# PRELIMINARY ASSESSMENT OF ENVIRONMENTAL IMPACTS RELATED TO SPRAYING OF AGENT ORANGE HERBICIDE DURING THE VIET NAM WAR

*VOLUME 2: APPENDICES*

**Hatfield Consultants Ltd.**
201-1571 Bellevue Avenue
West Vancouver, BC
Canada V7V 1A6
Tel: (604) 926.3261
Fax: (604) 926.5389
Email: hcl@hatfieldgroup.com
Website: www.hatfieldgroup.com

**National Committee For Investigation of the Consequences of the Chemicals Used During the Viet Nam War (10-80 Committee)**
Tôn Thất Tùng Street
Dong Da
Ha Noi
Viet Nam
Tel: 84.48.522.479
Fax: 84.48.523.514

HATFIELD
CONSULTANTS LTD.

10-80 Committee

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**Front Cover Photos**
- Top: C-123 applying herbicide over upland forest in Viet Nam. Photo courtesy of Dr. E.W. Pfeiffer, Missoula, Montana.
- Lower Left: Forested area near Aluoi Valley, untouched by herbicide (Hatfield Consultants Ltd. photo, January 1995).
- Lower Right: Once-forested area near Aluoi Valley that received herbicide during the Viet Nam War (Hatfield Consultants Ltd. photo, January 1995).

**Back Cover**
- Radarsat image of Aluoi Valley with herbicide spray lines superimposed (*cf.* Plate 5.1).

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### VOLUME 2

# Appendix A1

# Description of the Aluoi Valley Ecosystem

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# APPENDIX A1 DESCRIPTION OF THE ALUOI VALLEY ECOSYSTEM

## INTRODUCTION

The following Appendix includes a summary of data collected in Aluoi District between 1994 and 1996. The purpose of this Appendix is to provide background data on environmental setting in the study area and a context for the environmental sampling program. Data were collected through interviews and discussions with local Vietnamese agencies, and includes information from a variety of published and unpublished sources. Most of the data were obtained by our Vietnamese collaborating scientists, and were translated into English by our team.

## PHYSICAL DESCRIPTION OF ALUOI VALLEY

### Geography and Geomorphology

The Aluoi Valley is situated in Aluoi District approximately 65 km southwest of the city of Hue along the western side of Thua Thien Hue province in central Viet Nam (Figure A1.1). This narrow valley borders Laos to the west and was a major supply route along the Ho Chi Minh Trail from northern to southern Viet Nam during the war. The valley was of great strategic importance to the northern Vietnamese army moving into southern Viet Nam; considerable American efforts were spent to limit the flow of personnel and materiel through this region. To limit the ability of northern troops to move under cover, the Aluoi Valley was heavily bombed and sprayed with herbicides, between 1965 and 1970.

The Aluoi District covers 116,642 ha. Its main feature is the Aluoi Valley, which is approximately 30 km long, 3 km wide and surrounded by mountains ranging in height from 700 m to more than 1,000 m. The district's topography is mountainous; the Aluoi Valley is visible at ~600 m elevation (Figure A1.2). It is orientated from northwest to southeast in the district's western region. Figure A1.3 shows the district's main road (Highway [or Route] 14A) and rivers.

Table A1.1 summarizes slope and altitude data for Aluoi District. The average elevation is 500 to 600 m and most of the land has greater than 15° slope (source: Forest Inventory & Planning Institute [FIPI], Hue).

Figure A1.1 Aluoi District showing commune boundaries.

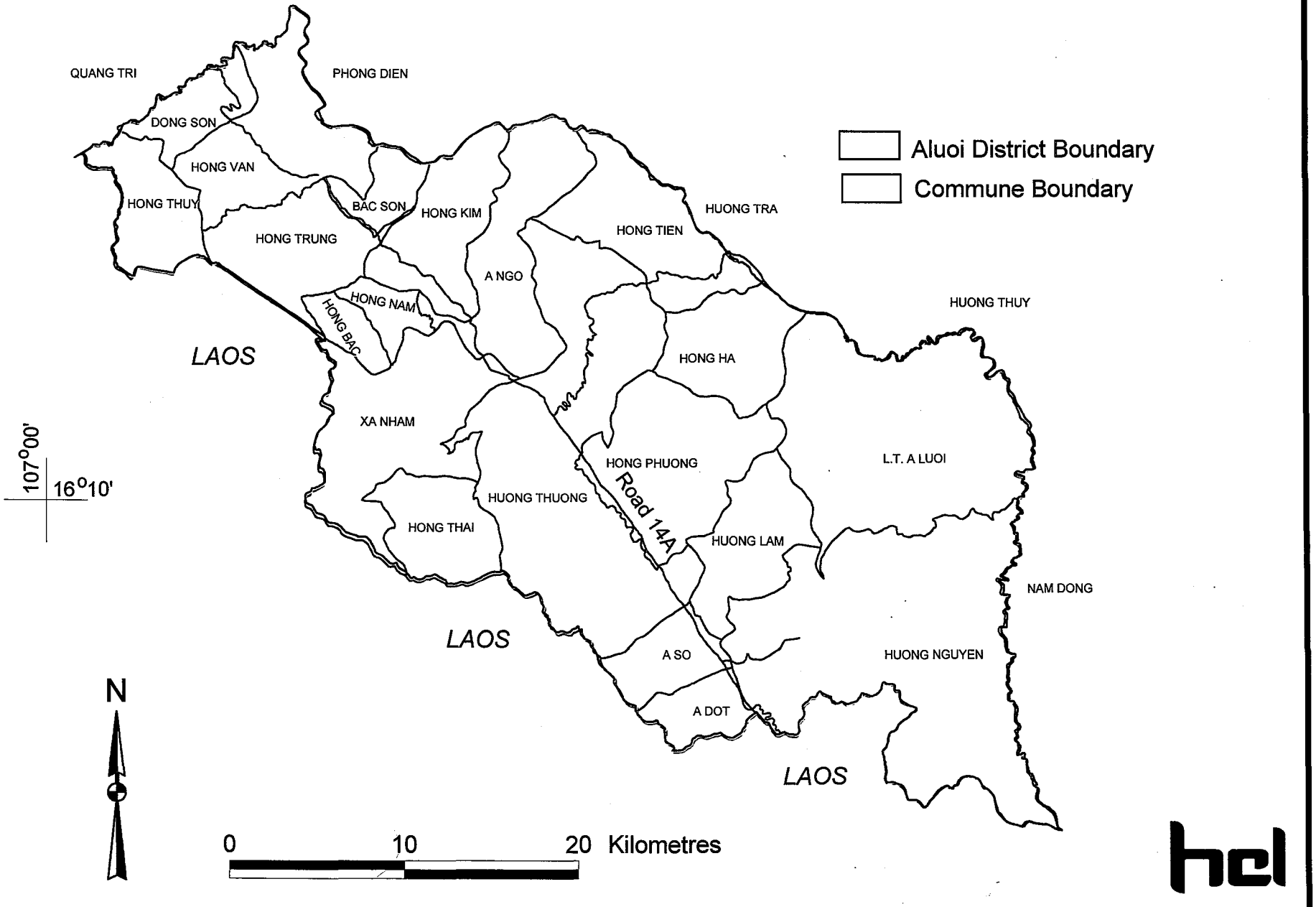


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Figure A1.2 Topographic (elevation) map of Aluoi District (data from FIPI 1995).

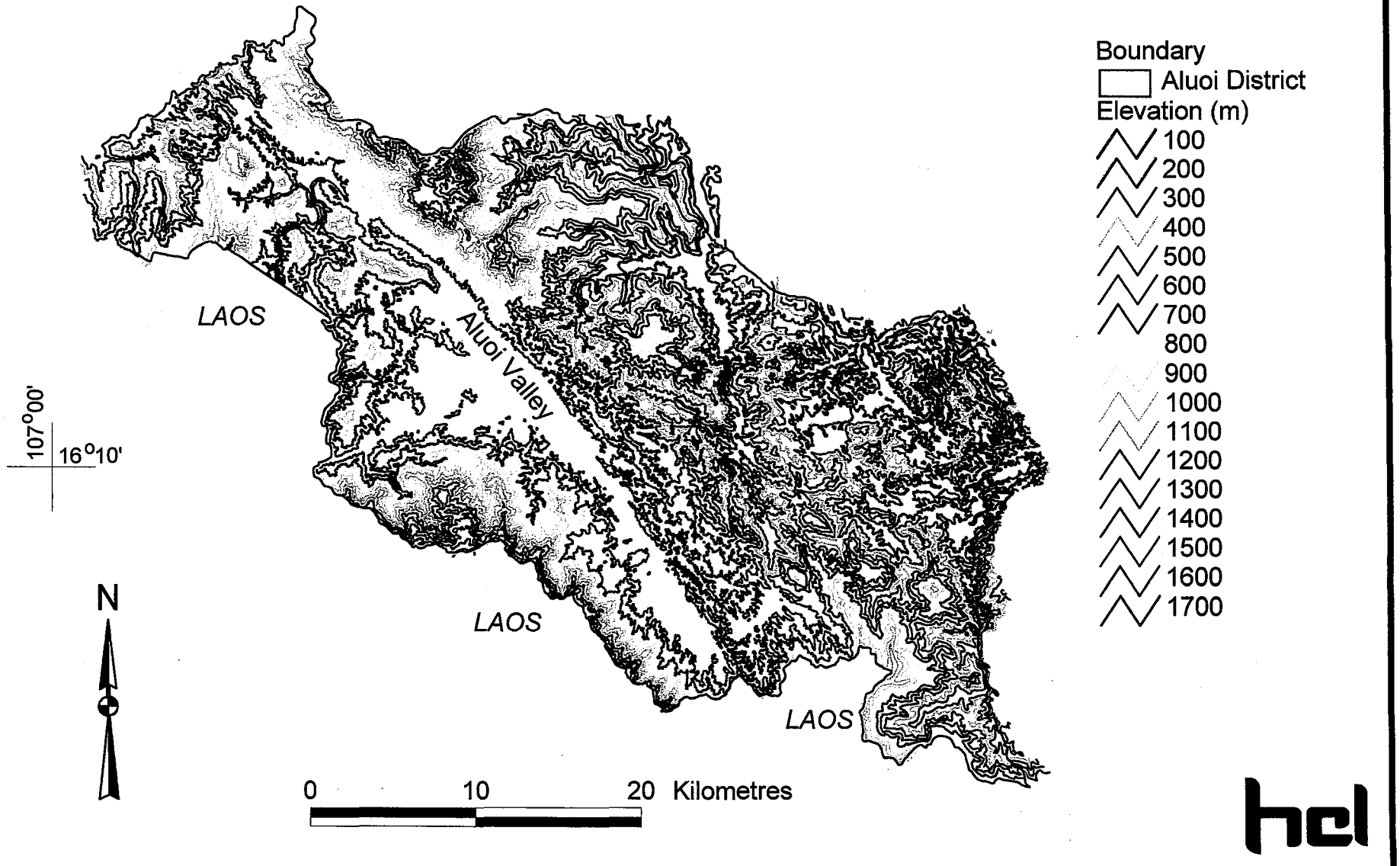


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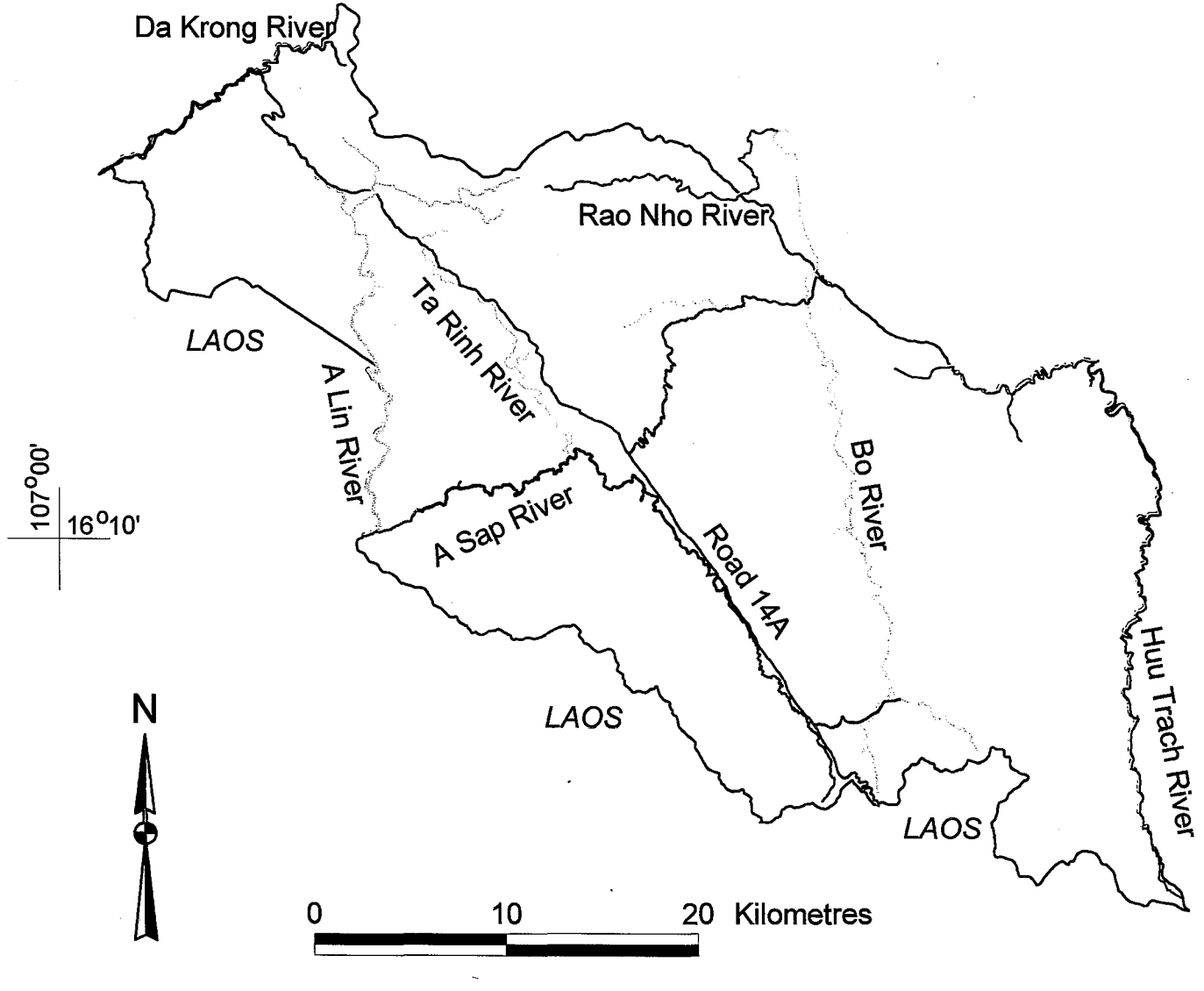
Figure A1.3 Main roads and rivers of Aluoi District (data from FIPI 1995).

