

# Leaching eXpert System

## A new environmental impact assessment tool

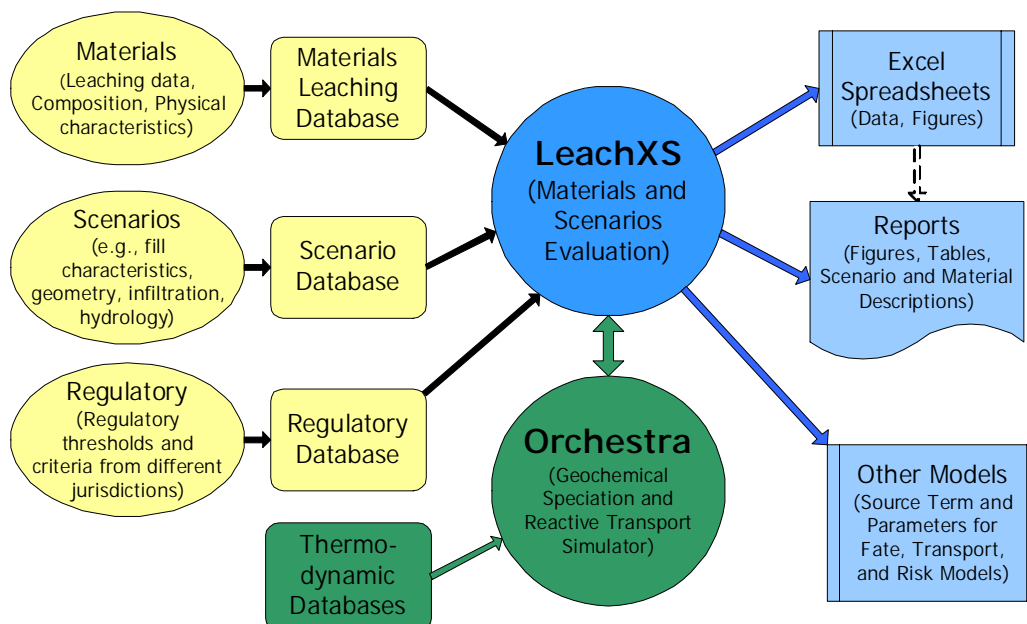
**LeachXS**, is a database/expert decision support system for characterisation and environmental impact assessment based on estimated contaminant release as derived from leaching tests. Applicable materials for assessment include:

- Soils and Contaminated Soil
- Sludge
- Compost
- Sediments
- Municipal Wastes
- Industrial and Hazardous Wastes

- Mining Wastes
- Preserved Wood
- Treated Wastes
- Stabilised Waste
- Construction Materials
- Cement Mortars and Concrete

The **materials leaching database** contains results of laboratory leaching tests, various lysimeter test results and field data from more than 600 materials and wastes. In a few cases, interrelated laboratory, lysimeter and field scale data are available.

Leaching tests are interpreted in an expert system to provide **estimates of the short and long term release of constituents of interest**. This makes the database/expert system a unique tool to study the release behaviour of different materials when used, recycled or landfilled.



A **regulatory database** allows comparison of test data against criteria for specific utilisation or disposal conditions. Constituents included comprise virtually all inorganic constituents, a selection of organic components and will be suitable for radionuclides. At present, the database system covers leaching/extraction test data, field data and composition data.

**Geochemical speciation** and chemical reaction/transport modelling capabilities are integrated into the system by using the modelling environment ORCHESTRA. The geochemical modelling includes mineral solubility (extended MINTEQ database), sorption on Fe-oxide (Dzombak & Morel), Al-oxide, dissolved organic carbon (DOC) and particulate organic carbon (POM) interaction according to NICA -DONNAN. Graphical and tabular output is generated in MS Excel.

LeachXS will facilitate compliance with environmental regulations for recycling, waste management, contaminated soil and sediment assessment, fertiliser use and construction product use. It also will facilitate the selection and development of appropriate treatment processes and engineering designs to minimise waterborne environmental impacts.

