTPRINT, 2014), acute and chronic data. The methodology for the development of benchmark equivalents is documented in the technical report (Luo et al., 2013)	replace) the USEPA benchmarks. Flag: "P"
USEPA Drinking Water Standards USEPA drinking water standard (USEPA, 2012), maximum contaminant level goal (MCLG)	If this option is selected, the MCLG will be used for prioritization if it's the lowest available toxicity value in all selected toxicity sources. Flag: "D"
USEPA Human Health Benchmarks (HHBP) USEPA human health benchmarks (USEPA, 2013), including both acute ("acute or one day HHBP") and chronic ("chronic or life time HHBP") data	If this option is selected, the HHBP will be used for prioritization if it's the lowest available toxicity value in all selected toxicity sources. Flag: "H"

Prioritization can be conducted based on acute toxicity, chronic toxicity, or both data types. With acute (or chronic) toxicity, the toxicity value for prioritization (TOX, ppb) is determined as the lowest value of acute (or chronic) toxicity in the selected data sources (e.g., USEPA Aquatic Life Benchmark and Drinking Water Standard). With both acute and chronic toxicity, TOX will be based on the lowest values of both acute and chronic toxicity values in the user selected data sources. A toxicity score is determined from the numerical toxicity value finally used in prioritization (Table 2).

Table 2. Ranking schemes for pesticide toxicity (Luo et al., 2013)

Toxicity score	Toxicity value (TOX, ppb) used in prioritization
8	$TOX \leq 0.001$
7	$0.001 < TOX \leq 0.01$
6	$0.01 < TOX \leq 0.1$
5	$0.1 < TOX \leq 1$
4	$1 < TOX \leq 10$
3	$10 < TOX \leq 100$
2	$100 < TOX \leq 1000$
1	$TOX > 1000$
0	No Data

5.4 SPATIAL DOMAIN FOR PRIORITIZATION

By default the model will make monitoring recommendations for the entire state of California. The model also provides options for users to refine the spatial domain by (1) counties or (2) watersheds.

5.4.1 PRIORITIZATION FOR COUNTIES

By selecting the option for "County/region based prioritization", one can type or select required counties in terms of county codes delimited by comma (Figure 6). For example, the text of "1,2,3" specifies three counties of Alameda, Alpine, and Amador. With this option, only PUR data in the selected counties will be used for prioritization.

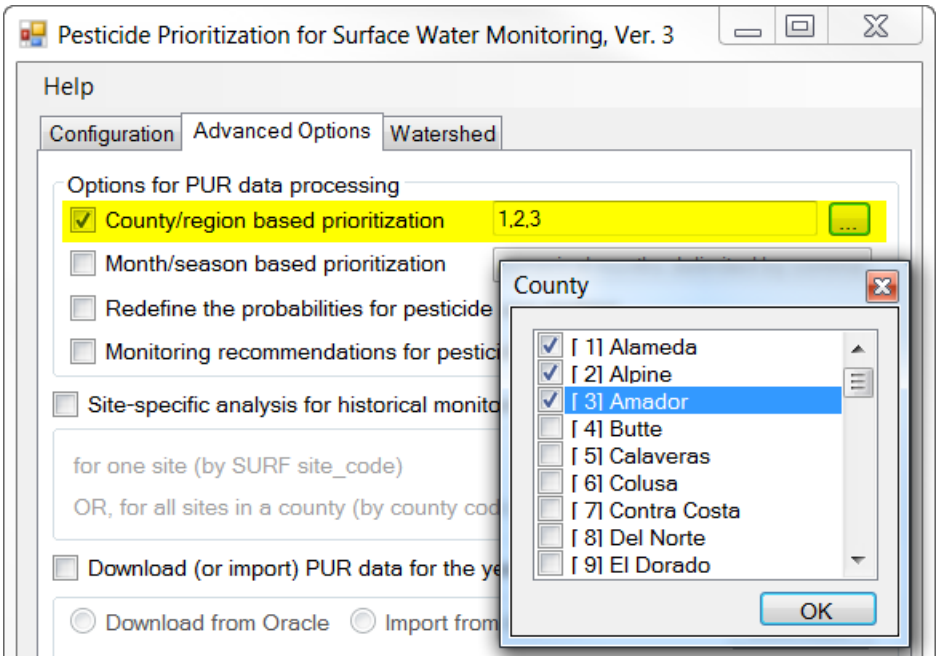


Figure 6. County/region based prioritization

5.4.2 PRIORITIZATION FOR WATERSHEDS

This option is activated by selecting "Enable watershed-based prioritization" in the "watershed" panel (Figure 7). Please refer to the later section of "Watershed-based prioritization" for more information.

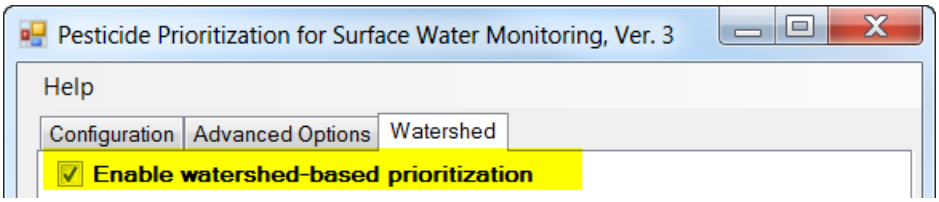


Figure 7. Watershed based prioritization

5.5 TEMPORAL DOMAIN FOR PRIORITIZATION

By default the model will make monitoring recommendations for all months of the PUR years defined in the "Years of PUR data". To refine the temporal resolution, a user can specify months of interest. By selecting the options of "Month/season based prioritization", one can type the required months (as numerical values) delimited by comma (Figure 8). For example, the text of "1,2,3" specifies three months of January, February, and March. With this option, only PUR data in the selected months will be used for prioritization.

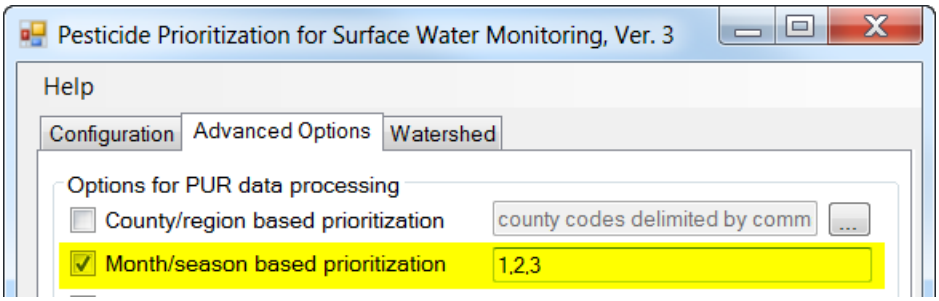


Figure 8. Month/season based prioritization

5.6 USER-DEFINED PESTICIDE USE RANKING

The probability-based method is used for pesticide use data ranking. Default critical percentages (Luo et al., 2013) are 2%, 4%, 8%, 15%, and 70% to classify very high (use score =5), high (4), moderate (3), low (2), and very low (1) uses, respectively. This means that the top 2% of the total number of pesticides (sorted by their use amount) will be assigned with a use score of 5 (very high use), the next 4% with a score of 4, and so on. One may change the critical percentages, delimited by comma, with the option of "Redefine the probabilities for pesticide use ranking". For example, the default probabilities can be written as "2,4,8,16,70" (Figure 9). Please ensure that the sum of the five critical percentages is 100.

