

## Fraser River Action Plan



## Effluent Point Source Inventory and Database for the Fraser Basin



CANADA'S GREEN PLAN  
LE PLAN VERT DU CANADA

Canada

DOE FRAP 1993-05



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# **EFFLUENT POINT SOURCE INVENTORY AND DATABASE FOR THE FRASER RIVER BASIN**

DOE FRAP 1993-05

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### **Disclaimer**

This report was prepared under contract to Environment Canada as part of the Fraser River Action Plan funded by Canada's Green Plan. The ideas and opinions expressed herein do not necessarily state "or reflect those of Environment Canada.

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## INTRODUCTION

The pollution abatement component of the Fraser River Action Plan, an initiative under Canada's Green Plan, directs that action be taken to identify and reduce contaminants entering the Fraser River Basin from effluent sources. Design of a cost-effective strategy for effluent characterization and control requires consideration of the number, locations and types of sources present. An inventory of wastewater sources in the Basin is also needed to provide planning level information for the Fraser River Basin Sustainable Management Program. To address this need, and to support the activities of interested parties and agencies involved in resource management decisions affecting the Fraser River Basin, the requirement for a georeferenced, personal computer based inventory of wastewater sources in the Fraser River Basin was identified.

The project described in this report has two main objectives:

1. To conduct an inventory of industrial and municipal point sources of wastewater discharges in the Fraser River Basin, including basic administrative, geographic and regulations data on each source.
2. To design a personal computer database system to maintain, examine and report the information collected in the inventory

A database was developed that lists the point sources of wastewater discharges entering the Fraser River Basin. Georeferenced information on the discharges is compiled in a PC-based system designed to allow flexible querying and reporting of inventory data. The scope of effluent data collection is limited to B.C. Waste Management Permit provisions, and for non-permitted federal facilities, typical flow estimates. Actual wastewater monitoring data is not included in this database.

## INVENTORY COMPILATION

Wastewater discharge sources in the Fraser River Basin have been identified. All industrial and municipal point sources that discharge direct to the Fraser River or its tributaries, and authorized point effluent discharges to land, are included. Non-point sources and sources that discharge to municipal storm sewer or sewage interceptors are not included.

Inventory data for point source discharges was obtained in electronic and hardcopy formats from provincial and federal offices. Inventory data for provincially permitted discharges was obtained in American standard code for information interchange (ASCII) from the WASTE data management system, administered by the Laboratory Services and Systems Management Branch, Ministry of Environment, Lands and Parks (MELP). The search criteria for the WASTE query is given in Appendix A. Information in the WASTE database that was incorporated into the inventory is listed in Appendix B. Information on point source discharges from federal facilities was acquired from the Federal Facilities Environmental Activities Database (FFEAD) administered by Environmental Protection, Conservation and Protection, Environment Canada. Information in the FFEAD database that was incorporated in the inventory is listed in Appendix

C. Both digital data sets were loaded as flat files into a temporary Dbase IV database and records external to the Fraser Basin were trimmed. These flat files provide the base information which was imported into the Fraser Pollution Source Inventory (FR\_PSI) database.

Permit listings were compiled for each MELP regional office and missing data identified. Regional visits occurred from September until November 1992 to the Surrey, Kamloops, Williams Lake and Prince George regional offices. Site visits to the regional Ministry of Environment, Lands and Parks offices provided additional inventory information. Photocopies were made of all available effluent permits within the Fraser Basin. The inventory data obtained from WASTE has been supplemented using the permits obtained from the regional offices. Data for the Penticton and Smithers regional offices were compiled through telephone and fax communications and delivered via the postal service. Selective data verification was performed for the Point Source Inventory, specifically parameter discharge minimum, maximum, average and units, latitude, longitude and NTS map sheet number.

The FFEAD was supplemented with site information for federal facilities obtained from Environment Canada files, the Department of Indian and Northern Affairs (DIAND), federal institutions, and Transport Canada.

Additional data such as latitude, longitude, NTS map sheet number, UTM zone, UTM casting, UTM northing and sub-basin have been compiled for each site as required. The NTS map sheet number was determined according to the B.C. Gazetteer and/or location maps included with the permit. One locational coordinate pair was determined for each site regardless of the number of discharges. Latitude/longitude information was recorded to the nearest minute using:

- i) site location maps and the 1:50 000 NTS map sheet;
- ii) written descriptions of the site locations included with the permit;
- iii) for Southern Interior Region sites, most of the northing and casting values had been previously obtained by MELP, Kamloops staff and these are recorded in the UTM format;
- iv) gazetteer latitude/longitude values were used when the above location map and written information were missing.

The field 'Water Body' in the database program refers to the water body that the wastewater is discharged to according to information on the front page of the permit. When entry is via a drainage ditch or slough rather than a direct input, this is indicated in the entry as 'ditch - {water body name}'. When discharge is to the land rather than to a water body, this is indicated as 'land - {location}'. Finally, when a parameter limit applies to a discharge to a tailing pond, this is recorded as 'tailings - {location}'.

Thirteen sub-basins and four regions (Figure 1) were defined according to the definitions provided in *Water in Sustainable Development: Exploring Our Common Future in the Fraser River Basin* (Dorcey and Griggs, 1991). When a discharge occurs at a confluence the downstream sub-basin / region was utilized.