#### **Functions of LeachXS include:**

- **Evaluation Guidance** – problem definition, selection of characterisation needs and methods, detailed methodologies; provision of existing information on characteristics and behaviour of materials similar to that in question.
- **Laboratory Guidance** – lysimeter and field data collection including experimental design and quality control considerations; existing information from similar pilot and field evaluations.
- **Data Management** – standardized formatting and graphical presentation, including consistency and quality control checking.
- **Data Evaluation** – parameter derivation and comparative data analysis
  - a. pH and redox dependency of aqueous concentrations (cations, anions, DOC, ionic strength), geochemical speciation, acid/base neutralisation capacity, leaching potential (availability) from batch testing.
  - b. Release of contaminants as a function of time for granular and monolithic materials from sequential data sets (liquid to solid ratio or time dependency from monolithic or compacted granular tank leaching tests, column testing, lysimeter testing), including geochemical speciation and mass transfer parameter estimation.
  - c. Quality control based on the use of simplified testing in comparison with earlier more detailed characterisation of the same or comparable materials.
- **Source Term Descriptions** – estimate constituent release as a function of time for default or user-defined application or management scenarios. This

would include selection of appropriate source term models, evaluation of the effects of potential external influences (e.g. mixing with other materials, carbonation, oxidation, reduction, and acidification) and uncertainty analysis.

- **Impact Evaluation** – potential impacts on soil, groundwater or surface water and risk estimation, including the application of default or user-defined transport and fate scenarios.
- **Decision Algorithms** – for comparison of evaluation results and decision-making based on regulatory criteria from different jurisdictions; recommendations on reduced-testing quality control programs; recommendations on approaches to reduce constituent release and environmental impacts.

The software for the database/expert system includes data conversion tools based on MS Excel and data import tools for the Access database. In this way a user may insert his own data into LeachXS and obtain the desired answer or result. If the user is interested in information on a specific type of material but does not have any data on that material, typical default data on more than a 100 different materials are available and may be drawn from the database.

The following activities associated with LeachXS are envisaged:

- Release of LeachXS to users for an annual licence fee (possibly in more than one version, depending on the purpose and the costumers' needs);
- Training courses on the use of LeachXS; and
- Performance of research projects and expert consultation by ECN, VU and DHI using LeachXS.

The released versions of LeachXS contains publicly available data on a wide range of different materials.

Versions of LeachXS for use on individual personal computers, through server-based licence use, and full server-based versions for remote system use are envisioned.