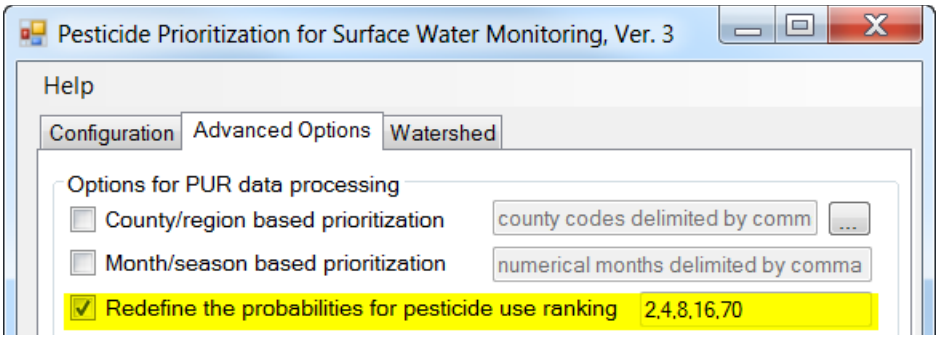


Figure 9. User-defined percentages for pesticide use ranking

5.7 PRIORITIZATION FOR PESTICIDE DEGRADATES

The option of "Monitoring recommendations for pesticide degradates" is to make monitoring recommendations for pesticide degradates. Based on available data of the parent AI and its degradates, the model will identify degradates which may cause higher exposure potentials compared to the parent AI's. The determination process is generally a simplified version of the registration evaluation for surface water protection (Luo et al., 2015). Please note that degradate prioritization may be limited by the data availability in the model, i.e., chemical properties in FOOTPRINT database and toxicity data in the selected databases (Table 1) for both parent AI's and degradates. If a degradate is not in FOOTPRINT, for example, it will not be considered in the prioritization even it's listed in toxicity databases such as USEPA aquatic life benchmarks.

5.8 MONITORING DATA ANALYSIS FOR SPECIFIC SITE(S)

This option ("Site-specific analysis") is developed to assist principal investigators (PI's) of monitoring projects in their final decision of monitoring candidates for a specific site or site group (Figure 10). By selecting this option, the model will report detection frequency (DF) and benchmark exceedance (BE) of pesticides in the sites of interest based on historical monitoring results. Monitoring data analysis is conducted in the domain defined by:

- Database: CDPR surface water database (SURF), version June 2015 (CDPR, 2015),
- Site(s): the user is required to provide the monitoring "site_code" in the SURF for one site (for example, "27_14" for "Salinas River@ Del Monte". Please refer to SURF website for more information on SURF site_code: http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm), or provide the county code for all SURF sites within the corresponding county,
- The option of "data analysis with all SURF data"
    - If this option is selected, DF and BE will be reported from data analysis results with all data available in the SURF database, not limited by the years and months defined by the user for prioritization.
    - If this option is not selected, DF and BE will be reported by limiting monitoring data within the years and months defined by a user for prioritization. See the section of "Years of PUR data" and "Temporal domain for prioritization" for more information.

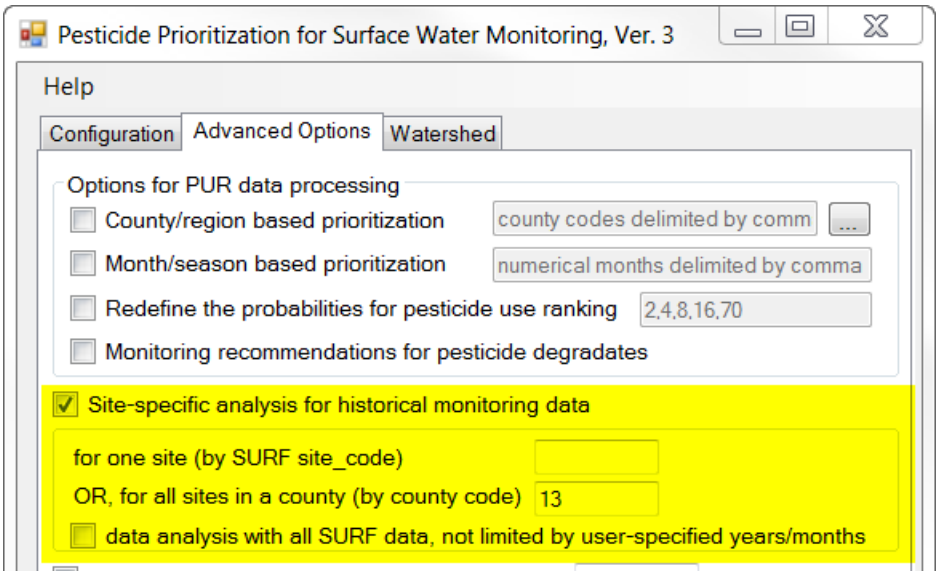


Figure 10. Site-specific analysis for historic monitoring data. This example shows a selection for all SURF sites in Imperial County (county_code=13)

5.9 OPTIONS FOR SIMPLIFYING RESULTS

Hundreds of pesticide AIs with PUR data may be processed in the prioritization. To simplify the results and only focus on top prioritized pesticides, two options are provided (Figure 11):

- "Max. number of top pesticides for reporting": one can specify the total number of top pesticides to be reported. Default number is 50, and a large number such as 1000 can be used if a full priority list of pesticides is needed.
- "Only report pesticides recommended for monitoring and with [final score]>___ and [use score]>___": to limit the reporting by monitoring recommendations and critical scores. Please refer to Modeling results for more details on monitoring recommendations, use scores, and final scores. Default critical value is 9 for final score and 3 for use score, according to the recent DPR study protocol for monitoring agricultural pesticides (Deng, 2015).

