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GreenDelta sustainability consulting + software

Elementary Flow Harmonization with openLCA and the LCA Harmonization Tool

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National Risk Management Research Laboratory, Sustainable Technology Division, Systems Analysis Branch

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- Background: Need for harmonization in LCA
- LCA Harmonization Tool
- JSON-LD Exchange Format
- Status & Outlook

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Acknowledgements

- Tom Transue (Lockheed Martin), Lead Developer, LCA Harmonization Tool
- Michael Srocka (GreenDelta), Lead Developer, openLCA
- David Meyer, Matthew Bergman (US EPA)
- Ezra Kahn, Peter Arbuckle (USDA)

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Background: The need for harmonization in LCA

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Background

- Experience with problems combining LCA data from multiple sources, which is essential for modelling (in a data scarce field)
- Recognition of lack of consistent nomenclature, and definition of elementary flows in these datasets
- Increasing potential for new and various data sources to be used in LCA → automated support for harmonization extremely desirable

Vision and concept for a harmonization tool

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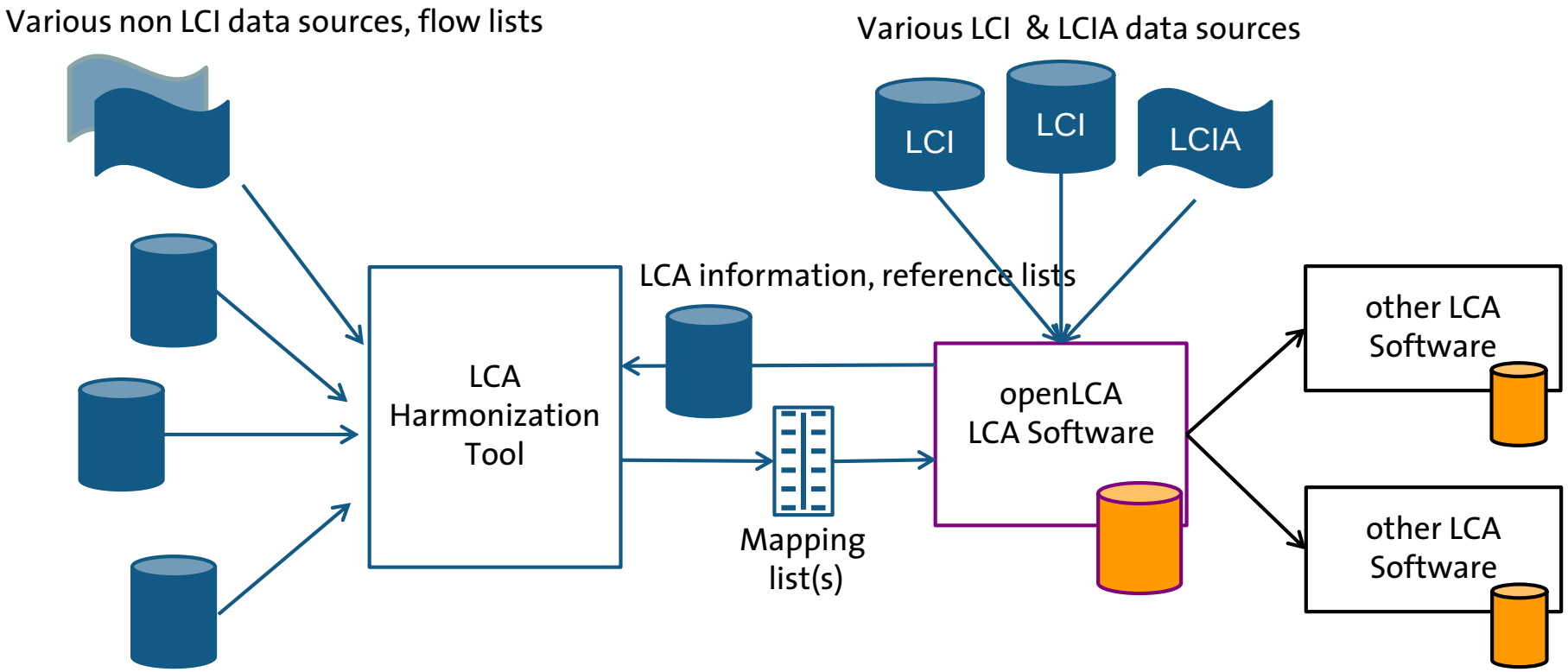
Harmonization Tool & data flow



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LCA Harmonization Tool (LCA-HT)

- Developed internally by EPA with support from USDA
- Java-based (PC and Mac compatible)
- Independent but direct exchange with openLCA
- Indirect exchange with other LCA software via standard exchange formats (ILCD, ecospold)
- To be freely available
- Built on a semantic web architecture (Resource Description Framework)

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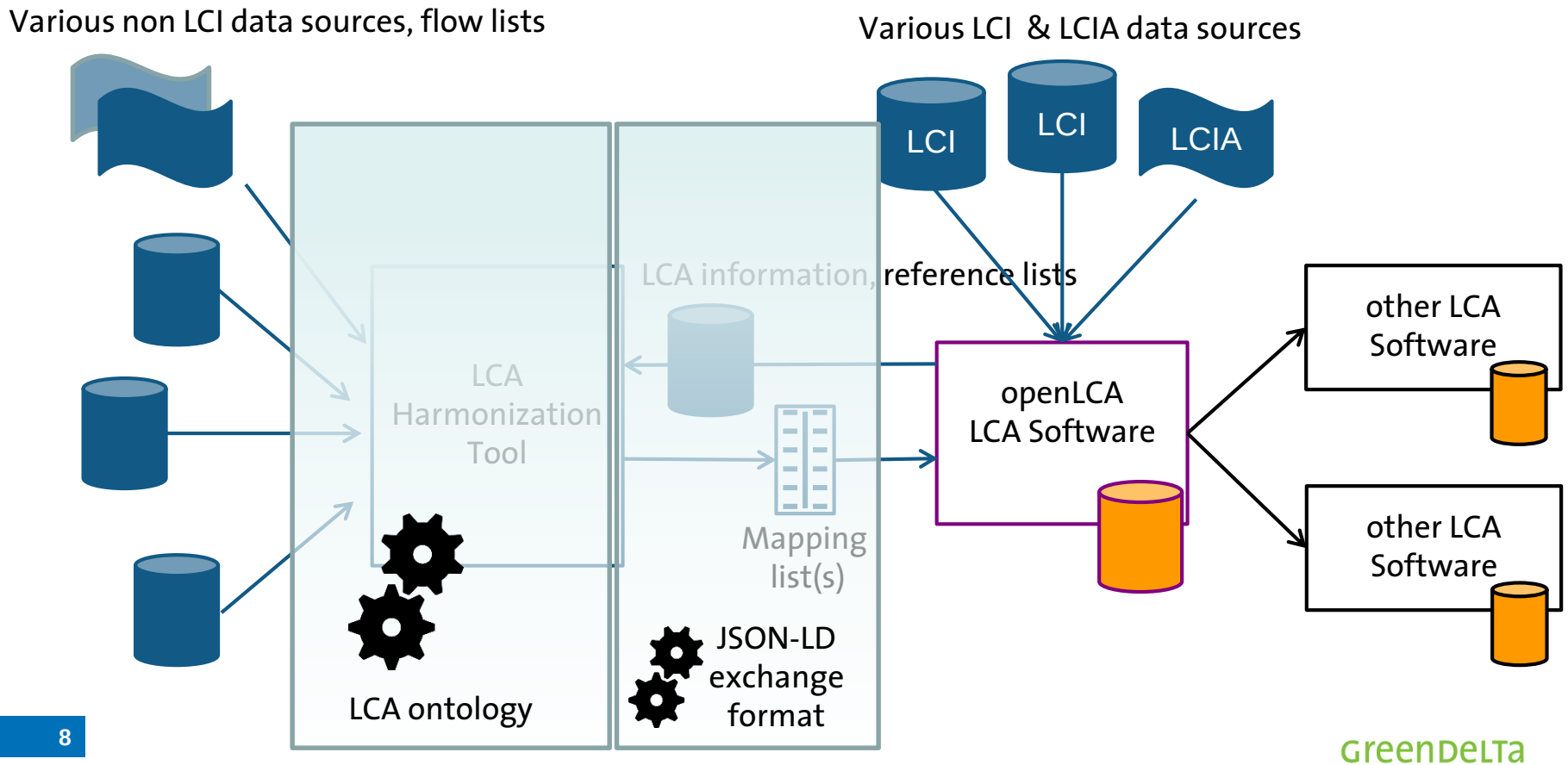
Harmonization Tool & data flow



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The harmonization tool more in detail

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LCA Harmonization Tool (LCA-HT)

- Ontology to structure and process / infer relations between LCA elements → flexible and powerful, and thus able to deal with a multitude of various data sources
- Reference and Master lists stored in RDF (ontology data format) in the tool
- User can choose this master list or their own master list
- Additions can be made to the master list from imported data