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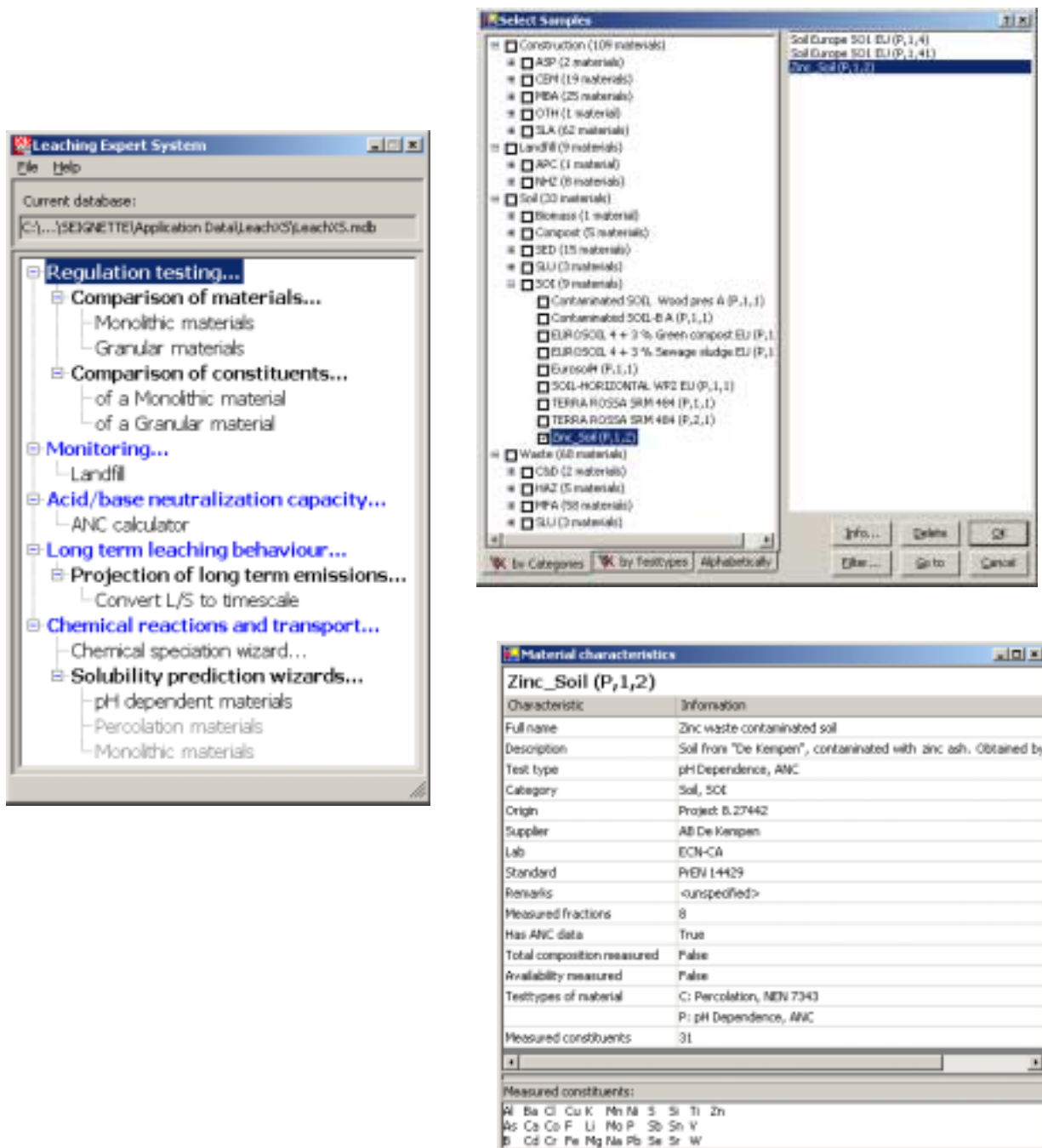
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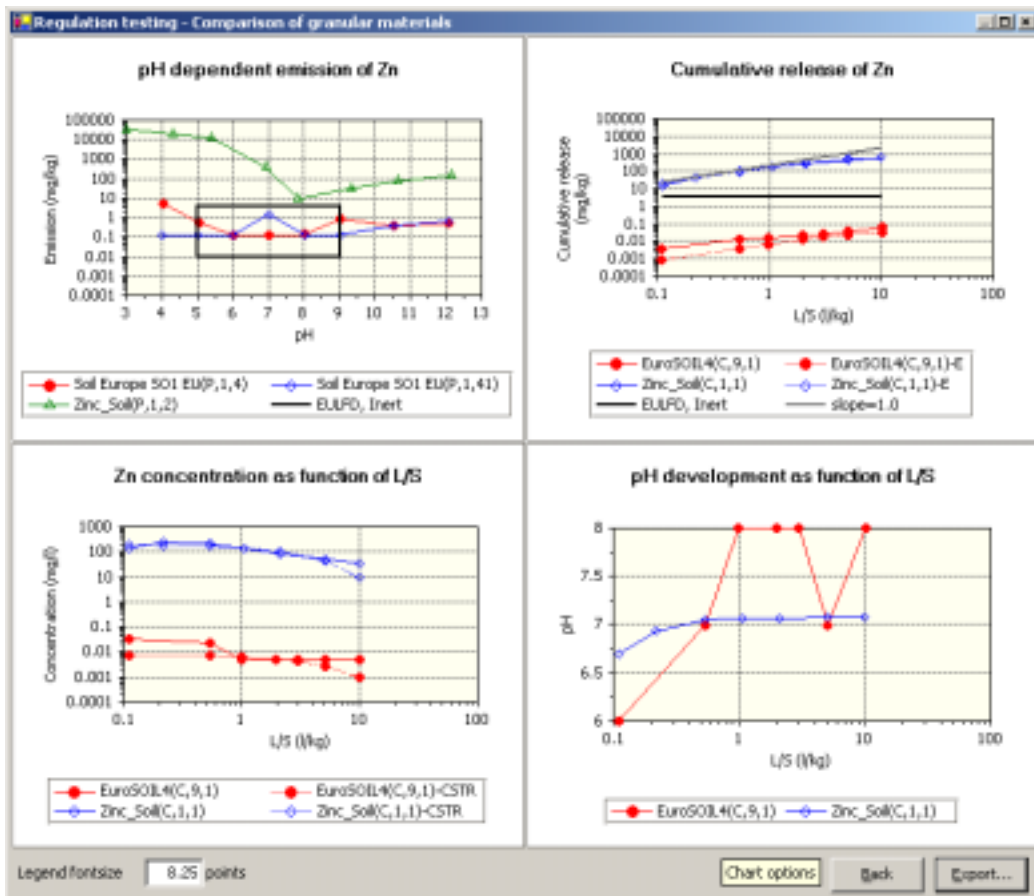
## Some screenshots of the LeachXS system

To enhance your productivity, special attention is given to the design of the user interface. On this page, you see:

- the LeachXS main menu, disclosing all functions;
- the Material selection dialog, assisting you in choosing the right materials;
- the Material information window, with detailed information on the materials you selected.