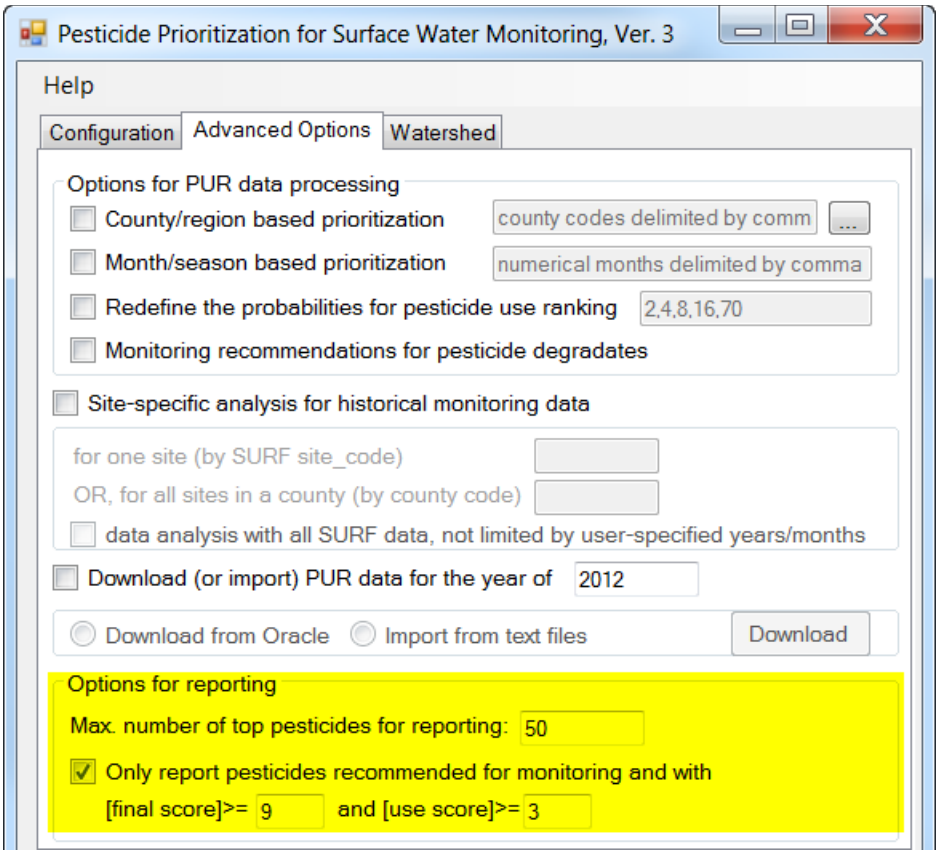


Figure 11. Reporting options

5.10 WATERSHED-BASED PRIORITIZATION

The model supports three types of watershed-based prioritization with: (1) standard watershed delineation based on USGS 12-digit Hydrologic Unit Code (HUC12), (2) user-customized watershed boundary, and (3) spatially continuous mapping for all HUC12's in California.

5.10.1 HUC12-BASED PRIORITIZATION

HUC12-based prioritization generates a priority list for a monitoring site at (or close to) an HUC12 outlet. Two pieces of information are required as model inputs, including the HUC12 and the property of the sampled water body (mainstream or tributary). While a tributary is only contributed by the local HUC12, a mainstream receives water flows and pesticide residues from both local and upstream HUC12's. The model provides some predefined monitoring sites as an example. Those sites are mainly based on DPR's monitoring projects for agricultural pesticide uses (Deng, 2015). For example, by selecting the site of "Salinas River at Del Monte Rd" (DPR site_code=27_14) from the site list, the associated information is populated automatically: HUC12=180600051509 and mainstream (Figure 12).

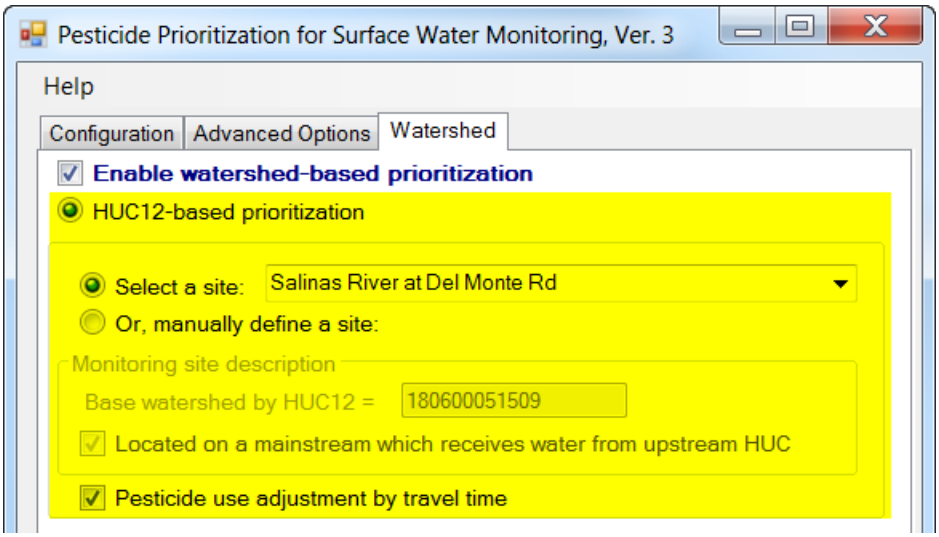


Figure 12. Defining a monitoring site for HUC12-based prioritization

If a monitoring site is not provided in the list, it can be manually defined by specifying HUC12 and check/uncheck the option of mainstream. The USGS National Map Viewer (http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd) can be used to locate a site for each HUC12, given the site coordinates (Figure 13).

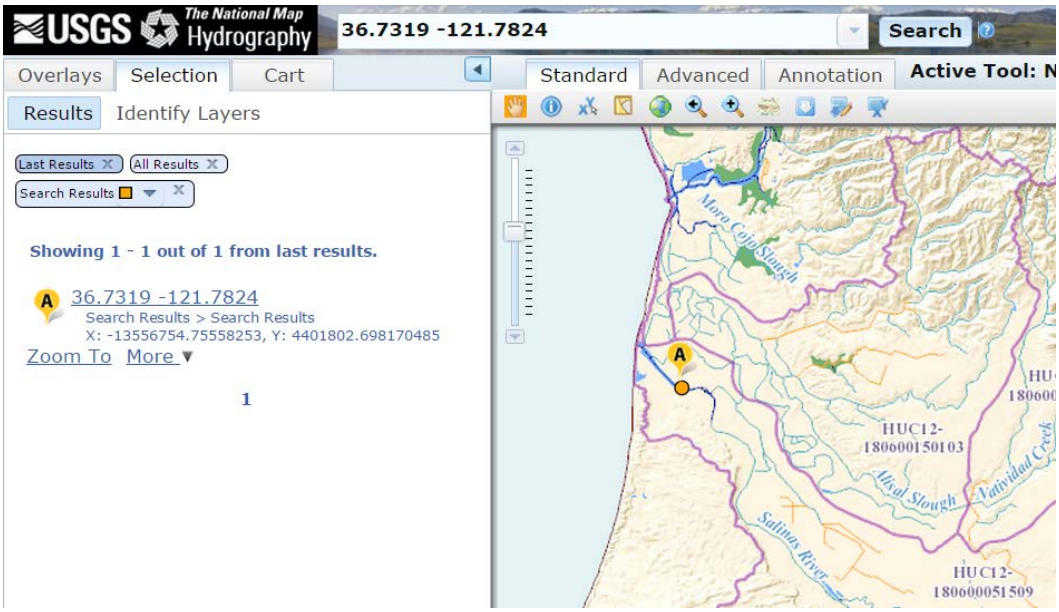


Figure 13. Georeferencing a monitoring site to HUC12, “Salinas River at Del Monte Rd” (DPR site_code=27_14, 36.7319N, -121.7824W) as an example

The option of “pesticide use adjustment by travel time” is to estimate pesticide dissipation from the treated location to the monitoring site. If this option is selected, monitoring prioritization will be conducted based on the adjusted use amount (rather than the original data of pesticide uses from PUR). Please note that this only affects prioritization with pesticide uses in multiple

HUC12's, and does not apply to headwater HUC12's or tributary sites. When this option is activated, the modeling report will give a warning message: "*use data reported in the following table have been adjusted by pesticide dissipation in the stream network*." The following recommendations may be considered for this option:

- Check this option for monitoring prioritization. The model will determine if the option will be actually applied to data analysis based on involved HUC12(s) in the prioritization.
- Uncheck this option for PUR data summary, so that pesticide use data aggregated for the drainage area of a monitoring site can be retrieved in the original values, without any adjustments.

