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USING THEORETICAL DESCRIPTORS IN STRUCTURAL ACTIVITY RELATIONSHIPS

IV. MOLECULAR ORBITAL BASICITY AND ELECTROSTATIC BASICITY

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Quantitative Structure Activity Relationships (QSAR) have been used to develop predictive equations for numerous biological and physicochemical properties. Linear Solvation Enery Relationship (LSER), a sub-set of QSAR have been used by Kamlet and Taft to correlate over 100 solute/solvent dependent interactions with a set of empirically derived descriptors. A major difficulty with this approach is the use of these empirically determined parameters. A new approach, based upon the generalized LSER approach, has been developed. This technique, called theoretical LSER, uses only structural and quantum chemically derived descriptors. The introduction of basicity ter into the theoretical LSER is discussed.

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PREFACE

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USING THEORETICAL DESCRIPTORS IN STRUCTURAL ACTIVITY RELATIONSHIPS

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1. INTRODUCTION

In many applications of basic, applied and developmental research, it is necessary to know certain physical and chemical properties of chemical compounds. Many times, the important physical and chemical properties are not available. For these instances, either the compound must be synthesized and the properties measured, or the properties must be estimated. In many cases, it is not possible, due to time or monetary constraints to do the former. The only recourse, then, is to use valid property estimation procedures. Several researchers have published compendia of useful property routines.[1,2]

Unfortunately, many of the classes of compounds of interest to the U.S. Army Chemical Research, Development and Engineering Center (CRDEC) are not in use elsewhere, and therefore many existing estimation methods may not be appropriate or sufficient. Therefore, it has been necessary for CRDEC to develop many of the class specific property estimation methods. A description of these methods were discussed at the 2nd Annual Simulant Workshop held at Fort McClellan, AL, 1-3 March 1988.

1.1 Quantitative Structure Activity Relationships

One approach that has proved highly successful for the correlation and prediction of various types of physical and biological activities has been Quantitative Structure Activity Relationships (QSAR).[3-5] QSAR, in principle, relates molecular parameters to these activities. This type of relationship originates from thermodynamics, where Hammet recognized the relationship of structure to the Gibb's Free Energy, and ultimately to equilibria and reaction rates.[6] The Hammet equation, also called the Linear Free Energy Relationship (LFER) because of the relationship of the Gibb's Free Energy to the molecular properties, has been used and modified extensively to link bulk properties and microscopic thermodynamic parameters.

1.2 Linear Solvation Energy Relationships

Kamlet and Taft modified the LFER approach and developed the Generalized Linear Solvation Energy Relationship (LSER).[7,8] The LSER is based upon the concepts of QSAR and LFER and relates solute/solvent interactions to molecular descriptors. The Generalized LSER, as devised by Kamlet and Taft, is shown in equation 1. The three principal components that define any solute/solvent interaction are size/steric, polarizability of the electron cloud, and the ability to hydrogen bond.

$$\text{LOG Property} = \text{Steric} + \text{Polarizability} + \text{Hydrogen Bonding} + \text{Constant} \quad (1)$$

Equation 2 shows the Generalized LSER with the descriptors used by Kamlet and Taft.

$$\text{LOG Property} = mV_m + p\pi^* + a\alpha + b\beta + C \quad (2)$$

The Molar Volume, V_m, describes the size of the molecule and is the steric term. The polarizability term, π^*, represents the degree to which a dipole may be induced in the molecule. This is directly proportional to the softness of the electron cloud, or the ability of the electron cloud to deform. The terms α and β are the hydrogen bonding terms and represent the degree to which the solute acts as a hydrogen bonding acid or base. The terms π^*, α, and β are the solvatochromic parameters and are determined from solvatochromic shifts. The terms m, p, a, and b are the regression coefficients, and C is the regression constant.

Kamlet and Taft found that the solvatochromic parameters correlate exceptionally well with a very wide variety of properties. Included in these are solubilities, GC and HPLC adsorptions, UV-Vis shifts, and toxicities.[9,10] Over 200 different properties have been correlated, all with a resulting correlation coefficient of over 0.90.

1.3 The Theoretical LSER

The Kamlet-Taft parameters, although extremely successful in correlating large numbers of diverse properties with execellent correlation coefficients, are not readily usable in predictive QSAR or QSAR-like equations. This is because all of the parameters used are empirically determined, and therefore, a priori prediction of properties is impossible.

In an attempt to make the technique and concepts of LSER useful to a priori predictions, the Theoretical LSER (TLSER) was developed and parameters derived to replace the solvatochromic parameters and the Molar Volume. The previous reports in this series have dealt with the development of the TLSER, describing first the Molecular Volume (V_{mc}), and second the Polarizability Index (π^*). Equation 3 describes the TLSER.[11-13]

$$\textbf{LOG Property} = mV_{mc} + p\pi_I + \textbf{Hydrogen Bonding} + C \qquad (3)$$

This report will deal with the replacement of the hydrogen bonding term (β) of the LSER with appropriate theoretically derived descriptors, completing the TLSER.

2. EXPERIMENTAL PROCEDURE

2.1 Experimental Data

In order to maintain consistency throughout the development of the Theoretical LSER parameters, the same data sets have been used in all of the reports. The β values have come from appropriate papers of Kamlet, Taft, and co-workers, dealing with toxicity, the Octanol/Water Partition Coefficient, and fish toxicity to industrial pollutants.[14] The actual data have come from the original authors.[15,16]

2.2 Calculations

All calculations were done on a microVaxII computer running under the VMS operating system. All geometries were optimized using the MNDO algorithm[19] in the MOPAC series of programs.[17] The TLSER parameters π_I, q_-, and ϵ_b were derived directly from MOPAC.[18,19] The Molecular Volume, V_{mc}, was calculated from the optimized geometry using the algorithm of Hopfinger,[20] incorporated in the Molecular Modeling Analysis and Display System, in operation

at the Chemometric and Biometric Modeling Branch.[21] Table 1 lists all of the compounds and identification numbers used in the regressions in this report.

All regression analyses were performed using the MINITAB Data Analysis Software (MINITAB, Inc., State College, PA). All x-y plots were done on a HP 9845B microcomputer using LSplot (written by Larry M. Sturdivan, CRDEC). In all regressions N is the number of compounds in the data set, R is the correlation coefficient, and SEE is the standard error of the estimate (standard deviation for multiple regressions).

3. RESULTS

Two descriptors adequately describe the β term, and contain all of that information necessary to generate linear regressions with correlation coefficients approximately on the same level as the LSER. These descriptors, the molecular orbital interaction basicity, and the electrostatic basicity, correlate highly with β and provide some theoretical insight into the concepts of solvation.

The Molecular Orbital Interaction Basicity ϵ_b, is defined as the difference in energy between the Highest Occupied Molecular Orbital (HOMO) of the solute of interest, and the Lowest Unoccupied Molecular Orbital (LUMO) of Water. Water was used as a standard because of its amphiprotic nature, and the fact that the method of Kamlet and Taft uses water soluble indicators. In essence, any standard can be used, and only the HOMO of the solute need be considered. However, a difference is easier to conceptualize and is therefore presented in this manner. The ϵ_b is the energy barrier the electrons find in attempting to migrate to the LUMO, according to standard Ligand Field Theory.[22]

The second term is the electrostatic basicity, q_-, and is the most negative formal charge in the molecule. For simplicity, the absolute magnitude is used, and the negative sign is dropped.

3.1 Predicting β

The first step in determining the applicability of one or more descriptors is to determine if they sufficiently describe the information being replaced. The correlation of β with ϵ_b and q_- will determine if the information contained in β is also adequately contained in the two theoretical descriptors.

Equation 5 shows the initial correlation of 35 aliphatic compounds with the theoretical descriptors.

$$\beta = 1.278 - 1.1089\epsilon_b/10 + 1.164q_- \quad (5)$$

N=35 R=0.9365 SEE=0.1018

Table 2 lists the compounds used by Indentification Number (ID), ϵ_b, q_-, and observed and predicted β's and residuals based upon Equation 5. Figure 1 shows a graphical representation of the predicted versus the observed values with a line of slope=1 and intercept=0 as a reference. Ideally, all points should fall on this line.

With the addition of alcohols, the regression does not dramatically change, as demostrated by equation 6.

$$\beta = 1.940 - 1.115\epsilon_b/10 + 1.139q_- \quad (6)$$

N=47 R=0.9343 SEE=0.0862

Table 3 lists the compounds used with this equation, along with the relevant data. Figure 2 shows a plot of the observed versus the predicted values.

The addition of aromatics does dramatically alter the regression coefficients, as is seen in equation 7, using the data in table 4.

$$\beta = 0.240 - 0.196\epsilon_b/10 + 1.699q_- \quad (7)$$

N=77 R=0.9518 SEE=0.0777

As seen in this equaiton, and when compared to equations 5 and 6, the coefficients for ϵ_b and q_- are significantly different. This can be rationalized as due to the different types of interactions possible with aromatics, and the tremendously different electronic nature of aromatic compounds. In this case, the aromatics tend to skew the regression towards the importance of the electrostatic term and away from the covalent term.

3.2 Rational for ϵ_b and q_-

One premise of Kamlet and Taft has been that all descriptors must make *chemical sense.* In other words, the descriptors must stand apart and explain in their own right a chemical or molecular phenomenon. For this reason, many models based upon mathematical techniques such as principal component analysis (PCA) or factor analysis (FA) have been considered inadequate.[23] Therefore, the TLSER descriptors must be founded on some chemical or physical basis and be able to qualitatively describe β.