# FRASER RIVER BASIN

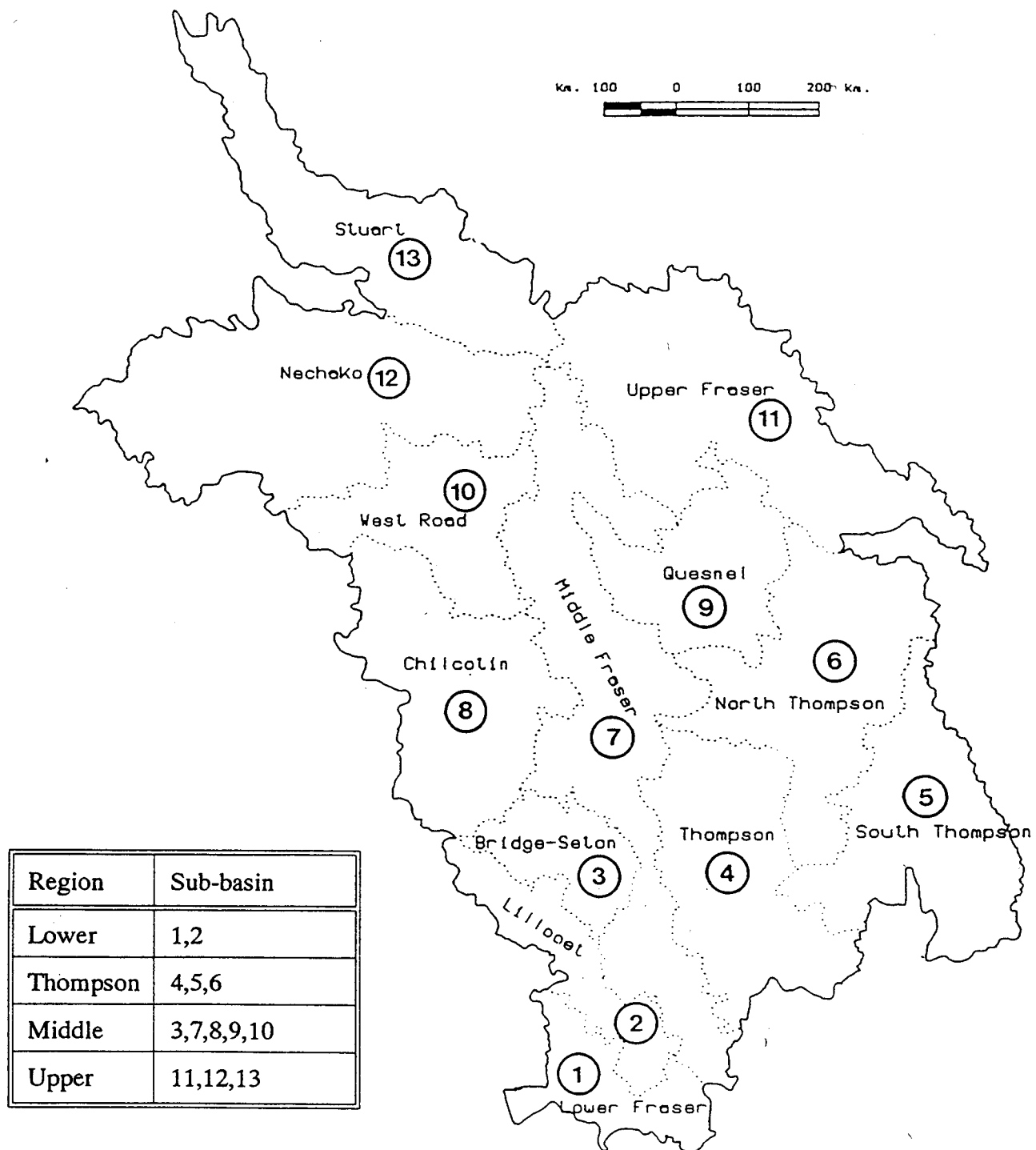


Figure 1. Map of Fraser River sub-basins and regions.

## DATA MANAGEMENT SYSTEM

A PC-based data management system was developed to maintain, search and report the point source inventory data. The system utilizes FoxPro version 2.5b and the FoxPro Distributors Kit for use on an IBM compatible computer running MS-DOS. The data files are formatted in a structure that facilitates data transfer to a GIS through georeferencing and the use of unique identifiers for each site and outfall. One of the design criteria for the FR\_PSI database is to maximize information exchange capability with related environmental database systems, both existing and developing. To this end, the database model was designed to conform to the Spatial Archive and Interchange Format (SAIF) developed by B.C. MELP.

### SAIF

SAIF is a standardized means for sharing of information which can be referenced to the earth. SAIF is designed to facilitate data exchange on a vendor neutral platform. Appendix D provides a description of the SAIF data exchange standard and explains how the formal definition of SAD? is applied in the case of the Fraser Point Source Inventory database. The SAIF database model and Class Syntax Notation for FR\_PSI are also included.

### DATA STRUCTURE

The database system organizes the inventory data into three primary data tables. The three tables include inventory records for site, outfall and parameter data. Specific data elements contained in each of these tables are outlined in the Database User's Manual (Informatics & Systems, 1994). The interrelation between the site, outfall and parameter tables is a one to many relationship. Each site can have one or many outfalls, and each outfall can have one or many parameters specified. The data on discharge flow rates and parameter concentration corresponds to the B.C. Waste Management Permit limits, or, for non-permitted federal facilities, typical flow estimates. Actual wastewater monitoring data is outside the scope of the FR\_PSI database.

Reference files define codes in the system for: sub-basin, region, Canadian Standard Industrial Classification, parameter name, B.C. MELP office, outfall site type, wastewater type, and "discharge to" location type. The use of codes for data entry, updating and searching routines helps to reduce errors in data entry and provides consistency for accurate querying of the database. Coding is designed to maximize commonality with related environmental data systems, specifically WASTE and FFEAD (Table 1).

The FR\_PSI database includes a calculation module to report the maximum allowable daily loading when the requisite input data is available. In order to allow for summary reporting of loading, units for parameter concentrations and flow rates are predefined, in the code tables. Important caveats regarding the loading calculation and reports are discussed in the Results section.

Table 1. Origin of data and codes

Variable Name	Source		
	FR_PSI	WASTE	FFEAD
Record Id	x	x	x
Manager		x	x
Facility		x	x
Sub-basin	x		
Region	x		
SIC Code		x	x
Production Capacity		x	
Production Units	x	x	
Mailing Address		x	x
Location	x	x	x
Phone Number		x	x
Fax Number		x	x
Contact Name		x	x
Legal Address		x	x
NTS Mapsheet	x		
UTM Zone	x		
UTM Easting	x	x	
UTM Northing	x	x	
Latitude	x	x	x
Longitude	x	x	x
MELP Office		x	
Federal Facility Number	x		x
Federal Regulations	x		
Permit Date		x	

Variable Name	Source		
	FR_PSI	WASTE	FFEAD
Date of Last Update	x		
WASTE Number		x	
Site Type		x	
Waste Type		x	
Flow Maximum		x	
Flow Minimum		x	
Flow Average		x	
Flow Units	x	x	
Discharge Duration	x		
Discharge To	x	x	
Receiving Waterbody	x	x	
Parameter Code	x	x	
Parameter Units	x	x	
Discharge Minimum		x	
Discharge Maximum		x	
Discharge Average		x	

### USING THE DATABASE

A pull-down menu system provides the user access to editing, viewing and reporting functions. Pick-lists are included for easy input and editing of most coded variables.

The FR\_PSI Database User's" Manual (Informatics & Systems, 1994) provides instructions on:

- database installation
- running the program, including importing/exporting, editing, viewing and reporting functions
- database maintenance and security

## RESULTS

The point source inventory contains records for 458 sites and 1207 parameters. Data summaries are comprised by sub-basin, region, key parameters and major SIC 'groups. Table 2 provides summaries of loadings for key parameters by sub-basin. Table 3 provides summaries of the key parameter loadings by watershed region. Table 4 provides summaries of parameter loadings for SIC groups. Table 5 provides the distribution of industries by SIC code as a provision of wastewater discharge in B.C. WASTE Management permits issued in the Fraser Basin. Summarized loadings (kg/d) for the major classes of wastewater sources are given in Table 6.

Several notes of caution concerning the loading reports require emphasis. First, the loading calculation module was developed to assist the planning process, and to facilitate gross comparisons between regions or industrial sectors. FR\_PSI does not include monitoring data. In practice, flows and concentrations are probably lower than permit levels used in the loading calculation. Loading values reported by the database should not be considered as a quantitative measure of actual pollutant loadings in the Basin, nor as a substitute for wastewater monitoring or characterization studies. The database loadings are to be used only to give a ballpark idea of the total authorized loadings of permitted parameters. Such extrapolations have no meaning outside the planning context.

## RECOMMENDATIONS

Some minor data deficiencies and inconsistencies still exist within the FR\_PSI. The current georeferencing is based on site location maps which are often rough and coordinates are determined from 1:50,000 scale NTS map sheets. Latitudes and longitudes derived from the B.C. TRIM 1:20,000 scale digital mapping series will provide more accurate locations as these files become available.

A small number of MELP permits were not available in paper copy at the time of collection and are being sent via the mail system. For these sites, locational coordinates are unknown. For a number of discharges, discharge volumes need to be determined and entered into the database. For all sites the discharge duration (days/year) needs to be determined and entered. Discharge duration is required to calculate maximum allowable annual loadings. Given the nonstandard format of the MELP permits, this task will require considerable time and could ideally form part of a summer student project.

It is recommended that the FR\_PSI be updated with the WASTE system data in approximately 6 months. Once the verification of WASTE is completed in conjunction with MELP's new permit fee system, permit data will only require updating on a periodic basis as new permits become active.

The information on point source discharges from federal sources includes the major federal discharges but many small federal facilities are not identified. A number of Indian Reserves are not currently included. Additionally the discharge volumes of domestic sewage from these sites is unknown. It is recommended that these smaller scale federal facilities be evaluated and where appropriate be incorporated, along with discharge estimates, into the FR\_PSI.