5.10.2 CUSTOMIZED WATERSHEDS

Prioritization for customized watershed is developed for monitoring sites with drainage areas not following HUC12 delineation. In this case, the drainage area will be defined with a list of sections (1×1 mi^2). Please note that this type of prioritization is designed for agricultural uses only, since urban PUR data are reported on a county basis. The model provides some predefined monitoring sites for DPR's monitoring sites. Users can also define their own watersheds by preparing a text file with the enclosed section codes in the watershed of interest.
Figure 14 shows an example of watershed definition file for "Alisal Slough @ Hartnell Rd" (DPR site_code=27_70). The first line is the name of the monitoring site (only used during results reporting). Sections in the watershed are listed from line 2. The customized watershed is finally defined by importing the list of sections to the model (Figure 15).

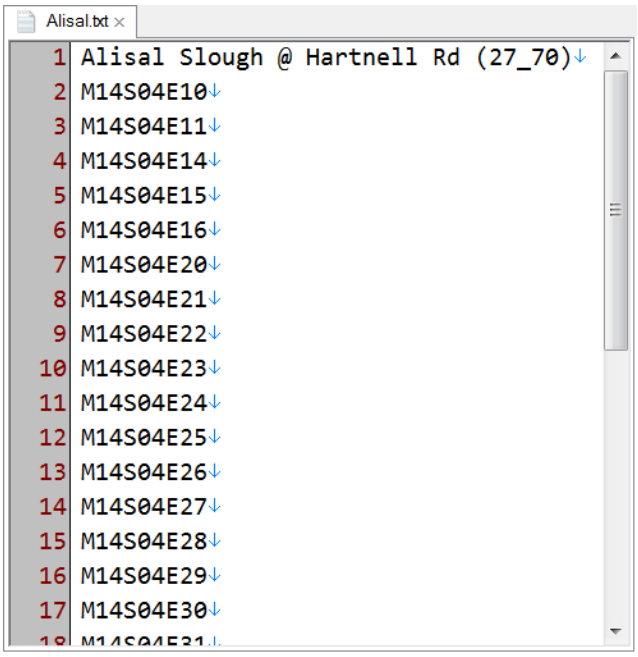


Figure 14. Preparing a text file for a customized watershed

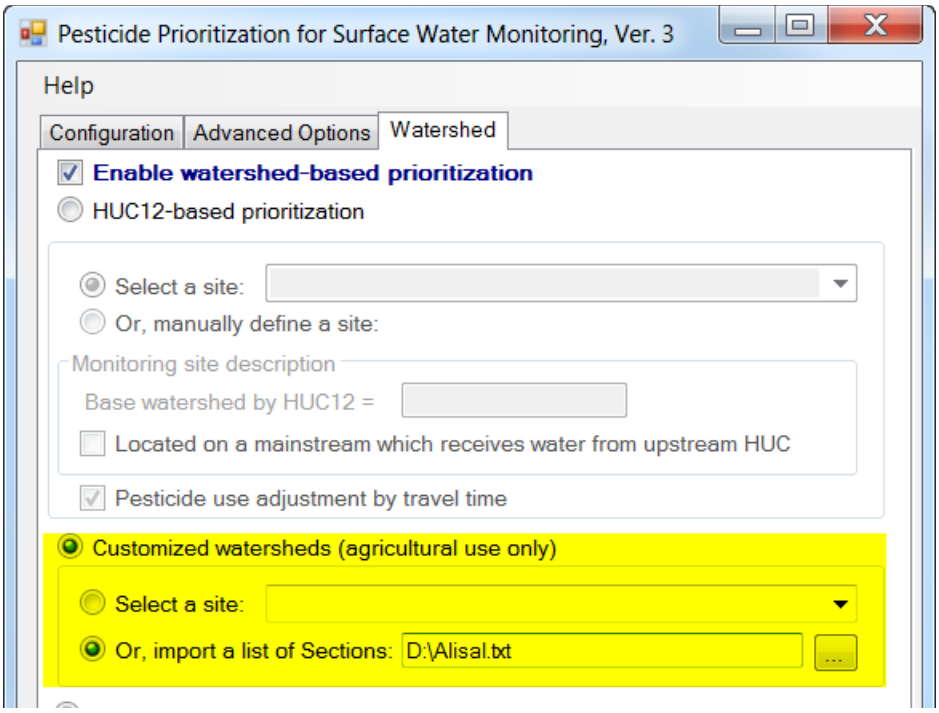


Figure 15. Importing a list of section to define a customized watershed

5.10.3 SPATIALLY CONTINUOUS MAPPING

Spatially continuous mapping is essentially a batch processing of HUC12-based prioritizations, by performing prioritizations for all HUC12's in a California hydrologic region (HUC2=18) and reporting results for user-specified pesticides. The only required input from users is a list of pesticides of interest by their chem_code's delimited by comma (Figure 16).