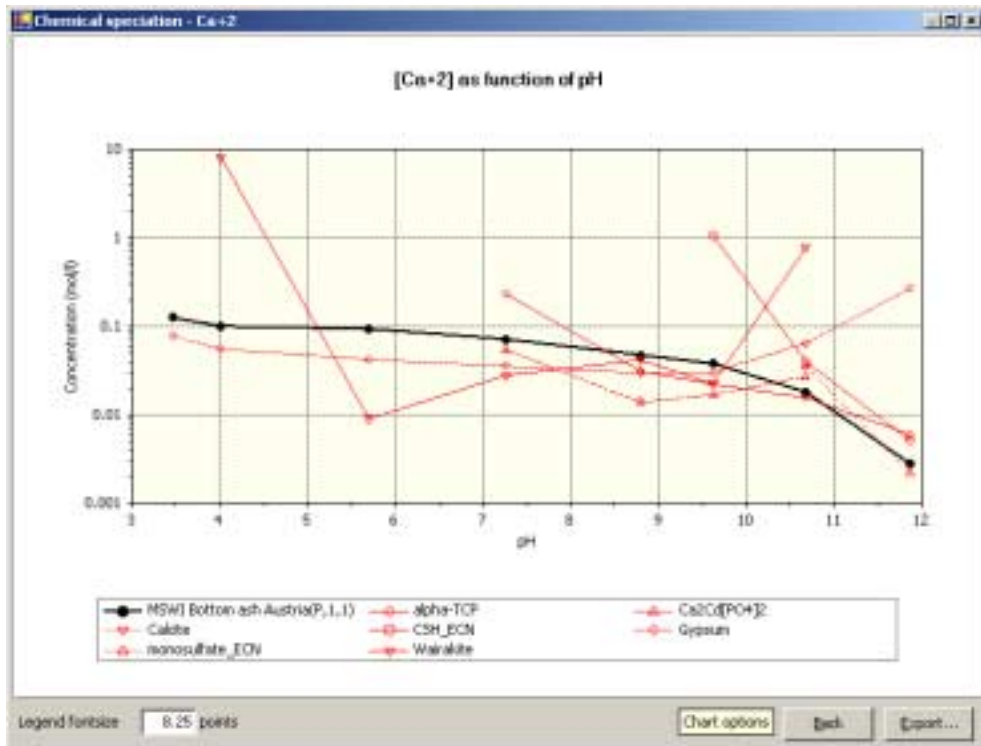
This page shows you one of the dialogs that assist you in comparing materials, together with the graphical presentation of the comparison results.



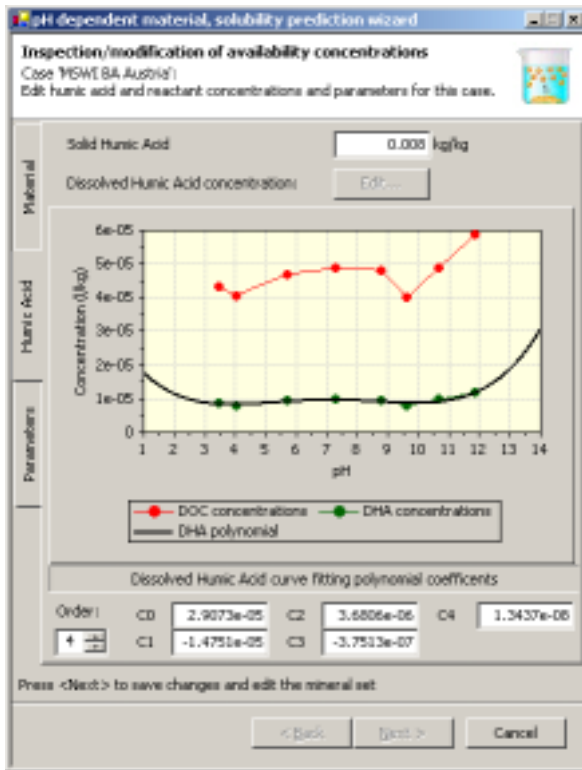
This page shows the selection of minerals in the Chemical Speciation Wizard with the aid of the calculated saturation indexes, together with the modelling results.