Table 2. Maximum allowable daily loadings (kg/d) by sub-basin,

SUB-BASIN	BOD	TOTAL P	AMMONIA	OIL & GREASE	RESIDUE> NON-FILTERABLE
Lower Fraser	86,617	0.5	61	22,196	69,253
Lillooet	72				107
Thompson	3,245	110		12	3,983
South Thompson	571	6.	1	51	722
North Thompson	38			320	3,181
Bridge-Seton	132				132
Middle Fraser	3,594			2	5,880
Chilcotin	17				17
Quesnel	2				331
West Road					
Upper Fraser	254	0.2		0.3	456
Nechako	392	1	0.5	0.1	452
Stuart	163				175

1

Table 3. Maximum allowable daily loadings (kg/d) by region.

REGION	BOD	TOTAL P	AMMONIA	OIL & GREASE	RESIDUE, NON-FILTERABLE
Lower	86,689	0.5	61	22,196	69,359
Thompson	3,853	18,116	1	384	7,886
Middle	3,744			2	6,360
Upper	809	1	0.5	0.4	1,084

Table 4. Maximum allowable daily loadings (kg/d) by SIC Code.

SIC CODE	DESCRIPTION	BOD	TOTAL P	Ammonia	OIL & GREASE	RESIDUE, Non-Filterable
3	Fishing & Trapping Ind.	122	0.5			114
31	Fishing Industries	15				42
312	Inland Fishing Industry	55		1		
321	Services Incidental To Fishing	447	1	0.5		638
41	Logging Industry	8				11
411	Logging Industry	1				1.3
6	Mining Industries	2				238
611	Gold Mines					926
614	Silver-Lead-Zinc Mines					2,901
821	Sand and Gravel Pits					16
101	Meat & Poultry Products Ind.	7			14	10
102	Fish Products Industry	2,106			324	810
1021	Fish Products Industry	2				1.5
1031	Canned Fruit & Veg. Ind.	1,746				6
1032	Frozen Fruit & Veg. Ind.	822			14	
25	Wood Industries	16				22
251	Sawmill, Planing & Shingle	3			1	13
2512	Sawmill & Planing Products				19	2
2591	Wood Preservation Industry				2	
271	Pulp & Paper Industry	1,250				1,250
2711	Pulp Industry	48,995				92,926
2713	Paperboard Industry	3,630				4,840
29	Primary Metal Industries	2			122	1,221
30	Fabricated Metal Products Ind.			60		40
3231	Motor Vehicle Industry					2
3281	Boat Building & Repair Ind.	0.3				0.3
35	Non-Metallic Mineral Products					8

SIC CODE	DESCRIPTION	BOD	TOTAL P	Ammonia	OIL & GREASE	RESIDUE, Non-Filterable
3521	Hydraulic Cement Industry				64	
3542	Structural Concrete Products	1				17
3549	Other Concrete Products					2
3551	Ready-Mix Concrete Industry				3	104
369	Petroleum & Coal Products				1	
3699	Petroleum & Coal Products				12	61
37	Chemical & Chemical Products				1	5
3711	Industrial Chemical Ind.	2				156
3712	Industrial Organic Chem. Ind.					1825
411	Industrial Construction	3				3
461	Pipeline Transport Industries				320	-
4611	Natural Gas Pipeline Transp.				11	113
479	Other Storage & Warehousing	1				1
5111	Petroleum Products, Wholesale				59	226
5731	Wholesale				3	11
633	Gasoline Service Stations				3	
6331	Gasoline Service Stations				0.4	
64	General Retail Merchandising	1.5				2
751	Operators of Bldgs & Dwellings	1.5				2
7511	Residential Bldgs.	19				26
759	Other Real Estate Operators	3				4
7599	Other Real Estate Operators	22				29
81	Federal Gov't Services			1		
82	Prov. & Terr. Gov't Services	2				2
8222	Correctional Services	24				32
8224	Fire Fighting Services				1	
8261	Health Administration	25				33
85	Education Services	4				5
8511	Elementary & Sec. Education	34				36



	DESCRIPTION	BOD	TOTAL P	Ammonia	OIL & GREASE	RESIDUE, Non-Filterable
	University Education	11				14
	Social Rehabilitation Services	41				91
	Accommodation Service Ind.	6				8
	Hotels, Motels, Tourist Courts	1				1.5
	Hotels & Motor Hotels	7				20
	Camp Grounds, Trailer Parks	9				12
	Camp Grounds, Trailer Parks	17				23
	Other Rec. & Vacation Camps	5				6
	Restaurants, Licensed	7				9
	Taverns, Bars, Night Clubs	0.5				0.7
	Amusement & Rec. Services	1.6				2
	Other Race Tracks	0.3				0.4
	Golf Courses	5				6
	Skiing Facilities	21				27
	Other Amusement & Rec.	17				23
	Laundries, Dry Cleaners	1.6			0.5	1.5
	Waste Disposal Operations	111,772	116		21,607	90,669
	Placer Mines					820
	Other Recycling Operations	300				400

Table 5. Distribution of Industries, by SIC code, in the Fraser River Basin.

SIC CODE	DESCRIPTION	FREQUENCY
NC02	WASTE DISPOSAL OPERATIONS . . . . .	94
91	ACCOMMODATION SERVICE INDUSTRIES . . . . .	45
10	FOOD INDUSTRIES . . . . .	32
75	REAL ESTATE OPERATOR INDUSTRIES . . . . .	31
03	FISHING AND TRAPPING industries . . . . .	23
35	NON-METALLIC MINERAL PRODUCTS INDUSTRIES . . . . .	21
25	WOOD INDUSTRIES . . . . .	21
06	MINING INDUSTRIES . . . . .	14
51	PETROLEUM PRODUCTS INDUSTRIES, WHOLESALE . . . . .	13
97	PERSONAL AND HOUSEHOLD SERVICE INDUSTRIES . . . . .	12
96	AMUSEMENT AND RECREATIONAL SERVICE INDUSTRIES . . . . .	11
85	EDUCATIONAL SERVICE INDUSTRIES . . . . .	10
27	PAPER AND ALLIED PRODUCTS INDUSTRIES . . . . .	10
08	QUARRY AND SAND PIT INDUSTRIES . . . . .	9
83	LOCAL GOVERNMENT SERVICE INDUSTRIES . . . . .	8
37	CHEMICAL AND CHEMICAL PRODUCTS INDUSTRIES . . . . .	8
82	PROVINCIAL AND TERRITORIAL GOV'T SERVICE INDUSTRIES . . . . .	7
36	REFINED PETROLEUM AND COAL PRODUCTS INDUSTRIES . . . . .	7
02	SERVICE INDUSTRIES INCIDENTAL TO AGRICULTURE . . . . .	7
92	FOOD AND BEVERAGE SERVICE INDUSTRIES . . . . .	5
63	AUTOMOBILE & PARTS INDUSTRIES, SALES AND SERVICE . . . . .	5
NC6	PLACER MINES . . . . .	4
46	PIPELINE TRANSPORT INDUSTRIES . . . . .	4
07	CRUDE PETROLEUM AND NATURAL GAS INDUSTRIES . . . . .	4
30	FABRICATED METAL PRODUCTS INDUSTRIES . . . . .	3
29	PRIMARY METAL INDUSTRIES . . . . .	3
16	PLASTIC PRODUCTS INDUSTRIES . . . . .	3
NC10	OTHER RECYCLING OPERATIONS . . . . .	2
NC09	OTHER REPAIR SHOPS . . . . .	2
NC04	STORAGE FACILITIES FOR BULK LIQUIDS : . . . . .	2
81	FEDERAL GOVERNMENT SERVICE INDUSTRIES . . . . .	2
57	MACHINERY, EQUIPMENT & SUPPLIES INDUSTRIES, WHOLESALE . . . . .	1
NC11	INDUSTRY-GROUP NOT DEFINED ELSEWHERE . . . . .	1
NC07	MEDICAL, HEALTH AND OTHER LABS . . . . .	1
86	HEALTH AND SOCIAL SERVICE INDUSTRIES . . . . .	1
59	OTHER PRODUCTS INDUSTRIES, WHOLESALE . . . . .	1
49	OTHER UTILITY INDUSTRIES . . . . .	1
45	TRANSPORTATION INDUSTRIES . . . . .	1
32	TRANSPORTATION EQUIPMENT INDUSTRIES . . . . .	1
11	BEVERAGE INDUSTRIES . . . . .	1
DSEW	DOMESTIC SEWAGE . . . . .	50
	UNCLASSIFIED . . . . .	59

Table 6. Maximum allowable daily loadings (kg/d) for major classes of wastewater sources.