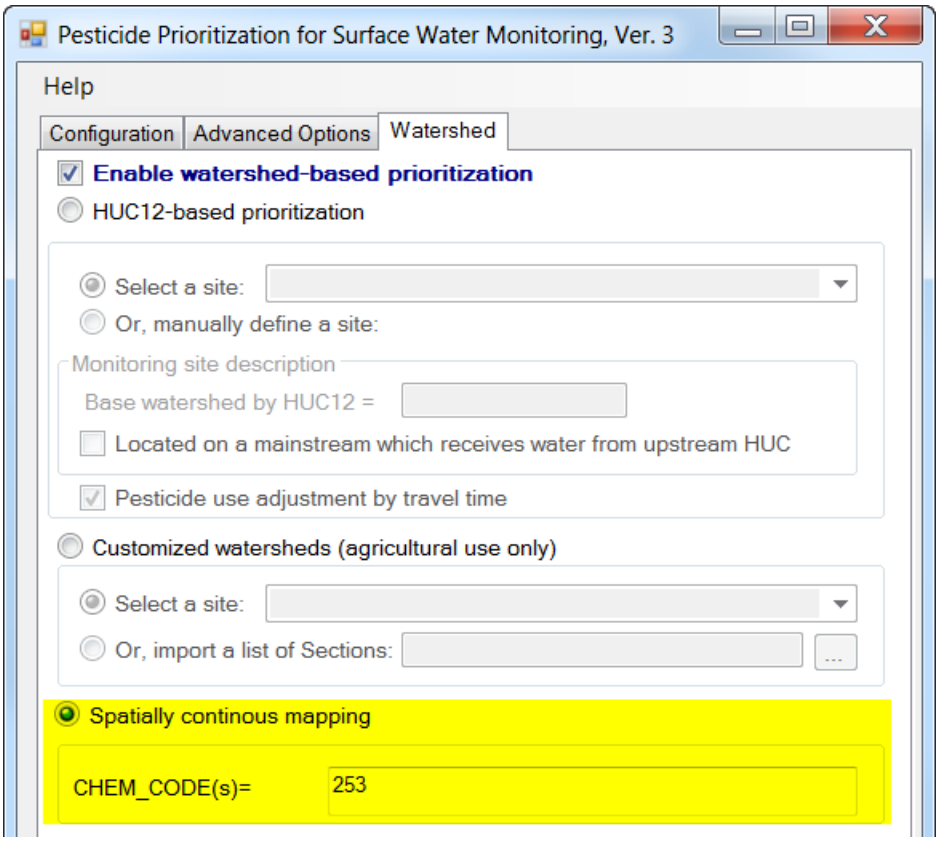
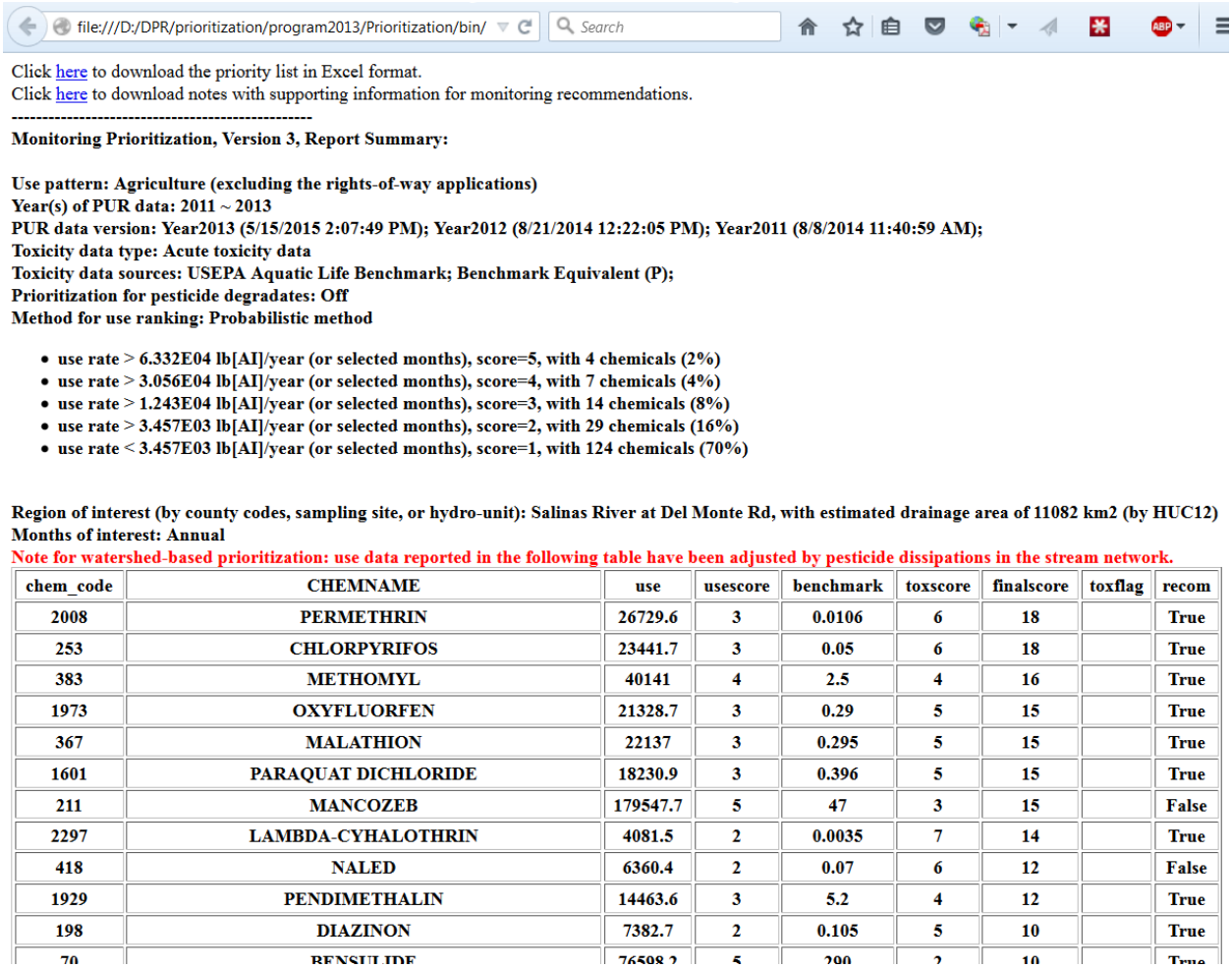


Figure 16. Specifying pesticides by chem_code's for spatially continuous mapping

6 MODELING RESULTS AND INTERPRETATIONS

6.1 RESULTS OF MONITORING PRIORITIZATION

Results of a prioritization will be displayed in a web browser, including a report summary, priority list with monitoring recommendations, and notes for supporting information (Figure 17). The priority list and notes can be downloaded separately in EXCEL and text formats, respectively. The links are provided on the top of the results ("Click here to download…", Figure 17).



file:///D:/DPR/prioritization/program2013/Prioritization/bin/

Click here to download the priority list in Excel format.
Click here to download notes with supporting information for monitoring recommendations.

Monitoring Prioritization, Version 3, Report Summary:

Use pattern: Agriculture (excluding the rights-of-way applications)
Year(s) of PUR data: 2011 ~ 2013
PUR data version: Year2013 (5/15/2015 2:07:49 PM); Year2012 (8/21/2014 12:22:05 PM); Year2011 (8/8/2014 11:40:59 AM);
Toxicity data type: Acute toxicity data
Toxicity data sources: USEPA Aquatic Life Benchmark; Benchmark Equivalent (P);
Prioritization for pesticide degradates: Off
Method for use ranking: Probabilistic method

- **use rate > 6.332E04 lb[AI]/year (or selected months), score=5, with 4 chemicals (2%)**
- **use rate > 3.056E04 lb[AI]/year (or selected months), score=4, with 7 chemicals (4%)**
- **use rate > 1.243E04 lb[AI]/year (or selected months), score=3, with 14 chemicals (8%)**
- **use rate > 3.457E03 lb[AI]/year (or selected months), score=2, with 29 chemicals (16%)**
- **use rate < 3.457E03 lb[AI]/year (or selected months), score=1, with 124 chemicals (70%)**

Region of interest (by county codes, sampling site, or hydro-unit): Salinas River at Del Monte Rd, with estimated drainage area of 11082 km2 (by HUC12)
Months of interest: Annual
Note for watershed-based prioritization: use data reported in the following table have been adjusted by pesticide dissipations in the stream network.

chem_code	CHEMNAME	use	usescore	benchmark	toxscore	finalscore	toxflag	recom
2008	PERMETHRIN	26729.6	3	0.0106	6	18		True
253	CHLORPYRIFOS	23441.7	3	0.05	6	18		True
383	METHOMYL	40141	4	2.5	4	16		True
1973	OXYFLUORFEN	21328.7	3	0.29	5	15		True
367	MALATHION	22137	3	0.295	5	15		True
1601	PARAQUAT DICHLORIDE	18230.9	3	0.396	5	15		True
211	MANCOZEB	179547.7	5	47	3	15		False
2297	LAMBDA-CYHALOTHRIN	4081.5	2	0.0035	7	14		True
418	NALED	6360.4	2	0.07	6	12		False
1929	PENDIMETHALIN	14463.6	3	5.2	4	12		True
198	DIAZINON	7382.7	2	0.105	5	10		True
70	BENSULIDE	76598.2	5	290	2	10		True

Figure 17. Example of prioritization results for agricultural pesticide uses in the Salinas River watershed. The priority list may include more columns according to additional options selected by the user.