Inspecting saturation indexes

		MSWI Bottom ash Austria(P,1,1)							
		Fractions							
		pH							
		8	7	6	5	4	3	2	1
		3.46	4.01	5.70	7.26	8.79	9.62	10.88	11.86
Minerals	ROM								
<input checked="" type="checkbox"/> Gypsum	001 (062+100)	0.21	0.26	0.35	0.31	0.21	0.10	-0.56	-1.57
<input type="checkbox"/> Anhydrite	091 (062+100)	0.23	0.29	0.39	0.33	0.23	0.13	-0.53	-1.95
<input type="checkbox"/> Calcite(1)	080 (058+100)	0.97	0.99	0.95	0.88	0.84	0.80	0.29	0.52
<input type="checkbox"/> Calcite(2)	075 (050+100)	1.24	1.24	1.13	1.05	1.04	1.03	0.60	0.09
<input type="checkbox"/> Aragonite(1)	067 (034+100)	-1.73	-1.73	-1.24	-0.96	-1.03	-1.02	-0.99	-1.95
<input checked="" type="checkbox"/> Wairakite	060 (044+075)	1.41	-1.91	1.02	0.41	0.06	0.23	-1.64	
<input checked="" type="checkbox"/> Ca2Cd(PO4)2	058 (066+050)	0.22	0.18	0.13	0.25	1.07	0.70	-0.36	
<input checked="" type="checkbox"/> alpha-TCP	059 (054+052)	0.13	0.08	0.07	-1.53	0.95	0.70	0.19	-0.99
<input type="checkbox"/> Wollastonite	056 (073+038)	0.07	0.09	0.44	0.11		0.70	0.41	0.49
<input type="checkbox"/> Ca2Si(PO4)2	054 (083+025)	1.35	0.94	0.67	0.42	-0.22			
<input type="checkbox"/> Ca2Si(PO4)2(001)	052 (079+025)	10.00	10.00	7.00	-0.52	-0.31			
<input type="checkbox"/> Wollastonite	052 (065+038)	0.14	0.09	0.07			0.90	0.13	0.82
<input type="checkbox"/> TCP	051 (052+050)	0.34	0.30	0.20	-0.20	1.48	0.93	-0.76	
<input type="checkbox"/> Wollastonite	048 (045+050)	0.20	0.24	0.55			-1.20	0.19	1.34
<input type="checkbox"/> Wollastonite(2)	048 (022+075)	-1.96	-1.60	-1.95	0.82	-1.22	-1.92		
<input checked="" type="checkbox"/> CSH_ECN	047 (056+038)	0.29	0.25	0.18	0.48	0.31	-1.45	-0.34	-0.26
<input type="checkbox"/> Anhydrite	046 (067+025)	0.08	0.06	0.10	0.09	0.04	0.14	0.17	0.19
<input type="checkbox"/> Ca2Si(PO4)2(001)	044 (062+025)	1.00	1.00	0.80	0.31	0.14			
<input type="checkbox"/> Ca2Si(PO4)2	044 (043+038)	0.36	0.33	0.25	0.99	1.37	0.55		
<input type="checkbox"/> alpha-TCP(001)	042 (060+025)	1.25	0.95	0.61	0.99	-0.95			
<input type="checkbox"/> alpha-TCP(001)	042 (058+025)	0.00	0.00	0.10	0.10	0.00	0.28	0.27	0.85
<input type="checkbox"/> alpha-TCP(2)	042 (034+050)	2.51	-1.15	-0.99	0.17	1.20	-0.33	-0.04	-0.03
<input checked="" type="checkbox"/> monosulfate_ECN	040 (056+025)	0.50	0.41	0.25	0.24	0.00	0.00	-1.16	-0.42
<input type="checkbox"/> alpha-TCP(100)	039 (053+025)	0.07	0.00	0.00	0.24	-1.31	0.00	0.00	0.00
<input type="checkbox"/> Wollastonite	039 (053+025)	0.94	1.00	0.80	1.00	0.47	0.04	0.00	0.00
<input type="checkbox"/> Ca2Si(PO4)2	030 (038+038)	0.70	0.50	0.00	0.91	0.01	-1.73	0.00	0.00
<input type="checkbox"/> Wollastonite(1)	038 (025+050)	0.10	-1.75	-1.71	-0.99	-1.38	0.00	0.00	0.00