CLASS	BOD	TOTAL P	AMMONIA	OIL & GREASE	RESIDUE, Non-Filterable
Pulp Industry	53,865				99,016
Other Industry	5,361	1.5	61.5	967	10,356
Business and Recreation	287		1	8	427
Municipal Waste Water	111,772	116		21,607	90,669
Total	171,285	117.5	62.6	21712	200,468

## **REFERENCES**

- Dorcey, A.H.J. and J.R. Griggs. 1991. Water in Sustainable Development: Exploring Our Common Future in the Fraser River Basin. Westwater Research Centre, University of British Columbia. 288 pp.
- Informatics and Systems, Environment Canada. 1994. User's Manual: Fraser Point Source Inventory. Fraser Pollution Abatement Office, Environmental Protection, Environment Canada. 16 pp plus appendices.
- Surveys and Resource Mapping Branch. 1992. Spatial Archive and Interchange Format: Formal Definition. Release 2.0, Reference Series Volume 1, B.C. Specifications and Guidelines for Geomatics. MELP. 322 pp.

## **Appendix A**

Search criteria for the WASTE query.

## REPORT FORMAT: ASCII with record format

Variable	Type	start	Length	Description
aaaaaa	Character	1	5	AAAAA
bbbbbb	Numeric	6	1 o(3)	BBBBB

Require all sites and all Parameters for:

## SEARCH CRITERIA:

OFFICES CODES: 20  
 30  
 50  
 60  
 70  
 80

FILE TYPE: Permit  
 WASTE TYPE: Effluent

**VARIABLE LISTING:**

Permit Number  
 Region Code  
 Office Code  
 Client Name  
 Location  
 Legal Address  
 Mailing Address  
 Phone Number  
 Fax Number  
 NTS Mapsheet Number  
 Latitude  
 Longitude  
 SIC Code  
 Production Capacity  
 Production Units  
 Discharge To  
 Parameter Code  
 Discharge Minimum  
 Discharge Maximum  
 Discharge Average  
 Parameter Units

## **Appendix B**

WASTE data

## WASTE Data Incorporated into FR\_PSI.

Variable	Type	Length	Description
Permit Number	Numeric	5	9(5)
Region Code	Numeric	2	99 "
Office Code	Character	2	
Client_Name	Character	50	
Location	Character	50	
Legal Address	Character	150	
Mailing Address	Character	150	
Phone Number	Character	10	Area code & number
Fax Number	Character	10	
NTS Mapsheet	Character	6	
Latitude	Character	7	9(7)
Longitude	Character	7	9(7)
SIC code	Character	5	
Production Capacity	Numeric	8	9(8)
Production Units	Character	15	
Discharge To	Character	1	
Parameter Code	Character	4	
Discharge Minimum	Numeric	13	
Discharge Maximum	Numeric	13	
Discharge Average	Numeric	13	
Parameter Code	Character	8	



## **Appendix C**

Federal Facilities Environmental  
Activities Database (FFEAD) Data

## FFEAD (Facility .dbf) Information Incorporated Into FR\_PSI.

Variable	Type	Length	Description
Facility Code	Character	6	A unique facility code
Facility Name	Character	40	Name of the facility
Custodian Dept.	Character	4	Abbrev. code for custodian dept.
Operator Dept.	Character	4	Abbreviated code for operator dept.
Address	Character	30	Facility address
City	Character	30	City in which facility is located
Province	Character	4	Province where facility is located
Postal Code	Character	6	Postal code for mailing
SIC Code	Character	5	Standard Industry Sector code
Latitude	Character	7	Location using degrees & minutes
Longitude	Character	7	Location using degrees & minutes
UTM Northing	Character	11	Location using zone 6
UTM Easting	Character	11	Location using zone 6
Contact	Character	30	Contact person name
Title	Character	30	Contact person title
Telephone	Character	10	Contact person telephone
Fax	Character	10	Contact person fax
Comments	Character	60	Additional information

## **Appendix D**

SAIF Data Exchange Standard, Data Model and Class Syntax Notation

## SAIF DATA EXCHANGE STANDARD

SAIF was developed as a means of sharing information which can be referenced to the earth. SAIF is designed to facilitate data exchange and to help users understand each other's data in a vendor neutral platform. The primary objectives of SAIF are (Surveys and Resource Mapping Branch, 1992):

- 1) modelling and transferability of data;
- 2) handling a broad range of spatial data;
- 3) handling temporal events;
- 4) dealing with updating and other data management requirements;
- 5) suitability for file transfer including telecommunications;
- 6) ease of use and cost effectiveness; and
- 7) meeting changing needs and technological advances

SAIF is a data exchange standard based on a multilevel, modular design. There are four main components to the formal definition of SAIF: (1) SAIF data model, (2) SAIF schema, (3) User Syntax Notation and (4) SAIF encoding rules. The SAIF data model follows a single inheritance, object oriented paradigm. It consists of definitions of the underlying building blocks, such as tuples, sets, lists, enumerations and primitives. It also includes the rules for defining higher level constructs, such as geographic objects. The SAIF schema consists of the definitions of classes based on the data model constructs. SAIF has an object oriented data definition language (Class Syntax Notation) which is used to describe the SAIF schema.

The SAIF data model recognizes three broad types: classes, enumerations and primitives. A **data model** is a set of concepts and associated composition rules used to describe types, including classes and relationships among the types. A **type** is a category for entities of like characteristics. A class is an abstract data type which describes a group of objects that share the same characteristics. A **subclass** typically defines a narrower central concept, additional attributes or methods. An **object** is an instance or a value of a class. An **AbstractObject** is the base class from which all other classes are derived. A **Tuple** is a subclass AbstractObject consisting of an ordered collection of attribute domain pairs. An **Enumeration** is an ordered collection of named values which permits the user to refer to values by their common names and describes all possible values which may be assigned to the attribute in question. Primitives are simple data types such as string, boolean, integers and real. An attribute is a characteristic ascribed to an object. A domain is the set of all possible values for an attribute. Typically a domain is indicated by type. Domain restrictions or constraints may apply to the attributes. Comments may be used to provide a common language definition of the class, the attributes or other pertinent information.

The SAIF database model and Class Syntax Notation for the Fraser River Point Source Inventory is included in Appendix D. In the SAIF schema the root class for all geographic objects is GeographicObject. The lines with a half-circle represent the IS-A-TYPE-OF relationship. Those

with a triangle refer to a CONTAINS relationship. The boxes with a heavy boundary designate classes and the name of the class is given in the box. Objects belonging to those classes are shown by the surrounding boxes with thin boundaries. Each geographic object has zero or one geometric objects, zero to n relationships to other geographic objects, and zero or one metadata objects.

In the Class Syntax Notation, the angled brackets (<>) are used to indicate the beginning and end of a class definition. For the FR\_PSI the first line begins with an angled bracket (<) and gives the name of the superclass from which it is derived, in this case GeographicObject. The second line provides the name of the subclass being defined and the name of the schema containing the class definition. In this case the subclass is Site and the schema is Fr\_PSI. Attributes are defined for the objects belonging to the subclass Site, notably outfall and site data. The schema has a constraint class limiting the location of sites. The final clause in the first definition is a comments notation providing a means to document the intended use of the defined class, namely that 'a site can have several different outfalls'. The class definition ends with a closing bracket (>). For additional class structure and enumeration definitions the reader is referred to the 'Spatial Archive and Interchange Format: Formal Definition' (Surveys and Resource Mapping Branch, 1992).