"Report summary" summarizes the input data and modeling options used in the current prioritization process, including pesticide use pattern, PUR data information (year, date of retrieval, county/watershed, and month), toxicity data, and calculated ranges for use ranking.

The priority list provides quantitative data for pesticide uses, toxicity, and monitoring recommendations:

- Chem_code's and chemical names, consistent with those in PUR.
- Annual average use amount, in lbs [AI] per year, within the user-defined study domain (by year, county/watershed, and month).
- Use score (1-5), based on the ranges of pesticide use amounts presented in the report summary.
- Toxicity values (ppb) based on selected toxicity databases.
- Toxicity scores (1-8), based on the toxicity values.

- The final score is the product of use score and toxicity score. The priority list is organized by pesticides sorted by their final scores in descending order. Since all data in the priority list can be downloaded in Excel format, users may develop and test their own formulas of final scores according to their specific study objectives.
- Flag of toxicity data ("*toxflag*")
    - Blank: from USEPA Benchmarks, provided as a specific value,
    - "<":from USEPA Benchmarks, provided as "less than" a certain value,
    - ">":from USEPA Benchmarks, provided as "larger than" a certain value,
    - "R": from USEPA Reregistration Eligibility Decisions (RED),
    - "P": from Benchmark Equivalents,
    - "D": from USEPA drinking water standard, or
    - "H": from USEPA human health benchmarks.
- Monitoring recommendations for pesticide AIs ("*recom*"): "True" indicates that this pesticide is recommended for surface water monitoring for the region of interest. With "False" it's suggested that the pesticide may not have high potentials to cause surface water toxicity and should be excluded from monitoring, even its use amount and aquatic toxicity are relatively high as indicated by the final score. Details on the exclusion are provided in the supporting information ("notes.txt").
- (Only available when the option "monitoring recommendations for pesticide degradates" is selected) Monitoring recommendations for pesticide degradates ("*deg*"): "True" suggests consideration of some degradates of the pesticide AI for monitoring. Details for the degradates with high risk potentials are provided in the supporting information ("notes.txt").
- (Only available when the option "site-specific analysis for historical monitoring data" is selected) Detection frequency ("*DFlocal*") and benchmark exceedance ("*BElocal*"): The results are reported as the number of detections or exceedances over the total number of records in the SURF database in the selected site(s) and years. "NoData" is shown if there is no historical monitoring data available during the sites/years of interest.

The model also generates a separate file "notes.txt" with supporting information for pesticide AI's excluded for monitoring and pesticide degradates recommended for monitoring. For example, the model does not recommend mancozeb for monitoring because of its short persistence in water column (Figure 18).

```
Notes for the phase-2 prioritization results:

====================
PUR Chem_code: 211
Chemical name: MANCOZEB
Short persistence in water, based on hydrolysis or other degradation processes

====================
PUR Chem_code: 418
Chemical name: NALED
Low soil runoff potentials, based on vapor pressure

====================
PUR Chem_code: 104
Chemical name: CAPTAN
Short persistence in water, based on hydrolysis or other degradation processes

====================
PUR Chem_code: 2210
Chemical name: FOSETYL-AL
Low bio-availability in water-sediment system

====================
PUR Chem_code: 5802
Chemical name: FLUMIOXAZIN
Short persistence in water, based on hydrolysis or other degradation processes
```

Figure 18. Detailed information for monitoring recommendations

6.2 RESULTS OF SPATIALLY CONTINUOUS MAPPING

Results of spatially continuous mapping are reported as a priority map index (Luo and Deng, 2015) for each of the HUC12's in the California hydrologic region (HUC2=18). Two formats are available for prioritization results: Excel format for both tributary and mainstream sites, and JSON (JavaScript Object Notation) format for mainstream sites only (Figure 19). The results can be directly linked to desktop GIS applications or online map services for visualization purposes. Figure 20 shows an example of monitoring priority mapping for chlorpyrifos in mainstreams of California HUC12's.

(a)

	A	B	C	D	E
1	FROM_NODE	HUC	HUCNAME	c253	c253acc
260	259	180101100601	Gill Creek-Russian River	4.686322	0.292451
261	260	180101100602	Sausal Creek-Russian River	22.3453	1.756
262	261	180101100603	Franz Creek	0	0
263	262	180101100604	Maacama Creek	1.804495	1.193915
264	263	180101100605	Brooks Creek-Russian River	0	1.638307
265	264	180101100701	Upper Laguna De Santa Rosa	0.049624	0.049624
266	265	180101100702	Upper Santa Rosa Creek	2.146451	2.146451
267	266	180101100703	Lower Santa Rosa Creek	0	1.536799
268	267	180101100704	Lower Laguna De Santa Rosa	5.560328	1.72843
269	268	180101100705	Windsor Creek	101.2231	101.2231
270	269	180101100706	Porter Creek-Mark West Creek	13.09921	14.65845
271	270	180101100801	East Austin Creek	0	0
272	271	180101100802	Ward Creek-Austin Creek	0	0
273	272	180101100901	Green Valley Creek	292.9369	292.9369
274	273	180101100902	Porter Creek-Russian River	105.6194	6.856086
275	274	180101100903	Dutch Bill Creek-Russian River	0	14.34443
276	275	180101100904	Willow Creek-Russian River	0	13.3787
277	276	180102010101	Headwaters Williamson River	0	0
278	277	180102010102	Haystack Draw-Williamson River	0	0
279	278	180102010103	Deep Creek-Williamson River	0	0

(b)

```
{"name": "Gill Creek-Russian River", "value": 0.2924514},
{"name": "Sausal Creek-Russian River", "value": 1.756},
{"name": "Franz Creek", "value": 0},
{"name": "Maacama Creek", "value": 1.193915},
{"name": "Brooks Creek-Russian River", "value": 1.638307},
{"name": "Upper Laguna De Santa Rosa", "value": 0.04962377},
{"name": "Upper Santa Rosa Creek", "value": 2.146451},
{"name": "Lower Santa Rosa Creek", "value": 1.536799},
{"name": "Lower Laguna De Santa Rosa", "value": 1.72843},
{"name": "Windsor Creek", "value": 101.2231},
{"name": "Porter Creek-Mark West Creek", "value": 14.65845},
{"name": "East Austin Creek", "value": 0},
{"name": "Ward Creek-Austin Creek", "value": 0},
{"name": "Green Valley Creek", "value": 292.9369},
{"name": "Porter Creek-Russian River", "value": 6.856086},
{"name": "Dutch Bill Creek-Russian River", "value": 14.34443},
{"name": "Willow Creek-Russian River", "value": 13.3787},
{"name": "Headwaters Williamson River", "value": 0},
{"name": "Haystack Draw-Williamson River", "value": 0},
{"name": "Deep Creek-Williamson River", "value": 0},
```