3.2.1 Molecular Orbital Interaction Basicity (ϵ_b)

As has been previously described, the molecular orbital interaction basicity, ϵ_b, is the difference in energy between the HOMO of the substrate of interest and the LUMO of water. According to Ligand Field Theory, when the acid-base interaction occurs, the resulting HOMO of the adduct is lowered in energy relative to the HOMO of the substrate. This is shown in Figure 3.

Also from standard Ligand Field Theory, the degree to which the HOMO of the acid-base pair is lowered in energy is inversely related to the difference in energies between the appropriate molecular orbitals. This difference is related to the overlap integral in quantum mechanics (S_{xx}). The larger the S_{xx} is for a particular HOMO-LUMO pair, the greater the probability that reaction will be, and therefore the better the interaction.[24]

This orbital interaction difference can be directly related to the basicity of a given substrate. Using a standard molecule as the acid, the basicities can be determined based upon the differences. Water was used as the standard acid, as most of Kamlet and Taft's work was done in aqueous solutions, and water was also used by them as a standard. The ϵ_b would then decrease as the basicity increased.

The solvatochromic basicity term, β, is proportional with respect to the basicity, as compounds with a greater degree of basicity have larger β values. In the relationships between β and ϵ_b a negative coefficient is expected, and is, in fact observed for each regression.

3.2.2 Electrostatic Basicity q_-

While ϵ_b adequately describes the importance for orbital interactions in describing the basicity, a more fundamental electrostatic charge term was also needed. This term, q_-, is the most negative formal charge in the molecule. This can be rationalized in much the same way as ϵ_b. Although the ϵ_b can be seen as

primarily a covalent term, q_ is solely an ionic or electrostatic term. Because acid-base interactions and hydrogen bonding depend upon the relative formal charge of the basic site, a straight charge related term would also seem appropriate.

As can be seen from the above equations, q_ is indeed very important in the correlation for β. According to the t-score (not shown) for each of the regressons, q_ is the more important of the two descriptors.[25]

*3.3 Replacement of β by ϵ_b and q_*

As the relationship between β and the regression of ϵ_b and q_ is very high, it seems reasonable that ϵ_b and q_ will adequately replace β in the actual regressions for the solute/solvent properties. The resulting TLSER equations should maintain comparable correlation coefficients as the LSERs. The following sections give two pertinent examples of this. In the first example, the correlation of the TLSER parameters with the Octanol/Water partition coefficient is shown. In the second example, a very different type of solute/solvent interaction (toxicity) is correlated.

3.3.1 Octanol/Water Partition Coefficient

The Octanol/Water partition coefficient has been used extensively in QSAR equations and in modeling to explain the transport of substrates across the blood-brain barrier. As such, several models have been developed for the estimation and prediction of the Octanol/Water partition coefficient. Since this parameter correlates well with many biological activities, it therefore seems reasonable to begin with the Octanol/Water partition coefficient.

Using the data for 35 aliphatic non-alcohol compounds, equation 8 shows the TLSER. The descriptors, compounds used, observed and predicted values, and residuals are listed in Table 3.

$$\text{LOG Kow} = 2.724(V_{mc}/100) - 2.160(\pi_I{*}10) + 1.422(\epsilon_b/10) \qquad (8)$$

$$- 6.563(q_-) + 0.489$$

$$N=33 \quad R=0.9397 \quad SEE=0.4377$$

The analogous equation with β is shown in equation 9. The relevant data is listed in Table 4.

$$\text{LOG Kow} = 2.757(V_{mc}/100) + 0.859(\pi_I{*}10) - 4.044(\beta) - 0.538. \quad (9)$$

N=33 R=0.9327 SEE=0.4541

It is evident from comparing these two equations that the degree of fit (R) and the SEE are nearly identical. The TLSER parameters predict the LOG Kow for this data set as well, in fact a little better, than β.

For the theoretical parameters to be valid, they must also impart logically derived information from the system being modeled. Molecular Volume and Polarizability Index have already been examined. As ϵ_b should decrease with increasing solubility in water, an increase in LOG Kow should follow an increase in ϵ_b, and the sign of the ϵ_b should therefore be positive. Similarily, as q_- increases in magnitude, a greater electrostatic attraction to water should occur. The sign of this coefficient would then be expected to be negative as well. The following equations show this to indeed be the case.

The addition of alcohols to the data set result in the regressions shown in equation 10 for the TLSER and in equation 11 for the LSER.

$$\text{LOG Kow} = 2.671(V_{mc}/100) - 0.348(\pi_I{*}10) + 2.326(\epsilon_b/10) \quad (10)$$
$$- 6.402(q_-) - 2.990$$

N=45 R=0.9471 SEE=0.3698

$$\text{LOG Kow} = 2.770(V_{mc}/100) + 1.739(\pi_I{*}10) - 5.474\beta - 0.996 \quad (11)$$

N=45 R=0..9423 SEE=0.3803

Table 4 lists the experimental, predicted and residual values for the compound data set used for equation 10, as well as the pertinent descriptors. Table 5 list the same information for equation 11. It can be seen that the TLSER equation generates a fit almost identical to that of the LSER for this data set. The one major difference is the π_I, where the TLSER correlates with a (-) coefficient, while the LSER correlates with a positive coefficient. In reality, the t-score for π_I in the TLSER is 0.37, indicating that this descriptor is not significant in this regression. The term has been included, therefore, only for comparison purposes and does not have much, if any, impact on the correlation.

The addition of aromatics to the data set for the correlation of the Octanol/Water Partition Coefficient yields, as in the other cases, very similar results between the TLSER, as shown in equation 12 and Table 6, and the LSER, shown in equation 13 and Table 7.

$$\text{LOG Kow} = 2.995(V_{mc}/100) - 0.847(\pi_I * 10) + 1.73(\epsilon_b/10) - 5.415(q_-) - 3.960 \quad (12)$$

N=64 R=0.9566 SEE=0.3568

$$\text{LOG Kow} = 2.869(V_{mc}/100) - 0.368(\pi_I * 10) - 3.859\beta - 0.263 \quad (13)$$

N=64 R=0.9581 SEE=0.3426

Figures 4 and 5 show graphically the difference between the observed LOG Kow and the predicted LOW Kow based upon equations 12 and 13, respectively. In each case, the line represents an ideal fit, where the predicted value would equal the observed value.

3.3.2 Konneman's Fish Toxicity

A second type of solute/solvent interaction, and a completely different application of the TLSER and LSER, is toxicity and biological activity. As noted above, the Octanol/Water partition coefficient is a valuble descriptor for the correlation and predicition of toxicity in QSAR. As the TLSER adequately predicts and correlates with this property, it would be expected that both the TLSER and the LSER would correlate highly with and be able to predict various toxicities.

Konneman measured the LC_{50} for a series of aliphatic and aromatic industrial pollutants on guppies (*Poecilia Reticulata*). Using this data, and obtaining the β term from Kamlet and Taft, a relationship for the LC_{50} can be determined. Equations 14 and 15 show the relationship of ϵ_b and q_- to β in an LSER for toxicity.

$$\text{LOG } LC_{50} = -0.928V_{mc} - 10.557(\pi_1{*}10) - 1.442(\epsilon_b/10) - 0.443(q_-) + 18.083 \quad (14)$$

N=32 R=0.9434 SEE=0.5736

$$\text{LOG } LC_{50} = -1.760V_{mc} - 4.741(\pi_1{*}10) - 2.935\beta + 9.389 \quad (15)$$

N=32 R=0.9550 SEE=0.5042

4. CONCLUSIONS

This study shows that the LSER parameters of Kamlet and Taft can be successfully modeled and replaced by a new set of descriptors, called the theoretical LSER or TLSER parameters. One special item is important to mention. Kamlet and Taft have developed an elaborate series of correction factors for each of their parameters based upon the particular class of the data item. This included corrections for alcohols, aromatics, chlorinated compounds, and high electronegative compounds. The absence of these correction factors would greatly diminish the correlations and would reduce the overall effectiveness of these equations. On the other hand, the TLSER parameters do not incorporate any correction factors. The incorporation of correction factors would greatly improve the fit with these parameters. Such implementation may be required in order to further reduce the error associated with the techniques employed.

TABLE 1. Compounds Used

ID Number	Compound Name	ID Number	Compound Name
mjk001	Hexane	mjk002	Cyclohexane
mjk005	Cyclopentane	mjk006	Butane
mjk007	1,1,2,2-Tetrachloroethylene	mjk008	Carbon Tetrachloride
mjk009	Tripropyl Amine	mjk011	1,1,1-Trichloroethane
mjk012	Propane	mjk013	1,1,2-Trichloroethylene
mjk014	Propyl Chloride	mjk015	Triethyl Amine
mjk016	2-Hexanone	mjk018	Ethyl Propionate
mjk019	2-Pentanone	mjk020	Diethyl Ether
mjk020	Diethyl Ether	mjk021	Butyraldehyde
mjk022	Cyclohexanone	mjk023	Ethyl Acetate
mjk024	Ethyl Dimethyl Amine	mjk025	Propanal
mjk026	Tetrahydrofuran	mjk028	Butanone
mjk029	Hexamethyl Phosphoramide	mjk03	Neopentane
mjk030	Methyl Acetate	mjk031	Nitroethane
mjk033	Propanonitrile	mjk034	Dimethyl Ether
mjk035	Methyl Acetate	mjk036	Acetonitrile
mjk037	Nitromethane	mjk038	Dimethyl Acetamide
mjk038	1,2-Dichloropropane	mjk039	Methanol
mjk04	Pentane	mjk040	Ethanol
mjk041	Propanol	mjk042	i-Propanol
mjk043	n-Butanol	mjk044	2-Methyl-1-Propanol
mjk045	2-Butanol	mjk046	t-Butanol
mjk047	n-Pentanol	mjk048	3-Pentanol
mjk049	2,2-Dimethyl-2-Butanol	mjk050	t-Pentanol
mjk051	3-Methyl-2-Butanol	mjk052	Hexanol
mjk053	3,3-Dimethyl-2-Butanol	mjk054	Benzene
mjk055	Ethyl Benzoate	mjk056	Acetophenone
mjk057	Dimethyl Aniline	mjk058	Benzaldehyde
mjk059	Toluene	mjk060	Methoxy Benzene
mjk061	Ethoxy Benzene	mjk062	Propyl Benzene
mjk063	1-Chlorobutane	mjk063	Chlorobenzene
mjk067	Mesitylene	mjk068	m-Xylene
mjk069	o-Methoxy Toluene	mjk070	N,N-DimethylAmino Toluene
mjk072	Phenyl Propanone	mjk085	Acetone
mjk086	4-Methyl-2-Pentnone	mjk087	5-Methyl-2-Hexanone
mjk088	Propyl Acetate	mjk089	Butyl Aceate