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## Table A1.1 Land area according to slope and altitude classes of Aluoi District mapped at 1:50,000 (data from FIPI 1995).

| Altitude (m) | Area (ha) and % of total area according to slope class inclination (°) | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| | 0°-7° | 8°-15° | 16°-25° | 26°-35° | >35° | Total |
| 701 to 1,800 | - | 644 (0.55%) | 5,640 (4.83%) | 6,800 (5.83%) | 23,278 (19.96%) | 36,363 (31.17%) |
| 300 to 700 | 7,846 (6.73%) | 5,400 (4.63%) | 23,292 (19.97%) | 15,4449 (13.24%) | 8,501 (7.29%) | 60,488 (51.86%) |
| <300 | 1,598 (1.37%) | 4,020 (3.45%) | 4,230 (3.63%) | 4,200 (3.601%) | 5,744 (4.92%) | 19,792 (16.97%) |
| Total | 9,444 (8.10%) | 10,064 (8.63%) | 33,162 (28.43%) | 26,449 (22.67%) | 37,523 (32.17%) | 116,642 (100%) |

Mountains (elevation 701 to 1,800 m) covering 36,363 ha (31.17% of the total area) of which:

Class 1 slope: no area;

Class 2 slope: 644 ha (0.55%) Located in the North West;

Class 3 slope: 5,640 ha (4.83%) Dong Ngai mountain, North West;

Class 4 slope: 6,800 ha (5.83%) North West area; and

Class 5 slope: 23,278 ha (19.96%) North West area;

Low mountains (elevation 300 to 700 m) Covering 60,488 ha (51.86% of the area) of which:

Class 1 slope: 7,846 ha (6.73%) Dispersed throughout;

Class 2 slope: 5,400 ha (4.63%) Areas beside Aluoi Valley;

Class 3 slope: 23,292 ha (19.97%) dispersed throughout;

Class 4 slope: 15,449 ha (13.24%) North and Central mountains; and

Class 5 slope: 8,501 ha (7.29%) South and South East mountains;

Hills (elevation < 300 m) covering 19,792 ha (16.97% of the area) of which:

Class 1 slope: 1,598 ha (1.37%) Along streams to the East;

Class 2 slope: 4,020 ha (3.45%) East along the Huu Trach River;

Class 3 slope: 4,230 ha (3.63%) East and Huu Trach, Rao Nai Rivers;

Class 4 slope: 4,200 ha (3.60%) North East and East, along the Rao Nai, and Huu Trach Rivers; and

Class 5 slope: 5,744 ha (4.92%) In the watershed of the Rao Nai River.

### Geology/Soils

Table A1.2 contains a summary of the major soil units and sub-units (classification by FIPI 1995) found in Aluoi District; Figure A1.4 provides an illustration of the distribution of these units. Soil types of the valley are dominated by Feralit soils on old silts ($N_3Fp$) and clay rock ($N_3Fj$).

Figure A1.4 Soil map of Aluoi District (data from FIPI 1995).

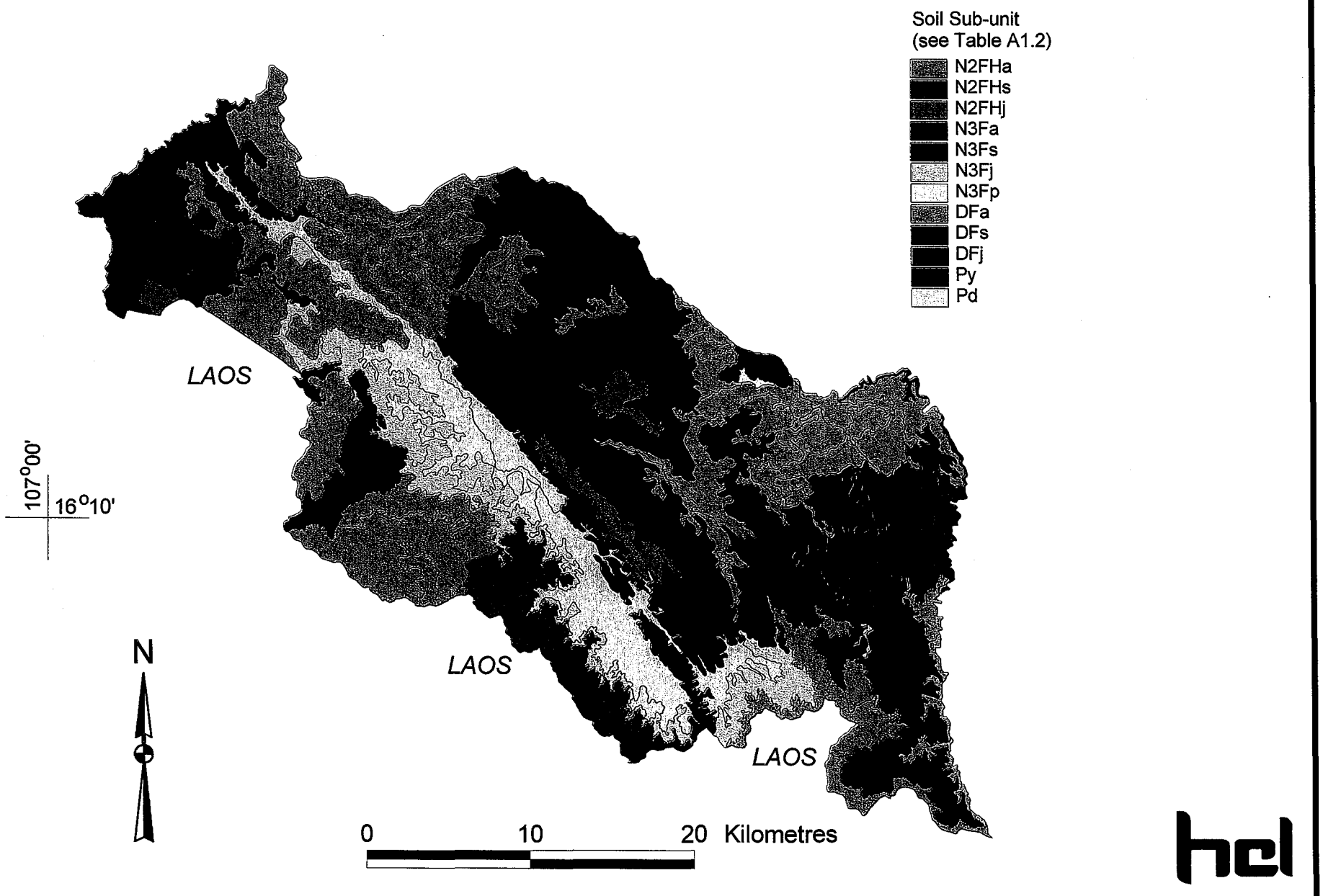


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**Table A1.2 The four major soil units, and 12 sub-units, from 1:50,000 soil mapping in Aluoi District (data from FIPI 1995).**

| Characteristics of major soil units | | | Characteristics of soil sub-units | |
|---|---|---|---|---|
| **Description** | **Soil/area (ha)/ % of total area** | **Distribution (topography / elevation (m) / location)** | **Soil sub-unit symbol/ area (ha) / % of total area** | **Soil Characteristics (colour / depth (cm) / texture / location)** |
| Humus feralit soil on mountains | $N_2FH$<br>36,362 ha<br>31.17% | Steep slopes<br>701 to 1,800 m<br>concentrated to the N and NW regions | $N_2FHa$<br>27,393 ha<br>23.48% | Humus soil on magma (acid) rock<br>colour : gray-yellow<br>depth: 50 to 100 cm<br>texture: loam sand-sand loam<br>location: N & NW |
| | | | $N_2FHs$<br>1,819 ha<br>1.56% | Humus soil on clay rock<br>colour: red-yellow colour<br>depth: 70 to 100 cm<br>texture: heavy loam-clay<br>location: E & SE |
| | | | $N_2FHj$<br>7,150 ha<br>6.13% | Humus soil on deformed rock (almost gnai, ortognai)<br>colour: red-yellow<br>depth: 70 to 100 cm<br>texture: sand loam and heavy loam<br>location: central and SW |

**Table A1.2 Cont'd**

| Characteristics of major soil units | | | Characteristics of soil sub-units | |
|---|---|---|---|---|
| **Description** | **Soil/area (ha)/ % of total area** | **Distribution (topography / elevation (m) / location)** | **Soil sub-unit symbol/ Area (ha) / % of total area** | **Soil Characteristics (colour / depth (cm) / texture / location)** |
| Feralit Soil on low mountains | $N_3F$<br>60,488 ha<br>51.86% | steep slopes<br>300 to 700 m<br>concentrated in the centre and perimeter of Aluoi Valley | $N_3Fa$<br>25,531 ha<br>21.89% | Feralit soil on magma (acid) rock (granite)<br>colour: gray yellow<br>depth: 50 to 100 cm<br>texture: loam sand-sand loam<br>location: NE region. |
| | | | $N_3Fs$<br>16,796 ha<br>14.40% | Feralit soil on clay rock<br>colour: red-yellow<br>depth: >100 cm<br>texture: heavy loam and loam and clay<br>location: central region |
| | | | $N_3Fj$<br>7,532 ha<br>6.46% | Feralit soil on clay rock<br>colour: red-yellow<br>depth: >100 cm<br>texture: heavy loam and loam and clay<br>location: SW region |
| | | | $N_3Fp$<br>10,629 ha<br>9.11% | Feralit soil on old alluvials<br>colour: brown-gray<br>depth: 50 to >100cm<br>texture: Sand loam and loam-sand<br>location: throughout the valley |

**Table A1.2 Cont'd**

| Characteristics of major soil units | | | Characteristics of soil sub-units | |
|---|---|---|---|---|
| **Description** | **Soil/area (ha)/ % of total area** | **Distribution (topography / elevation (m) / location)** | **Soil sub-unit symbol/ Area (ha) / % of total area** | **Soil Characteristics (colour / depth (cm) / texture / location)** |
| Feralit soil on hills | DF<br>18,194 ha<br>15.60% | Steep slopes<br><300 m<br>throughout the valley and along rivers to the East | Dfa<br>12,060 ha<br>10.34% | Feralit soil on acidic rock<br>colour: yellow-red<br>depth: 50 to 100 cm<br>texture: Sand-loam to loam sand<br>location: NE region |
| | | | DFs<br>1,801ha<br>1.54% | Feralit soil on clay rock<br>colour: red-yellow<br>depth: >100 cm<br>texture: Loam-clay to clay<br>location: NE along the Rao Nai River |
| | | | DFj<br>4,333 ha<br>3.72% | Feralit soil on deformed rock<br>colour: red-yellow to yellow-red<br>depth: >100 cm<br>texture: loam-clay to clay-loam<br>location: E along Huu Trach River |
| River silts | Py/Pd<br>1,598 ha<br>1.37% | Valley bottoms<br><300 m<br>along Huu Trach, Rao Nai and Asap Rivers | Py<br>1,508 ha<br>1.29% | stream alluvial soil<br>colour: gray-brown<br>depth: >100 cm<br>texture: loam and loam sand<br>location: along rivers |
| | | | Pd<br>90 ha<br>0.6 % | valley bottom deposit soil<br>colour: brown/-yellow / gray-brown<br>depth: >100 cm<br>texture: Loam-clay<br>location: N |

## Climate

Table A1.3 presents a summary of average temperature and rainfall data collected between 1991 to 1994 in Aluoi District. Local temperatures are moderate and annual rainfall can exceed 3,000 mm.

**Table A1.3 Monthly mean temperature (°C) and total rainfall (mm) data for Aloui District from 1991 to 1994 (data from General Department of Hydro–Meterology [GDHM]).**

| Month | 1991 | | 1992 | | 1993 | | 1994 | |
|---|---|---|---|---|---|---|---|---|
| | Temp. (°C) | Rain (mm) | Temp (°C) | Rain (mm) | Temp. (°C) | Rain (mm) | Temp. (°C) | Rain (mm) |
| January | 19.0 | 36.7 | 19.2 | 23.0 | 22.7 | 81.3 | 16.1 | 160.5 |
| February | 19.2 | 38.0 | 18.8 | 13.9 | 19.2 | 56.4 | 16.6 | 200.5 |
| March | 20.5 | ND | 20.1 | 177.7 | 19.7 | 39.9 | 18.3 | 84.8 |
| April | 22.0 | ND | 21.6 | 96.4 | 21.3 | 21.3 | 23.0 | 83.8 |
| May | 25.6 | ND | 25.2 | 201.7 | 24.9 | 240.8 | 24.0 | 273.2 |
| June | 24.8 | 112.1 | 25.0 | ND | 24.9 | 164.1 | 24.7 | 240.8 |
| July | 25.0 | 112.4 | 25.8 | ND | 24.6 | 193.1 | ND | ND |
| August | 24.4 | 167.9 | 24.9 | 90.0 | 24.6 | 129.9 | ND | ND |
| September | 23.6 | 105.3 | 23.3 | 386.7 | 23.2 | 112.4 | ND | ND |
| October | 21.1 | 817.1 | 20.1 | 1,483.1 | 26.6 | 998.9 | ND | ND |
| November | 19.2 | 356.5 | 17.8 | 464.6 | 17.9 | 240.4 | ND | ND |
| December | 18.0 | 506.3 | 18.6 | 284.1 | 16.6 | 350.2 | ND | ND |
| **Total Rainfall** | | 2,222.3 | | 3,218.2 | | 2,808.7 | | |

ND = no rainfall data recorded.

Meteorological climate data for the Aluoi District are listed in Table A1.4 for the early 1990s. Wet season rains peak in October and November; dry season minimums occur January through March.