Figure 19. Results of spatially continuous mapping in (a) Excel, and (b) JSON format. Here shows an example with chlorpyrifos (chem_code=253)

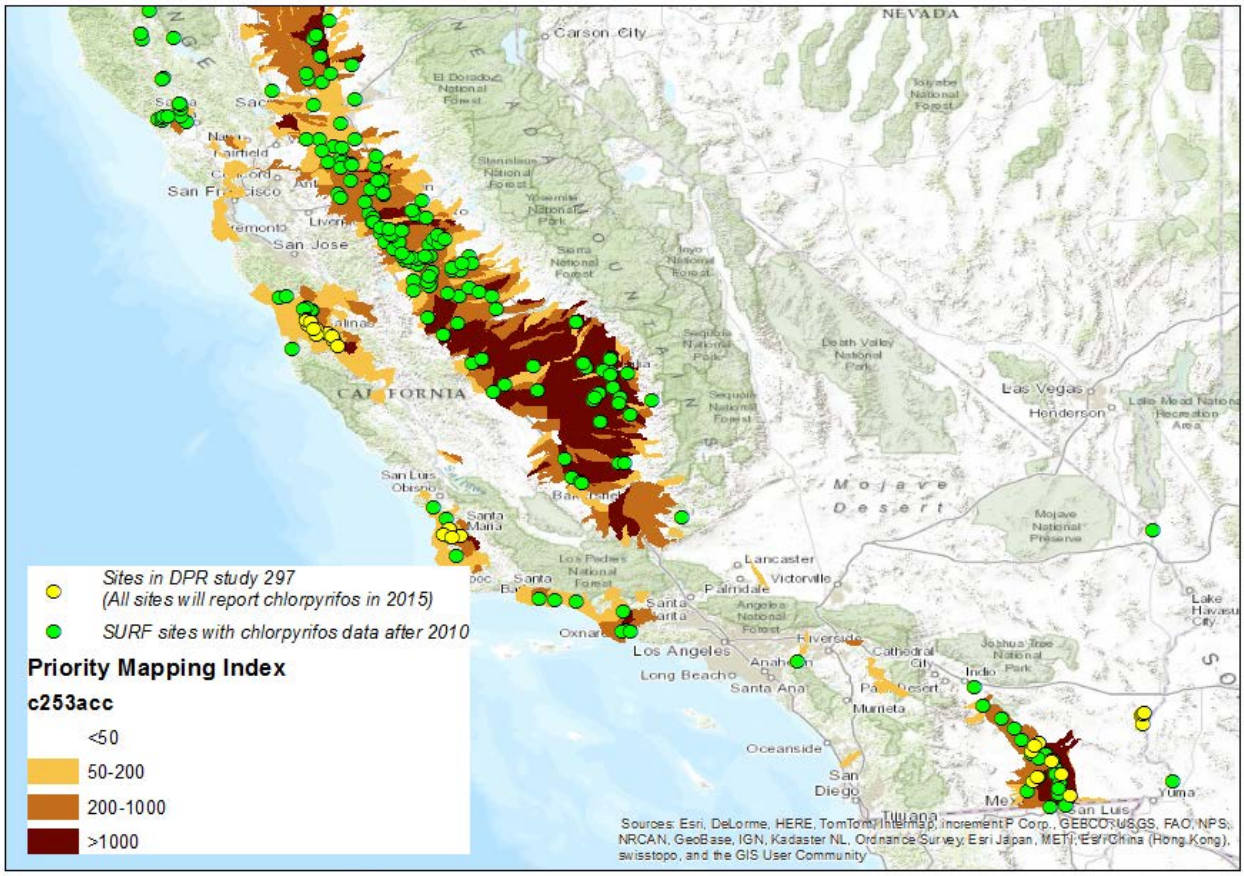


Figure 20. Monitoring priority mapping for chlorpyrifos in main streams of 12-digit hydrological units, based on total (agricultural, urban, and right-of-way) uses of chlorpyrifos. “c253acc” is the priority mapping index of chlorpyrifos (lb/mi^2/ppb)

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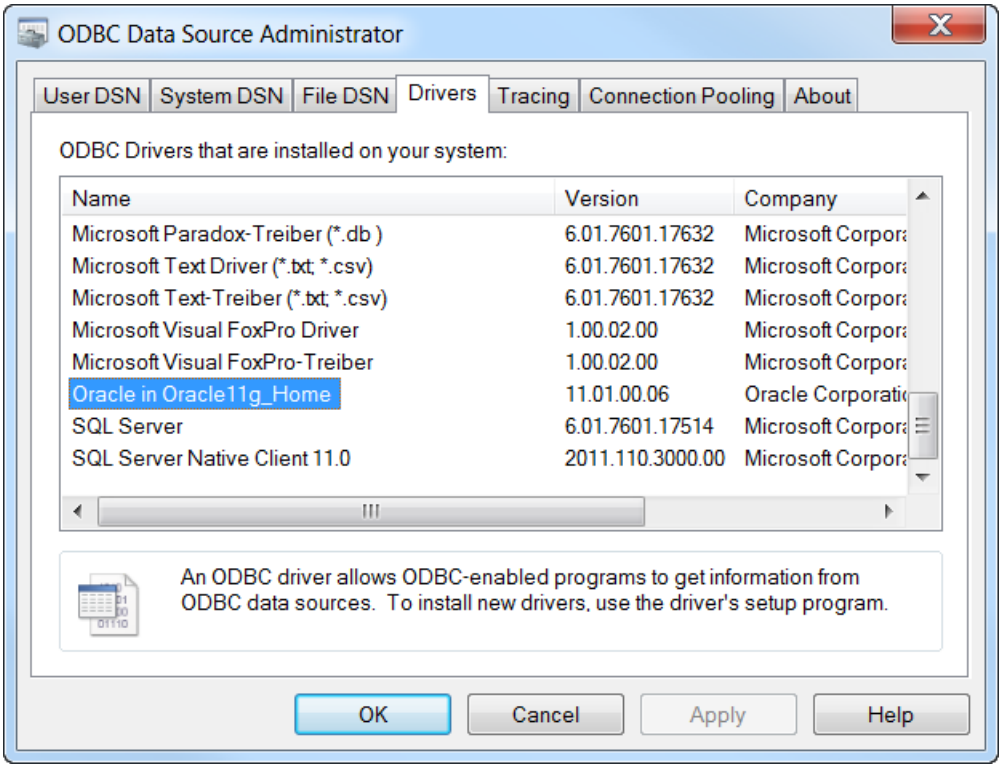
9 APPENDIX: SYSTEM CONFIGURATION FOR ORACLE CONNECTION