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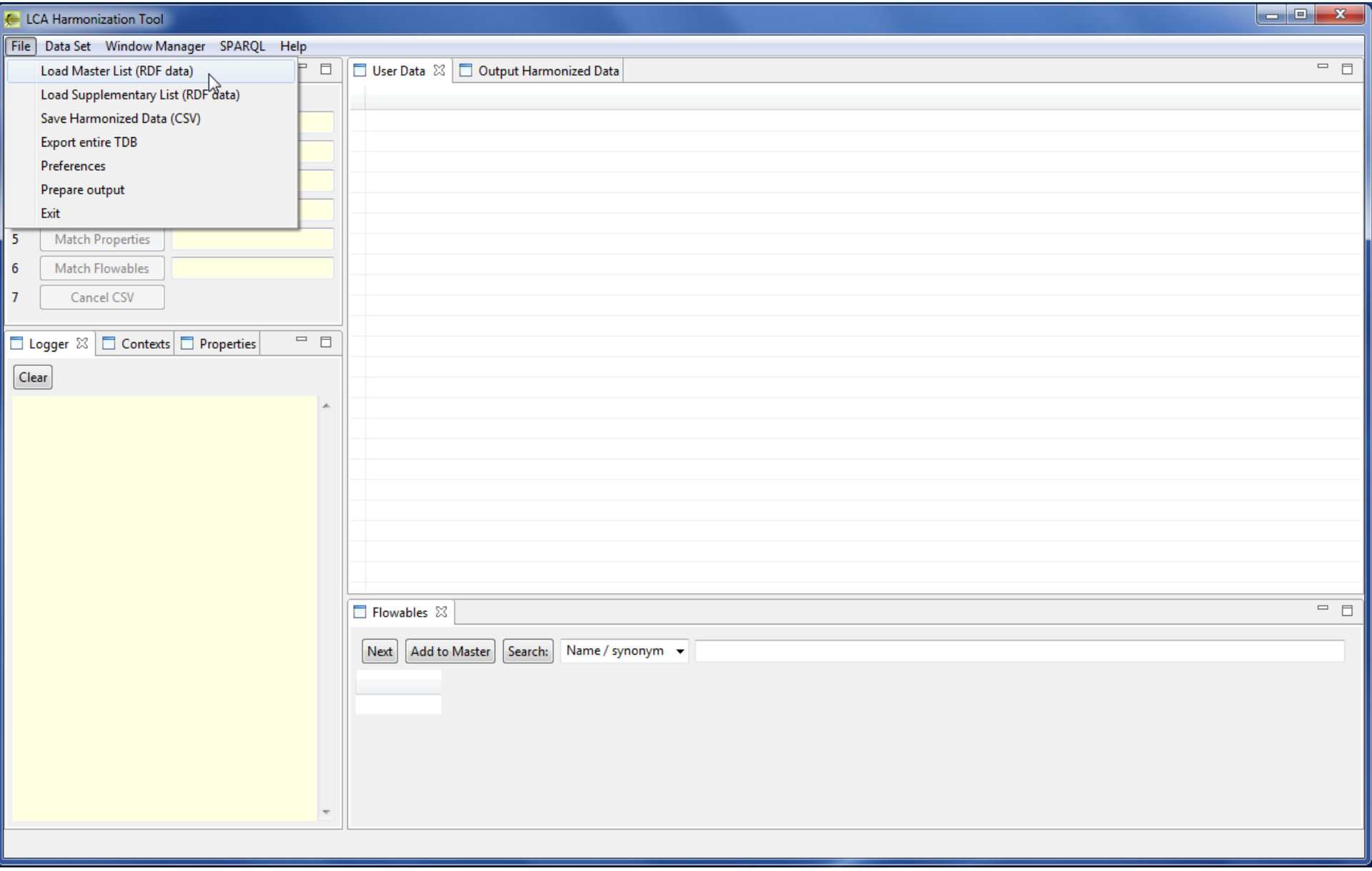
Progress to date

- Match list of elementary flows (chemicals, resources) from .txt or openLCA with a master list
- Automated matching by name and CAS, also permits match by search string
- Various match types defined including exact, superset/subset, proxy, and not a match
- Export original list along with matched flows to .txt
- Permits addition to master list


LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Load Master List (RDF data)
Load Supplementary List (RDF data)
Save Harmonized Data (CSV)
Export entire TDB
Preferences
Prepare output
Exit
5
Match Properties
6
Match Flowables
7
Cancel CSV
Logger
Contexts
Properties
Clear
User Data
Output Harmonized Data
Flowables
Next
Add to Master
Search:
Name / synonym

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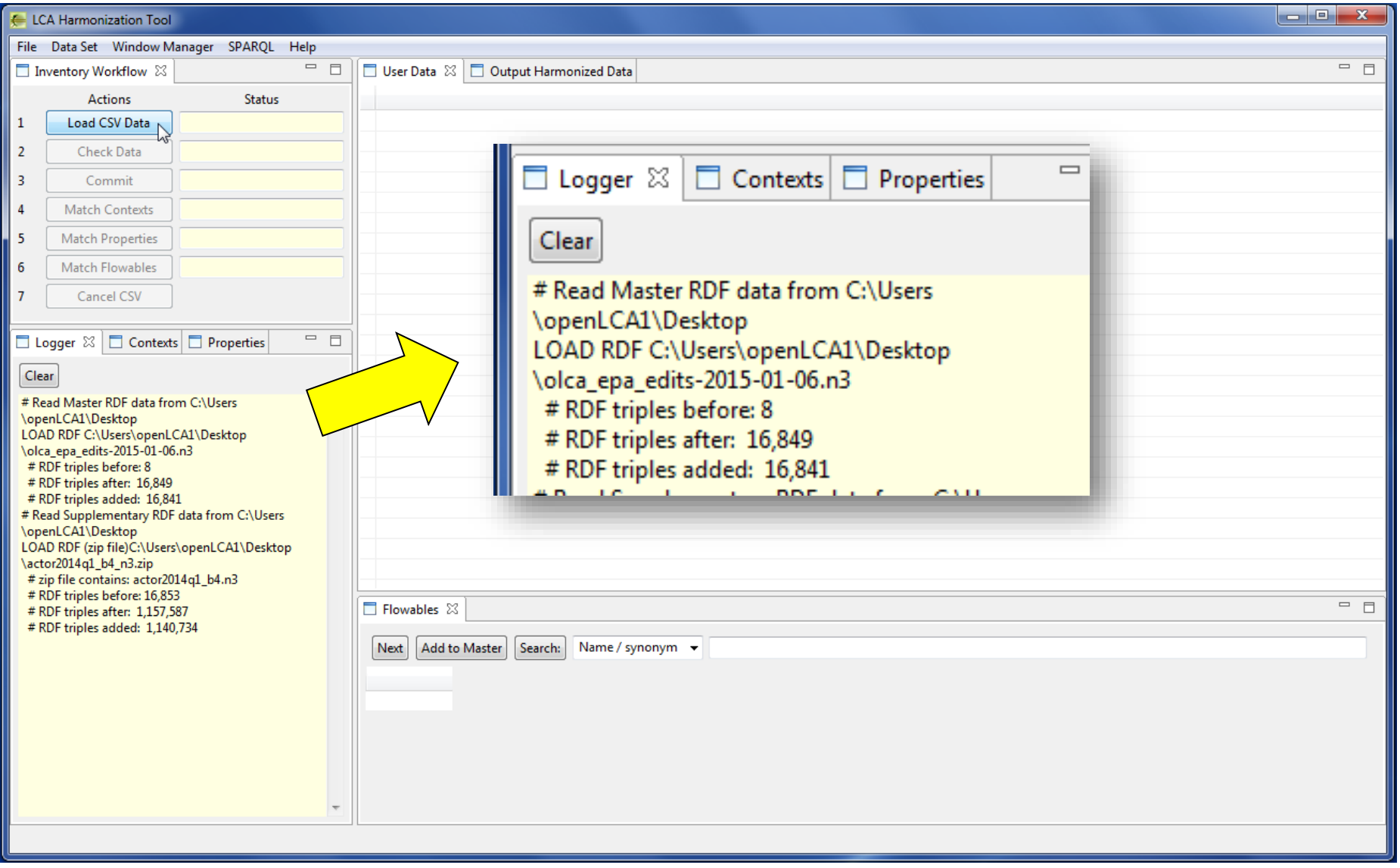
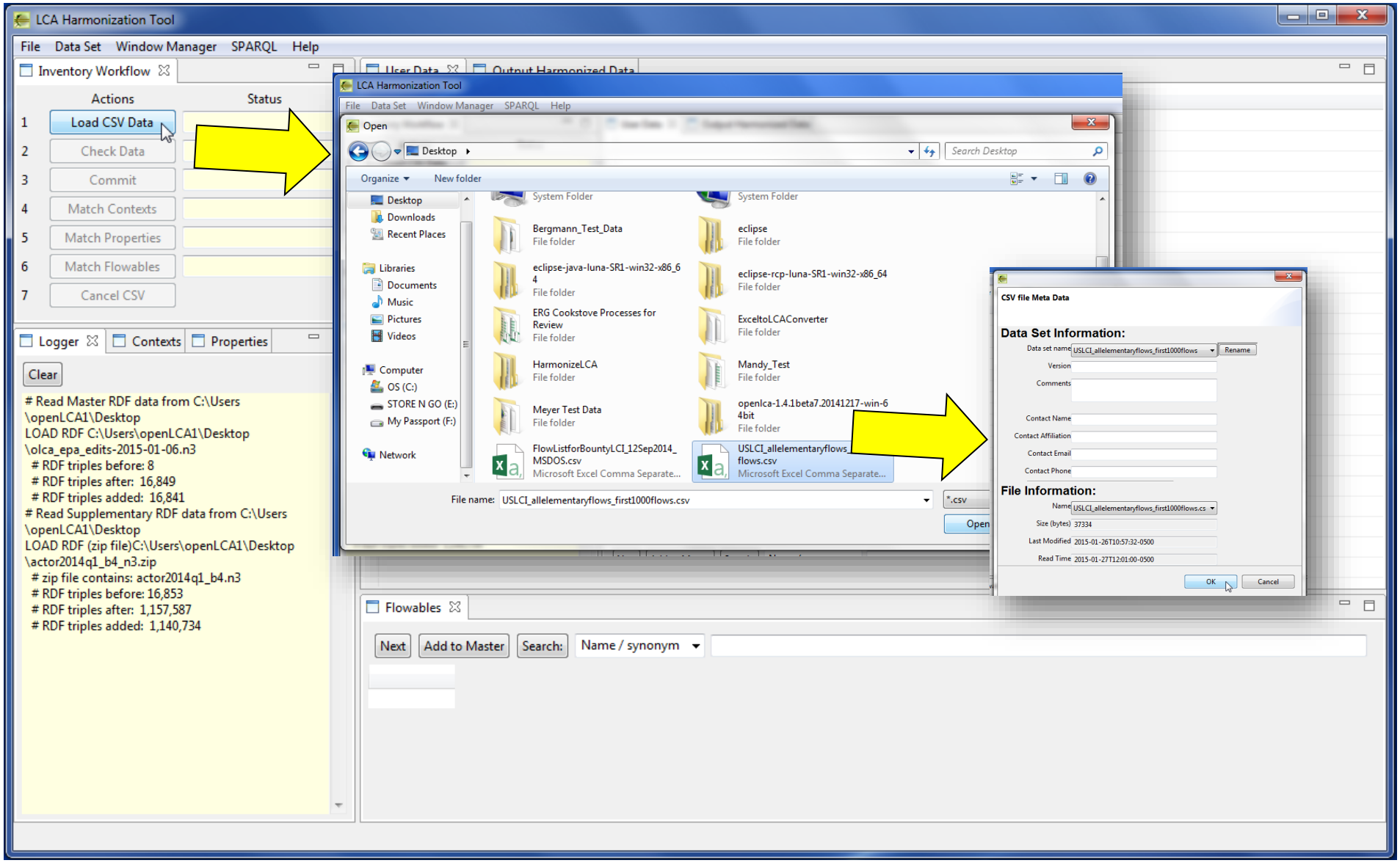

LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
1
Load CSV Data
2
Check Data
3
Commit
4
Match Contexts
5
Match Properties
6
Match Flowables
7
Cancel CSV
Logger
Contexts
Properties
Clear
Read Master RDF data from C:\Users
\openLCA1\Desktop
LOAD RDF C:\Users\openLCA1\Desktop
\olca_epa_edits-2015-01-06.n3
RDF triples before: 8
RDF triples after: 16,849
RDF triples added: 16,841
Read Supplementary RDF data from C:\Users
\openLCA1\Desktop
LOAD RDF (zip file)C:\Users\openLCA1\Desktop
\actor2014q1_b4_n3.zip
zip file contains: actor2014q1_b4.n3
RDF triples before: 16,853
RDF triples after: 1,157,587
RDF triples added: 1,140,734
User Data
Output Harmonized Data
Logger
Contexts
Properties
Clear
Read Master RDF data from C:\Users
\openLCA1\Desktop
LOAD RDF C:\Users\openLCA1\Desktop
\olca_epa_edits-2015-01-06.n3
RDF triples before: 8
RDF triples after: 16,849
RDF triples added: 16,841
Flowables
Next
Add to Master
Search:
Name / synonym


LCA Harmonization Tool
File Data Set Window Manager SPARQL Help
Inventory Workflow
Actions
Status
1 Load CSV Data
2 Check Data
3 Commit
4 Match Contexts
5 Match Properties
6 Match Flowables
7 Cancel CSV
Logger
Contexts
Properties
Clear
Read Master RDF data from C:\Users\openLCA1\Desktop
LOAD RDF C:\Users\openLCA1\Desktop\olca_epa_edits-2015-01-06.n3
RDF triples before: 8
RDF triples after: 16,849
RDF triples added: 16,841
Read Supplementary RDF data from C:\Users\openLCA1\Desktop
LOAD RDF (zip file)C:\Users\openLCA1\Desktop\actor2014q1_b4_n3.zip
zip file contains: actor2014q1_b4.n3
RDF triples before: 16,853
RDF triples after: 1,157,587
RDF triples added: 1,140,734
Open
Desktop
Search Desktop
Organize
New folder
Libraries
Documents
Music
Pictures
Videos
Computer
OS (C:)
STORE N GO (E:)
My Passport (F:)
Network
Bergmann_Test_Data
eclipse
eclipse-java-luna-SR1-win32-x86_64
eclipse-rcp-luna-SR1-win32-x86_64
ERG Cookstove Processes for Review
ExceltoLCAConverter
HarmonizeLCA
Mandy_Test
Meyer Test Data
openlca-1.4.1beta7.20141217-win-64bit
FlowListforBountyLCI_12Sep2014_MSDOS.csv
USLCI_allelementaryflows_first1000flows.csv
File name: USLCI_allelementaryflows_first1000flows.csv
CSV file Meta Data
Data Set Information:
Data set name
Rename
Version
Comments
Contact Name
Contact Affiliation
Contact Email
Contact Phone
File Information:
Size (bytes) 37334
Last Modified 2015-01-26T10:57:32-0500
Read Time 2015-01-27T12:01:00-0500
OK
Cancel
Flowables
Next
Add to Master
Search:
Name / synonym