## Table A1.4 Meteorological data for Aluoi District, Thua Thien Hue Province for the early 1990's (data from GDHM).

| Parameter | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average air temperature (°C) | 16.8 | 18.2 | 20.7 | 22.7 | 24.1 | 24.8 | 24.8 | 24.6 | 23.0 | 21.5 | 19.4 | 17.3 |
| Maximum air temp. (°C) | 30.2 | 33.9 | 36.2 | 38.1 | 35.2 | 34.6 | 34.6 | 33.3 | 33.5 | 31.6 | 30.1 | 30.7 |
| Minimum air temp. (°C) | 6.6 | 8.2 | 8.1 | 12.5 | 14.2 | 18.3 | 17.2 | 17.4 | 15.4 | 12.9 | 9.2 | 4.0 |
| Average ground temp. (°C) | 19.2 | 21.0 | 21.7 | 26.4 | 27.5 | 27.7 | 28.4 | 27.5 | 25.9 | 23.5 | 20.9 | 18.9 |
| Rain (mm) | 64.5 | 16.4 | 58.3 | 161.3 | 194.7 | 251.4 | 148.1 | 150.0 | 433.6 | 732.0 | 639.1 | 168.8 |
| Number of rain days | 15.5 | 12.8 | 11.8 | 17.5 | 18.5 | 16.9 | 14.8 | 15.4 | 21.6 | 23.6 | 23.6 | 20.4 |
| Total evaporation (mm) | 41.4 | 42.6 | 70.1 | 74.0 | 99.1 | 135.8 | 155.0 | 148.5 | 60.2 | 42.4 | 32.1 | 32.5 |
| Humidity max. (%) | 90.0 | 90.0 | 87.0 | 84.0 | 85.0 | 81.0 | 78.0 | 80.0 | 89.0 | 91.0 | 92.0 | 91.0 |
| Humidity min. (%) | 70.0 | 68.0 | 61.0 | 58.0 | 60.0 | 59.0 | 54.0 | 59.0 | 66.0 | 71.0 | 78.0 | 74.0 |
| Average speed wind (m/s) | 2.0 | 1.9 | 2.2 | 1.9 | 2.1 | 3.0 | 3.4 | 3.6 | 1.6 | 1.6 | 2.0 | 1.7 |

## ECOSYSTEM OF ALUOI DISTRICT

### Vegetation and Forests

The total area of forested lands in Aluoi District is approximately 60,095 ha; "bare" land covers 40,950 ha and "non-forest" land 15,598 ha (Table A1.5). The current known forest, bare land and other land cover types in Aluoi District are shown in Figure A1.5. Aluoi Valley is dominated by bare land (cleared grassland and brushland) and agricultural land on the relatively level valley bottom.

Pre-war forest cover was approximately 80% with high species diversity, as the region straddles two climate types (FIPI 1995). The forest types are dominated by moist, evergreen, broadleaf species. FIPI (1991) reported that most forest cover in the valley was destroyed by herbicides, with slow restoration observed after 18 years; they speculated that over 100 years would be needed for full reforestation. A FIPI forest cover map of the Aluoi Valley created in the early 1990s shows most land in the area, particularly on steep slopes surrounding the valley, to be bare or poor forest. FIPI (1991) concluded that the quickest way to rehabilitate sprayed areas was through active reforestation.

There are no natural gas or electric stoves in Aluoi; most families use firewood for cooking and heating in winter. Deforestation is extensive throughout the valley. Villagers travel considerable distances to collect wood. Recently, the government privatized land ownership to allow people to control their forest harvesting practices. Now that people are in charge of forests, they are responsible for conserving and managing their plots. Nonetheless, there is concern that local forests will be seriously depleted if present harvesting levels continue.

Figure A1.5 Current (1991) land use map of Aluoi District (data from FIPI 1995).

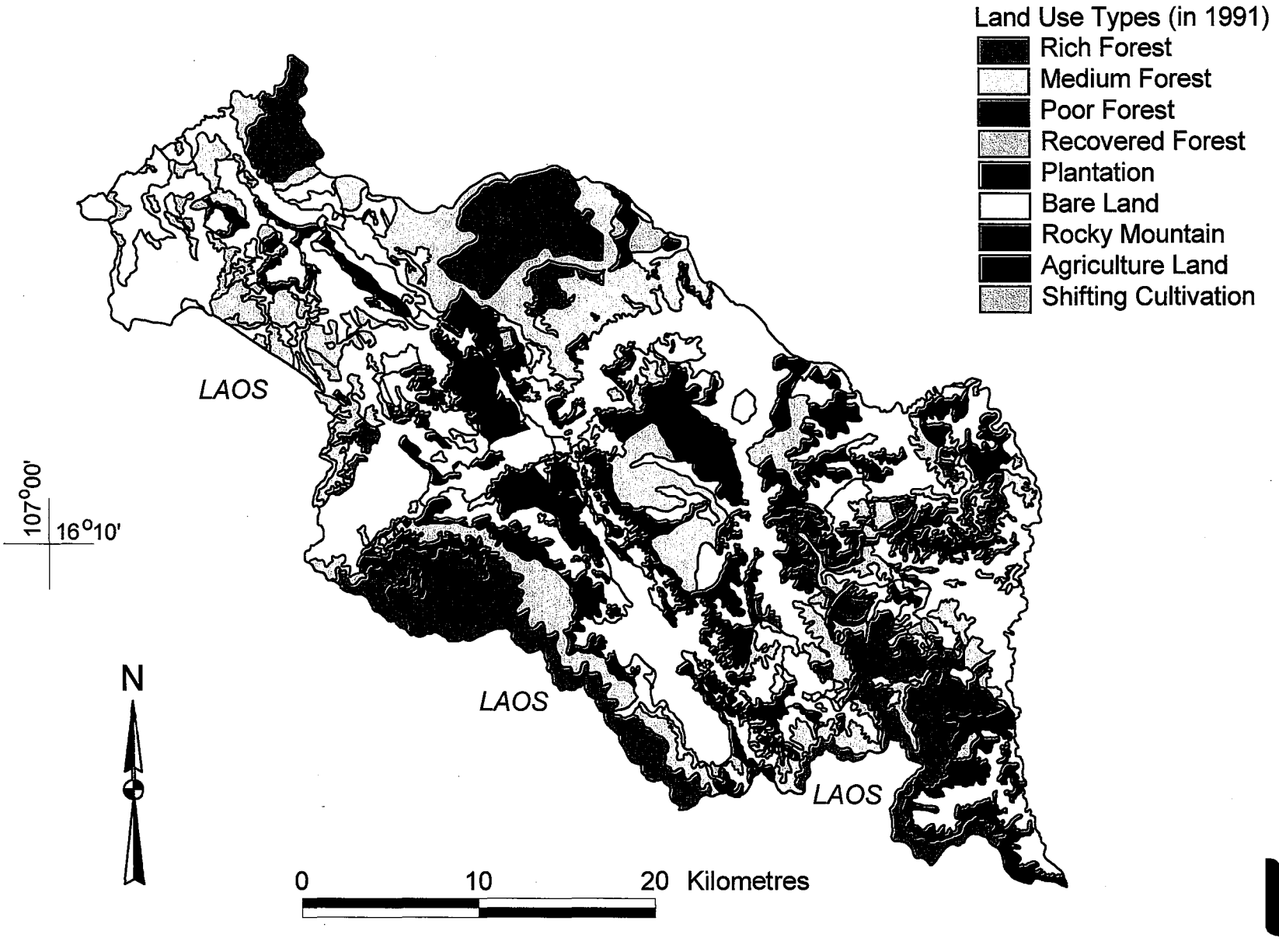


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**Table A1.5 Current (1990-1995) land cover data for Aluoi District (data from FIPI 1995).**

| Type of land cover | | Area (ha) | % of total |
|---|---|---|---|
| Total forest land | | 60,095 | 51.5 |
| | Natural forest | 59,502 | |
| | Rich forest | 19,541 | |
| | Medium forest | 20,557 | |
| | Poor forest | 17,707 | |
| | Recovered forest | 1,697 | |
| | Plantation* | 593 | |
| Total bare land | | 40,950 | 35.2 |
| | Grassland | 8,122 | |
| | Brushland | 5,773 | |
| | Mixed grass/brush land with some trees | 26,698 | |
| | Rocky mountain | 357 | |
| Total non-forest land | | 15,598 | 13.4 |
| | Agriculture land | 3,504 | |
| | Potential agriculture land | 10,661 | |
| | Shifting cultivation land | 462 | |
| | Other land (village, road) | 971 | |
| Total | | 116,642 | 100 |
| Total wood volume: | 8,699,400 $m^3$ | | |
| Rich Forest: | 4,357,000 $m^3$ | | |
| Medium Forest: | 2,615,700 $m^3$ | | |
| Poor Forest: | 1,726,700 $m^3$ | | |

* plantation trees are: *Pinus, Eucalyptus, Acacia and* Cinnamon.

Listed in Table A1.6 are the current planned land uses for Aluoi district; Table A1.7 describes the planned land use types used by FIPI. The map in Figure A1.6 shows the distribution of these land use types in Aluoi District. The need for improvement of water resources is addressed with the "protected area watershed" designation. The need to promote reforestation and forest management is evident by the fact that 58.8% of lands have been designated for some form of forest use (FIPI 1995).

**Table A1.6 Post-war (1975) planned land use for Aluoi District (data from FIPI 1995).**

| Type | | Area (ha) | % |
|---|---|---|---|
| 1. | Protected area of watershed | 41,489 | 35.5 |
| 2. | Natural regeneration forest | 20,797 | 17.9 |
| 3. | Tending forest | 19,504 | 16.7 |
| 4. | Exploitation forest | 4,181 | 3.6 |
| 5. | Plantation forest | 593 | 0.5 |
| 6. | Land for forest planting | 14,024 | 12.1 |
| 7. | Agriculture land and potential agriculture land | 14,265 | 12.2 |
| 8. | Shifting cultivation land | 462 | 0.4 |
| 9. | Rocky mountain | 357 | 0.3 |
| 10. | Other land (resident land, road ...) | 971 | 0.8 |
| | **Total** | 116,642 | 100 |

**Table A1.7 Background of planned land use types as listed in Table A1.6 (data from FIPI 1995).**

| |
|---|
| **1. Protected watershed area**<br>*Function*: regulating water resources, flood limitation and supplying water for streams in the dry season, counteracting soil erosion and limiting sedimentation in rivers, streams and lakes.<br>*Objectives*: improving forest quality, increasing forest cover and soil conservation.<br>*Targets*: including medium/poor forest in watersheds at high altitudes and on slopes with soils <50 cm deep. |
| **2. Natural regeneration forest**<br>*Function:* Silviculture using natural regeneration in forest succession for rehabilitation through. Prevention of forest fires and excessive logging.<br>*Targets: b*are land with scattered trees and shrub land with good natural regeneration potential. |
| **3. Tending forest**<br>*Function:* Silviculture of young forests by excluding competitors of commercial species and increasing forest production and quality.<br>*Targets:* plantation and regenerating forests on the former shifting cultivation land. |
| **4. Exploiting forest**<br>*Function:* Silviculture for improved forest harvest and local economic development.<br>*Targets:* natural forest, mature plantation and mature regenerating forest for exploitation. |
| **5. Plantation forest**<br>*Targets:* all plantations established prior to 1990. |
| **6. Land for forest planting**<br>*Function:* Silviculture applied to grasslands for establishing plantations and includes activities of seedling production, planting, tending and forest protection.<br>*Targets:* bare lands with poor natural regeneration capacity, e.g., lands near villages and along roads. |
| **7. Agricultural land and potential agricultural land**<br>*Targets:* all areas used for agriculture such as flat and alluvium areas along rivers, areas at low altitudes and near villages with good soils (may be covered with poor forest, brush land and grassland). |
| **8. Shifting cultivation land**<br>*Targets:* marginal agricultural land used in rotation according to soil fertility and ease of access. |
| **9. Rocky mountain**<br>*Targets:* steep slopes with >70 % rocky cover that may have some forest cover. |
| **10. Other lands (residential, etc.)**<br>*Targets:* Includes villages, towns and roads. |

Table A1.8 lists 271 tree species recorded from Aluoi District forests. The District's forests have relatively high species diversity, but are under threat from human activities.

Figure A1.6 Planned land use for Aluoi District (data from FIPI 1995).

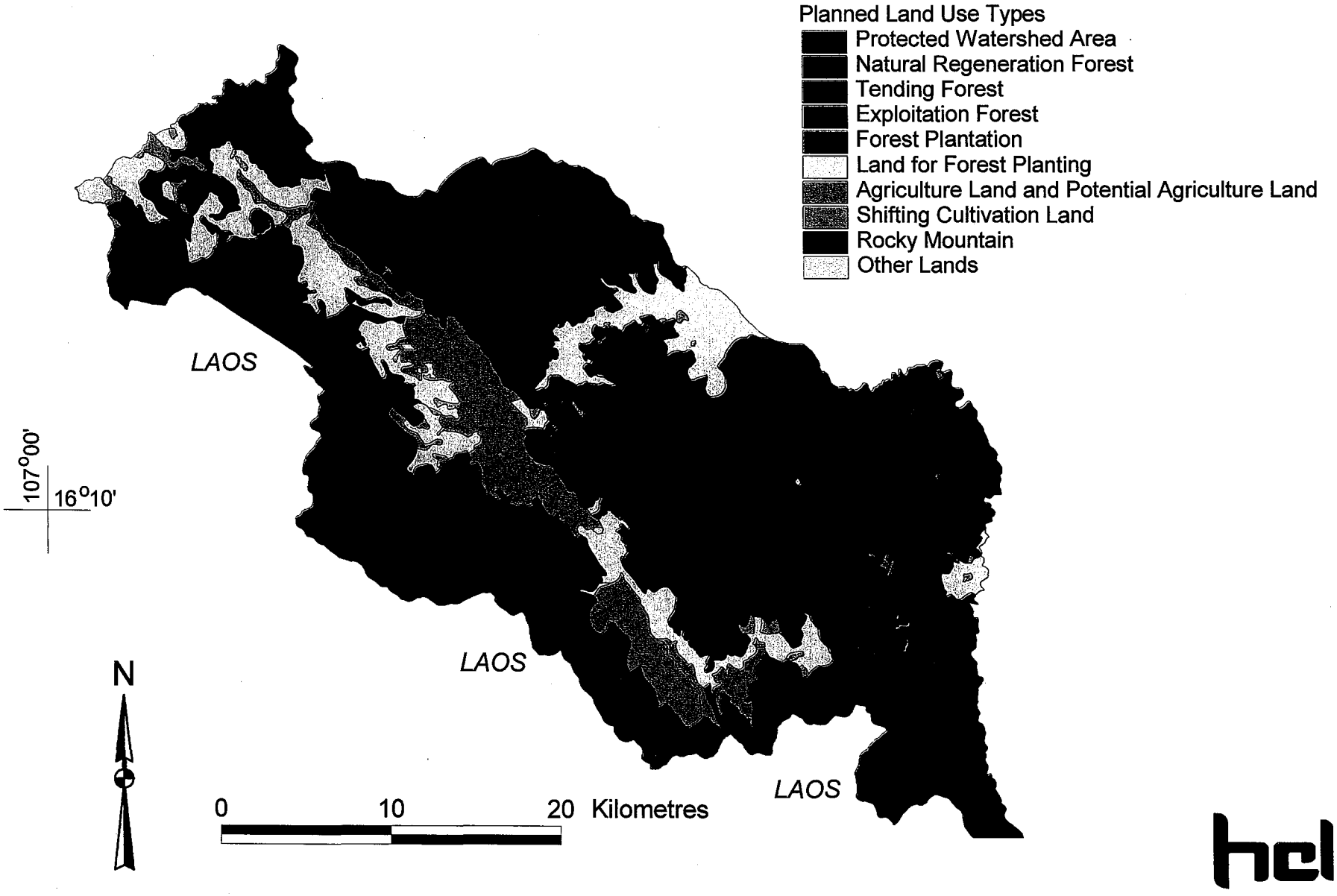


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**Table A1.8 List of forest trees in Aluoi District (data from FIPI 1995).**