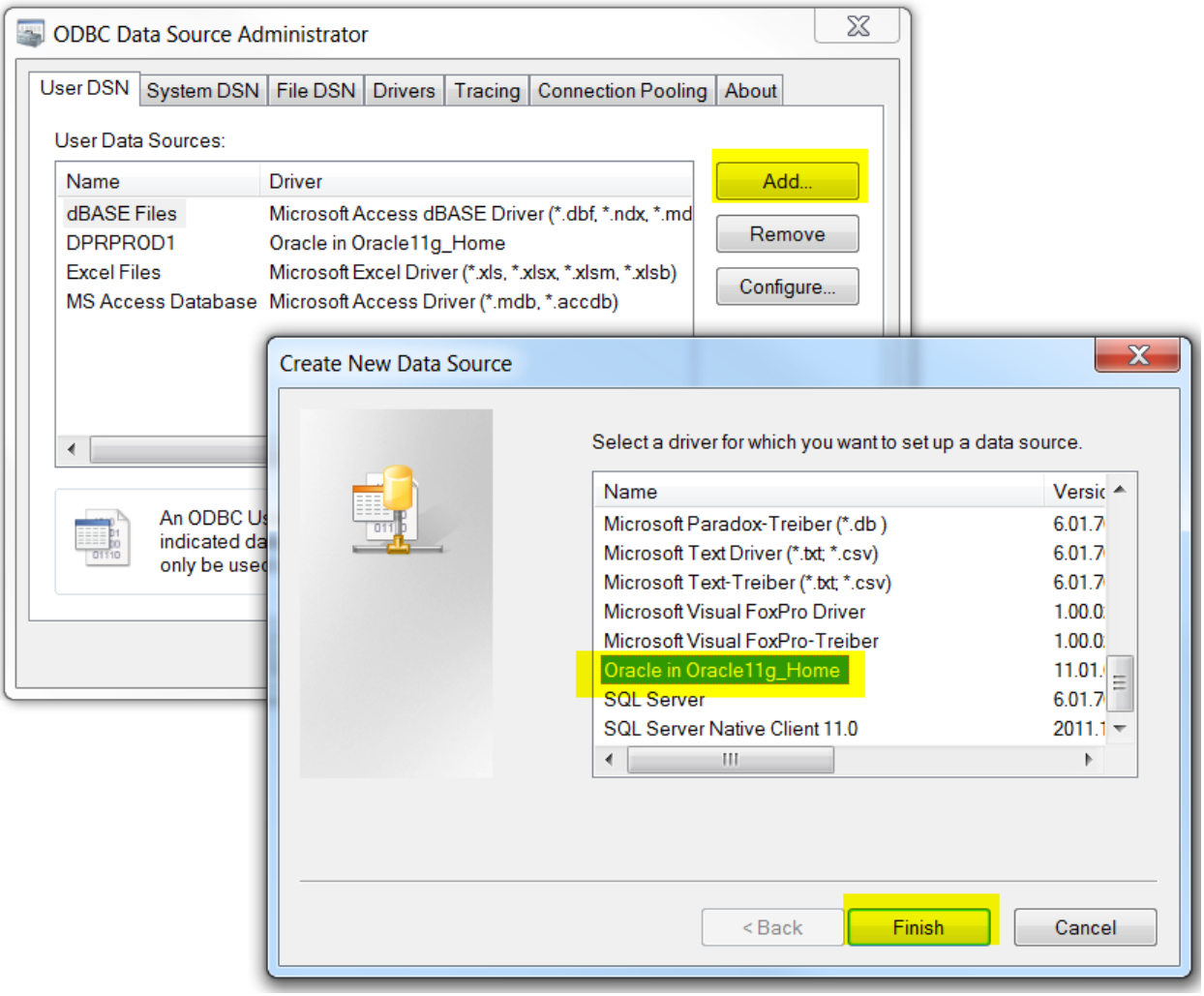
Note: the following demonstration is based on Windows 7. In other Windows versions, some names and dialog windows may look different

1) Locate and open “ODBC Data source Administrator”: Your computer -> Control Panel -> Administrative Tools -> Data Sources (ODBC)
2) Under the "Drivers" tab, make sure the Oracle driver ("Oracle in Oracle 11g_Home") is installed in your computer. If not, please contact IT.



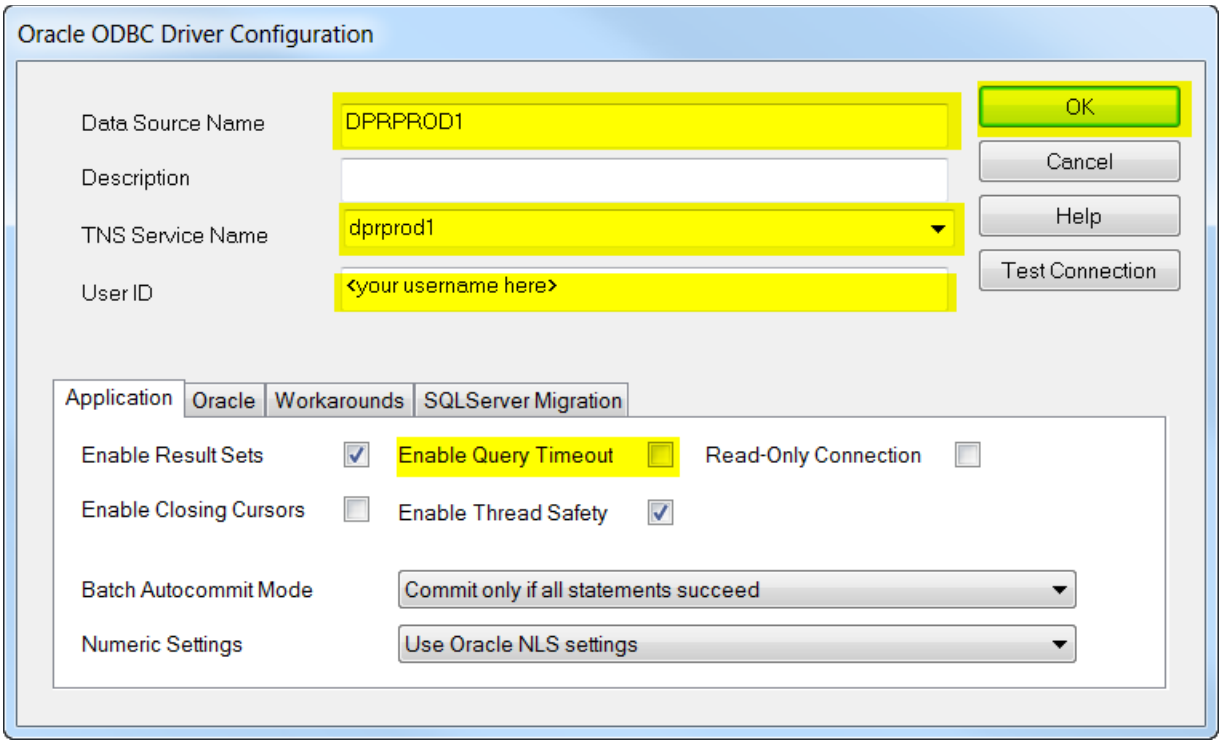
3) Under the "User DSN" tab, add "DPRPROD1" from the Oracle driver if it does not already exist.

[Step 1] Click [Add] for the dialog window of “Create New Data Source”
[Step 2] Select “Oracle in Orace11g_Home”, and click [Finish]



[Step 3] the dialog window for "Oracle ODBC Drive Configuration" will show.

- "Data Source Name" = "DPRPROD1"
- "TNS Service Name" = "dprprod1" (select from the pull-down menu)
- "User ID" = the username of your Oracle account
- Uncheck "Enable Query Timeout" (it's checked by default)
- Click [OK]



[Step 4] Oracle account name and password may be required for connection