mjk090	Amyl Acetate	mjk091	i-Propyl Acetate
mjk092	i-Butyl Acetate	mjk093	Valeraldehyde
mjk094	Acrolein	mjk095	Vinyl Acetate
mjk096	Di-n-Propyl Ether	mjk097	Di-i-Propyl Ether
mjk099	1,3-Dichloropropane	mjk010	Butyl Chloride
mjk100	2-Ethyl-1-Butanol	mjk101	2-Ethyl-1-Hexanol
mjk102	2-Propen-1-ol	mjk103	Cyclohexanol
mjk104	o-DichloroBenzene	mjk105	Dichloromethane
mjk106	Chloroform	mjk107	o-Xylene
mjk108	1,1-Dichloroethane	mjk109	1,1,2-Trichloroethane
mjk110	1,1,2,2-Tetrachloroethane	mjk111	1,2-Dichloroethane
mjk114	1,2,3-Trichlorobenzene	mjk115	1,2,4-Trichlorobenzene
mjk116	1,2,3,4-Tetrachlorobenzene	mjk117	1,2,3,5-Tetrachlorobenzene
mjk118	1,2,4,5-Tetrachlorobenzene	mjk119	Pentachlorobenzene
mjk120	2,5-Dichloro-m-xylene	mjk032	Trimethyl Amine

TABLE 2. Correlation of β with ϵ_b and $q_{\_}$

ID No.	ϵ_b	$q_{\_}$	β Observed	β Predicted	Residual
mjk001	17.4761	0.022	0.00	0.02	-0.02
mjk003	17.5626	0.126	0.00	0.13	-0.13
mjk004	16.2816	0.081	0.00	0.20	-0.20
mjk005	17.5049	0.017	0.00	0.01	-0.01
mjk006	17.6357	0.020	0.00	0.00	0.00
mjk007	16.1723	0.024	0.10	0.14	-0.04
mjk008	18.6798	0.070	0.10	-0.04	0.14
mjk009	14.9135	0.428	0.69	0.73	-0.04
mjk010	17.5187	0.217	0.10	0.24	-0.14
mjk011	18.2329	0.117	0.10	0.06	0.04
mjk012	17.7786	0.035	0.00	0.00	0.00
mjk013	16.0881	0.072	0.10	0.21	-0.11
mjk014	17.5424	0.217	0.10	0.24	-0.14
mjk015	14.6005	0.500	0.71	0.84	0.13
mjk016	16.1189	0.284	0.65	0.45	0.20
mjk017	15.1300	0.230	0.70	0.48	0.22
mjk018	16.7994	0.354	0.46	0.47	-0.01
mjk019	16.1245	0.284	0.50	0.45	0.05
mjk020	16.3503	0.342	0.47	0.50	-0.03
mjk021	16.2406	0.286	0.38	0.44	-0.06
mjk022	16.0235	0.280	0.53	0.45	0.08
mjk023	16.8569	0.357	0.45	0.47	-0.02
mjk024	14.8625	0.459	0.70	0.77	-0.07
mjk025	16.2565	0.286	0.38	0.44	-0.06
mjk026	16.2192	0.327	0.55	0.49	0.06
mjk028	16.1381	0.285	0.48	0.45	0.03
mjk029	15.4321	0.650	1.05	0.94	0.11
mjk030	16.9034	0.357	0.42	0.46	-0.04
mjk032	15.0143	0.337	0.65	0.61	0.04
mjk033	18.0304	0.441	0.37	0.45	-0.08
mjk034	16.4839	0.352	0.47	0.49	-0.02
mjk035	16.1915	0.287	0.48	0.45	0.03
mjk036	18.22838	0.115	0.37	0.06	0.31
mjk037	16.9806	0.335	0.30	0.43	-0.13
mjk038	15.4775	0.336	0.76	0.59	0.17

TABLE 3. Correlation of β with ϵ_b and q_- (Alcohols Added)

ID No.	ϵ_b	q_-	β Observed	β Predicted	Residual
mjk001	17.4761	0.022	0.00	0.02	-0.02
mjk003	17.5626	0.126	0.00	0.13	-0.13
mjk005	17.5049	0.017	0.00	0.01	-0.01
mjk006	17.6357	0.020	0.00	-0.00	0.00
mjk007	16.1723	0.024	0.10	0.16	-0.06
mjk008	18.6798	0.070	0.10	-0.06	0.16
mjk009	14.9135	0.428	0.69	0.77	-0.08
mjk010	17.5187	0.217	0.10	0.24	-0.14
mjk011	18.2329	0.117	0.10	0.05	0.05
mjk012	17.7786	0.035	0.00	-0.00	0.00
mjk013	16.0881	0.072	0.10	0.23	-0.13
mjk014	17.5424	0.217	0.10	0.24	-0.14
mjk015	14.6005	0.500	0.71	0.88	-0.17
mjk016	16.1189	0.284	0.65	0.47	0.18
mjk017	15.1300	0.230	0.70	0.51	0.19
mjk018	16.7994	0.359	0.46	0.48	-0.02
mjk019	16.1245	0.284	0.50	0.46	0.03
mjk020	16.3503	0.342	0.47	0.51	-0.04
mjk021	16.2406	0.286	0.38	0.46	-0.08
mjk022	16.0235	0.280	0.53	0.47	0.06
mjk023	16.8569	0.357	0.45	0.47	-0.02
mjk024	14.8625	0.459	0.70	0.81	-0.11
mjk025	16.2565	0.286	0.38	0.46	-0.08
mjk026	16.2192	0.327	0.55	0.51	0.04
mjk028	16.1381	0.285	0.48	0.47	0.01
mjk029	15.4321	0.650	1.05	0.97	0.08
mjk030	16.9034	0.357	0.42	0.47	-0.05
mjk031	18.0304	0.441	0.37	0.44	-0.07
mjk033	16.4839	0.352	0.47	0.51	-0.04
mjk035	16.1915	0.287	0.48	0.46	0.02
mjk037	16.9806	0.335	0.30	0.43	-0.13
mjk038	15.4775	0.356	0.76	0.62	0.14
mjk039	16.8580	0.329	0.40	0.44	-0.04
mjk040	16.7375	0.324	0.45	0.45	0.00
mjk041	16.7367	0.325	0.45	0.45	0.00

mjk042	16.6451	0.320	0.51	0.45	0.06
mjk043	16.7365	0.325	0.45	0.45	0.00
mjk044	16.7320	0.324	0.45	0.45	0.00
mjk045	16.6458	0.322	0.51	0.45	0.06
mjk046	16.5795	0.318	0.57	0.46	0.11
mjk047	16.7383	0.325	0.45	0.45	0.00
mjk048	16.5620	0.325	0.51	0.47	0.05
mjk049	16.6644	0.325	0.45	0.46	-0.01
mjk050	16.5728	0.322	0.57	0.46	0.11
mjk051	16.6332	0.324	0.51	0.46	0.05
mjk053	16.7386	0.325	0.45	0.46	0.00

TABLE 4. Correlation for β (All Compounds)

ID No.	ϵ_b	q	β Observed	β Predicted	Residual
mjk001	17.4761	0.0220	0.00	-0.07	0.07
mjk003	17.5626	0.1260	0.00	0.11	-0.11
mjk005	17.5049	0.0170	0.00	-0.07	0.07
mjk006	17.6357	0.0200	0.00	-0.07	0.07
mjk007	16.1723	0.0240	0.10	-0.04	0.14
mjk008	18.6798	0.0700	0.10	-0.01	0.11
mjk009	14.9135	0.4280	0.69	0.67	0.02
mjk010	17.5187	0.2170	0.10	0.27	-0.17
mjk011	18.2329	0.1170	0.10	0.08	0.02
mjk012	17.7786	0.0350	0.00	-0.05	0.05
mjk013	16.0881	0.0720	0.10	0.05	0.05
mjk014	17.5424	0.2170	0.10	0.26	-0.16
mjk015	14.6005	0.5000	0.71	0.80	-0.09
mjk018	16.7994	0.3590	0.46	0.52	-0.06
mjk019	16.1245	0.2840	0.50	0.41	0.09
mjk020	16.3503	0.3420	0.47	0.50	-0.03
mjk021	16.2406	0.2800	0.38	0.41	-0.03
mjk022	16.0235	0.2800	0.53	0.40	0.13
mjk023	16.8569	0.3570	0.45	0.52	-0.07
mjk024	14.8625	0.4590	0.70	0.73	-0.03
mjk025	16.2565	0.2860	0.38	0.41	-0.03
mjk026	16.2192	0.3270	0.55	0.48	0.07
mjk028	16.1381	0.2850	0.48	0.41	0.07
mjk029	15.4321	0.6500	1.05	1.04	0.01
mjk030	16.9034	0.3570	0.42	0.52	-0.10
mjk034	16.4839	0.3520	0.47	0.51	-0.04
mjk035	16.1915	0.2870	0.48	0.41	0.07
mjk036	15.4775	0.3560	0.76	0.54	0.22
mjk039	16.8580	0.3290	0.40	0.47	-0.07
mjk040	16.7375	0.3240	0.45	0.46	-0.01
mjk041	16.7367	0.3250	0.45	0.46	-0.01
mjk042	16.6451	0.3200	0.51	0.46	0.05
mjk043	16.7365	0.3250	0.45	0.46	-0.01
mjk044	16.7320	0.3240	0.45	0.46	-0.01
mjk045	16.6458	0.3220	0.51	0.46	0.05
mjk046	16.5795	0.3180	0.57	0.46	0.11