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| *I. GYMNOSPERMATOPHYTA* | ***NGANH HAT TRAN*** | 13. *Dracontomelum duperreanum* | Sau |
| PINACEA | HO THONG | 14. *Mangifera spp.* | Xoai |
| 1. *Pinus caribaea* | Thong Caribe | 15. *Semecarpus caudata* | Sung duoi |
| 2. *P. kesya* | - | 16. *S. pamiciora* | Sung |
| PODOCARPACEAE | HO KIM GIAO | 17. *Rhus semialata* | Muoi |
| 3. *Dacrydium pierrei* | Hoang dan gia | 18. *R. succedanea* | Son |
| 4. *Podocarpus imbricatus* | Thong nang | APOCYNACEAE | HO NA |
| 5. *P. neriifolius* | Thong tre | 19. *Polyalthia jucunda* | Nhoc |
| 6. *P. fleuryi* | Kim giao | 20. *Polyalthia sp.* | Leo heo |
| *II. ANGIOSPERMATOPHYTA* | ***NGANH HAT KIN*** | 21. *Xylopia vielana* | Den |
| **DICOTYLEDONAE** | **LOP HAI LA MAM** | APOCYNACEAE | - |
| ACERACEAE | HO THICH | 22. *Alstonia scholaris* | Sua |
| 7. *Acer campbelii* | Thich xe thung | 23. *Wrightia annamensis* | Thung muc |
| 8. *A. decandrum* | Thich muoi nhi | 24. *W. rubiflora* | Muc |
| ALANGIACEAE | HO THOI BA | AQUIFOLIACEAE | HO NHUA RUOI |
| 9. *Alangiun kurzii* | Thoi ba | 25. *Ilex crenata* | Nhua |
| 10. *A. ritley* | Nang | 26. *I. godajam* | Bui |
| ANACARDIACEAE | HO XOAI | 27. *I. fabrilis* | Bui nhui |
| 11. *Allospondias lakonensis* | Dau da xoan | ARALIACEAE | HO NGU GIA BI |
| 12. *Bouea oppositifolin* | Thanh tra | 28. *Schefflera octophylla* | Chan chim |

## Table A1.8 Cont'd

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 29. *S. pes-avis* | Chan chim nui | CAPRIFOLIACEAE | HO COM CHAY |
| ASTERACEAE | HO CUC | 43. *Viburnum colebrookianum* | Rang cua |
| 30. *Vernonia arborea* | Bong hac | COMBRETACEAE | HO BANG |
| BETULACEAE | HO HOA | 44. *Terminablia catappa* | Bang |
| 31. *Betula alnoides* | Cang lo | CORNACEA | HO BUI LUA |
| BOMBACEAE | HO GAO | 45. *Aucuba* sp. | San ho |
| 32. *Ceiba pentandra* | Gia | 46. *Mastixia poilanei* | Bui lua |
| BORAGINACEAE | | DILLENIACEAE | HO SO |
| 33. *Cordia subcordata* | Co mun | 47. *Dillenia ovata* | So |
| BIGNONIACEAE | HO DINH | 48. *D. pentagyna* | Tai tuong |
| 34. *Oroxylum indicum* | Nuc nac | DIPTEROCARPACEAE | HO DAU |
| BURSERACEAE | HO TRAM | 49. *Dipterocarpus dyeri* | Dau song namg |
| 35. *Canarium tonkinensis* | Tram chim | 50. *D. hasseltii* | Dau dot do la thoi |
| 36. *Dacryodes dungii* | Coc da. tram hong | 51. *D. kerrii* | Dau ke |
| CAESALPINIACEAE | HO VANG | 52. *Hopea pierrei* | Ken ken |
| 37. *Cassia siamea* | Muong den | 53. *Pasashorea stellata* | Cho chai |
| 38. *Delonix regia* | Phuong vi | 54. *Vatica fhuryana* | Tan muoi |
| 39. *Erythorophleum foedii* | Lim xanh | EBENACEAE | HO TRI |
| 40. *Gymnocladus chinensis* | La tham | 55. *Diospyros buxifolia* | Vay oc |
| 41. *Peltophorum dasyrrachys* | Lim xet | 56. *D. dasyphylla* | Thi rung |
| 42. *Sindora siamensis* | Gu mat | 57. *D. eriantha* | Nho noi |

**Table A1.8 Cont'd**

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 58. *D. longipedicellata* | Hong rung | 77. *M. codimdrixensis* | Ba bet do |
| 59. *D. sylvatica* | Thi nui | 78. *M. yunnanense* | Ba bet Van nam |
| ERICACEAE | HO DO QUYEN | 79. *Ostodes paniculata* | Gai go |
| 60. *Phododendron simsii* | Do quyen hoa do | 80. *Sapium discolor* | Soi |
| EUPHORBIACEAE | HO BA MANH VO | ELAEOCARPACEAE | HO COM |
| 61. *Alenrites moluccana* | Lai | 81. *Elaeocarpus dubius* | Com tang |
| 62. *Vernicia montana* | Trau | 82. *E. bachmaensis* | Com bach ma |
| 63. *Antidesma chomon* | Choi moi | 83. *E. hainanensis* | Com nuoc |
| 64. *Aporosa microcalyx* | Trau tau | 84. *E. petiolatus* | Com cuong dai |
| 65. *Baccaurea sylvetris* | Du mooc | FABACEAE | HO DAU |
| 66. *Baccaurea sapida* | Dau da dat | 85. *Dalbergia balansae* | Co khiet |
| 67. *Bischofia javanica* | Nhoi | 86. *Derris microphylla* | Coc ken |
| 68. *Breynia grandiflora* | Bo cu ve vo boc | 87. *Milletia nigrescens* | Than mat nuoc |
| 69. *Bridelia monoica* | Tho mat | 88. *M. pachyloba* | Than mat |
| 70. *Endospermum chinense* | Vang | 89. *Ormosia balansae* | Rang rang mit |
| 71. *Erismanthus indochinensis* | Nen | 90. *Sesbania grandiflora* | So dua |
| 72. *Glochidion glaucifolium* | Bot ech | FABACEAE | HO DE |
| 73. *G. macrophyllum* | Bot ech than go | 91. *Castanopsis india* | Ca oi An do |
| 74. *Macaranga denticulata* | Ba soi la nen | 92. *C. nebulorum* | Ca oi hoa mu |
| 75. *M. furetianus* | Choc noc | 93. *C. ferox* | Ca oi gai nhieu |
| 76. *Mallotus bartatus* | Bum bup | 94. *C. fissa* | Soi phang |

## Table A1.8 Cont'd

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 95. *Lithocarpus corneus* | Soi ghe | 112. *Cratoxylon formosum* | Thanh nganh dep |
| 96. *L. ducampii* | Soi do, De do | 113. *C. polyalthum* | Thanh nganh |
| 97. *L. gigantophylla* | De la to, Soi la to | ICACINACRAE | HO THU DU |
| 98. *L. touranensis* | De quan bai, soi da nang | 114. *Gonocaryum poilanei* | Cuong vang |
| 99. *Quercus bambusaefolia* | De la tre | ILLICIACEAE | HO HOI |
| 100.Q. *rubertris* | De da | 115. *Illicium poilanei* | Hoi nui |
| FLACOURTIACEAE | HO MUNG QUAN | JUGLANDACEAE | HO HO DAO |
| 101. *Flacourtia jamgomas* | Mung quan rung | 116. *Engelhardtia colebrookiana* | Cheo trang |
| 102. *Hydnocarpucs annamensis* | Nang trung | 117. *E. spicata* | Cheo bong |
| GUTTIFERAE | HO BUA | 118. *E. wallichiana* | Cheo tia |
| 103. *Calophyllum soulattri* | Cong trang | LAURACEAE | HO RE |
| 104. *C. thorelii* | Cong | 119. *Actinodaphne cochinchinensis* | Bop |
| 105. *C.* sp. | Chuon | 120. *Beilschmiedia percoriacea* | Chap xanh |
| 106. *Garcinia oblongifolia* | Bua | 121. *Cinnamomum cassia* | Que |
| 107. *G. cowa* | Tai chua | 122. *Cinnamomum burmannii* | Re |
| 108. *G. gaudichaudii* | Vang nghe | 123. *C. inerr* | Re gung |
| HAMAMELIACEAE | HO SAU SAU | 124. *C. obtusifolium* | Re gung |
| 109. *Altingi siamensis* | To hap | 125. *Cryptocarya lenticellata* | Nanh chout |
| 110. *Thodoleia championii* | Hong quang, Po linh | 126. *C. maclurei* | Mo lung bac |
| 111. *Symgtonia populnea* | Chapo tay | 127. *Endinandra hainanensis* | Tho nam |
| HYPERICACEAE | HO BAN | 128. *Lindera myrrha* | Long trung |

**Table A1.8 Cont'd**

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 129. *Litsea baviensis* | Boi boi Ba vi | MELASTOMACEAE | HO MUA |
| 130. *L. cambodiana* | Boi boi Cam bot | 149. *Melastoma candidum* | Mua |
| 131. *L. cubeba* | Mang tang | 150. *M. eberhardtii* | Mua tep |
| 132. *L. monopelata* | Boi boi la tron | MELIACEAE | HO XOAN |
| 133. *L. robusta* | Boi boi la to | 151. *Aglaia gigantea* | Goi nep |
| 134. *L. verticillata* | Boi boi vong | 152. *Aphanamixis polystachya* | Goi te |
| 135. *L. glutinosa* | Boi boi nhot | 153. *Chisocheton paniculata* | Quyech |
| 136. *Machilus odoratissima* | Re huong | 154. *Dysoxylum acutangulum* | Chua khet |
| 137. *Neolitsen zeylanica* | Boi boi moi | 155. *Khaya senegalensis* | Xa cu |
| 138. *Persen americana* | Bo | 156. *Melia azedarach* | Xoan |
| 139. *Phoebe cuneata* | Su. khao | MIMOSACEAE | HO TRINGH NU |
| 140. *Pheobe* sp. | Khao nuoc | 157. *Acacia auriculliformis* | Tram bong vang |
| LECYTHIDACEAE | HO LOC VUNG | 158. *A. mangium* | Keo mo |
| 141. *Barringtonia acutangula* | Loc vung | 159. *A. pinnata* | Xuong ran |
| LINNACEAE | HO LANH | 160. *Adenanthera microsperma* | Muong rang rang |
| 143. *Ixonanthes cochinchinensis* | Ha nu | 161. *Albizia chinensis* | Song ran |
| MAGNOLIACEAE | HO MOC LAN | 162. *Pithecellobium clypearia* | Man dia |
| 144. *Manglietia conifera* | Mo | 163. *P.* sp. | Man dia |
| 145. *M. fardiana* | Vang tam | 164. *Paralbizia lucida* | Dut ngua |
| 146. *Michelia hypoloampra* | Gioi xanh | 165. *P. tyrgida* | Dai bo |
| 147. *M. foveolata* | Gioi nhung | MORACEAE | HO DAU TAM |
| 148. *Pachylaman praecalva* | Mo vang | 166. *Artocarpus intergrifolia* | Mit |

## Table A1.8 Cont'd

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 167. *A. hirta* | Mit nai | 185. *S. tinctorium* | Tran nhuom |
| 168. *A. styracifolia* | Chay la bo de | 186. *S. zeylanicum* | Tram do |
| 169. *Broussonetia payrifera* | Duong | 187. *S. polyalthum* | Tram san |
| 170. *Dimerocarpus brinieri* | May leo | 188. *Syzygium* sp. | Tram oi |
| 171. *Morus alba* | Dau | MYRSINACEAE | HO DON NEM |
| 172. *Ficus auriculata* | Va | 189. *Ardisia* sp. | Trong dua |
| 173. *F. hispida* | Ngai | 190. *Rapanea aff cochinchinensis* | Mat cat |
| 174. *Ficus fulva* | Ngoa | POLYGALACEAE | HO VIEN CHI |
| 175. *F. championii* | Da xanh | 191. *Xantophyllum annamense* | La vang |
| 176. *Ficus* sp. | Da | PROTEACEAE | HO MA SUA |
| MYRISTICACEAE | HO MAU CHO | 192. *Helicia nigilarica* | Ma sua |
| 177. *Horsfieldia amygdalina* | Xang mau | RHIZOPHORACEAE | HO DUOC |
| 178. *Knema laurina* | Mau cho | 193. *Carallia brachiata* | Truc tiet |
| 179. *K. wangii* | Mau cho la to | ROSACEAE | HO HOA HONG |
| MYRTACEAE | HO SIM | 194. *Eriobotrya deplesa deflexa* | Ti ba |
| 180. *Eucalyptus tereticornis* | Bach dan trang | 195. *Malus doumeri* | Tao meo |
| 181. *Psidium guyava* | Oi | 196. *Prunus arborea* | Xoan dao |
| 182. *Rhodomyrtus tomentosa* | Sim | 197. *Rhaphiolepis indica* | Dao banh xe |
| 183. *Syzygium cumini* | Tram voi | RUBIACEAE | HO CA PHE |
| 184. *S. operculatum* | Voi | 198. *Adina globiflora* | Gao nuoc |