The SAIF data model provides a standardized methodology for describing the relationships between a set of objects. FoxPro 2 is a microcomputer database systems that conforms substantially to the relational model. Although the SAIF data model could best be implemented by an object oriented database, many of the SAIF elements and concepts can be implemented in a relational database. In the FR\_PSI the SAIF data model was implemented in a relational database (FoxPro). Additionally, the process of specifying the SAIF data model clarified many of the relationships between the data elements in the FR\_PSI.

## FRASER RIVER SAIF DATA MODEL-CLASS SYNTAX NOTATION

<Tuple

**subclass:** **GeographicObject**

attributes: site Site::Fr\_PSI  
metadata MetaData  
geometricObject GeometricObject

comments: “ This class includes attributes for site position, site description ,  
and record updating information”

>

<Geographic Object

**subclass:** **Site::Fr\_PSI**

attributes: outfall Outfall::Fr\_PSI  
sitedata SiteData::Fr\_PSI

constraints: “A site must be situated close to a water body”

comments: “ A site can have several different outfalls.”

>

<Geographic Composite

**subclass:** **subBasinFr\_PSI**

attributes: sub-basin Watershed::Fr\_PSI

restricted: geometry: ^Polygon  
geometry \*Coordinate: ^Coordinate

constraints: “site portions must fall within polygon’s boundary”

comments: “A subbasin is a subcategory of a basin. “

>

<Tuple

**subclass:** **GeometricObject**

attributes: qualifier Qualifier

comments: “ The qualifier allows for the notion of fuzziness of position”

>

<tuple

<b>subclass:</b>	<b>Qualifier</b>	
attributes:	positiotipprox	position Approximate
comments:	" "	

>

<Geometric Object

<b>subclass:</b>	<b>PointClass</b>	
attributes:	point	Point
comments:	" "	

>

<Tuple

<b>subclass:</b>	<b>Point</b>	
attributes:	position	Coordinate
comments:	" "	

>

<Tuple

<b>subclass:</b>	<b>Coordinate</b>	
attributes:	coordxyz	Coordxyz
comments:	"This specifies the location of the site"	

>

<Tuple

<b>subclass:</b>	<b>Outfall:Fr_PSI</b>	
attributes:	wasteno	Integer
	wastewater Type	WwType::Fr_PSI
	treatment	String
	flowMax	Real
	flow Ave	Real
	flowUnits	Flow::Fr_PSI
	dischDuration	Integer
	sitetype	SiteType::Fr_PSI
	dischargeTo ,	disTo::Fr_PSI
	receivingWaterBody	String
	effluent Characteristics	EffluentCharacteristics:Fr_PSI

constraints: "Flow average <= flow maximum"

comments: "An outfall is a discharge of effluent into a water body or to the ground. DischDuration is days per year of discharge."

>

<Tuple

**subclass: EffluentCharacteristics::Fr\_PSI**

parameter	Parameter::Fr_PSI
parameterUnits	String
permitMin	Real
permitMax	Real
typical	Real
loading	LoadingFr_PSI

comments: "permitMin and permitMax are the concentration limits specified in the BC Waste Management Permit.  
typical is an estimate of the typical concentration.  
parameterUnits are fixed for an type of parameter. "

>

<Enumeration

**subclass: Parameter::Fr\_PSI**

values: **see** listing of parameter codes

comments: "Parameters are measured in pre-defined units'."

>

<Tuple

**subclass: SiteData::Fr\_PSI**

record ID	WasteManPermit::Fr_PSI
guideline	FedInstrument::Fr_PSI
manager	Manager::Fr_PSI
facility	Facility ::Fr_PSI
officecode	OfficeCode::Fr_PSI
sic	SIC::Fr_PSI
watershed	Watershed::Fr_PSI
region	Region::Fr_PSI

comments: "A site may have a BC Waste Management Permit and maybe subject to federal regulations or guidelines ."

>

<Tuple



```

subclass:          Facility:Fr_PSI
attributes:         name                String
                   fedfaccode          String
                   production           Integer
                   prodUnit             String

comments:          ‘ “Federal facility code is a cross reference to the Federal
                   Environmental Activities Database (FFEAD).
                   A federal facility is a site owned by the federal government.”
>

```

<Tuple

```

subclass:          Manager::Fr_PSI
attributes:         name                String
                   contact              Agency
                   agency               Agency
                   legal                Agency

comments:          “The name is the company name for provincial data and the
                   federal department name for federal data. The contact attribute
                   specifies who to contact for environmental information at the
                   head office or departmental headquarters. Agency is details of
                   the Head Office address and phone number. “
>

```

<Tuple

```

subclass:          WasteManPermit::Fr_PSI
attributes:         office              EnvOffice::Fr_PSI
                   permitNo            String
                   pVersion             Real
                   expiry               Date

comments:          “Each permit has a BC environment office which administers it”
>

```

<Enumeration

```

subclass:          EnvOffice::Fr_PSI
values:            Kamloops Prince George - see listing of BC environment offices

comments:          !!
>

```

<Tuple

**subclass: FedGuideline::Fr\_PSI**

attributes: fedRegInst FedRegInst::Fr\_PSI  
inspectdate Date

comments: “These federal regulation include fisheries and other environmental regulations. A site can be subject to many different environmental regulations.”

>

<Tuple

**subclass: Loading:Fr\_PSI**

attributes: dailyMax Real  
annualMax Real

comments: “dailyMax and annualMax loadings are calculated values based on the following formulas:  
dailyMax = permitMax X dischMax (units of mass/day)  
annualMax = dailyMax X dischDuration (units of mass/year).”

>

<Enumeration

**subclass: FedRegInst:Fr\_PSI**

values: **see** listing of federal regulatory instruments

comments: “A site maybe subject to many different regulatory instruments.”

>

<Enumeration

**subclass: Watershed.Fr\_PSI**

values: see listing of watersheds

comments: !! !!

>

<Enumeration

**subclass: Region::Fr\_PSI**

values: **see** listing of regions for the Fraser Basin.

constraints: “The watershed specified must lie within the region.”

comments: !! 19

>

<Enumeration

**subclass:**

**SIC:Fr\_PSI**

values:

see listing of SIC codes

comments:

“A SIC code is the standard industry code for the site. This corresponds to the major industry at the site.”

>

<Enumeration

**subclass:**

**Sitetype::Fr\_PSI**

values:

**see** listing of Sitetypes,

comments:

“A sitetype is the type of site that the outfall discharges to.”

>

<Enumeration

**subclass:**

**DisTo::Fr\_PSI**

values:

**see** listing of Discharge To types.

comments:

“A discharge to is the type of environment for the discharge.”

>

<Enumeration

**subclass:**

**WWTYPE::Fr\_PSI**

values:

**see** listing of Wastewater treatment types.

comments:

“A wastewater treatment is the type of treatment for the effluent.”