mjk047	16.7383	0.3250	0.45	0.46	-0.01
mjk048	16.5620	0.3220	0.51	0.46	0.05
mjk049	16.6644	0.3250	0.45	0.47	-0.02
mjk050	16.5728	0.3220	0.57	0.46	0.11
mjk051	16.6332	0.3240	0.51	0.46	0.05
mjk052	16.7386	0.3250	0.45	0.46	-0.01
mjk054	14.8338	0.0593	0.10	0.05	0.05
mjk059	14.6702	0.1010	0.11	0.12	-0.01
mjk154	15.2887	0.0821	0.04	0.08	-0.04
mjk105	17.9301	0.1600	0.00	0.16	-0.16
mjk085	16.1915	0.2870	0.48	0.41	0.07
mjk106	18.3533	0.1130	0.10	0.07	0.03
mjk107	14.6706	0.0790	0.12	0.09	0.03
mjk108	17.8447	0.1630	0.10	0.17	-0.07
mjk109	18.0184	0.1730	0.10	0.18	-0.08
mjk110	18.1773	0.1230	0.10	0.09	0.01
mjk111	17.7307	0.1850	0.10	0.21	-0.11
mjk112	17.6561	0.1880	0.10	0.21	-0.11
mjk114	15.5518	0.0711	0.02	0.06	-0.04
mjk115	15.4836	0.0880	0.02	0.09	-0.07
mjk116	15.6634	0.0607	0.02	0.04	-0.02
mjk117	15.7047	0.0750	0.00	0.06	-0.06
mjk118	15.6473	0.0600	0.00	0.04	-0.04
mjk119	15.8312	0.0530	0.00	0.02	-0.02
mjk068	14.6796	0.1060	0.00	0.13	-0.13
mjk121	15.4174	0.0980	0.07	0.10	-0.03
mjk122	15.2888	0.0810	0.07	0.08	-0.01
mjk123	15.3351	0.0962	0.07	0.10	-0.03
mjk124	15.2675	0.1000	0.07	0.11	-0.04
mjk125	14.9478	0.1085	0.07	0.13	-0.06
mjk126	15.2239	0.1020	0.07	0.11	-0.04
mjk129	15.9971	0.0280	0.07	-0.03	0.10

TABLE 5. Theoretical LSER for Octanol/Water Partition Coefficient
Aliphatic Compounds Only

ID No.	ϵ_b	q	V_{mc}	π_1	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	17.4761	0.022	119.0	0.1000	3.90	3.91	-0.01
mjk003	17.5626	0.126	99.6	0.0997	3.11	2.72	0.39
mjk004	16.2816	0.081	100.4	0.0997	3.39	2.85	0.54
mjk005	17.5049	0.017	89.2	0.1025	3.00	3.09	-0.08
mjk006	17.6357	0.020	82.4	0.0986	2.89	2.98	-0.09
mjk007	16.1723	0.024	101.3	0.1204	2.60	2.79	-0.19
mjk008	18.6798	0.070	91.6	0.1159	2.83	2.68	0.15
mjk009	14.9135	0.428	181.6	0.1052	2.79	2.48	0.31
mjk010	17.5187	0.217	98.3	0.1025	2.64	2.02	0.62
mjk011	18.2329	0.117	94.1	0.1109	2.49	2.48	0.01
mjk012	17.7786	0.035	65.5	0.0953	2.30	2.51	-0.21
mjk013	16.0881	0.072	86.2	0.1162	1.45	0.66	0.79
mjk014	17.5424	0.217	80.9	0.1010	2.04	1.58	0.46
mjk015	14.6005	0.500	131.5	0.1020	1.45	0.66	0.79
mjk016	16.1189	0.284	117.1	0.1021	1.38	1.90	-0.52
mjk017	15.1300	0.230	79.6	0.1196	1.30	0.72	0.58
mjk018	16.7994	0.354	107.3	0.1022	1.20	1.24	-0.04
mjk019	16.1245	0.284	100.1	0.1001	0.91	1.48	-0.57
mjk020	16.3503	0.342	90.5	0.0995	0.89	0.89	0.00
mjk021	16.2406	0.286	80.4	0.1002	0.88	0.95	-0.07
mjk022	16.0235	0.280	105.6	0.1064	0.81	1.51	-0.70
mjk023	16.8569	0.357	88.9	0.1018	0.73	0.77	-0.04
mjk024	14.8625	0.459	96.2	0.1010	0.70	0.03	0.67
mjk025	16.2565	0.286	64.3	0.0979	0.59	0.56	0.03
mjk026	16.2192	0.327	78.6	0.1025	0.46	0.58	-0.12
mjk028	16.1381	0.285	81.0	0.1009	0.29	0.94	-0.65
mjk029	15.4321	0.650	181.4	0.1127	0.28	0.93	-0.64
mjk030	16.9034	0.357	70.8	0.1005	0.18	0.31	-0.13
mjk032	15.0143	0.337	78.0	0.1066	0.16	0.24	-0.08
mjk033	18.0304	0.441	63.1	0.0975	0.10	-0.23	0.33
mjk034	16.4839	0.352	55.1	0.0940	0.10	-0.01	0.11
mjk035	16.1915	0.287	63.9	0.0979	-0.24	0.53	-0.77
mjk037	16.9806	0.335	47.0	0.1101	-0.35	-0.39	0.04

TABLE 6. LSER for Octanol/Water Partition Coefficient
Aliphatic Compounds Only

ID No.	β	V_{mc}	π^*	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	0.00	119.0	0.1000	3.90	3.91	-0.01
mjk003	0.00	99.6	0.0997	3.11	2.72	0.39
mjk004	0.00	100.4	0.997	3.39	2.85	0.54
mjk005	0.00	89.2	0.1025	3.00	3.09	-0.08
mjk006	0.00	82.4	0.0986	2.89	2.98	-0.09
mjk007	0.10	101.3	0.1204	2.60	2.79	-0.19
mjk008	0.10	91.6	0.1159	2.83	2.68	0.15
mjk009	0.69	181.6	0.1052	2.79	2.48	0.31
mjk010	0.10	98.3	0.1025	2.64	2.02	0.62
mjk011	0.10	94.1	0.1109	2.49	2.48	0.01
mjk012	0.10	65.5	0.0953	2.30	2.51	-0.21
mjk013	0.10	86.2	0.1162	1.45	0.66	0.79
mjk014	0.10	80.9	0.1010	2.04	1.58	0.46
mjk015	0.71	131.5	0.1020	1.45	0.66	0.79
mjk016	0.65	117.1	0.1021	1.38	1.90	-0.52
mjk017	0.70	79.6	0.1196	1.30	0.72	0.58
mjk018	0.46	107.3	0.1022	1.20	1.24	-0.04
mjk019	0.50	100.1	0.1001	0.91	1.48	-0.57
mjk020	0.47	90.5	0.0995	0.89	0.89	0.00
mjk021	0.38	80.4	0.1002	0.88	0.95	-0.07
mjk022	0.53	105.6	0.1064	0.81	1.51	-0.70
mjk023	0.45	88.9	0.1018	0.73	0.77	-0.04
mjk024	0.90	96.2	0.1010	0.70	0.03	0.67
mjk025	0.38	64.3	0.0979	0.59	0.56	0.03
mjk026	0.55	78.6	0.1025	0.46	0.58	-0.12
mjk028	0.48	81.0	0.1009	0.29	0.94	-0.65
mjk029	1.05	181.4	0.1127	0.28	0.93	-0.64
mjk030	0.42	70.8	0.1005	0.18	0.31	-0.13
mjk032	0.65	78.0	0.1066	0.16	0.24	-0.08
mjk033	0.37	63.1	0.0975	0.10	-0.23	0.33
mjk034	0.47	55.1	0.0940	0.10	-0.01	0.11
mjk035	0.48	63.9	0.0979	-0.24	0.53	-0.77
mjk037	0.30	47.0	0.1101	-0.35	-0.39	0.04

TABLE 7. Theoretical LSER for Octanol/Water Partition Coefficient Aliphatic and Alcohols