## Table A1.8 Cont'd

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 199. *Anthocephalus chinensis* | Gao | 215. *M. sundaicus* | Truong ken |
| 200. *Canthium dicoccum* | Xuong ca | 216. *Nephelium lappaceum* | Chom chom |
| 201. *Coffea liberica* | Ca phe mit | 217. *N. chryseum* | Vai rung |
| 202. *Coffea arabica* | Ca phe che | 218. *Pometia pinnata* | Truong sang |
| 203. *Randia spinosa* | Gang | 219. *Sapindus mukorossi* | Bo hon |
| 204. *R. oxyodonta* | Mai tap | SAPOTACEAE | HO SEN |
| 205. *Randia sp.* | | 220. *Madhuca pasquieri* | Sen mat |
| 206. *Wendlandia paniculata* | Hoc quang | 221. *M. alpina* | Sen |
| RUTACEAE | HO CAM | 222. *Planchonella annmensis* | Nong gian |
| 207. *Acronychia pedunculata* | Buoi bung | SIMARUBACEAE | |
| 208. *Evodia calophyllum* | Thoi chanh | 223. *Ailanthus triphylsa* | Thanh that |
| 209. *E. lepta* | Ba gac | 224. *Eurycoma longifolia* | Bach benh |
| 210. *Zanthoxylumn avicennae* | Xen | SONNERATICACEAE | HO BAN |
| 211. *Z. rhetsoides* | Xen la to | 225. *Duabanga gradiflora* | Phay |
| SAMYDACEAE | | STERCULIACEAE | HO TROM |
| 212 Casearia sp. | Ma qua | 226. *Commersonia bartramia* | Hu day |
| SAURAURINACEAE | HO PHI LAO | 227. *Scaphium dychnophorum* | Uoi |
| 213. *Casuarina equisetifolia* | Phi lao | 228. *Sterculia lanceolata* | Sang |
| SAPINDACEAE | HO BO DAO | 229. *S. pierrei* | Bai thua |
| 214. *Mischocarpus aff. Oppositifolius* | Truong cuong | 230. *Pterospermum megalocarpum* | Long mang trai to |

**Table A1.8 Cont'd**

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 231. *P. grandiflorum* | Long mang trai to | 244. *Aquilaria crassna* | Tram huong |
| 232. *Tarrietia javanica* | Huynh | TILIACEAE | HO DAY |
| STRYACAEAE | HO BO DE | 245. *Grevvia bulot* | Bu lot |
| 233. Styrax benjoin | Bo de vo do | 246. *G. microcos* | Me co ke |
| 234. *Styrax* sp. | Bo de la to | ULMACEAE | HO DU |
| SYMPLOCACEAE | HO DUNG | 247. *Gironniera subaequalis* | Ngat |
| 235. *Symplocos adenophylla* | Dung che | 248. *Trema orientalis* | Mu day |
| 236. *S. graveolens* | Dung vo mem | VERBENACEAE | HO CO ROI NGUA |
| 237. *S. crassilimba* | Dung san | 249. *Vitex trifolia* | - |
| THEACEAE | HO CHE | 250. *V. quinata* | - |
| 238. *Adinandra caudata* | Che beo | **MONOCOTYLEDONAE** | LOP MOT LA MAM |
| 239. *Eurua tonkinensis* | Sum bac | BAMBUSACEAE | HO TRE NUA |
| 240. *E. japonica* | Sum nhat | 251. *Arundinaria* sp. | Sat tom |
| 241. *Schima crenata* | Voi thuoc | 252. *Bambusa arundinacea* | Tre gai |
| 242. *Temstroemica* sp. | Thach dam | 253. *B. blumeana* | Tre la nga |
| 243. *Thea sinensis* | Che | 254. *Dendrocalamus* sp. | Giang |
| THYMELEACEAE | HO TRAM | 255. *Dinochloa macleldlandu* | Lin |

## Table A1.8 Cont'd

| Scientific Name | Common Name | Scientific Name | Common Name |
|---|---|---|---|
| 256. *Lingnania* sp. | Mung | 264. *C. tonkinesis* | Mai |
| 257. *Neohouzeaua dullooa* | Nua | 265. *Carysta mytis* | Dung dinh |
| 258. *Neohouzenna* sp. | Nua long dai | 266. *Daemonorops pierrei* | Heo |
| PALMAE | HO CAU DUA | 267. *Korthalsia laciniosa* | May ra |
| 259. *Areca laoensis* | Cau rung | 268. *Plectocomia elongata* | Song voi |
| 260. *A. triandra* | Cau rung nhu | 269. *Licuala spinosa* | La non |
| 261. *Arenga pinnata* | Bung bang, doac | 270. *Livistona cochinchinensis* | Co |
| 262. *Calamus poilanei* | Song bot | 271. *L. chinensis* | Co xe ke |
| 263. *C. tetradactylus* | May tat | | |

## Aquatic Ecosystem and Fish

Table A1.9 describes a basic aquatic food chain for freshwater biota in Aluoi District. It is based on food and habitat data on dominant species. Dominants are classified into nutritional levels (producers and four levels of consumers).

### Table A1.9 General food chain of Aluoi freshwater ecosystem.

| |
|---|
| • **Producers** are the three main groups of phytoplankton such as *Chlorophyta*, *Cyanophyta* and *Chrysophyta* and benthic plants such as *Ceratophyllum*, *Myriophyllum* and *Vallisneria*. |
| • First level **consumers** are zooplankton groups such as *Protozoa, Rotatoria, Copepoda and Cladocera,* and insect larvae (*diptera*), plus there are benthic molluscs including: *Limmea, Melanoides, Corbicula, Angulyagra, Antimelanoides* and some herbivorous fish species such as *Osteochilus* and *Gastromyzon.* |
| • Second level **consumers** include insect larvae (*Ephemeroptera, Plecoptera, Trichoptera, Odonata)* and crustaceans such as *Macrobrachium* and *Somaniathelphusa,* and some fish predators of plankton. |
| • Third level **consumers** are fishes such as *Mastacembelus, Ophiocephalus, Mystus* and *Anguilla.* |
| • Fourth (top) level **consumers** are *Varanus salvator, Natrix piscator*, storks, kingfishers and humans. |

The District's wild fish species are well utilized by local people and many species are consumed for subsistence purposes (Tables A1.10, A1.11, A1.12 and A1.13).

**Table A1.10 Fish species collected from the A Sap River near Son Thuy Village, Aluoi District (A Sap River) (collected by Dr. Duc in 1982 & June, 1995 and by T. Boivin and Dr. Levy April, 1995).**

| Scientific name | Common name | Local name | A* | Eaten (Y/N) |
|---|---|---|---|---|
| **Cyprinidae** | | | | |
| *Hampala macrolepidota* (Van Hasselt 1842) | Ca ngua | Soc ngang | ++ | Y |
| *Osteochilus hasselti* (Cuvier et Valnciennes 1842) | Ca lui | Ca troi | ++ | N |
| *Puntius semifasciolatus* (Gunther 1868) | Dong dong | Ca can | + | Y |
| *Puntius* sp. | Ca sao | Ca sao | + | Y |
| *Carassius auratus* L. 1758 | Ca diec | Ca diec | ++ | Y |
| *Onychostoma gelarchi* (Peters 1880) | Ca sinh | Ca xanh | ++ | Y |
| *Barilius pulchellus* (Smith 1931) | -- | Mai rang | + | Y |
| *Lissochilus* sp. | – | – | + | Y |
| **Cobitidae** | | | | |
| *Misgurnus anguillicaudatus* (Canter 1842) | Chach bun | Ca nhec | ++ | Y |
| *M. misolepis* (Gunther 1888) | Chach bun nui | Ca nhec | + | Y |
| *Barbatula* sp. | Chach da | Bong da | + | Y |
| **Claridae** | | | | |
| *Clarias fuscus* (Lacepede 1803) | Tre den | Tre den | + | Y |
| **Bagridae** | | | | |
| *Mystus nemurus* (Cuvier et Valenciennes 1839) | Lang nha | Ca lang | + | Y |
| **Ophiocephalidae** | | | | |
| *Ophiocephalus gachua* | Chuoi suoi | Trau suoi | + | Y |
| *Ophiocephalus maruliodes* | Mat qua | Trau day | + | Y |
| **Cyprinodontidae** | | | | |
| *Oryzias latipes* | Ca soc | Mat nuoc | + | N |
| **Gobiidae** | | | | |
| *Glossogobius* sp. | Bong | Bong | + | Y |
| *Rhinogobius* sp. | Bong | Bong | + | Y |
| *Ctenogobius balurioides* (Bleexer 1849) | Bong | Bong | + | Y |
| **Mastacembellidae** | | | | |
| *Mastacembellus armatus favus* (Hora 1923) | Chach hoa | Lau bong | ++ | Y |
| *M.aculeatus* (Basilewski 1855) | Chach gai | Lau gai | + | Y |
| *Ctenogobius ocellatus* (Fowler 1937) | Bong | Bong | + | Y |

*A = abundance: + = present / ++ = common.

## Table A1.11 Fish species recorded in Hong Van Village, Aluoi District (collected by Dr. Duc, June 1995).

| Scientific name | Common name | Local name | A* | Eaten (Y/N) |
|---|---|---|---|---|
| **Cyprinidae (Carp)** | | | | |
| *Onychostoma gelarchi* (Peters 1880) | Sinh | Ca xanh | ++ | Y |
| *Onychostoma microcorpus* (Hao et Hoa 1969) | Ca mom | Ca xanh | ++ | N |
| *Barilius pulchellus* Smith 1931 | | Mai rang | + | Y |
| *Hampala macrolepidota* (Van Hasselt 1842) | Ca ngua | Soc ngang | ++ | Y |
| **Cobitidae (Loaches)** | | | | Y |
| *Schistura* sp. | Chach da | Bong suoi | + | Y |
| *Misgurnus anguillicaudatus* (Cantor 1842) | Chach bun | Ca nhec | +++ | Y |
| **Homalopteridae** | | | | |
| *Homaloptera zollingeri* (Bleeker 1853) | Bam nam | Bam da | ++ | Y |
| *Sewellia* sp. | Bam da | Dep | + | Y |
| **Sisoridae** | | | | |
| *Glyptosternon* spp. | Chien suoi | Chien nguon | + | Y |
| **Ophiocephalidae (Snakeheads)** | | | | |
| *Ophiocephalus gachua* (Hamilton-Buchanan 1822) | Chuoi suoi | Trau suoi | + | Y |
| **Mastacembelidae (Spiny eels)** | | | | |
| *Mastacembelus armatus favus* (Hora 1923) | Chach hoa | Lau bong | ++ | Y |

*A = abundance: + = present / ++ = common/ +++ = abundant.

**Table A1.12 Fish species collected fron the Bo River, Hong Ha Village, Aluoi District (collected by Dr. Duc, June 1995).**

| Scientific name | Common name | Local name | A* | Eaten (Y/N) |
|---|---|---|---|---|
| **Cyprinidae (Carp)** | | | | |
| *Garra orientalis* (Nichols 1925) | Ca sut mui | Cap bra | ++ | Y |
| *Garra* sp. | | Cap bra | ++ | Y |
| *Lissochilus kremfi* (Pelegrin et Chevey 1936) | Ca chat | Xanh | ++ | Y |
| *Onychostoma laticeps* (Gunther 1896) | Sinh gai | Xanh mieng | ++ | Y |
| *Opsarichthys uncirostris bidens* (Gunther 1873) | Chao | Mai rang vang | + | Y |
| **Homalopteridae** | | | | |
| *Homaloptera zollingeri* (Bleeker 1853) | Bam nam | Bam da | + | Y |
| *Sewellia lineolata* (Cuvier et Valenciennes 1846) | Bam da | Dep | + | Y |
| **Gobiidae (loaches)** | | | | |
| *Schitura nicholsi* (Smith 1993) | Chach da | Chach da | + | Y |
| **Anguillidae (true eels)** | | | | |
| *Anguilla marmorata* (Gaimard et Quoy) | Chinh hoa | Chinh bong | ++ | Y |
| **Mastacembellidae** | | | | |
| *Mastacembellus armatus favus* (Hora 1923) | Chach hoa | Lau bong | ++ | Y |
| *Mastacembellus* sp. | | Lau | + | Y |

*A = abundance: + = present / ++ = common.

## Table A1.13 Fish species in the ponds of the Aluoi Valley (collected by Dr. Duc, June 1995).

| Scientific Name | Common name | Local name | A* | Eaten (Y/N) |
|---|---|---|---|---|
| **Cyprinidae (Carp)** | | | | |
| *Carassius auratus*, L. 1758 | Ca diec | Ca diec | ++ | Y |
| *Puntius semifasciolatus* (Gunther 1868) | Dong dong | Ca can | +++ | Y |
| *Rasbora* sp. | Long tong | Mai | ++ | No |
| **Cobitidae** | | | | |
| *Misgurnus anguillicaudatus* (Cantor 1842) | Chach bun | Ca nhec | +++ | Y |
| **Clariidae** | | | | |
| *Clarias fuscus* | Tre den | Tre den | + | Y |

*A = abundance: + = present / ++ = common / +++ = abundant.

## Amphibians and Reptiles

Table A1.14 provides a partial list of amphibians and reptiles found in Aluoi District. Some species, such as the abundant frog *Rana rugolosa,* are protein sources in the diets of local people.

**Table A1.14 Amphibians and reptiles of Aluoi Valley (collected by Dr. Duc June, 1995).**

| Scientific Name | Common name | Local name | A* | Eaten (Y/N) |
|---|---|---|---|---|
| **Amphibians (toads, frogs, salamanders)** | | | | |
| *Bufo melanostictus* | Coc nha | | + | N |
| *Rana rugolosa* | Ech dong | A cuot | +++ | Y |
| *R. limnocharis* | Nhai | Longatulo | ++ | Y |
| *R. guentheri* | Chau chuoc | | + | N |
| *Rhacophorus* sp. | Chau | | + | Y |
| *Leucomystax* sp. | Chang | | + | N |
| **Reptiles (lizards, snakes & turtles)** | | | | |
| *Hemidactylus frenatus* | Thach sung | Taro dooc | ++ | N |
| *Varanus salvator* | Ky da hoa | Ta ri | + | Y |
| **Boidae** | | | | |
| *Python morulus* | Tran hoa | Tu lan | + | Y |
| **Colubridae** | | | | |
| *Sybinophys collaris* | Ran rong | | + | N |
| *Elaphe radiata* | Soc dua | | + | N |
| *Ptyas korros* | Ran lai | | + | N |
| *Xenochrophis piscator* | Ran nuoc | | + | N |
| **Elapidae** | | | | |
| *Bungaruns fasciatus* | Cap nong | Nep mong | + | N |
| *B. candidus* | Cap nia | | + | N |
| *Naja naja* | Ho mang | | + | Y |
| **Emydidae** | | | | |
| *Cuora galbinifrons* | Rua hop | | + | Y |
| **Trinychidae** | | | | |
| *Trionyx* sp. | Baba | | + | Y |

*A: + = present / ++ = common / +++ = abundant.

## Birds

Many bird species in Aluoi Valley are hunted by local people (Table A1.15).