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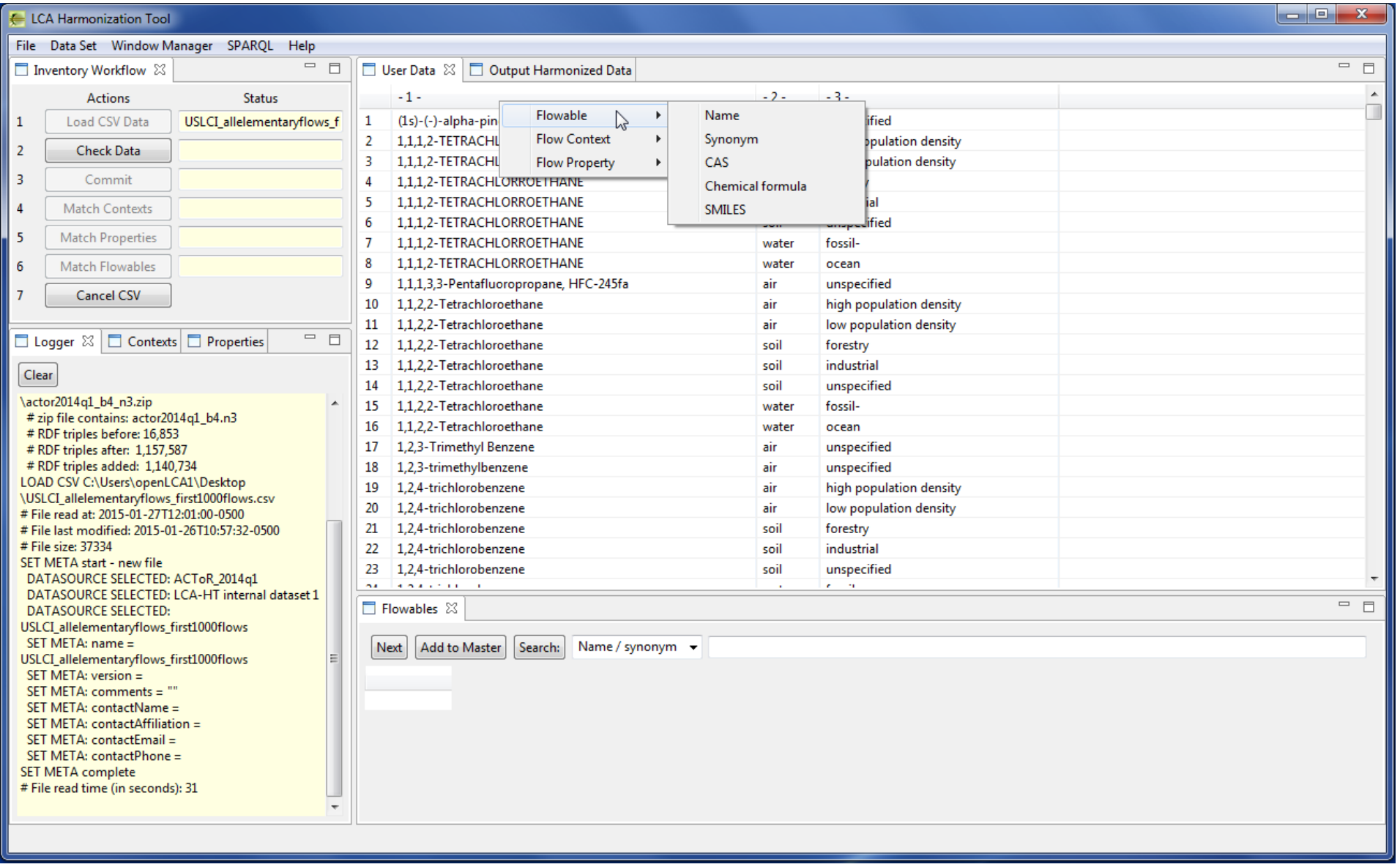
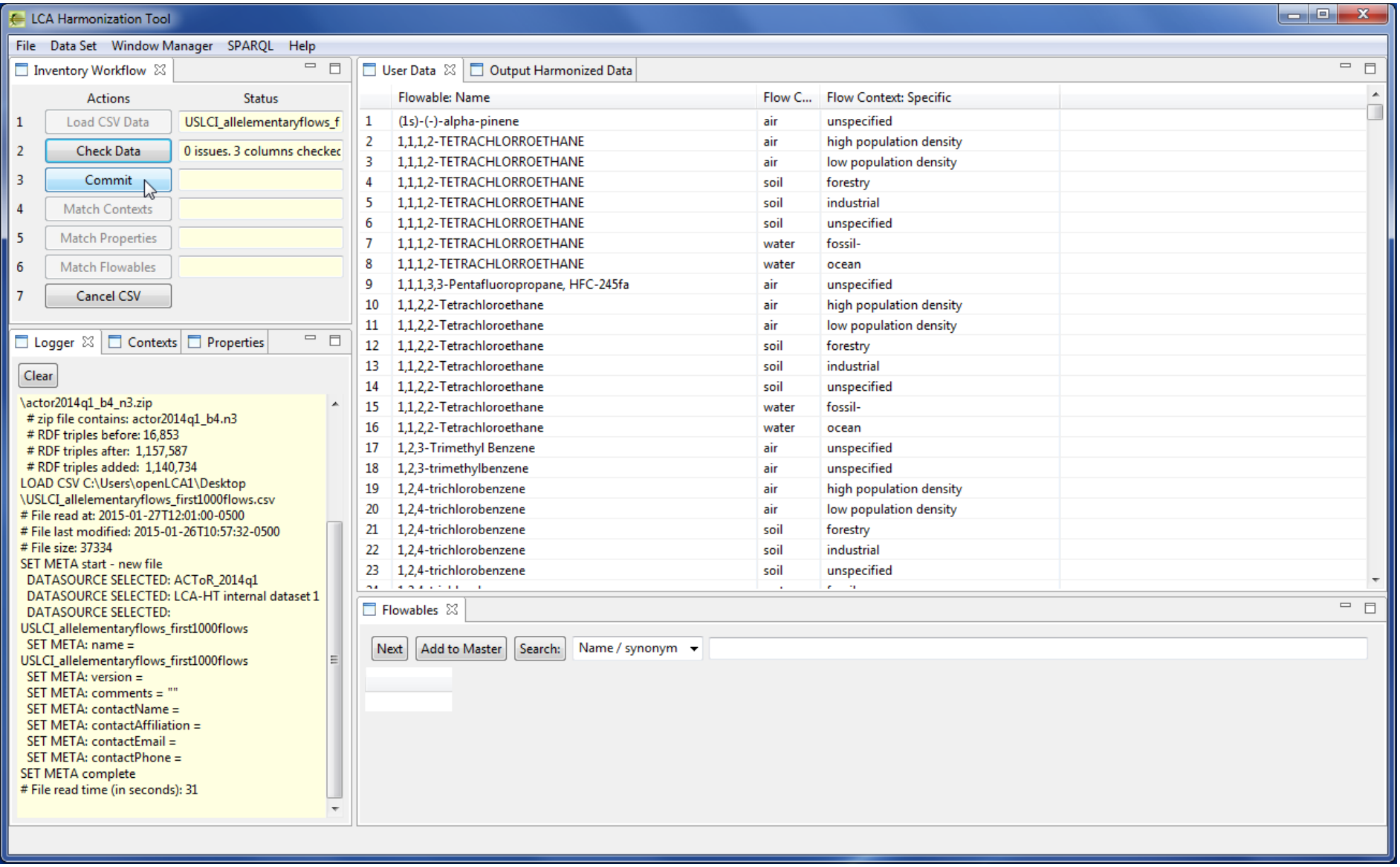

LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
1
Load CSV Data
USLCI_allelementaryflows_f
2
Check Data
3
Commit
4
Match Contexts
5
Match Properties
6
Match Flowables
7
Cancel CSV
Logger
Contexts
Properties
Clear
\actor2014q1_b4_n3.zip
zip file contains: actor2014q1_b4.n3
RDF triples before: 16,853
RDF triples after: 1,157,587
RDF triples added: 1,140,734
LOAD CSV C:\Users\openLCA1\Desktop
\USLCI_allelementaryflows_first1000flows.csv
File read at: 2015-01-27T12:01:00-0500
File last modified: 2015-01-26T10:57:32-0500
File size: 37334
SET META start - new file
DATASOURCE SELECTED: ACToR_2014q1
DATASOURCE SELECTED: LCA-HT internal dataset 1
DATASOURCE SELECTED:
USLCI_allelementaryflows_first1000flows
SET META: name =
USLCI_allelementaryflows_first1000flows
SET META: version =
SET META: comments = ""
SET META: contactName =
SET META: contactAffiliation =
SET META: contactEmail =
SET META: contactPhone =
SET META complete
File read time (in seconds): 31
User Data
Output Harmonized Data
- 1 -
- 2 -
- 3 -
1 (1s)-(-)-alpha-pin
2 1,1,1,2-TETRACHL
3 1,1,1,2-TETRACHL
4 1,1,1,2-TETRACHLORROETHANE
5 1,1,1,2-TETRACHLORROETHANE
6 1,1,1,2-TETRACHLORROETHANE
7 1,1,1,2-TETRACHLORROETHANE water fossil-
8 1,1,1,2-TETRACHLORROETHANE water ocean
9 1,1,1,3,3-Pentafluoropropane, HFC-245fa air unspecified
10 1,1,2,2-Tetrachloroethane air high population density
11 1,1,2,2-Tetrachloroethane air low population density
12 1,1,2,2-Tetrachloroethane soil forestry
13 1,1,2,2-Tetrachloroethane soil industrial
14 1,1,2,2-Tetrachloroethane soil unspecified
15 1,1,2,2-Tetrachloroethane water fossil-
16 1,1,2,2-Tetrachloroethane water ocean
17 1,2,3-Trimethyl Benzene air unspecified
18 1,2,3-trimethylbenzene air unspecified
19 1,2,4-trichlorobenzene air high population density
20 1,2,4-trichlorobenzene air low population density
21 1,2,4-trichlorobenzene soil forestry
22 1,2,4-trichlorobenzene soil industrial
23 1,2,4-trichlorobenzene soil unspecified
Flowable
Flow Context
Flow Property
Name
Synonym
CAS
Chemical formula
SMILES
Flowables
Next
Add to Master
Search:
Name / synonym


LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
1
Load CSV Data
USLCI_allelementaryflows_f
2
Check Data
0 issues. 3 columns checkec
3
Commit
4
Match Contexts
5
Match Properties
6
Match Flowables
7
Cancel CSV
Logger
Contexts
Properties
Clear
\actor2014q1_b4_n3.zip
zip file contains: actor2014q1_b4.n3
RDF triples before: 16,853
RDF triples after: 1,157,587
RDF triples added: 1,140,734
LOAD CSV C:\Users\openLCA1\Desktop
\USLCI_allelementaryflows_first1000flows.csv
File read at: 2015-01-27T12:01:00-0500
File last modified: 2015-01-26T10:57:32-0500
File size: 37334
SET META start - new file
DATASOURCE SELECTED: ACToR_2014q1
DATASOURCE SELECTED: LCA-HT internal dataset 1
DATASOURCE SELECTED:
USLCI_allelementaryflows_first1000flows
SET META: name =
USLCI_allelementaryflows_first1000flows
SET META: version =
SET META: comments = ""
SET META: contactName =
SET META: contactAffiliation =
SET META: contactEmail =
SET META: contactPhone =
SET META complete
File read time (in seconds): 31
User Data
Output Harmonized Data
Flowable: Name
Flow C...
Flow Context: Specific
1 (1s)-(-)-alpha-pinene air unspecified
2 1,1,1,2-TETRACHLORROETHANE air high population density
3 1,1,1,2-TETRACHLORROETHANE air low population density
4 1,1,1,2-TETRACHLORROETHANE soil forestry
5 1,1,1,2-TETRACHLORROETHANE soil industrial
6 1,1,1,2-TETRACHLORROETHANE soil unspecified
7 1,1,1,2-TETRACHLORROETHANE water fossil-
8 1,1,1,2-TETRACHLORROETHANE water ocean
9 1,1,1,3,3-Pentafluoropropane, HFC-245fa air unspecified
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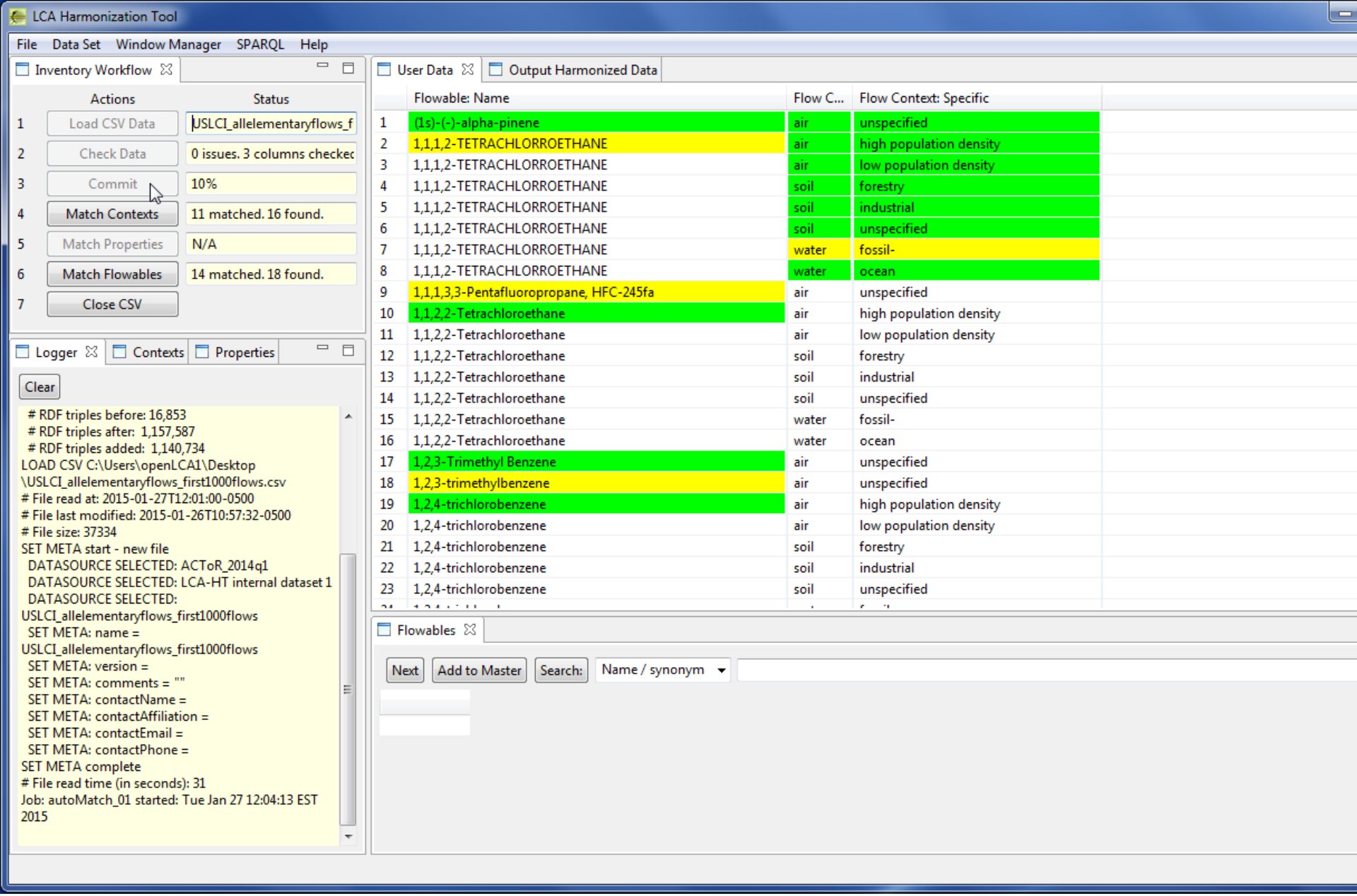
11 1,1,2,2-Tetrachloroethane air low population density
12 1,1,2,2-Tetrachloroethane soil forestry
13 1,1,2,2-Tetrachloroethane soil industrial
14 1,1,2,2-Tetrachloroethane soil unspecified
15 1,1,2,2-Tetrachloroethane water fossil-
16 1,1,2,2-Tetrachloroethane water ocean
17 1,2,3-Trimethyl Benzene air unspecified
18 1,2,3-trimethylbenzene air unspecified
19 1,2,4-trichlorobenzene air high population density
20 1,2,4-trichlorobenzene air low population density
21 1,2,4-trichlorobenzene soil forestry
22 1,2,4-trichlorobenzene soil industrial
23 1,2,4-trichlorobenzene soil unspecified
Flowables
Next
Add to Master
Search:
Name / synonym


LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
1
Load CSV Data
USLCI_allelementaryflows_f
2
Check Data
0 issues. 3 columns checkec
3
Commit
10%
4
Match Contexts
11 matched. 16 found.
5
Match Properties
N/A
6
Match Flowables
14 matched. 18 found.
7
Close CSV
Logger
Contexts
Properties
Clear
RDF triples before: 16,853
RDF triples after: 1,157,587
RDF triples added: 1,140,734
LOAD CSV C:\Users\openLCA1\Desktop
\USLCI_allelementaryflows_first1000flows.csv
File read at: 2015-01-27T12:01:00-0500
File last modified: 2015-01-26T10:57:32-0500
File size: 37334
SET META start - new file
DATASOURCE SELECTED: ACToR_2014q1
DATASOURCE SELECTED: LCA-HT internal dataset 1
DATASOURCE SELECTED:
USLCI_allelementaryflows_first1000flows
SET META: name =
USLCI_allelementaryflows_first1000flows
SET META: version =
SET META: comments = ""
SET META: contactName =
SET META: contactAffiliation =
SET META: contactEmail =
SET META: contactPhone =
SET META complete
File read time (in seconds): 31
Job: autoMatch_01 started: Tue Jan 27 12:04:13 EST
2015
User Data
Output Harmonized Data
Flowable: Name
Flow C...
Flow Context: Specific
1 (1s)-(-)-alpha-pinene air unspecified
2 1,1,1,2-TETRACHLORROETHANE air high population density
3 1,1,1,2-TETRACHLORROETHANE air low population density
4 1,1,1,2-TETRACHLORROETHANE soil forestry
5 1,1,1,2-TETRACHLORROETHANE soil industrial
6 1,1,1,2-TETRACHLORROETHANE soil unspecified
7 1,1,1,2-TETRACHLORROETHANE water fossil-
8 1,1,1,2-TETRACHLORROETHANE water ocean
9 1,1,1,3,3-Pentafluoropropane, HFC-245fa air unspecified
10 1,1,2,2-Tetrachloroethane air high population density
11 1,1,2,2-Tetrachloroethane air low population density
12 1,1,2,2-Tetrachloroethane soil forestry
13 1,1,2,2-Tetrachloroethane soil industrial
14 1,1,2,2-Tetrachloroethane soil unspecified
15 1,1,2,2-Tetrachloroethane water fossil-
16 1,1,2,2-Tetrachloroethane water ocean
17 1,2,3-Trimethyl Benzene air unspecified
18 1,2,3-trimethylbenzene air unspecified
19 1,2,4-trichlorobenzene air high population density
20 1,2,4-trichlorobenzene air low population density
21 1,2,4-trichlorobenzene soil forestry
22 1,2,4-trichlorobenzene soil industrial
23 1,2,4-trichlorobenzene soil unspecified
Flowables
Next
Add to Master
Search:
Name / synonym

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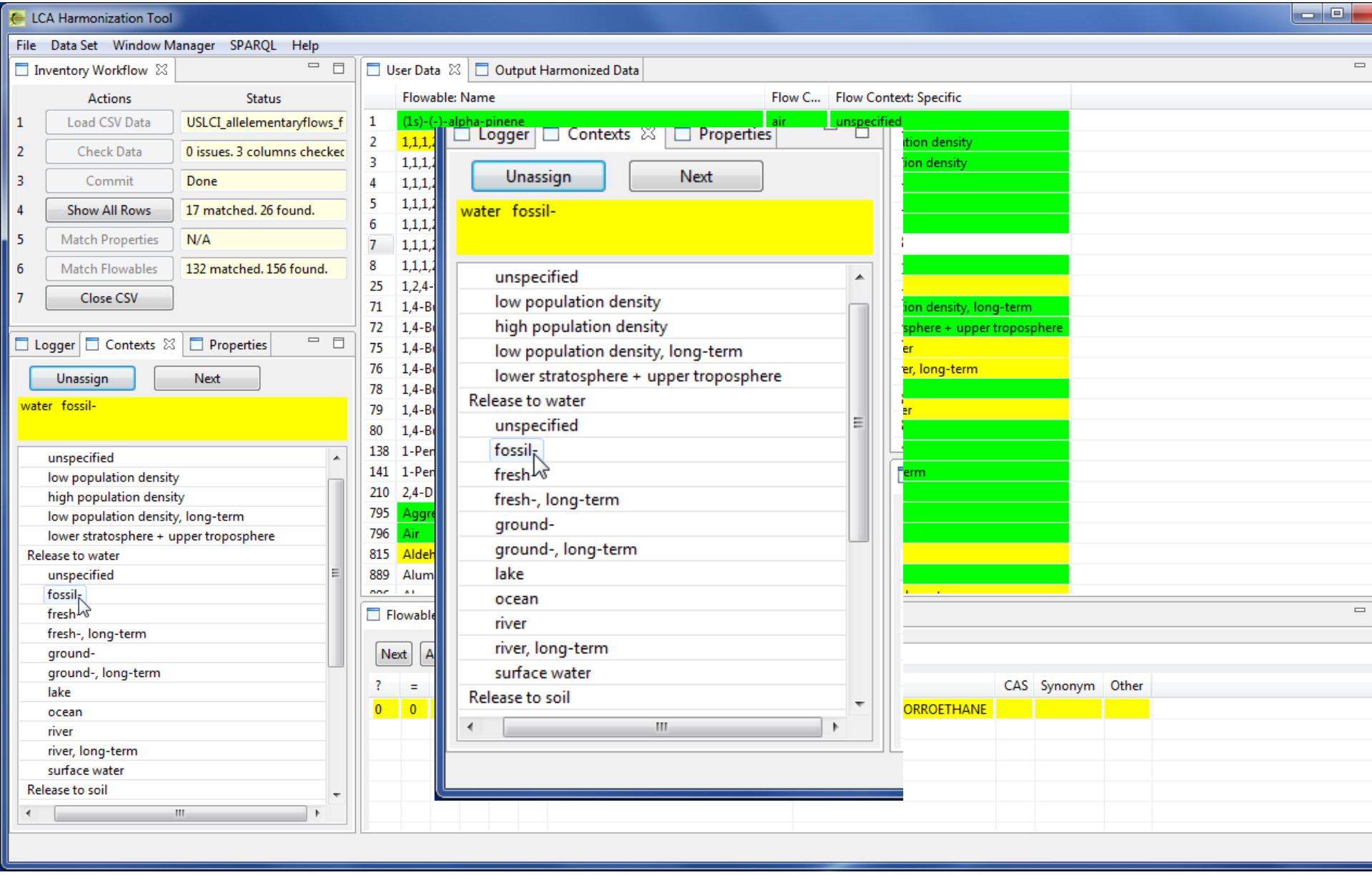
LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
1
Load CSV Data
USLCI_allelementaryflows_f
2
Check Data
0 issues. 3 columns checkec
3
Commit
Done
4
Show All Rows
17 matched. 26 found.
5
Match Properties
N/A
6
Match Flowables
132 matched. 156 found.
7
Close CSV
Logger
Contexts
Properties
Unassign
Next
water fossil-
unspecified
low population density
high population density
low population density, long-term
lower stratosphere + upper troposphere
Release to water
unspecified
fossil-
fresh
fresh-, long-term
ground-
ground-, long-term
lake
ocean
river
river, long-term
surface water
Release to soil
User Data
Output Harmonized Data
Flowable: Name
Flow C...
Flow Context: Specific
(1s)-(-)-alpha-pinene
air
unspecified
CAS
Synonym
Other