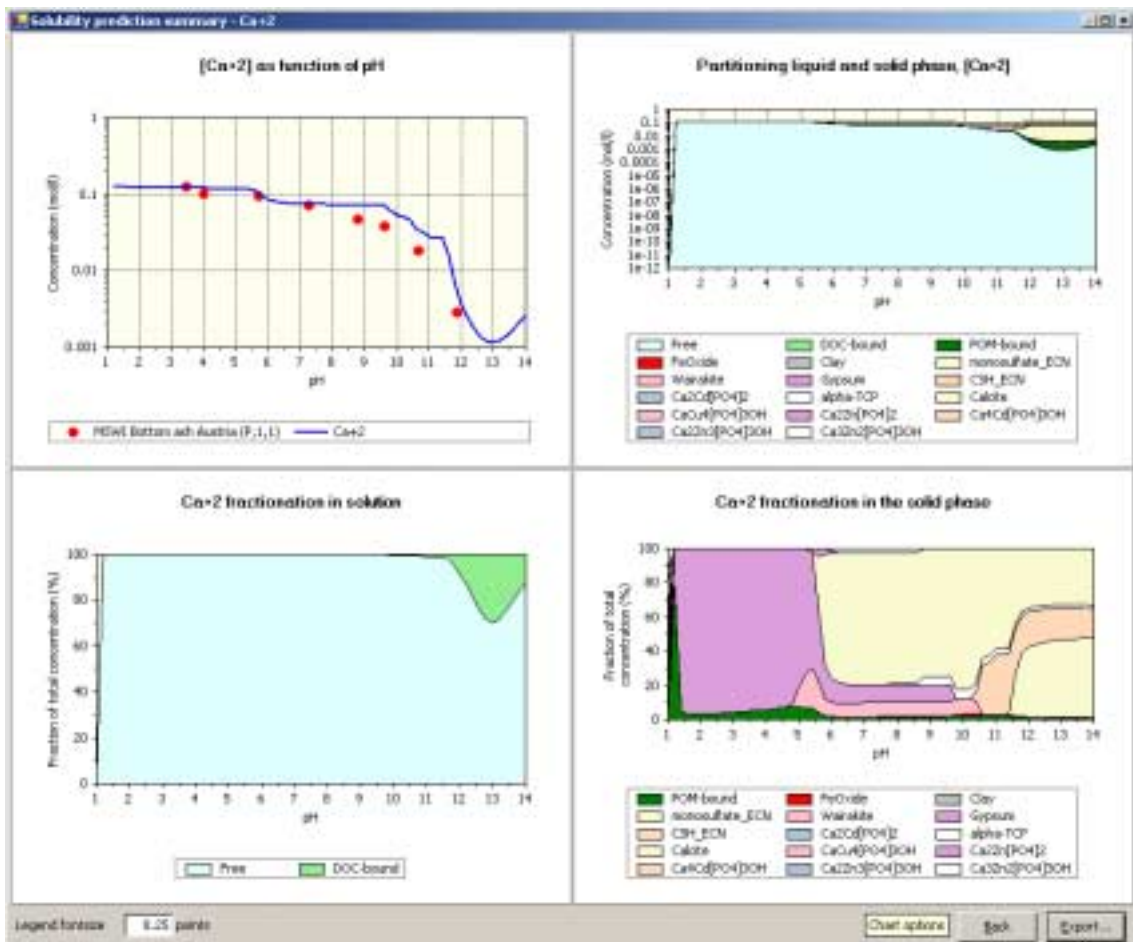


Here are some screenshots of one of the steps in the Solubility Prediction Wizard for pH dependent materials, along with an overview of the modeling results for  $\text{Ca}^{2+}$ .



pH	[DHA] (kg/t)	fraction DHA
1.00	not measured	empty
3.46	4.320e-05	0.20
4.01	4.070e-05	0.20
5.70	4.790e-05	0.20
7.26	4.890e-05	0.20
8.79	4.820e-05	0.20
9.62	4.010e-05	0.20
10.68	4.500e-05	0.20
11.86	5.690e-05	0.20
14.00	not measured	empty

Set all DOC concentrations to: 0.001 kg/t Set  
Set all DHA fractions to: 0.20 Set



Future:

Prediction tool for modeling release from laboratory leaching tests

- percolation test
- tank leach test

Models for different utilization and disposal scenarios are available off line, after testing they will become available as scenarios in LeachXS. Typical scenarios include:

- road base construction
- embankment
- mixed waste landfill
- monolithic waste landfill
- drinking water pipes
- treated wood constructions
- multilayer applications,
- oxidation of mining waste
- monolithic structures
- design of release from material mixtures
- interface reactions