**Table A1.15 Birds of Aluoi Valley (collected by Dr. Duc June, 1995).**

| Scientific Name | Common name | A* |
|---|---|---|
| **Hirundinidae** | | |
| *Hirundo rustica gutturalis* | Nhan bung trang | ++ |
| **Motacillidae** | | |
| *Motacilla alba alboides* | Chia voi trang | ++ |
| *M. flava taivana* | Chia voi trang | ++ |
| **Pycnonotidae** | | |
| *Pycnonotus sinensis sinensis* | Bong lau gay trang | ++ |
| *P.aurigaster delicurus* | Bong lau dit do | ++ |
| *P. jocosus jocosus* | Chao mao | ++ |
| **Sturnidae** | | |
| *Sturnus sinensis* | Sao da | ++ |
| *Acridotheris cristallus brevipennis* | Sao mo nga | ++ |
| *Gracula religiosa intermedia* | Yeng | + |
| **Dicruridae** | | |
| *Dicrurus anneetans annectans* | Cheo beo qua | ++ |
| *D.macrocercus cathoecus* | Cheo beo | ++ |
| *D. aenea aenea* | Cheo beo rung | ++ |
| **Corvidae** | | |
| *Corvus torquatus* | Qua khoang | + |
| *C.macrohynchus* | Qua den | + |
| **Muscicapidae** | | |
| *Copysychus saularis saularis* | Chich choe | ++ |
| *Timalia pileata* | Hoa mi nho | + |
| *Stachyris nigriceps nigriceps* | Khuou dau den | + |
| *Grarulax nomiliger pasquieri* | Khuou khoanh co | + |
| *G. chinensis chinensis* | Khuou bac ma | + |
| **Ploiceidae** | | |
| *Emberiza fucata fucata* | Se dong xam | ++ |
| *E. aureola ornata* | Se dong nguc vang | ++ |
| **Ardeidae** | | |
| *Butorides striatus actophilus* | Co xanh | + |

**Table A1.15 Cont'd**

| Scientific Name | Common name | A* |
|---|---|---|
| *Gorsachinus melanolophus melanolophus* | Vac rung | + |
| **Accipitridae** | | |
| *Milvus korselum lineatus* | Dieu hau | + |
| **Falconidae** | | |
| *Falco severus severus* | Cat bung hung | + |
| **Phasianidae** | | |
| *Pavo munticus imperator* | Cong | Endangered |
| *Pheinatia ocellata ocellata* | Tri sao | Endangered |
| *Lophura nycthemera beli* | Ga loi beli | Endangered |
| *Gallus gallus* | Ga rung | Rare |
| **Rallidae** | | |
| *Porzana fuscus brythrothorax* | Cuoc nguc nau | ++ |
| **Columbidae** | | |
| *Streptopelia orientalis orientalis* | Cu sen | ++ |
| *S.chinensis tigrina* | Cu quy | ++ |
| *S. tranquebarica humilis* | Cu ngoi | +++ |
| **Psittacidae** | | |
| *Psittacula alexandri fasciata* | Vet nguc do | ++ |
| *Loriculus vernalis vernalis* | Vet lun | ++ |
| **Cuculidae** | | |
| *Centropus ainensis intermedius* | Bim bip lon | + |
| **Strigidae** | | |
| *Otus bakkamoena lettia* | Cu meo khoang co | + |
| **Alcedinidae** | | |
| *Ceryle rudis insignis* | Boi ca nho | + |
| *Halcion pileata* | Sa dau den | + |
| **Coracidae** | | |
| *Eurystomus orientalis* | Yeng qua | + |
| **Bucerotidae** | | |
| *Buceros biamis cavatus* | Hong hoang | + |

*A: + = present / ++ = common / +++ = abundant.

## Mammals

The list of mammals in Table A1.16 indicates a historically wide species diversity which has been decreasing, especially among the large mammals (FIPI 1995).

**Table A1.16 Mammals of Aluoi Valley according to three surveys from 1952 to 1995 (data courtesy of FIPI).**

| Scientific Name | Common name | Local name | Before* 1952 | 1982 | 1995 |
|---|---|---|---|---|---|
| *Elephas maximus* | Voi | | + | No | Endangered |
| *Bubalus bubalus* | Trau rung | | + | No | No |
| *Bos garus* | Bo tot | | + | No | No |
| *Cervus unicolor* | Nai | Nai | + | + | ++ |
| *Muntiacus muntiak* | Hoang | Mang | + | + | ++ |
| *Sur scrofa* | Lon rung | Heo rung | + | ++ | ++ |
| *Capricorius sumatraentis* | Son duong | De rung | + | No | Rare |
| *Tragulus javanicus* | Cheo | | + | Rare | Rare |
| *Panthera tigris* | Ho | Cop | + | Rare | Rare |
| *P. pardus* | Bao | | + | ++ | ++ |
| *Paradoxurus hermaphroditus* | Cay voi | | + | ++ | ++ |
| *Vivera zibetha* | Cay giong | | + | + | Rare |
| *Viverricula indica* | Cay huong | Cay huong | + | + | + |
| *Helarotos malyanus* | Gau cho | | + | Rare | + |
| *Selenarctos thibetanus* | Gau ngua | | No | Rare | + |
| *Lutra lutra* | Rai ca | | + | + | + |
| *Felis nebulosa* | Meo gau | | + | ++ | ++ |
| *Hylobates concolor* | Vuon den | | + | No | + |
| *Pygathrix nemaeus* | Vooc va | | + | No | + |
| *Macaca mulata* | Khi vang | | + | Rare | Rare |
| *Nycticebus* sp. | Culi | | + | No | No |
| *Pataurista pentaurista* | Soc bay | | + | No | No |
| *Calloscuirus erythraens* | Soc bung do | | + | ++ | ++ |
| *Menetes berdmorei* | Soc lung van | | + | ++ | ++ |
| *Taminops* sp. | Soc chuot | | + | ++ | ++ |
| *Hystrix hogeoni* | Nhim | | + | ++ | ++ |
| *Atherurus macrourus.* | Don | | + | ++ | ++ |
| *Rhzomys* sp. | Dui | | + | ++ | ++ |
| *Rattus* sp. | Chuot | | + | ++ | ++ |
| *Manis pentadactyla* | Tete | | + | ++ | ++ |
| *Chiroptera* sp. | Doi | | + | ++ | ++ |
| *Rhinocros sendasicus* | Te giac | | + | No | No |

* + = present / ++ = common.

## SOCIO-ECONOMIC CONDITIONS IN ALUOI VALLEY

### Human Population

The Aluoi Valley is very remote from the rest of Viet Nam, and inhabited mainly by ethnic minorities which differ in culture and language from lowland Vietnamese. Even by Vietnamese standards, the residents of this area are poor. They subsist on slash-and-burn agriculture, some rice cultivation, and modest fish farming and animal husbandry.

A 1992 census estimated that the population of 31,012 persons was comprised mainly of ethnic minorities such as Ca Tu, Kinh, Pa Co and Ta Oi. Table A1.17 contains a more recent listing of populations in villages of Aluoi District and their main agricultural activities. Data are not available on population age distribution.

Transportation to the area is limited with one (unpaved) main road (Highway 14A), which is not always passable during the wet season. This road is connected to Highway 12 which leads to Hue. Local people tend to be conservative and follow traditional practices; for example, the marriage of a daughter involves provision of a large dowry of food, clothing and means of agricultural production to the son-in-law.

**Table A1.17 Village populations, main agricultural activities and main ethnic minority groups in Aluoi District representations (collected by Mr. Hoang from Peoples' Committee of Aluoi Valley [April, 1995]).**

| Village | Households | Population | Females | Minority | Rice (ha) | Cassava (ha) |
|---|---|---|---|---|---|---|
| A Ruong | 281 | 1,767 | 869 | Ta Oi | 69.9 | 80.0 |
| A Dot | 257 | 1767 | 810 | Ta Oi | 54.0 | 80.0 |
| Huong Lam | 225 | 1,300 | 653 | Ca Tu | 47.0 | 60.0 |
| Huong Phong | 56 | 287 | 144 | Kinh | 1.2 | 7.0 |
| Hong Thuong | 269 | 1,504 | 754 | Ca Tu | 23.0 | 50.0 |
| Hong Thai | 154 | 945 | 480 | Ta Oi | 17.0 | 85.0 |
| Hong Quang | 254 | 1,567 | 787 | Pa Co | 18.0 | 45.0 |
| A Ngo | 707 | 4,012 | 2,015 | Ta Oi | 47.0 | 120.0 |
| Son Thuy | 679 | 3,563 | 1,782 | Kinh | 83.4 | 32.0 |
| Phu Vinh | 157 | 900 | 465 | Kinh | 3.2 | 17.0 |
| Hong Kim | 213 | 1,382 | 694 | Pa Co | 31.0 | 55.0 |
| Hong Nam | 293 | 1,602 | 805 | Pa Co | 4.0 | 55.0 |
| Hong Bac | 241 | 1,345 | 678 | Pa Co | 19.0 | 56.0 |
| Hong Van | 278 | 1,675 | 840 | Pa Co | 17.0 | 55.0 |
| Hong Trung | 205 | 1,215 | 736 | Pa Co | 23.0 | 61.0 |
| Bac Son | 113 | 732 | 369 | Pa Co | 15.5 | 50.0 |
| Hong Thuy | 304 | 1,796 | 898 | Pa Co | 10.0 | 85.0 |
| Dong Son | 173 | 990 | 498 | Pa Co | 23.0 | 50.0 |
| Hung Nguyen | 140 | 880 | 446 | Ca Tu | 5.0 | 55.0 |
| Hong Ha | 154 | 1,007 | 506 | Ca Tu | 12.0 | 65.0 |
| Nham | 287 | 1,466 | 735 | Ta Oi | 9.4 | 85.0 |
| TOTAL | 5,440 | 31,702 | 15,964 | | 532.6 | 1,248 |

| Minority Group | Population | % of total population |
|---|---|---|
| Kinh | 4,750 | 15 |
| Pa Co | 12,304 | 39 |
| Ta Oi | 9,957 | 31 |
| Ca Tu | 4,691 | 15 |

Education levels of local people are low; for example, in 1992 more than 8,900 people had never attended school, 307 had completed high school (ages 14 to 17), 477 had received secondary vocational training and 149 residents had completed university.

A preliminary survey of local primary and secondary schooling as of 1995 had the following results:

- Primary schools (one per village; ages 6 to 11) 20
- Primary and secondary (ages 11 to 14) schools (Son Thuy and Hoang Thong) 2
- Total students (~70% of all children) 7,658
- Female 3,231

Over 90% of the population is atheist/animist, with small numbers of Catholics and Buddhists. Intermarriage is permitted by various ethnic minority groups in Aluoi Valley. The husband is the final arbiter of disputes and paramount leader within the family unit. Until recently, the wife would be responsible for most physical work including agriculture; the husband would hunt and cut trees. Now there is a division of tasks with the husband taking on the more heavy work. If a family member becomes ill, a magician/shaman may be called.

The water resources of Aluoi are virtually unmanaged. The main source of potable water is streams; people often use unclean water. The Health Service promotes well digging, but up to now only approximately 19 wells have been dug. There are virtually no hydrological data for Aluoi. The September to December wet season includes a flooding period from October to November, particularly when annual rains exceed 3,000 mm. Only 50 ha of cropland are actively irrigated (from a diversion dam).

Aluoi has limited electricity supply by line; families usually share generator costs. A small dam for hydroelectric power (20 KW) was completed in 1984.

### Public Health (survey by Dr. Hoang Trong Quynh in 1995)

There is one district hospital (A Ngo) and 21 village health clinics in Aluoi Valley. All health clinics have medical staff; however, 11 do not have their own buildings and use rooms of their village committee buildings. Medical equipment in the A Ngo hospital includes an X-ray machine, a dental drill, a microscope, a freezer, and an autoclave which are powered by generator. Available medicines in Aluoi include iodized salt, leprosy medicine, and vaccines (for whooping cough, tetanus, diphtheria, measles, tuberculosis and poliomyelitis).

The numbers of medical staff in the hospital and village health clinics are listed in Table A1.18.

**Table A1.18 Staffing at the hospital and clinics of Aluoi District (data from the Vice Director of the District Health Centre).**

| Hospital | | Village Health Clinics | |
|---|---|---|---|
| Medical doctors | 4 | Practical nurses | 2 |
| Laboratory technicians | 4 | Assistant midwife | 1 |
| Practical nurses | 9 | Nurses | 2-3 |
| Assistant pharmacists | 3 | | |
| Midwives | 4 | | |
| Orderly assistants | 14 | | |

The number of in-patients treated in 1994 was 2,105. Table A1.19 lists some serious diseases, among which respiratory illness and Malaria dominated. It should be noted, that these figures are likely low as not all villagers would go to clinics or report their illnesses.

**Table A1.19 Serious diseases of in-patients in Aluoi District in 1994.**

| Disease | % of total in-patients |
|---|---|
| Respiratory diseases | 13.9 |
| Malaria | 10.7 |
| Diarrhea | 7.5 |
| Dysentery | 5.5 |
| Tuberculosis | 1.5 |
| Schizophrenia | 0.09 |
| Epilepsy | 0.04 |
| Leprosy | 0.03 |

A survey of Malaria in the District's villages revealed that 3,506 person had the disease; the data are listed according to village in Table A1.20.

**Table A1.20 Number of cases of Malaria in 1994 in villages of Aluoi Valley according to village (data from Thua Thien Hue Province Malaria Department)**

| Village | No. of cases | Village | No. of cases |
|---|---|---|---|
| Nham | 188 | A Ngo | 53 |
| Hong Quang | 334 | Hong Nam | 151 |
| Hong Thai | 118 | Hong Thuy | 208 |
| Hong Bac | 282 | Bac Son | 395 |
| Hong Kim | 125 | Hong Trung | 82 |
| Huong Phong | 105 | Dong Son | 166 |
| Huong Lain | 152 | Hong Thuong | 152 |
| A Dot | 181 | A Roang | 208 |
| Phu Vinh | 50 | Hong Van | 134 |
| Hong Ha | 109 | Huong Nguyen | 250 |
| Son Thuy | 63 | TOTAL | 3,506 |

DDT spraying was discontinued in 1993; people now soak their mosquito nets with permethrin (also preferred over DDT for killing bed bugs). Mosquito density is determined by the number of mosquitoes a person can catch per hour (mosquitoes/per hour/per person). In 1994, mean local mosquito density in cowsheds and pigsties was 3.6 (for *Anopheles*) and 33.4 (for other mosquitoes). The Malaria fever rate in people was 5.03%; 15 died from Malaria in 1994.