ID No.	ϵ_b	q	V_{mc}	π_I	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	119.0	0.1000	17.4761	0.022	3.90	-0.13	0.13
mjk003	99.6	0.0997	17.5626	0.126	3.11	-0.51	0.51
mjk005	89.2	0.1025	17.5049	0.017	3.00	-0.00	0.00
mjk006	82.4	0.0986	17.6357	0.020	2.89	-0.05	0.05
mjk007	101.3	0.1204	16.1723	0.024	2.60	0.41	-0.31
mjk008	91.6	0.1159	18.6798	0.070	2.83	0.22	-0.12
mjk009	181.6	0.1052	14.9135	0.428	2.79	0.12	0.57
mjk010	98.3	0.1025	17.5187	0.217	2.64	-0.57	0.67
mjk011	94.1	0.1109	18.2329	0.117	2.49	0.24	-0.14
mjk012	65.5	0.0953	17.7786	0.035	2.30	0.04	-0.04
mjk013	86.2	0.1162	16.0881	0.072	2.04	0.25	-0.15
mjk014	80.9	0.1010	17.5424	0.217	2.04	-0.43	0.53
mjk016	117.1	0.1021	16.1189	0.284	1.38	0.98	-0.33
mjk017	79.6	0.1196	15.1300	0.230	1.30	0.17	0.53
mjk018	107.3	0.1022	16.7994	0.359	1.20	0.39	0.07
mjk019	100.1	0.1001	16.1245	0.284	0.91	0.86	-0.36
mjk020	90.5	0.0995	16.3503	0.342	0.89	0.26	0.19
mjk021	80.4	0.1002	16.2406	0.286	0.88	0.26	0.12
mjk022	105.6	0.1064	16.0235	0.280	0.81	1.12	-0.59
mjk023	88.9	0.1018	16.8569	0.357	0.73	0.39	0.06
mjk024	96.2	0.1010	14.8625	0.459	0.70	-0.25	0.95
mjk025	64.3	0.0979	16.2565	0.286	0.59	0.13	0.25
mjk026	78.6	0.1025	16.2192	0.327	0.46	0.52	0.03
mjk028	81.0	0.1009	16.1381	0.285	0.29	0.94	-0.46
mjk029	181.4	0.1127	15.4321	0.650	0.28	1.66	-0.61
mjk030	70.8	0.1005	16.9034	0.357	0.18	0.44	-0.02
mjk032	78.0	0.1066	15.0143	0.337	0.16	0.55	0.10
mjk033	63.1	0.0975	18.0304	0.441	0.10	-0.00	0.37
mjk034	55.1	0.0940	16.4839	0.352	0.10	0.11	0.36
mjk035	63.9	0.0979	16.1915	0.287	-0.24	1.03	-0.55
mjk037	47.0	0.1101	16.9806	0.335	-0.35	0.34	-0.04
mjk039	36.5	0.0859	16.8580	0.329	-0.65	0.55	-0.15
mjk040	54.2	0.0927	16.7375	0.324	-0.30	0.70	-0.25
mjk041	71.3	0.0969	16.7367	0.325	0.28	0.56	-0.11

mjk042	72.0	0.0955	16.6451	0.320	0.05	0.88	-0.37
mjk043	89.8	0.0980	16.7365	0.325	0.99	0.34	0.11
mjk044	89.4	0.0982	16.7320	0.324	0.76	0.56	-0.11
mjk045	89.7	0.0976	16.6458	0.322	0.61	0.78	-0.27
mjk046	89.1	0.0978	16.5795	0.318	0.36	1.08	-0.51
mjk047	107.4	0.0995	16.7383	0.325	1.48	0.32	0.13
mjk048	106.8	0.0919	16.5620	0.322	1.21	0.63	-0.12
mjk049	108.2	0.0981	16.6644	0.325	1.34	0.46	-0.01
mjk050	106.5	0.0996	16.5728	0.322	0.89	0.98	-0.41
mjk051	107.2	0.0992	16.6332	0.324	1.28	0.55	-0.04
mjk052	121.1	0.1039	16.7386	0.325	2.03	0.12	0.33

TABLE 8. LSER for Octanol/Water Partition Coefficient
Aliphatics and Alcohols

ID No.	β	V_{mc}	π^*	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	119.0	0.1000	0.00	3.90	-0.33	0.33
mjk003	99.6	0.0997	0.00	3.11	-0.08	0.08
mjk005	89.2	0.1025	0.00	3.00	-0.22	0.22
mjk006	82.4	0.0986	0.00	2.89	-0.35	0.35
mjk007	101.3	0.1204	0.10	2.60	0.43	-0.33
mjk008	91.6	0.1159	0.10	2.83	-0.12	0.22
mjk009	181.6	0.1052	0.69	2.79	0.47	0.22
mjk010	98.3	0.1025	0.10	2.64	0.08	0.02
mjk011	94.1	0.1109	0.10	2.49	0.22	-0.12
mjk012	65.5	0.0953	0.00	2.30	-0.27	0.27
mjk013	86.2	0.1162	0.10	2.04	0.52	-0.42
mjk014	80.9	0.1010	0.10	2.04	0.18	-0.08
mjk016	117.1	0.1021	0.65	1.38	0.17	0.48
mjk017	79.6	0.1196	0.70	1.30	-0.72	1.42
mjk018	107.3	0.1022	0.46	1.20	0.66	-0.20
mjk019	100.1	0.1001	0.50	0.91	0.61	-0.11
mjk020	90.5	0.0995	0.47	0.89	0.44	0.03
mjk021	80.4	0.1002	0.38	0.88	0.46	-0.08
mjk022	105.6	0.1064	0.53	0.81	0.85	-0.32
mjk023	88.9	0.1018	0.45	0.73	0.65	-0.20
mjk024	96.2	0.1010	0.70	0.70	0.11	0.59
mjk025	64.3	0.0979	0.38	0.59	0.27	0.11
mjk026	78.6	0.1025	0.55	0.46	0.34	0.21
mjk028	81.0	0.1009	0.48	0.29	0.77	-0.29
mjk029	181.4	0.1127	1.05	0.28	1.96	-0.91
mjk030	70.8	0.1005	0.42	0.13	0.77	-0.35
mjk032	78.0	0.1066	0.65	0.16	0.37	0.28
mjk033	63.1	0.0975	0.37	0.10	0.76	-0.39
mjk034	55.1	0.0940	0.47	0.10	0.18	0.29
mjk035	63.9	0.0979	0.48	-0.24	0.79	-0.31
mjk037	47.0	0.1101	0.30	-0.35	1.13	-0.83
mjk039	36.5	0.0859	0.40	-0.65	0.53	-0.13
mjk040	54.2	0.0927	0.45	-0.30	0.60	-0.15
mjk041	71.3	0.0969	0.45	0.28	0.55	-0.10
mjk042	72.0	0.0955	0.51	0.05	0.60	-0.09

mjk043	89.8	0.0980	0.45	0.99	0.37	0.08
mjk044	89.4	0.0982	0.45	0.76	0.59	-0.14
mjk045	89.7	0.0976	0.51	0.61	0.56	-0.05
mjk046	89.1	0.0978	0.57	0.36	0.61	-0.04
mjk047	107.4	0.0995	0.45	1.48	0.38	0.07
mjk048	106.8	0.0919	0.51	1.21	0.36	0.15
mjk049	108.2	0.0981	0.45	1.34	0.53	-0.08
mjk050	106.5	0.0996	0.57	0.89	0.58	-0.01
mjk051	107.2	0.0992	0.51	1.28	0.39	0.12
mjk052	121.1	0.1039	0.45	2.03	0.27	0.18

TABLE 9. Theoretical LSER for Octanol/Water Partition Coefficient
Aliphatic, Alcohols and Aromatics

ID No.	ϵ_b	q	V_{mc}	π_1	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	119.0	0.1000	17.4761	0.0220	3.90	3.63	0.27
mjk003	99.6	0.0997	17.5626	0.1260	3.11	2.49	0.62
mjk005	89.2	0.1025	17.5049	0.0170	3.00	2.79	0.21
mjk006	82.4	0.0986	17.6357	0.0200	2.89	2.56	0.33
mjk007	101.3	0.1204	16.1723	0.0240	2.60	3.04	-0.44
mjk008	91.6	0.1159	18.6798	0.0700	2.83	2.89	-0.06
mjk009	181.6	0.1052	14.9135	0.4280	2.79	2.88	-0.09
mjk010	98.3	0.1025	17.5187	0.2170	2.64	1.97	0.67
mjk011	94.1	0.1109	18.2329	0.1170	2.49	2.59	-0.10
mjk012	65.5	0.0953	17.7786	0.0350	2.30	1.97	0.33
mjk013	86.2	0.1162	16.0881	0.0720	2.04	2.27	-0.23
mjk014	80.9	0.1010	17.5424	0.2170	2.04	1.44	0.60
mjk015	131.5	0.1020	14.6005	0.5000	1.45	0.91	0.54
mjk018	107.3	0.1022	16.7994	0.3590	1.20	1.34	-0.14
mjk019	100.1	0.1001	16.1245	0.2840	0.91	1.40	-0.49
mjk020	90.5	0.0995	16.3503	0.3420	0.89	0.83	0.06
mjk021	80.4	0.1002	16.2406	0.2860	0.88	0.82	0.06
mjk022	105.6	0.1064	16.0235	0.2800	0.81	1.62	-0.81
mjk023	88.9	0.1018	16.8569	0.3570	0.73	0.80	-0.07
mjk024	96.2	0.1010	14.8625	0.4590	0.70	0.11	0.59
mjk025	64.3	0.0979	16.2565	0.2860	0.59	0.32	0.27
mjk026	78.6	0.1025	16.2192	0.3270	0.46	0.55	-0.09
mjk028	130.4	0.1038	15.4328	0.7800	0.34	-0.50	0.84
mjk029	81.0	0.1009	16.1381	0.2850	0.29	0.83	-0.54
mjk030	70.8	0.1005	16.9034	0.3570	0.18	0.26	-0.08
mjk032	78.0	0.1066	15.0143	0.3370	0.16	0.31	-0.15
mjk033	63.1	0.0975	18.0304	0.4410	0.10	-0.26	0.36
mjk034	55.1	0.0940	16.4839	0.3520	0.10	-0.31	0.41
mjk035	63.9	0.0979	16.1915	0.2870	-0.24	0.29	-0.53
mjk037	47.0	0.1101	16.9806	0.3350	-0.35	-0.24	-0.11
mjk039	36.5	0.0859	16.8580	0.3290	-0.65	-0.75	0.10
mjk040	54.2	0.0927	16.7375	0.3240	-0.30	-0.15	-0.15
mjk041	71.3	0.0969	16.7367	0.3250	0.28	0.39	-0.11
mjk042	72.0	0.0955	16.6451	0.3200	0.05	0.41	-0.36