>

<Enumeration

**subclass:**

**Flow::Fr\_PSI**

values:

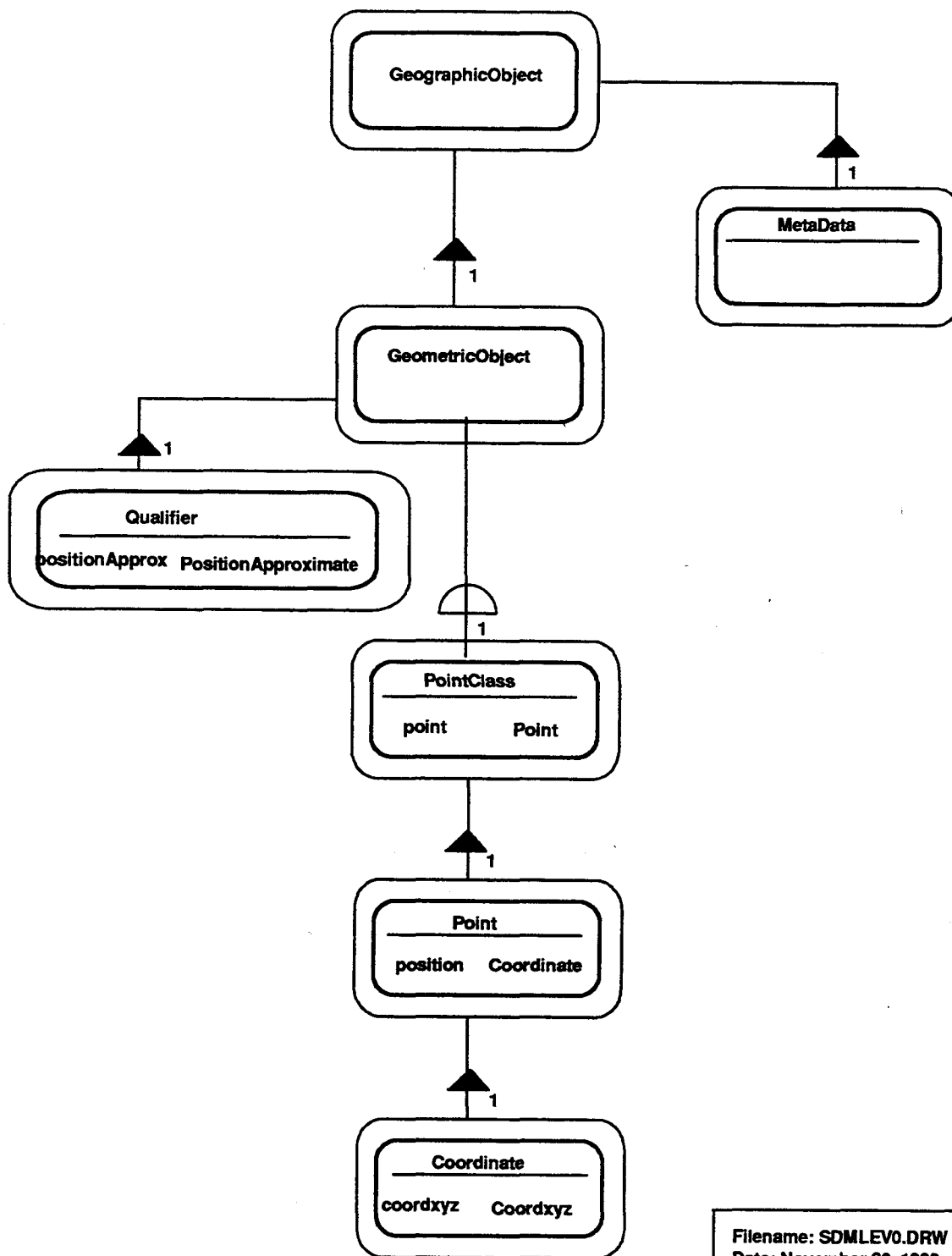
**see** listing of flow unit types.

comments:

“A flow unit is usually specified in m3/day.”