The number of patients suffering from thyroid problems in 1994 was 9,452 representing 30.6% of the population, for which a village to village count is provided in Table A1.21. The daily use of iodized salt decreases the rate of thyroid problems.

**Table A1.21 Numbers of persons per village in Aluoi District suffering from thyroid problems in 1994 (data from District health clinics).**

| Village | No. of cases | Village | No. of cases |
|---|---|---|---|
| A Roang | 403 | Hong Kim | 526 |
| A Dot | 520 | Hong Nam | 459 |
| Huong Nguyen | 280 | Hong Bac | 293 |
| Huong Lam | 664 | Hong Van | 378 |
| Huong Phong | 206 | Hong Trung | 474 |
| Hong Thuong | 638 | Hong Thuy | 315 |
| Hong Thai | 620 | Bac Son | 321 |
| Hong Quang | 406 | Dong Son | 380 |
| A Ngo | 752 | Hong Ha | 213 |
| Son Thuy | 659 | X Nham | 472 |
| Phu Vinh | 473 | TOTAL | 9,452 |

Frequent diseases in children include pneumonia, bronchitis and diarrhea. Beriberi, caused by malnutrition, is a serious problem for local children and a good indication of the district's general poverty. For example, in two villages the infection rate was 20% among children under three years of age. Recently, treatment with B-vitamins has provided much improvement.

Contraception is rarely used as it is against customary beliefs. Men are more likely to undergo voluntary sterilization than women; for example, in A Ngo Village, the number of sterilizations in men was 49, compared to 11 for women. According to the people in Son Thuy Village, the rate of abortions in women is high. There are no occurrences of AIDS or venereal diseases such as gonorrhea or syphilis.

## Economic Activities

*Agriculture (data from local Head of Agriculture Department – Mr. Ho On)*

The chief occupation of people living in Aluoi Valley is farming of cassava (manioc), rice and livestock (Table A1.22). According to FIPI, approximately 3,900 ha are used for agriculture, which is dominated by cassava.

**Table A1.22 Summary of agricultural production in Aluoi District in 1994.**

| Crop | ha | Type | Crops per year | Seasons | Productivity (kg/ha) |
|---|---|---|---|---|---|
| Cassava | 1,250 | 2-3 | 1 | Apr.-Oct. | 7,000 |
| Rice (paddy) | 506 | long grain | 2 | Apr.-Aug./Nov.-May | 2,400 (X 2) |
| | | short grain | 2 | May-Aug./Dec.-May | |
| Rice (dry land) | 782 | NA | 1 | Apr.-Oct. | 1,000 |
| Maize | 317 | various | 2 | May-Jun./Nov.-Apr. | 1,200 (total) |
| Sweet potato | 200 | NA | 2 | Nov.-Feb/May-Aug | 3,500 (total) |
| Peanut | 56 | NA | 1 | Jan.-May | 1,300 |
| Vegetables | 50 | * | NA | NA | NA |
| Fruit | NA | ** | NA | NA | NA |
| Other | NA | *** | NA | NA | NA |

NA = not applicable/unknown.

* = cucumber, carrot, leaves of sweet potato, beans.

** = pineapple, banana, orange, kaki (like apple), grapefruit, jackfruit, mango, papaya, watermelon.

*** = tea, chili, coffee (Hong Van), sugar cane, tobacco.

Both manure and chemical fertilizers are used. Limited amounts of pesticides are used because of their high cost (Padan [Validacin 5DD] and Trebon); herbicides include Sofid and Butavi.

Local people also forage in forests for bamboo shoots, mushrooms, banana flowers and medicinal plants. Hunting is common and many different animal species are taken.

Most farmers' families subsist on cassava as their staple; rice is eaten less frequently. Fish is eaten more than meat (which is eaten rarely). Only relatively wealthy families have surplus food. The average household experiences food shortages for up to three months a year and "poor" households may lack food for up to six months annually.

Cows are the District's most abundant livestock (Table A1.23). According to the JIVC (Japan International Volunteer Center, Hue), pig farming has not contributed significantly to improving local income levels. There is, however, a side benefit to raising pigs as their

dung is good fertilizer. Cow rearing contributes 450,000 Dong (approximately $45 U.S.) per head every three years. Families sell livestock rather than use them for food.

**Table A1.23. Livestock raised in Aluoi District.**

| Type | Number |
|---|---|
| Cow | 4,993 |
| Buffalo | 1,345 |
| Pig | 3,947 |
| Goat | 360 |
| Chicken/Duck | 10,500 |

### Aquaculture

Fish culture is well established in the Aluoi Valley; most households have fishponds. There are approximately 100 ha of ponds in use. Ponds are relatively productive (approximately 4,800 kg/ha), and are the primary source of protein for the area. An average size pond in the Aluoi Valley yields approximately 200 fish per household. Table A1.24 lists the main aquaculture species.

Grass carp is the most important species. In 1990, the Hong Thuong hatchery supplied 50,000 juveniles to local farmers; since 1991 distribution has increased to 1,000,000 annually. The district hatchery has 130 ha of ponds; 60% of their production is directed at supplying grass carp fingerlings to stock local farmer's ponds. Fifteen to twenty million fry are produced per year, as well as three to four tonnes of grown-out fish. Fish are sold when they reach 3.5 to 4.0 cm (80 to 100 Dong per fish) or from 7 to 10 cm (400 to 500 Dong per fish). Juveniles take six to eight months to reach market size. The hatchery organizes workshops to help villagers build fish ponds and grow fish.

Pituitary hormones from China are used to stimulate breeding. Broodstock lasts seven to eight years; fish spawn three times per year. Some viral infections, fungal diseases and outbreaks of red ulcers have occurred in the past. Temperature and excessive rain (causing flooding and escapement from ponds) are key problems.

Aquaculture production is now greater than wild-caught fish from streams. Some sea fish, from Hue, are also marketed in the region.

**Table A1.24. Fish species currently used in aquaculture in Aluoi District (data from FIPI 1995).**

| Scientific name | Local name | Source |
|---|---|---|
| **Cyprinidae** | | |
| *Ctenopharyngodon idellus* (Cuvier et Valenciennes) | Tram co (Grass carp) | China |
| *Hypopthalmichthys molitrix* (Cuvier et Valenciennes) | Me trang hoa (Silver Carp) | China |
| *H. harmandi* (Sauvage) | Me trang | Viet Nam |
| *Aristichthys nobilis* (Richardson) | Me hoa | China |
| *Labeo rohita Hamilton* | Troi an | India |
| *Cirrhinus mrigal* | Ca mrigan | USA |
| *Cyprinus carpio* L. | Ca chep lai | Hungary |
| *C. carpio* | (Hibrid) | Viet Nam |
| **Cichlidae** | | |
| *Tilapia nilotica* | Ro phi van (Nile Tilapia) | Taiwan |

## References

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FIPI 1995. The effects of herbicides on forest and environment on Aluoi district, Thua Thein-Hue Province. 49 p. Ha Noi: FIPI.

# Appendix A2

1. • **Spread Sheet Summaries and Congener Profile Graphics of Viet Nam dioxin data, 1996 and 1997, incorporating analytical data appearing in Appendices A2.2, A2.3 and A2.4**

   • **Statistics on Human Participants in the Collection of Blood for Dioxin Analyses, A So (Aluoi Valley), Viet Nam, 1997**

2. **Axys Analytical Report to Hatfield Consultants Ltd. October 1997**

   *Analytical Data on 1996 Viet Nam Samples*

3. • **Axys Analytical Report to Hatfield Consultants Ltd. April 1998**

   *Analytical Data on 1997 Viet Nam Samples*

   • **Addendum**

   **Analytical Data on 1997 PCB/Pesticide Analyses - Reports and Batch Summary Sheets (See Appendix A2.2 for Analytical Protocols)**

4. **Environmental Technology Centre (ETC) (Environment Canada) Report to Hatfield Consultants Ltd. February 1998**

   *Analytical Data on 1997 Viet Nam Samples*

5. **Tabulation of Dioxin Analyses Summarized from Specific Reference Materials (Provided Courtesy of Axys Analytical Services, Sydney, British Columbia, Canada)**

## Section 1

- **Spread Sheet Summaries and Congener Profile Graphics of Viet Nam dioxin data, 1996 and 1997, incorporating analytical data appearing in Appendices A2.2, A2.3 and A2.4**

- **Statistics on Human Participants in the Collection of Blood for Dioxin Analyses, A So (Aluoi Valley), Viet Nam, 1997**

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**Table A2.1.1 Dioxin and furan residues (pg/g dry weight [soils], pg/g wet weight [biological tissues]) in samples collected from Viet Nam, January 1996.**

| Sample Location and Type | Sample ID | 2,3,7,8 TCDD | Total TCDD | 2,3,7,8 P5CDD | Total P5CDD | 2,3,7,8 H6CDD | Total H6CDD | 2,3,7,8 H7CDD | Total H7CDD | Total OCDD | 2,3,7,8 TCDF | Total TCDF | 1,2,3,7,8 PCDF | 2,3,4,7,8 PCDF | 2,3,7,8 PCDF | Total PCDF | 2,3,7,8 H6CDF | Total H6CDF | 2,3,7,8 H7CDF | Total H7CDF | Total OCDF | TEQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A Ngo, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| bomb crater soil (0-10cm) | VN9605 | 1.1 | 2.0 | ND | 0.5 | 1.2 | 3.9 | 11 | 26 | 830 | ND | 0.8 | ND | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 | ND | 0.5 | 1.0 | 2.3 |
| bomb crater soil (10-30cm) | VN9613 | 0.9 | 1.2 | ND | ND | 1.0 | 3.0 | 11 | 27 | 950 | ND | 0.5 | ND | ND | ND | 0.1 | ND | 0.2 | ND | 0.5 | 0.9 | 2.1 |
| fish pond sediment | VN9619 | 5.3 | 7.7 | 0.5 | 6.3 | 1.7 | 9.7 | 15 | 35 | 880 | 0.2 | 0.8 | ND | ND | ND | ND | 0.2 | 0.3 | ND | ND | ND | 6.8 |
| carp liver | VN9618 | 1.0 | 1.5 | ND | 0.4 | ND | ND | ND | ND | 1.0 | 0.4 | 2.6 | ND | 0.1 | 0.1 | 1.3 | ND | ND | ND | ND | ND | 1.2 |
| manioc root | VN9603 | ND | ND | ND | ND | ND | ND | ND | ND | 1.1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| **Hong Thuong, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| carp liver | VN9620 | 1.6 | 1.6 | NDR | ND | ND | ND | ND | ND | 1.6 | 0.7 | 1.1 | ND | 0.2 | 0.2 | 0.9 | ND | ND | ND | ND | ND | 1.9 |
| manioc root | VN9606 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| **Hong Ha, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| farmer's field soil (10-30cm) | VN9615 | 1.7 | 1.9 | ND | ND | 0.6 | 2.9 | 1.6 | 2.7 | 48 | 0.2 | 0.5 | ND | ND | ND | 0.3 | ND | ND | ND | ND | ND | 2.1 |
| fish pond sediment | VN9635 | 0.3 | 0.3 | ND | ND | 0.2 | 0.3 | 0.6 | 1.1 | 18 | ND | ND | ND | ND | ND | ND | ND | ND | 0.1 | 0.1 | ND | 0.4 |
| carp liver | VN9623 | 0.3 | 0.6 | ND | ND | ND | 1.6 | 1.5 | 3.9 | 4.0 | 0.3 | 1.1 | ND | 0.1 | 0.1 | 1.6 | ND | 1.1 | ND | 0.6 | ND | 0.5 |
| **Hong Van, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| farmer's field soil (10-30cm) | VN9643 | 0.7 | 6.9 | 0.2 | 3.0 | NDR | 16 | 18 | 42 | 1700 | ND | 0.4 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.9 |
| **Son Thuy, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| pig liver | VN9629 | ND | ND | ND | ND | 0.4 | 0.4 | 16 | 17 | 300 | ND | ND | ND | 0.6 | 0.6 | 0.6 | 3.4 | 3.4 | 7.2 | 7.2 | 2.7 | 1.3 |
| **Xa Nham, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| farmer's field soil (10-30cm) | VN9631 | 4.3 | 6.5 | NDR | 3.9 | 1.5 | 6.6 | 5.3 | 9.9 | 230 | ND | ND | ND | ND | ND | ND | ND | ND | NDR | ND | ND | 5.0 |
| carp fat | VN9640 | 0.7 | 2.3 | ND | ND | ND | ND | ND | ND | 5.1 | 1.2 | 9.2 | 0.4 | ND | 0.4 | 1.7 | ND | ND | ND | ND | ND | 1.5 |
| **A So, Aluoi Valley** | | | | | | | | | | | | | | | | | | | | | | |
| former airbase soil (0-10cm) | VN9642 | 110 | 120 | 1.1 | 7.8 | 3.8 | 13 | 27 | 47 | 460 | 3.6 | 11 | 0.4 | 0.5 | 0.9 | 8.8 | 1.1 | 8.4 | 7.8 | 28 | 36 | 112.6 |
| former airbase soil (10-30cm) | VN9622 | 32 | 34 | NDR | 0.2 | 3.2 | 7.8 | 12 | 23 | 430 | 1.1 | 2.7 | 0.2 | 0.2 | 0.4 | 2.9 | 0.7 | 3.7 | 2.4 | 6.7 | 7.5 | 33.3 |
| fish pond sediment | VN9602 | 6.9 | 9.5 | NDR | 3.1 | 1.0 | 9.1 | 7.9 | 19 | 460 | 0.6 | 1.7 | ND | ND | ND | 1.4 | ND | 0.5 | 0.8 | 0.8 | 1.2 | 7.8 |
| A Sap River sediment | VN9650 | 0.8 | 0.8 | ND | ND | ND | 0.5 | 1.5 | 3.6 | 69 | ND | 0.4 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.2 |
| carp fat | VN9646 | 51 | 59 | 1.9 | 2.4 | ND | ND | ND | ND | ND | 6.6 | 25 | 0.9 | 1.2 | 2.1 | 12 | ND | ND | ND | ND | ND | 53.7 |
| carp liver | VN9614 | 2.4 | 3.0 | ND | 0.4 | ND | ND | ND | ND | ND | 0.4 | 1.3 | ND | ND | ND | 0.4 | ND | ND | ND | ND | ND | 2.6 |
| duck liver | VN9608 | 1.4 | 1.4 | ND | ND | ND | ND | ND | ND | ND | 0.2 | 0.2 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.6 |
| **Dong Ha, Quang Tri province** | | | | | | | | | | | | | | | | | | | | | | |
| former airbase soil (0-10cm) | VN9645 | ND | 0.2 | ND | ND | 3.7 | 9.2 | 31 | 58 | 290 | 0.4 | 1.1 | ND | 0.3 | 0.3 | 3.5 | 1.6 | 11 | 8.3 | 23 | 26 | 1.6 |
| former airbase soil (10-30cm) | VN9630 | ND | ND | ND | ND | 1.0 | 3.6 | 6.5 | 13 | 62 | ND | ND | ND | ND | ND | ND | ND | 1.3 | NDR | 2.1 | 3.9 | 0.6 |
| **Chi Khe, Nhge An province (reference)** | | | | | | | | | | | | | | | | | | | | | | |
| farmer's field soil (0-10cm) | VN9636 | ND | 0.2 | ND | ND | 1.8 | 1.8 | 0.6 | 1.3 | 13 | 0.2 | 1.1 | ND | ND | ND | 0.1 | 0.7 | 0.8 | ND | ND | ND | 0.4 |
| farmer's field soil (10-30cm) | VN9624 | ND | ND | ND | ND | 2.0 | 2.0 | 0.7 | 1.4 | 16 | ND | 0.8 | ND | ND | ND | ND | 0.6 | 0.6 | ND | ND | ND | 0.6 |
| **Con Cuong, Nhge An province (reference)** | | | | | | | | | | | | | | | | | | | | | | |
| carp liver | VN9621 | ND | 0.1 | ND | ND | ND | ND | ND | ND | ND | 0.2 | 0.4 | ND | ND | ND | 0.3 | ND | ND | ND | ND | ND | 0.2 |
| duck liver | VN9644 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.2 | 0.4 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| pig liver | VN9641 | ND | ND | ND | ND | ND | ND | 0.7 | 1.2 | 4.1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.2 |

ND = Not detected.
NDR = Peak detected but did not meet quantification criteria.