mjk043	89.8	0.0980	16.7365	0.3250	0.99	0.95	0.04
mjk044	89.4	0.0982	16.7320	0.3240	0.76	0.95	-0.19
mjk045	89.7	0.0976	16.6458	0.3220	0.61	0.95	-0.34
mjk046	89.1	0.0978	16.5795	0.3180	0.36	0.94	-0.58
mjk047	107.4	0.0995	16.7383	0.3250	1.48	1.49	-0.01
mjk048	106.8	0.0919	16.5620	0.3220	1.21	1.40	-0.19
mjk049	108.2	0.0981	16.6644	0.3250	1.34	1.49	-0.15
mjk050	106.5	0.0996	16.5728	0.3220	0.89	1.45	-0.56
mjk051	107.2	0.0992	16.6332	0.3240	1.28	1.47	-0.19
mjk052	121.1	0.1039	16.7386	0.3250	2.03	1.94	0.09
mjk053	125.9	0.0992	16.6084	0.3230	1.48	2.03	-0.55
mjk054	84.6	0.1204	15.3738	0.0593	2.13	2.20	-0.07
mjk055	143.1	0.1204	15.1687	0.1750	2.64	3.29	-0.65
mjk056	119.1	0.1204	15.1111	0.2590	1.58	2.10	-0.52
mjk057	131.4	0.1252	13.7231	0.2190	2.28	2.48	-0.20
mjk058	100.8	0.1249	15.1802	0.3060	1.48	1.34	0.14
mjk059	101.8	0.1209	14.6702	0.0810	2.69	2.48	0.21
mjk060	109.0	0.1237	14.2832	0.2160	2.11	1.91	0.20
mjk061	126.4	0.1224	14.2563	0.1700	2.51	2.67	-0.16
mjk062	144.3	0.1208	14.2502	0.1840	3.18	3.12	0.06
mjk063	99.8	0.1237	15.0664	0.0780	2.84	2.53	0.31
mjk064	105.8	0.1280	14.9953	0.0744	2.99	2.75	0.24
mjk065	136.5	0.1210	14.6870	0.1100	3.42	3.37	0.05
mjk068	118.9	0.1212	14.6796	0.1060	3.20	2.86	0.34
mjk069	134.7	0.1224	14.4632	0.2800	2.21	2.35	-0.14
mjk070	149.1	0.1257	13.6750	0.1670	3.61	3.30	0.31
mjk071	167.5	0.1175	14.7071	0.3870	3.31	2.75	0.56
mjk072	137.0	0.1186	15.1042	0.2810	2.20	2.50	-0.30

TABLE 10. LSER for Octanol/Water Partition Coefficient
Aliphatics, Alcohols and Aromatics

ID No.	β	V_{mc}	π^*	LOG Kow Observed	LOG Kow Predicted	Residual
mjk001	119.0	0.1000	0.000	3.90	3.63	0.27
mjk003	99.6	0.0997	0.000	3.11	2.49	0.62
mjk005	89.2	0.1025	0.000	3.00	2.79	0.21
mjk006	82.4	0.0986	0.000	2.89	2.56	0.33
mjk007	101.3	0.1204	0.100	2.60	3.04	-0.44
mjk008	91.6	0.1159	0.100	2.83	2.89	-0.06
mjk009	181.6	0.1052	0.690	2.79	2.88	-0.09
mjk010	98.3	0.1025	0.100	2.64	1.97	0.67
mjk011	94.1	0.1109	0.100	2.49	2.59	-0.10
mjk012	65.5	0.0953	0.000	2.30	1.97	0.33
mjk013	86.2	0.1162	0.100	2.04	2.27	-0.23
mjk014	80.9	0.1010	0.100	2.04	1.44	0.60
mjk015	131.5	0.1020	0.710	1.45	0.91	0.54
mjk018	107.3	0.1022	0.460	1.20	1.34	-0.14
mjk019	100.1	0.1001	0.500	0.91	1.49	-0.49
mjk020	90.5	0.0995	0.470	0.89	0.83	0.06
mjk021	80.4	0.1002	0.380	0.88	0.82	0.06
mjk022	105.6	0.1064	0.530	0.81	1.62	-0.81
mjk023	88.9	0.1018	0.450	0.73	0.80	-0.07
mjk024	96.2	0.1010	0.700	0.70	0.11	0.59
mjk025	64.3	0.0979	0.380	0.59	0.32	0.27
mjk026	78.6	0.1025	0.550	0.46	0.55	-0.09
mjk028	130.4	0.1038	0.780	0.34	-0.50	0.84
mjk029	81.0	0.1009	0.480	0.29	0.83	-0.54
mjk030	70.8	0.1005	0.420	0.18	0.26	-0.08
mjk032	78.0	0.1066	0.650	0.16	0.31	-0.15
mjk033	63.1	0.0975	0.370	0.10	-0.26	0.36
mjk034	55.1	0.0940	0.470	0.10	-0.31	0.41
mjk035	63.9	0.0979	0.480	-0.24	0.29	-0.53
mjk037	47.0	0.1101	0.300	-0.35	-0.24	-0.11
mjk039	36.5	0.0859	0.400	-0.65	-0.75	0.10
mjk040	54.2	0.0927	0.450	-0.30	-0.15	-0.15
mjk041	71.3	0.0969	0.450	0.28	0.39	-0.11
mjk042	72.0	0.0955	0.510	0.05	0.41	-0.36

mjk043	89.8	0.0980	0.450	0.99	0.95	0.04
mjk044	89.4	0.0982	0.450	0.76	0.95	-0.19
mjk045	89.7	0.0976	0.510	0.61	0.95	-0.34
mjk046	89.1	0.0978	0.570	0.36	0.94	-0.58
mjk047	107.4	0.0995	0.450	1.48	1.49	-0.01
mjk048	106.8	0.0919	0.510	1.21	1.40	-0.19
mjk049	108.2	0.0981	0.450	1.34	1.49	-0.15
mjk050	106.5	0.0996	0.570	0.89	1.45	-0.56
mjk051	107.2	0.0992	0.510	1.28	1.47	-0.19
mjk052	121.1	0.1039	0.450	2.03	1.94	0.09
mjk053	125.9	0.0992	0.510	1.48	2.03	-0.55
mjk054	84.6	0.1204	0.100	2.13	2.20	-0.07
mjk055	143.1	0.1204	0.410	2.64	3.29	-0.65
mjk056	119.1	0.1204	0.480	1.58	2.10	-0.52
mjk057	131.4	0.1252	0.330	2.28	2.48	-0.20
mjk058	100.8	0.1249	0.440	1.48	1.34	0.14
mjk059	101.8	0.1209	0.110	2.69	2.48	0.21
mjk060	109.0	0.1237	0.220	2.11	1.91	0.20
mjk061	126.4	0.1224	0.230	2.51	2.67	-0.16
mjk062	144.3	0.1208	0.230	3.18	3.12	0.06
mjk063	99.8	0.1237	0.070	2.84	2.53	0.31
mjk064	105.8	0.1280	0.060	2.99	2.75	0.24
mjk065	136.5	0.1210	0.150	3.42	3.37	0.05
mjk068	118.9	0.1212	0.130	3.20	2.86	0.34
mjk069	134.7	0.1224	0.400	2.21	2.35	-0.14
mjk070	149.1	0.1257	0.421	3.61	3.30	0.31
mjk071	167.5	0.1175	0.350	3.31	2.75	0.56
mjk072	137.0	0.1186	0.480	2.20	2.50	-0.30