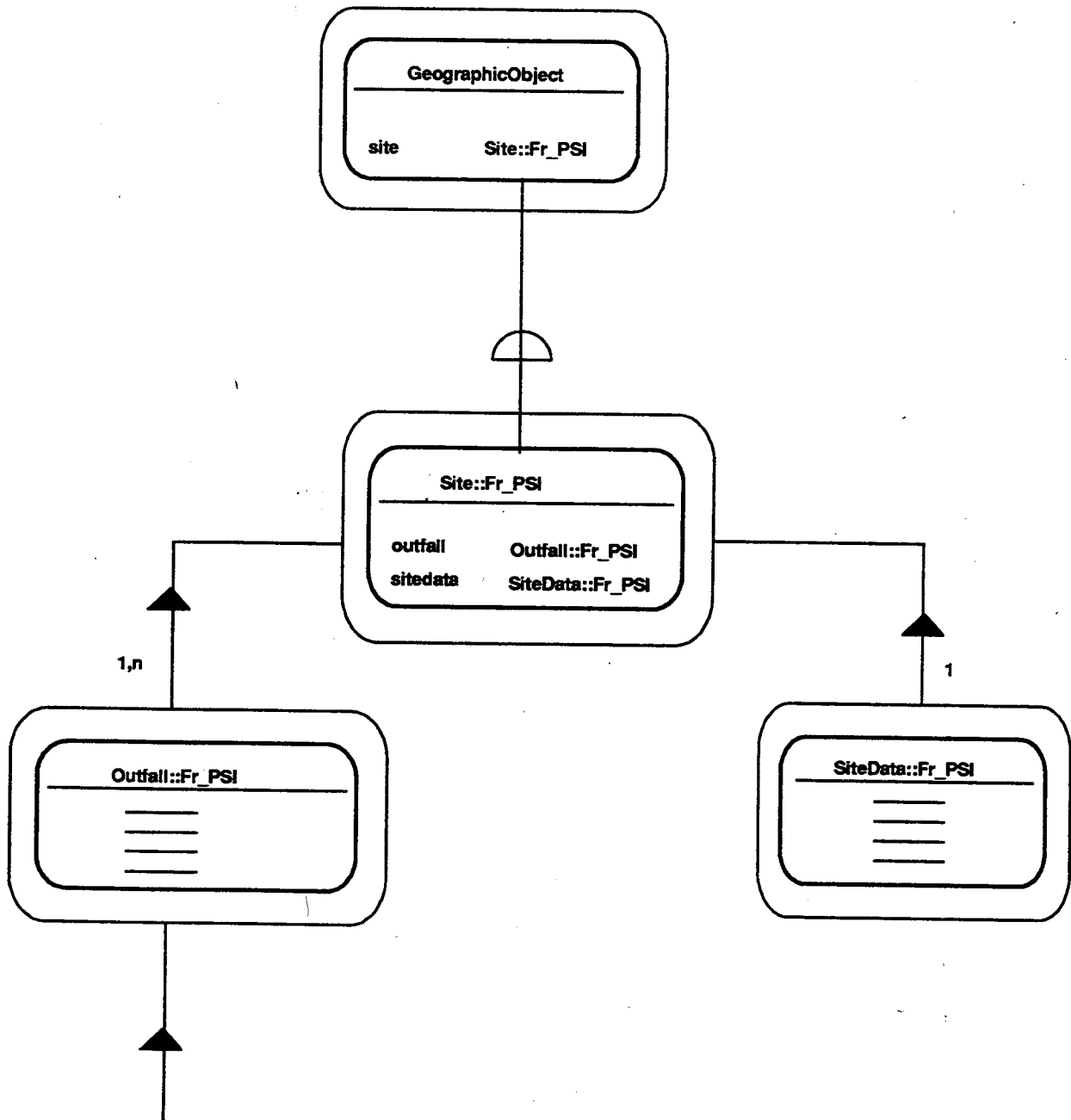
>

# FR\_PSI SAIF Data Model Level 0



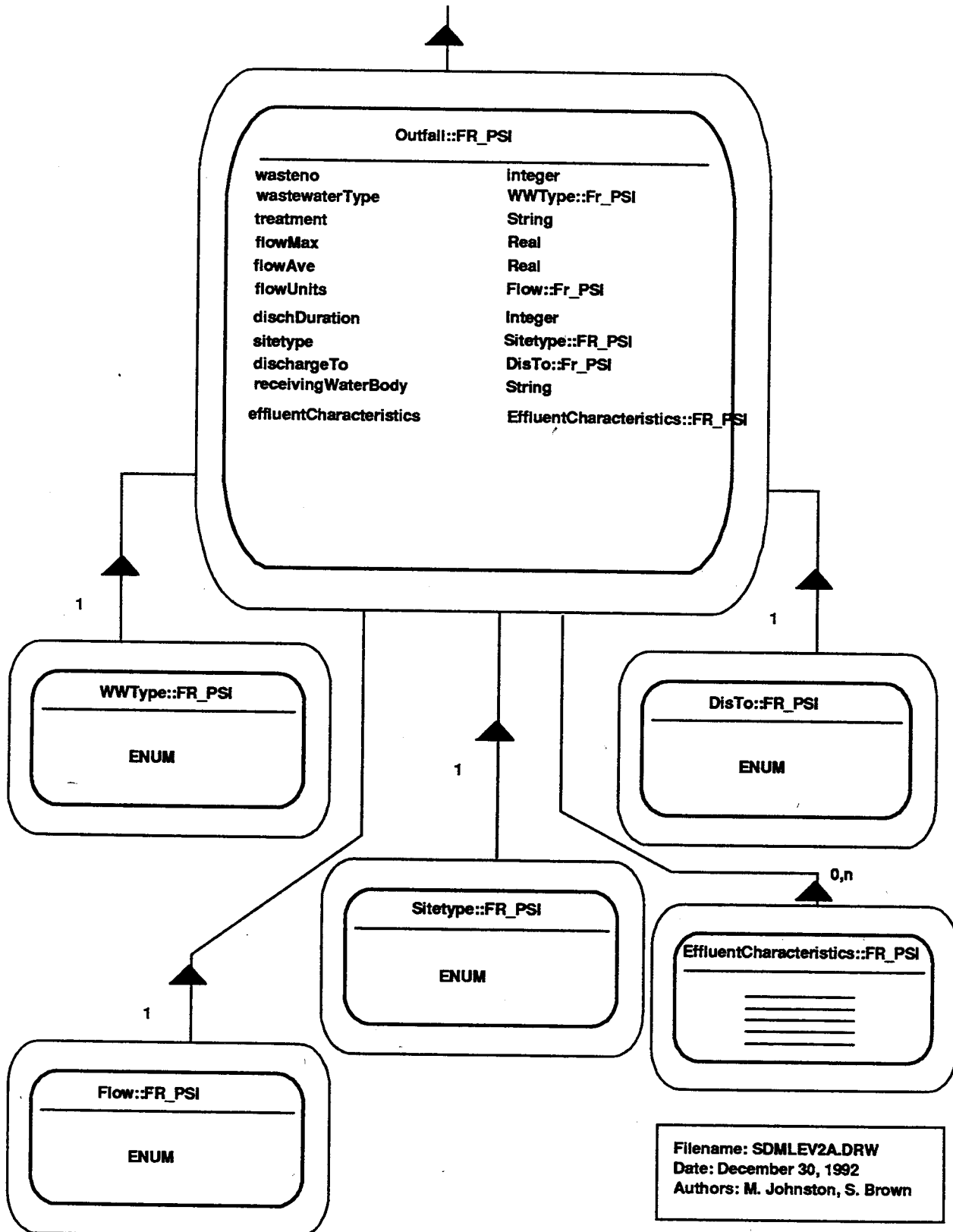
Filename: SDMLEV0.DRW  
Date: November 30, 1992  
Authors: M. Johnston, S. Brown