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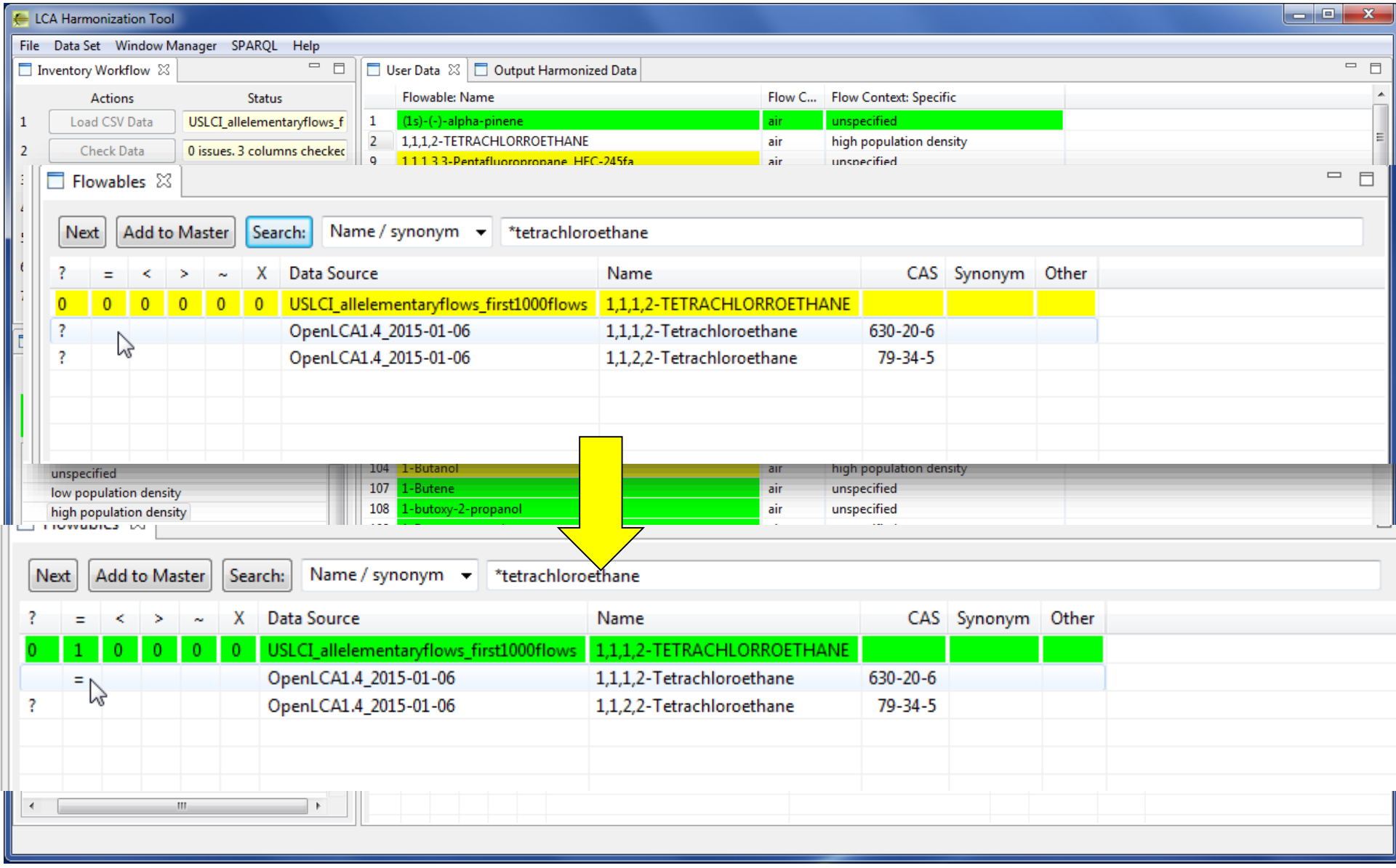
LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Inventory Workflow
Actions
Status
Load CSV Data
USLCI_allelementaryflows_f
Check Data
0 issues. 3 columns checkec
User Data
Output Harmonized Data
Flowable: Name
Flow C...
Flow Context: Specific
(1s)-(-)-alpha-pinene
air
unspecified
1,1,1,2-TETRACHLORROETHANE
air
high population density
Flowables
Next
Add to Master
Search:
Name / synonym
*tetrachloroethane
? = < > ~ X
Data Source
Name
CAS
Synonym
Other
USLCI_allelementaryflows_first1000flows
1,1,1,2-TETRACHLORROETHANE
OpenLCA1.4_2015-01-06
1,1,1,2-Tetrachloroethane
630-20-6
OpenLCA1.4_2015-01-06
1,1,2,2-Tetrachloroethane
79-34-5
unspecified
low population density
high population density
1-Butanol
1-Butene
1-butoxy-2-propanol