TABLE 11. Theoretical LSER for Konnemann's Fish Toxicity

ID No.	ϵ_b	q	V_{mc}	π_1	LOG Kow Observed	LOG Kow Predicted	Residual
mjk054	84.6	0.1204	14.8338	0.0593	2.91	2.42	0.49
mjk059	101.8	0.1209	14.6702	0.1010	2.69	2.22	0.47
mjk104	115.1	0.1259	15.2887	0.0821	1.50	1.48	0.12
mjk105	60.5	0.1035	17.9301	0.1600	3.54	3.94	-0.40
mjk008	91.6	0.1159	18.6798	0.0700	2.93	2.27	0.66
mjk020	90.4	0.0995	16.3503	0.3420	4.46	4.23	0.23
mjk085	63.9	0.0979	16.1915	0.2870	5.04	4.69	0.35
mjk106	76.3	0.1100	18.3533	0.1130	2.93	3.07	-0.14
mjk107	119.9	0.1199	14.6706	0.0790	2.52	2.16	0.36
mjk108	78.1	0.1061	17.8447	0.1630	3.03	3.51	-0.48
mjk109	92.7	0.1104	18.0184	0.1730	3.00	2.89	0.11
mjk110	108.8	0.1130	18.1773	0.1230	2.85	2.47	0.38
mjk111	78.1	0.1043	17.7307	0.1850	3.01	3.71	-0.70
mjk112	95.3	0.1061	17.6561	0.1880	3.02	3.37	-0.35
mjk040	54.2	0.0927	16.6925	0.3240	5.07	5.24	-0.17
mjk042	72.0	0.0955	16.6451	0.3200	4.68	4.79	-0.11
mjk046	89.1	0.0978	16.8101	0.3180	4.05	4.38	-0.32
mjk048	106.8	0.0919	16.5620	0.3220	5.90	4.86	1.04
mjk114	130.1	0.1283	15.5518	0.0711	1.11	1.06	0.05
mjk115	130.2	0.1290	15.4836	0.0880	1.12	0.99	0.13
mjk116	144.8	0.1310	15.6634	0.0607	1.26	0.62	0.64
mjk117	145.1	0.1311	15.7047	0.0750	0.57	0.60	-0.03
mjk118	145.2	0.1315	15.6473	0.0600	0.57	0.57	-0.00
mjk119	160.0	0.1331	15.8312	0.0530	0.15	0.24	-0.09
mjk068	118.9	0.1212	14.6796	0.1060	0.05	2.02	-1.97
mjk121	164.0	0.1283	15.4174	0.0980	-0.16	0.75	-0.91
mjk122	115.0	0.1260	15.2888	0.0810	1.60	1.47	0.13
mjk123	115.1	0.1264	15.3351	0.0962	1.70	1.42	0.28
mjk124	115.0	0.1270	15.2675	0.1000	1.43	1.36	0.07
mjk125	117.1	0.1241	14.9478	0.1085	1.67	1.69	-0.02
mjk126	132.7	0.1259	15.2239	0.1020	1.46	1.32	0.14
mjk129	176.1	0.1339	15.9971	0.0280	0.05	-0.01	0.06

TABLE 12. LSER for Konnemann's Fish Toxicity

ID No.	β	V_{mc}	π^*	LOG Kow Observed	LOG Kow Predicted	Residual
mjk054	84.6	0.1204	0.10	2.91	2.49	0.42
mjk054	101.8	0.1209	0.11	2.69	2.19	0.50
mjk054	115.1	0.1259	0.04	1.60	1.51	0.09
mjk054	60.5	0.1035	0.00	3.54	3.42	0.12
mjk054	91.6	0.1159	0.10	2.93	2.58	0.35
mjk054	90.4	0.0995	0.47	4.46	4.46	-0.00
mjk054	63.9	0.0979	0.48	5.04	5.03	0.01
mjk054	76.3	0.1100	0.10	2.93	3.12	-0.19
mjk054	119.9	0.1199	0.12	2.52	1.95	0.57
mjk054	78.1	0.1061	0.10	3.03	3.28	-0.25
mjk054	92.7	0.1104	0.10	3.00	2.82	0.18
mjk054	108.8	0.1130	0.10	2.85	2.41	0.44
mjk054	78.1	0.1043	0.10	3.01	3.36	-0.35
mjk054	95.3	0.1061	0.10	3.02	2.97	0.05
mjk054	54.2	0.0927	0.45	5.07	5.36	-0.29
mjk054	72.0	0.0955	0.51	4.68	5.09	-0.41
mjk054	89.1	0.0978	0.57	4.05	4.86	-0.81
mjk054	106.8	0.0919	0.51	5.90	4.65	1.25
mjk054	130.1	0.1283	0.02	1.11	1.08	0.03
mjk054	130.2	0.1290	0.02	1.12	1.04	0.08
mjk054	144.8	0.1310	0.02	1.26	0.69	0.57
mjk054	145.1	0.1311	0.00	0.57	0.62	-0.05
mjk054	145.2	0.1315	0.00	0.57	0.60	-0.03
mjk054	160.0	0.1331	0.00	0.15	0.26	-0.11
mjk054	118.9	0.1212	0.00	0.05	1.55	-1.50
mjk054	164.0	0.1283	0.07	-0.16	0.63	-0.79
mjk054	115.0	0.1260	0.07	1.60	1.60	0.00
mjk054	115.1	0.1264	0.07	1.70	1.58	0.12
mjk054	115.0	0.1270	0.07	1.43	1.55	-0.12
mjk054	117.1	0.1241	0.07	1.67	1.65	0.02
mjk054	132.7	0.1259	0.07	1.46	1.29	0.17
mjk054	176.1	0.1339	0.07	0.05	0.15	-0.10