# FR\_PSI SAIF Data Model Level 1

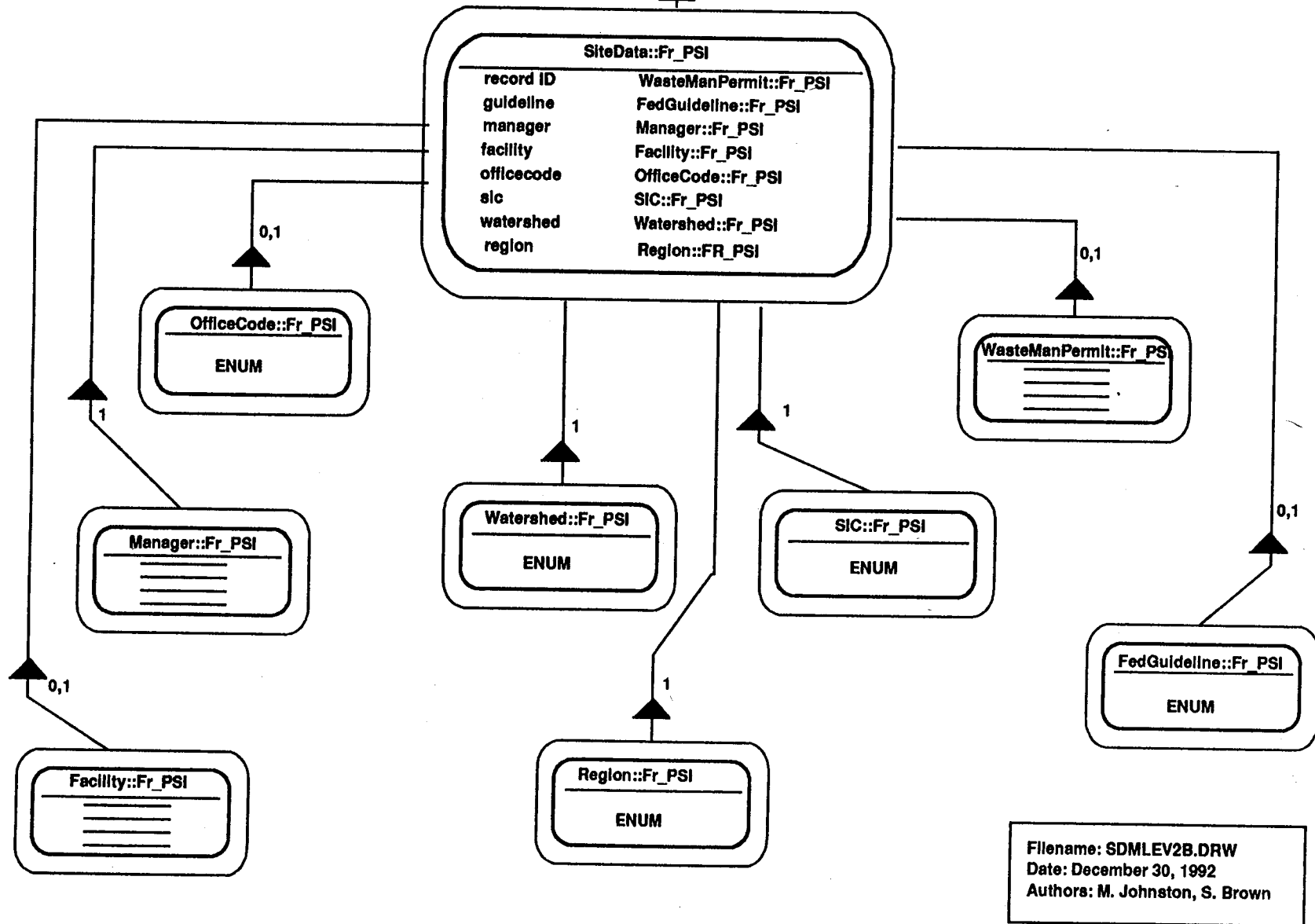


Filename: SDMLEV1.DRW  
Date: November 30, 1992  
Authors: M. Johnston, S. Brown

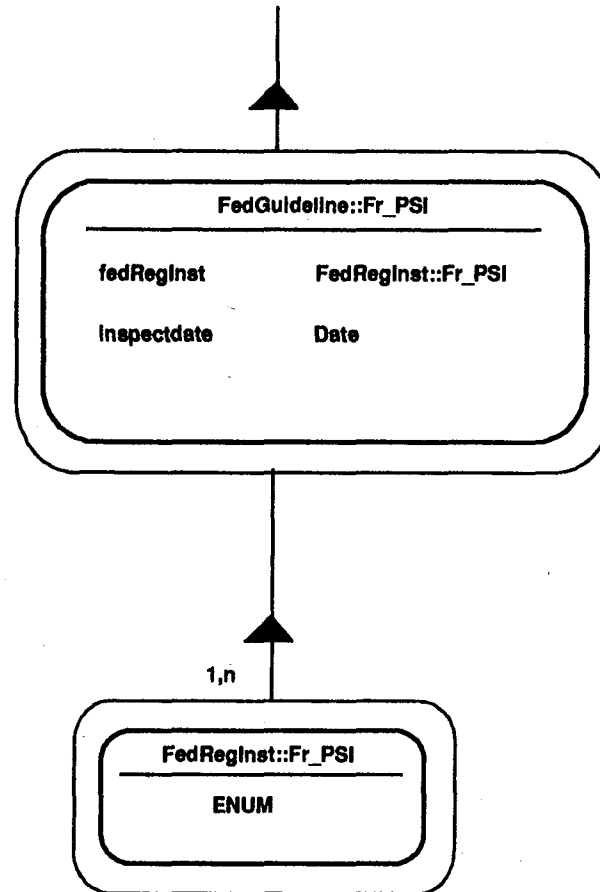
# FR\_PSI SAIF Data Model Level 2



## FR\_PSI SAIF Data Model Level 2



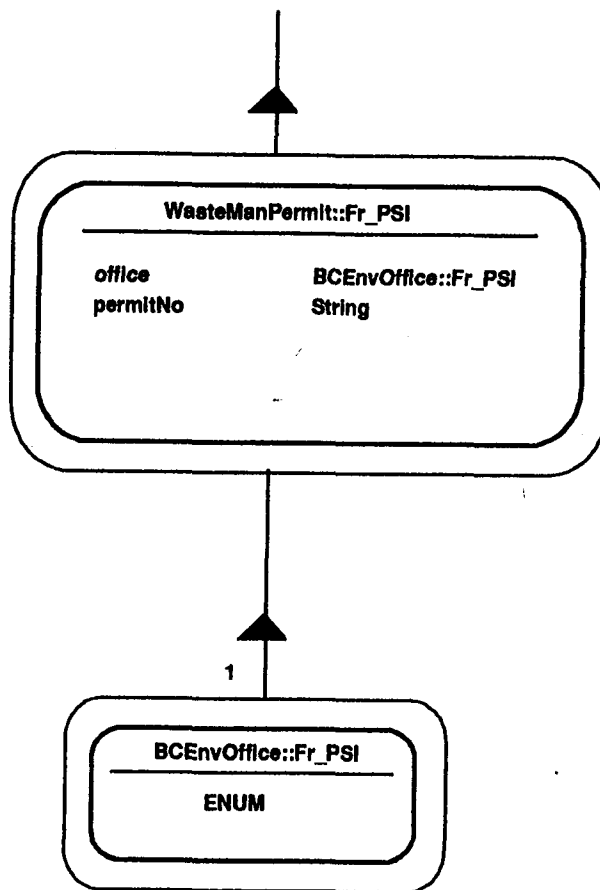
## FR\_PSI SAIF Data Model Level 3



Filename: SDMLEV3A.DRW  
Date: December 30, 1992  
Authors: M. Johnston, S. Brown

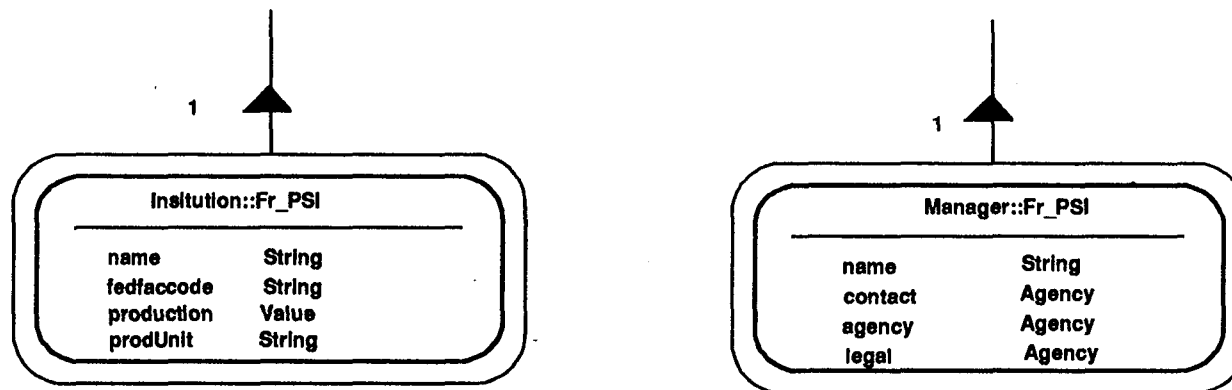


## FR\_PSI SAIF Data Model Level 3



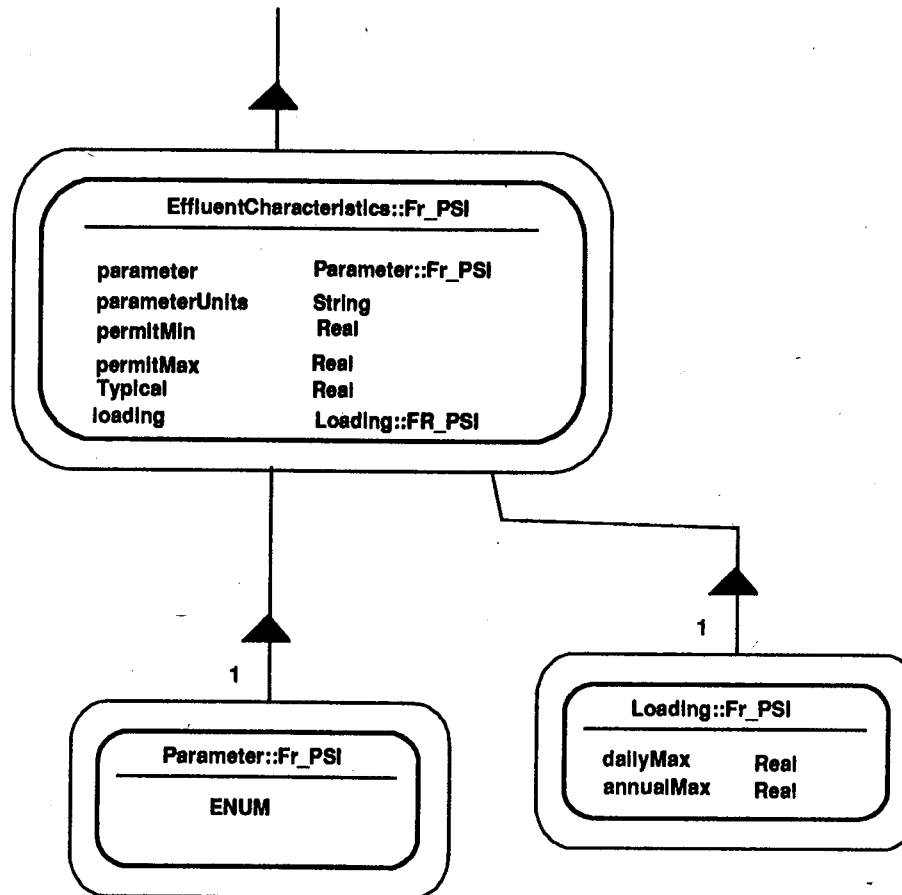
Filename: SDMLEV3B.DRW  
Date: December 30, 1992  
Authors: M. Johnston, S. Brown

## FR\_PSI SAIF Data Model Level 3



Filename: SDMLEV3C.DRW  
Date: November 30, 1992  
Authors: M. Johnston, S. Brown

## FR\_PSI SAIF Data Model Level 3



Filename: SDMLEV3D.DRW  
Date: December 30, 1992  
Authors: M. Johnston, S. Brown