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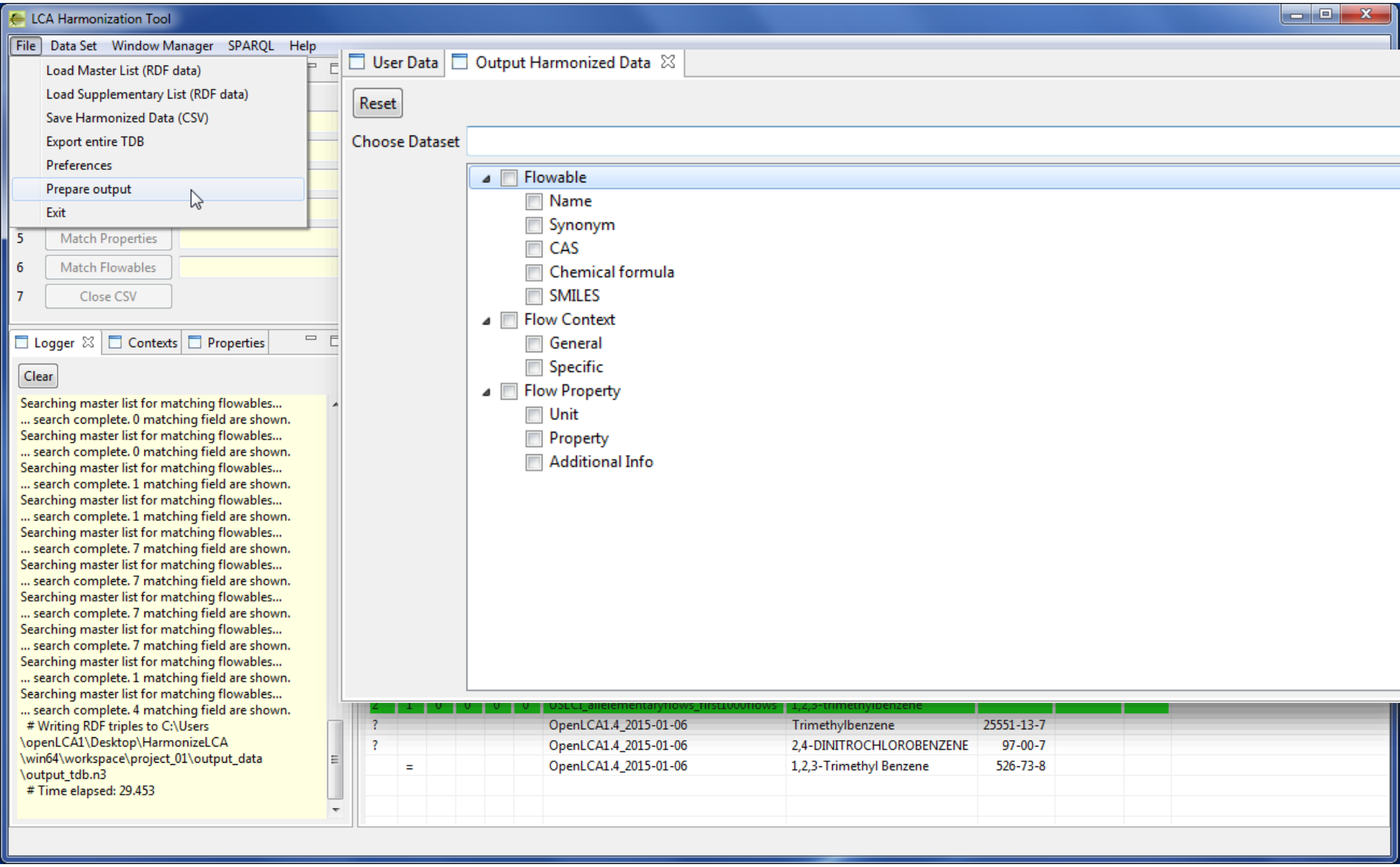
LCA Harmonization Tool
File
Data Set
Window Manager
SPARQL
Help
Load Master List (RDF data)
Load Supplementary List (RDF data)
Save Harmonized Data (CSV)
Export entire TDB
Preferences
Prepare output
Exit
5
Match Properties
6
Match Flowables
7
Close CSV
Logger
Contexts
Properties
Clear
Searching master list for matching flowables...
... search complete. 0 matching field are shown.
Searching master list for matching flowables...
... search complete. 0 matching field are shown.
Searching master list for matching flowables...
... search complete. 1 matching field are shown.
Searching master list for matching flowables...
... search complete. 1 matching field are shown.
Searching master list for matching flowables...
... search complete. 7 matching field are shown.
Searching master list for matching flowables...
... search complete. 7 matching field are shown.
Searching master list for matching flowables...
... search complete. 7 matching field are shown.
Searching master list for matching flowables...
... search complete. 7 matching field are shown.
Searching master list for matching flowables...
... search complete. 1 matching field are shown.
Searching master list for matching flowables...
... search complete. 4 matching field are shown.
Writing RDF triples to C:\Users
\openLCA1\Desktop\HarmonizeLCA
\win64\workspace\project_01\output_data
\output_tdb.n3
Time elapsed: 29.453
User Data
Output Harmonized Data
Reset
Choose Dataset
Flowable
Name
Synonym
CAS
Chemical formula
SMILES
Flow Context
General
Specific
Flow Property
Unit
Property
Additional Info
? OpenLCA1.4_2015-01-06 Trimethylbenzene 25551-13-7
? OpenLCA1.4_2015-01-06 2,4-DINITROCHLOROBENZENE 97-00-7
= OpenLCA1.4_2015-01-06 1,2,3-Trimethyl Benzene 526-73-8

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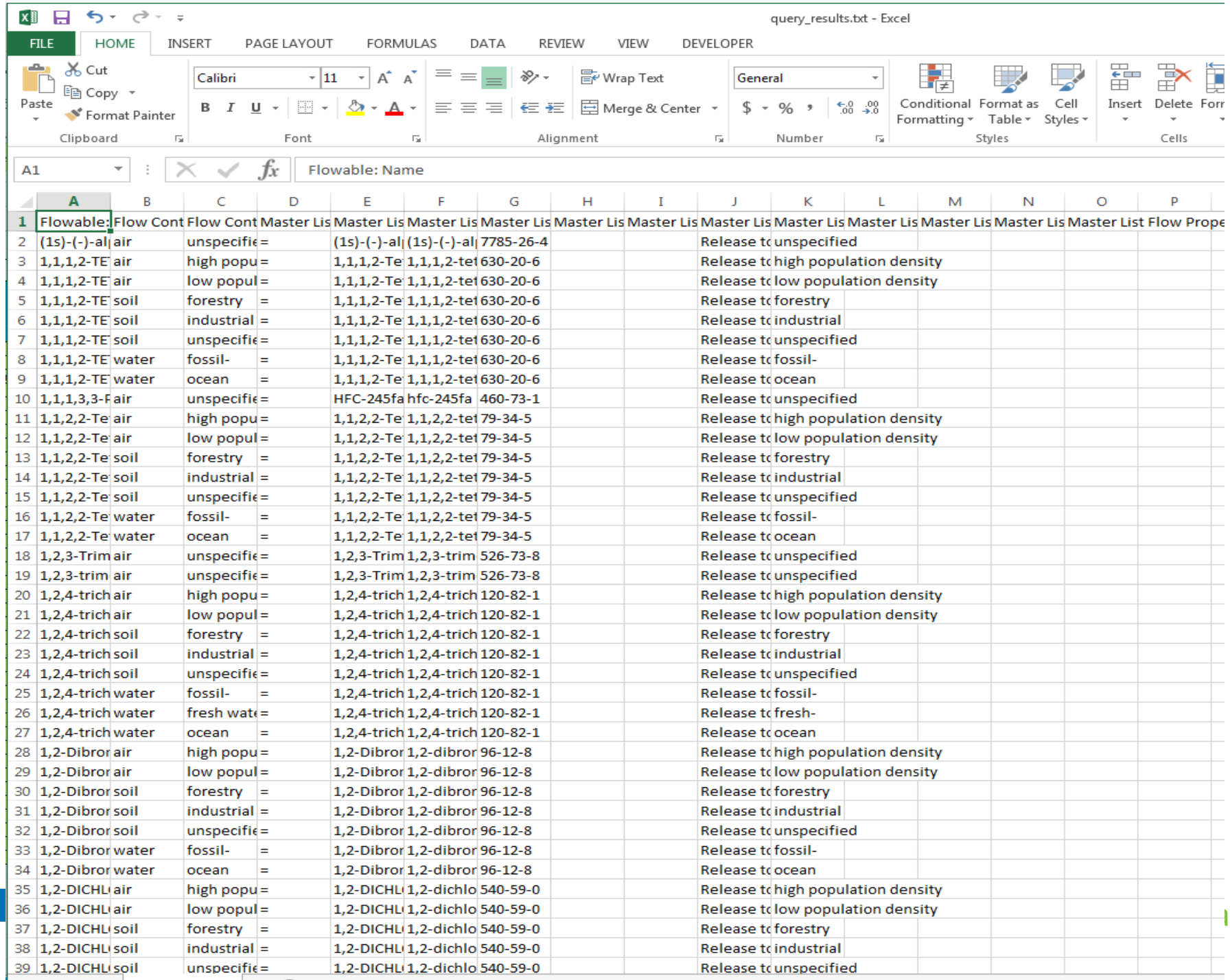

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Flowable:	Flow Cont	Flow Cont	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master Lis	Master List	Flow Prope
2	(1s)-(-)-al	air	unspecifie	=	(1s)-(-)-al	(1s)-(-)-al	7785-26-4			Release to	unspecified					
3	1,1,1,2-TE	air	high popu	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	high population density					
4	1,1,1,2-TE	air	low popul	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	low population density					
5	1,1,1,2-TE	soil	forestry	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	forestry					
6	1,1,1,2-TE	soil	industrial	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	industrial					
7	1,1,1,2-TE	soil	unspecifie	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	unspecified					
8	1,1,1,2-TE	water	fossil-	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	fossil-					
9	1,1,1,2-TE	water	ocean	=	1,1,1,2-Te	1,1,1,2-tet	630-20-6			Release to	ocean					
10	1,1,1,3,3-F	air	unspecifie	=	HFC-245fa	hfc-245fa	460-73-1			Release to	unspecified					
11	1,1,2,2-Te	air	high popu	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	high population density					
12	1,1,2,2-Te	air	low popul	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	low population density					
13	1,1,2,2-Te	soil	forestry	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	forestry					
14	1,1,2,2-Te	soil	industrial	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	industrial					
15	1,1,2,2-Te	soil	unspecifie	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	unspecified					
16	1,1,2,2-Te	water	fossil-	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	fossil-					
17	1,1,2,2-Te	water	ocean	=	1,1,2,2-Te	1,1,2,2-tet	79-34-5			Release to	ocean					
18	1,2,3-Trim	air	unspecifie	=	1,2,3-Trim	1,2,3-trim	526-73-8			Release to	unspecified					
19	1,2,3-trim	air	unspecifie	=	1,2,3-Trim	1,2,3-trim	526-73-8			Release to	unspecified					
20	1,2,4-trich	air	high popu	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	high population density					
21	1,2,4-trich	air	low popul	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	low population density					
22	1,2,4-trich	soil	forestry	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	forestry					
23	1,2,4-trich	soil	industrial	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	industrial					
24	1,2,4-trich	soil	unspecifie	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	unspecified					
25	1,2,4-trich	water	fossil-	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	fossil-					
26	1,2,4-trich	water	fresh wate	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	fresh-					
27	1,2,4-trich	water	ocean	=	1,2,4-trich	1,2,4-trich	120-82-1			Release to	ocean					
28	1,2-Dibror	air	high popu	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	high population density					
29	1,2-Dibror	air	low popul	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	low population density					
30	1,2-Dibror	soil	forestry	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	forestry					
31	1,2-Dibror	soil	industrial	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	industrial					
32	1,2-Dibror	soil	unspecifie	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	unspecified					
33	1,2-Dibror	water	fossil-	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	fossil-					
34	1,2-Dibror	water	ocean	=	1,2-Dibror	1,2-dibror	96-12-8			Release to	ocean					
35	1,2-DICHL	air	high popu	=	1,2-DICHL	1,2-dichlo	540-59-0			Release to	high population density					
36	1,2-DICHL	air	low popul	=	1,2-DICHL	1,2-dichlo	540-59-0			Release to	low population density					
37	1,2-DICHL	soil	forestry	=	1,2-DICHL	1,2-dichlo	540-59-0			Release to	forestry					
38	1,2-DICHL	soil	industrial	=	1,2-DICHL	1,2-dichlo	540-59-0			Release to	industrial					
39	1,2-DICHL	soil	unspecifie	=	1,2-DICHL	1,2-dichlo	540-59-0			Release to	unspecified					