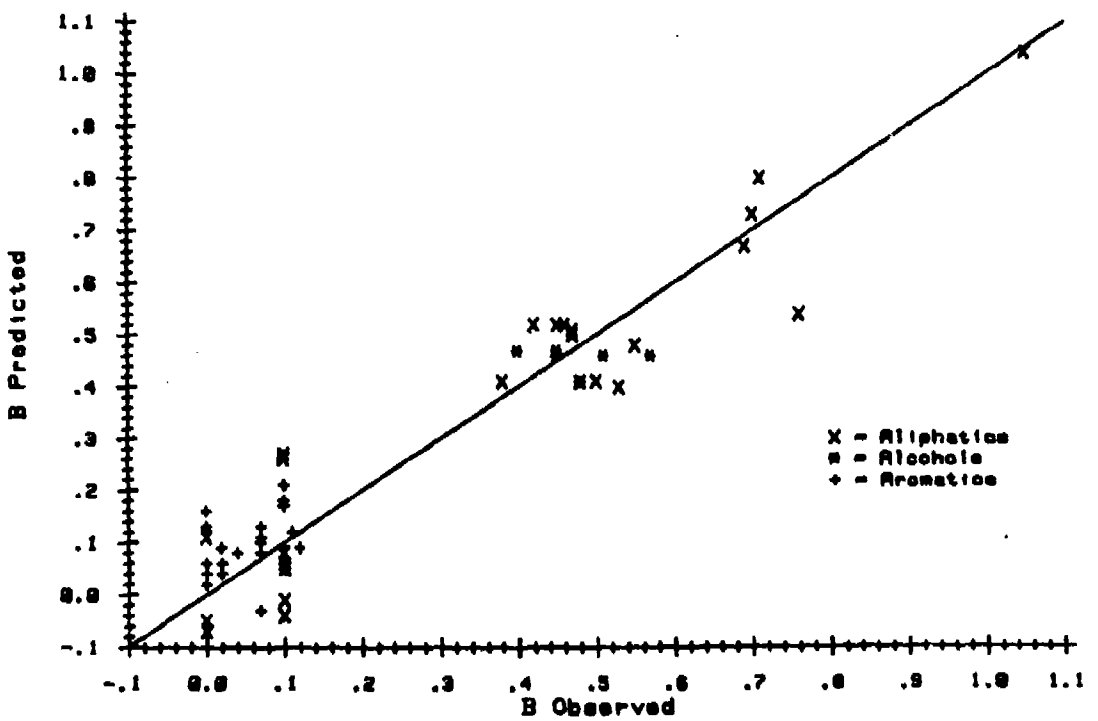

Figure 1. Observed vs Predicted β

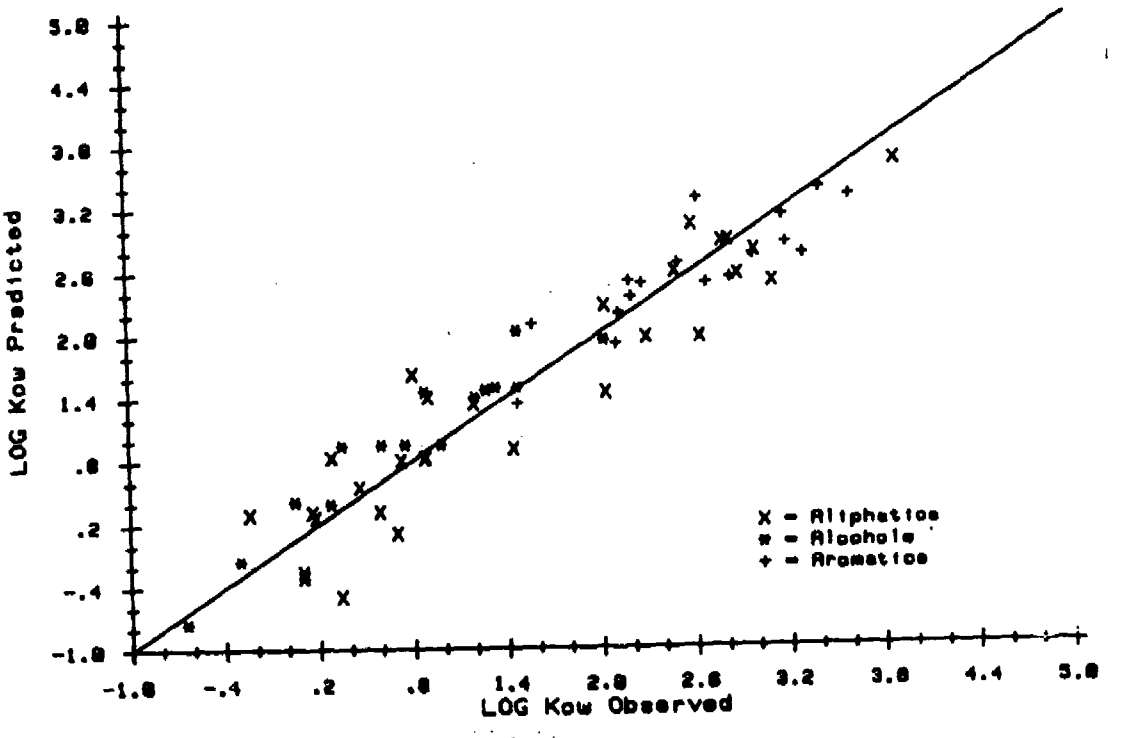

Figure 2. Theoretical LSER: Octanol/Water Partition Coefficient

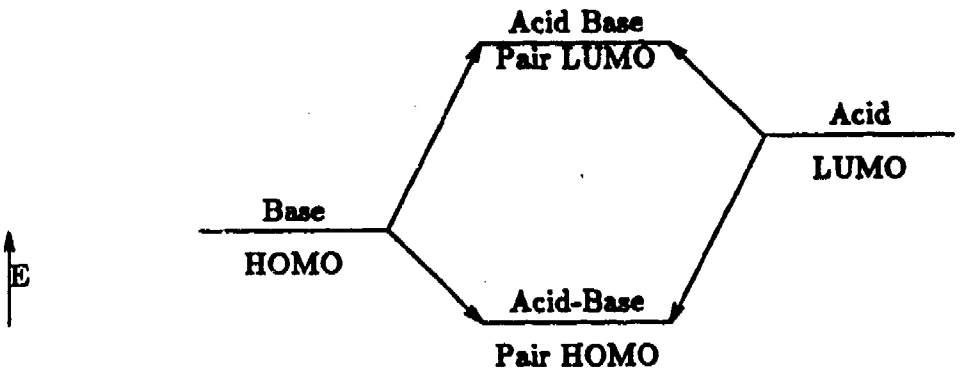

Figure 3. Acid Base HOMO LUMO Interactions

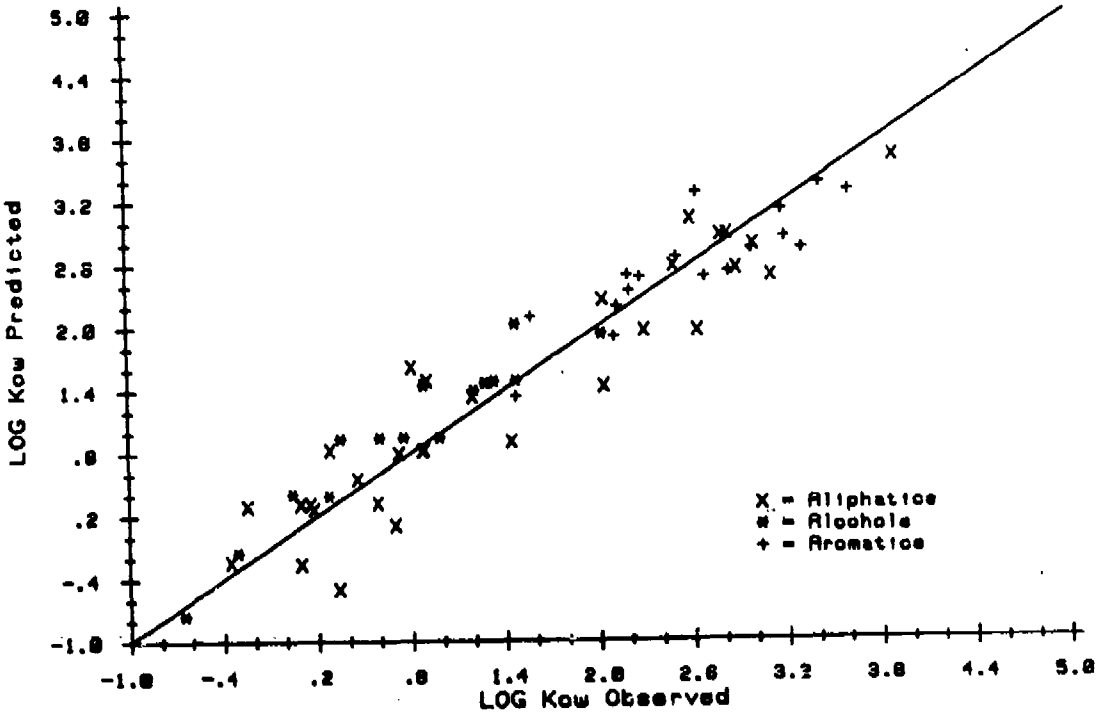

Figure 4. LSER: Octanol/Water Partition Coefficient

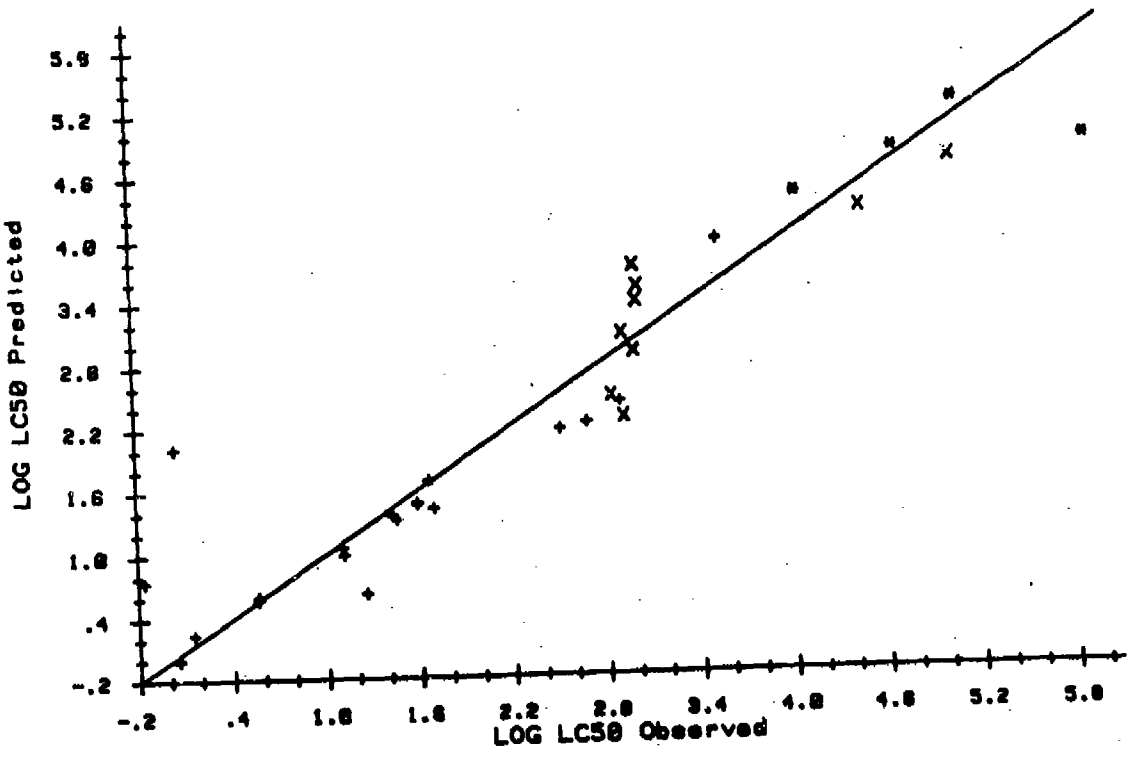

Figure 5. Theoretical LSER: Konneman's Fish Toxicity

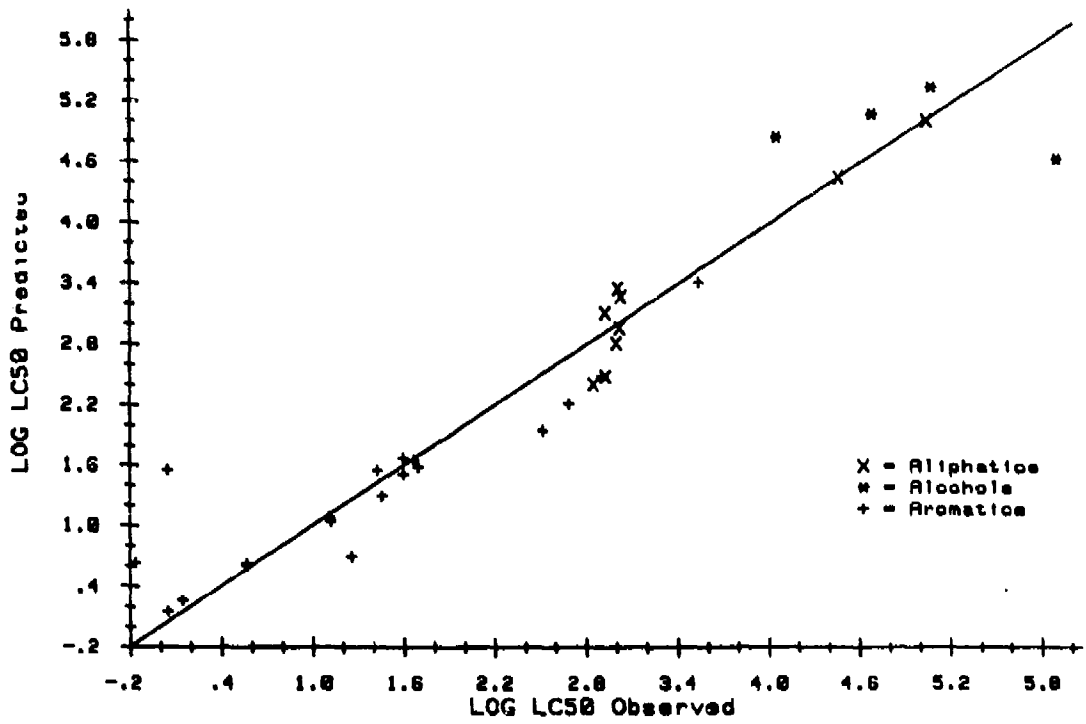

Figure 6. LSER: Konneman's Fish Toxicity

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