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LCA-HT Next Steps for Beta Release

- Consolidate Master list
  - Currently using openLCA 1.4.1 master list
  - Will curate to improve consistency; remove redundancy
- Implement LCIA harmonization in tool

JSON-LD as new data exchange format

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openLCA connects with the LCA-HT via JSON-LD.
Why?

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openLCA connects with the LCA-HT via JSON-LD. Why?

- JSON-LD: "**J**ava**S**cript **O**bject **N**otation for **L**inked **D**ata", lightweight, short, W3C recommended for linked data (14 January 2014)
- Can directly read from and also write to ontologies (RDF format)
- Lightweight, human-readable, Google and Yahoo are supporters
- Modern (2010)

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openLCA connects with the LCA-HT via JSON-LD.
Why?

→(We think) a very useful alternative to XML (i.e., EcoSpold, EcoSpold2, ILCD)

→Helps overcome shortcomings of existing LCA data formats, and can fully replace them

→Overcomes also shortcomings of Ontology triple-store data, more efficient and faster

- Is implemented as one import/ export format in current openLCA 1.4.1 release

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ILCD format, process data set, one exchange: disposal wood ash mixture, export from openLCA

```
<ns2:exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="50"
olca:unitId="20aadc24-a391-41cf-b340-3e4529f44bde" olca:propertyId=
"93a60a56-a3c8-11da-a746-0800200b9a66" olca:amount="1.1464E-4">
    <ns2:referenceToFlowDataSet type="flow data set" refObjectId=
    "02da3b87-8de6-37f5-be94-204c54304356" version="01.00.000" uri=
    "../flows/02da3b87-8de6-37f5-be94-204c54304356">
        <shortDescription xml:lang="en">disposal, wood ash mixture, pure, 0% water, to
        landfarming</shortDescription>
    </ns2:referenceToFlowDataSet>
    <ns2:exchangeDirection>Input</ns2:exchangeDirection>
    <ns2:meanAmount>1.1464E-4</ns2:meanAmount>
    <ns2:resultingAmount>1.1464E-4</ns2:resultingAmount>
    <ns2:uncertaintyDistributionType>log-normal</ns2:uncertaintyDistributionType>
    <ns2:relativeStandardDeviation95In>1.159784462734350096724256218294613063335418701171875
    </ns2:relativeStandardDeviation95In>
</ns2:exchange>
```


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JSON-LD openLCA format, process data set, one exchange: disposal wood ash mixture


```
{
    "@type": "Exchange",
    "avoidedProduct": false,
    "input": true,
    "amount": 1.1464E-4,
    "flow": {
        "@type": "Flow",
        "@id": "d52f395a-a097-3cd5-b4d5-f0fb981745ec",
        "name": "disposal, wood ash mixture, pure, 0% water, to municipal incineration"
    },
    "unit": {
        "@type": "Unit",
        "@id": "20aadc24-a391-41cf-b340-3e4529f44bde",
        "name": "kg"
    },
    "flowProperty": {
        "@type": "FlowProperty",
        "@id": "93a60a56-a3c8-11da-a746-0800200b9a66",
        "name": "Mass"
    },
    "uncertainty": {
        "@type": "Uncertainty",
        "distributionType": "LOG_NORMAL_DISTRIBUTION",
        "geomMean": 1.1464E-4,
        "geomSd": 1.15978446273435
    }
```


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JSON-LD: Annotations

```
"distributionType": "LOG_NORMAL_DISTRIBUTION",
"geomMean": 1.1464E-4,
"geomSd": 1.1597844627343 5
```

ILCD: Markups

```
<ns2:meanAmount>1.1464E-4</ns2:meanAmount>
<ns2:resultingAmount>1.1464E-4</ns2:resultingAmount>
<ns2:uncertaintyDistributionType>log-normal</ns2:uncertaintyDistribution
<ns2:relativeStandardDeviation95In>1.15978446273435009672425621829461306
</ns2:relativeStandardDeviation95In>
```


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Status, outlook, discussion

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Status

- LCA-HT: About to be released as beta-version, free and open source tool, summer 2015, including mapping lists and ontology
- JSON-LD: Established in openLCA as first implementation for LCA data exchange, including an implicit ontology

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Outlook and discussion

- (I think) Both LCA-HT and JSON-LD are a major step forward, …
- … and both need to be carefully discussed with stakeholders

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Outlook and discussion

- JSON-LD for LCA data exchange could help
  - Link ontologies to LCA data in a efficient and practical way
  - Overcome existing shortcomings of individual LCA data formats (and data format interoperability) as one commonly acceptable meta format
- Reference implementation available in openLCA, free and open source → “inspiration” for LCA software and database developers

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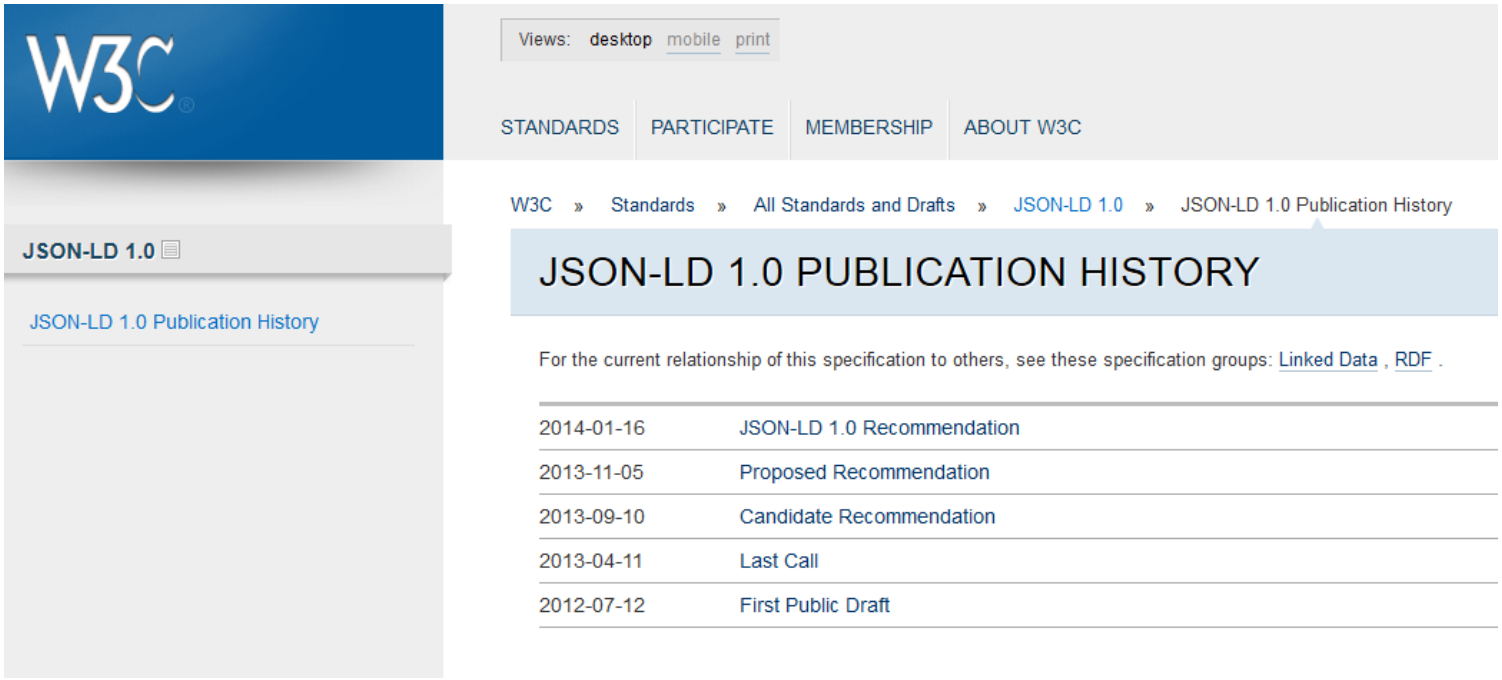
Outlook and discussion



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Disclaimer

The U.S. Environmental Protection Agency through its Office of Research and Development partially collaborated in the research described here. It has not been subject to Agency review and does not necessarily reflect the views of the Agency. No official endorsement should be inferred.

Thank you very much!

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