**Table A2.1.2 Dioxin and furan residues (pg/g dry weight [soils], pg/g wet weight [biological tissues]) in samples collected from Viet Nam, November 1997.**

| Sample Location and Type | Sample ID | 2,3,7,8 TCDD | Total TCDD | 2,3,7,8 P5CDD | Total P5CDD | 2,3,7,8 H6CDD | Total H6CDD | 2,3,7,8 H7CDD | Total H7CDD | Total OCDD | 2,3,7,8 TCDF | Total TCDF | 1,2,3,7,8 PCDF | 2,3,4,7,8 PCDF | 2,3,7,8 PCDF | Total PCDF | 2,3,7,8 H6CDF | Total H6CDF | 2,3,7,8 H7CDF | Total H7CDF | Total OCDF | TEQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A So, Aluoi valley** | | | | | | | | | | | | | | | | | | | | | | |
| **Soil (0 to 10 cm)** | | | | | | | | | | | | | | | | | | | | | | |
| Manioc field | 97VN001 | 6.61 | 8.26 | NDR | 1.56 | 0.83 | 8.49 | 4.91 | 10.92 | 142.29 | 0.64 | 3.17 | ND | ND | ND | 0.87 | 0.55 | 0.55 | 0.92 | 0.92 | 1.61 | 7.01 |
| Ploughed field | 97VN013 | 4.2 | 6.49 | NDR | 2.93 | 1.12 | 10.49 | 4.63 | 10.88 | 136.34 | 0.24 | 1.66 | ND | ND | ND | 0.78 | ND | ND | 0.78 | 0.78 | 1.95 | 4.53 |
| Former airbase | 97VN051 | 897.85 | 897.85 | 1.69 | 7.76 | 2.79 | 24.35 | 32.03 | 68.44 | 563.84 | 10.46 | 30.3 | ND | ND | ND | 23.59 | 2.2 | 8.19 | 7.59 | 19.83 | 16.5 | 901.22 |
| Former airstrip | 97VN057 | 88.32 | 88.32 | 2.91 | 7.4 | 5.66 | 19.83 | 32.93 | 65.82 | 697.05 | 3.08 | 11.27 | 0.46 | 0.29 | 0.75 | 6.94 | 2.66 | 8.94 | 6.9 | 22.37 | 30.31 | 92.21 |
| **Fish pond sediment** | | | | | | | | | | | | | | | | | | | | | | |
| Fish pond #1 | 97VN005 | 5.2 | 9.9 | 0.8 | 13 | 0.8 | 10 | 2.4 | 5.3 | 64 | 0.3 | 2.3 | ND | ND | ND | 1.1 | ND | 0.3 | ND | ND | ND | 5.9 |
| Fish pond #2 | 97VN007 | 5.4 | 7.1 | 0.4 | 4.5 | 0.8 | 9.3 | 3.5 | 7.9 | 170 | 0.3 | 1.5 | ND | ND | ND | 0.9 | ND | 0.2 | ND | ND | ND | 6.0 |
| Fish pond #3 | 97VN009 | 8.5 | 11 | 0.4 | 3.3 | 0.7 | 5.8 | 4.1 | 9.4 | 220 | 0.5 | 2.2 | ND | ND | ND | 1.1 | ND | 0.2 | ND | ND | ND | 9.2 |
| Fish pond #4 | 97VN011 | 1.8 | 3.3 | 0.1 | 2.5 | ND | 1.5 | 0.6 | 1.4 | 23 | 0.1 | 0.6 | ND | ND | ND | 0.4 | ND | ND | ND | ND | ND | 2.0 |
| **Animal tissue** | | | | | | | | | | | | | | | | | | | | | | |
| Grass carp fat (pond#1) | 97VN019 | 7.9 | 10 | NDR | 2.3 | 0.7 | 1.5 | 0.9 | 1.6 | 2.9 | 2.3 | 13 | 0.3 | 0.6 | 0.9 | 3.4 | 0.3 | 0.5 | 0.4 | 0.4 | NDR | 8.7 |
| Grass carp fat (pond#2) | 97VN027 | 16 | 20 | 0.7 | 4.2 | NDR | 1.4 | 0.4 | 0.7 | 1.0 | 2.4 | 11 | 0.3 | NDR | 0.3 | 4.0 | 0.7 | 1.1 | 0.1 | 0.1 | ND | 16.7 |
| Grass carp fat (pond#3) | 97VN031 | 21 | 25 | 0.8 | 4.0 | NDR | 0.6 | 0.8 | 0.8 | 3.3 | 4.0 | 15 | 0.6 | 0.8 | 1.4 | 5.0 | NDR | ND | 0.5 | 0.5 | ND | 22.4 |
| Grass carp fat (pond#4) | 97VN039 | 34 | 41 | 1.2 | 9.5 | 0.4 | 1.8 | 0.2 | 0.2 | 0.6 | 4.4 | 15 | NDR | 0.5 | 0.5 | 5.3 | 0.4 | 0.6 | 0.2 | 0.2 | 0.1 | 35.4 |
| Duck fat | 97VN045 | 6.1 | 7.0 | 0.7 | 3.4 | ND | 0.8 | ND | ND | 2.2 | 1.1 | 2.7 | 0.3 | 0.3 | 0.6 | 2.1 | ND | ND | ND | ND | ND | 7.0 |
| **Human blood (lipid basis)** | | | | | | | | | | | | | | | | | | | | | | |
| Males, age >25 | 97VN047 | 31 | 31 | NDR | ND | 6.9 | 6.9 | 10 | 10 | 52 | ND | ND | ND | 3.4 | 3.4 | 3.4 | 16.9 | 17 | NDR | ND | NDR | 37.2 |
| Females, age >25 | 97VN048 | 11 | 11 | ND | ND | ND | ND | 14 | 14 | 64 | ND | ND | ND | ND | ND | ND | ND | ND | NDR | ND | NDR | 14.3 |
| Males, age 12 to 25 | 97VN049 | 21 | 21 | ND | ND | NDR | ND | 10 | 10 | NDR | ND | ND | ND | ND | ND | ND | 14 | 14 | 24 | 24 | 76 | 25.5 |
| Females, age 12 to 25 | 97VN050 | 12 | 12 | ND | ND | ND | ND | 7.7 | 19 | 50 | ND | ND | ND | ND | ND | ND | NDR | ND | 12 | 12 | ND | 15.4 |
| **Rang Rang village, Ma Da forest region** | | | | | | | | | | | | | | | | | | | | | | |
| **Soil (0 to 10 cm)** | | | | | | | | | | | | | | | | | | | | | | |
| South of former airstrip | 97VN075 | 7.86 | 10.13 | 0.6 | 1.41 | 1.24 | 7.22 | 3.29 | 6.62 | 16.58 | 1.03 | 4.02 | ND | ND | ND | 1.54 | ND | 0.51 | ND | ND | 0.81 | 8.44 |
| North of Ma Da River | 97VN077 | 19.1 | 24.88 | 1.76 | 8.94 | ND | 26.37 | 4.38 | 7.54 | 26.86 | 2.48 | 8.98 | 0.32 | ND | 0.32 | 5.42 | ND | 1.13 | 0.95 | 1.44 | 1.4 | 20.33 |
| Former airstrip | 97VN079 | 1.82 | 2.46 | 0.51 | 3.76 | 1.54 | 7.6 | 4.91 | 9.58 | 24.91 | 0.59 | 1.15 | ND | ND | ND | 0.71 | ND | ND | 0.44 | 1.07 | ND | 2.37 |
| **Sediment** | | | | | | | | | | | | | | | | | | | | | | |
| Fish pond near Ba Hao | 97VN073 | 7.8 | 9.71 | ND | ND | ND | ND | 2.98 | 5.85 | 29.51 | 0.59 | 0.88 | ND | ND | ND | 1.07 | ND | ND | 0.68 | 1.32 | 1.41 | 7.93 |
| Ba Hao Reservoir | 97VN089 | 2.28 | 3.34 | NDR | ND | 2.55 | 7.59 | 5.78 | 10.4 | 18.76 | 0.27 | 2.12 | ND | ND | ND | ND | ND | ND | 0.58 | 1.01 | 0.69 | 2.64 |

ND = Not detected.
NDR = Peak detected but did not meet quantification criteria.

**Table A2.1.3** **Statistics on human participants in the collection of blood for dioxin analyses, A So (Aluoi Valley), Viet Nam, 1997.**

| Age Category | Donor Number | Age | Directly subjected to herbicide spray | Smoking | Number of Children | Child Mortality |
|---|---|---|---|---|---|---|
| **Males: >25 years old** | | | | | | |
| | 1 | 67 | Yes | No | 9 | 0 |
| | 2 | 63 | Yes | No | 3 | 0 |
| | 3 | 56 | Yes | Yes | 6 | 0 |
| | 4 | 67 | Yes | Yes | 8 | 0 |
| | 5 | 70 | Yes | Yes | 10 | 0 |
| | 6 | 79 | Yes | Yes | 4 | 0 |
| | 7 | 70 | Yes | Yes | 4 | 0 |
| | 8 | 67 | Yes | No | 11 | 3 |
| | 9 | 100 | Yes | No | 10 | 2 |
| | 10 | 66 | Yes | No | 6 | 5 |
| | 11 | 71 | Yes | No | 4 | 1 |
| | 12 | 64 | Yes | Yes | 6 | 0 |
| | 13 | 55 | Yes | No | 5 | 2 |
| | 14 | 65 | Yes | No | 4 | 1 |
| | 15 | 35 | Yes | Yes | 8 | 1 |
| | 16 | 65 | Yes | Yes | 9 | 0 |
| | 17 | 78 | Yes | Yes | 8 | 2 |
| | 18 | 45 | Yes | Yes | 4 | 1 |
| | 19 | 42 | Yes | No | 8 | 2 |
| | 20 | 65 | Yes | Yes | 12 | 5 |
| | 21 | 56 | Yes | Yes | 11 | 3 |
| | 22 | 78 | Yes | Yes | 9 | 3 |
| | 23 | 35 | Yes | No | 10 | 2 |
| | 24 | 65 | Yes | No | 3 | 1 |
| | 25 | 58 | Yes | No | 13 | 3 |
| | 26 | 69 | Yes | No | 8 | 2 |
| | 27 | 40 | Yes | No | 6 | 0 |
| | 28 | 41 | Yes | No | 7 | 2 |
| | 29 | 35 | Yes | No | 5 | 2 |
| | 30 | 72 | Yes | Yes | 7 | 5 |
| | 31 | 56 | Yes | No | 10 | 2 |
| | 32 | 38 | Yes | No | 7 | 2 |
| | 33 | 57 | Yes | No | 7 | 3 |
| | 34 | 63 | Yes | No | 8 | 1 |
| | 35 | 73 | Yes | No | 8 | 1 |
| | 36 | 50 | Yes | Yes | 5 | 2 |
| | 37 | 55 | Yes | No | 7 | 0 |
| | 38 | 65 | Yes | No | 8 | 0 |
| | 39 | 35 | Yes | No | 9 | 2 |
| | 40 | 33 | Yes | No | 8 | 4 |
| | 41 | 41 | Yes | Yes | 5 | 3 |
| | 42 | 66 | Yes | No | 8 | 2 |
| | 43 | 50 | Yes | Yes | 9 | 1 |
| | 44 | 66 | Yes | Yes | 5 | 1 |
| | 45 | 55 | Yes | Yes | 5 | 1 |
| | 46 | 49 | Yes | No | 7 | 2 |
| | 47 | 50 | Yes | No | 8 | 1 |
| | 48 | 68 | Yes | No | 7 | 2 |
| | 49 | 67 | Yes | No | 5 | 1 |
| | 50 | 88 | Yes | No | 12 | 5 |

**Table A2.1.3 Cont'd.**

| Age Category | Donor Number | Age | Directly subjected to herbicide spray | Smoking | Number of Children | Child Mortality |
|---|---|---|---|---|---|---|
| **Females: >25 years old** | | | | | | |
| | 1 | 50 | Yes | No | 8 | 0 |
| | 2 | 32 | Yes | No | 8 | 0 |
| | 3 | 60 | Yes | No | 9 | 0 |
| | 4 | 50 | Yes | No | 4 | 0 |
| | 5 | 50 | Yes | No | 8 | 0 |
| | 6 | 52 | Yes | Yes | 8 | 0 |
| | 7 | 55 | Yes | No | 14 | 0 |
| | 8 | 52 | Yes | Yes | 4 | 0 |
| | 9 | 50 | Yes | No | 4 | 0 |
| | 10 | 50 | Yes | Yes | 5 | 0 |
| | 11 | 60 | Yes | Yes | 10 | 0 |
| | 12 | 55 | Yes | No | 6 | 0 |
| | 13 | 35 | Yes | Yes | 0 | 0 |
| | 14 | 56 | Yes | Yes | 6 | 6 |
| | 15 | 66 | Yes | No | 10 | 3 |
| | 16 | 41 | Yes | No | 5 | 2 |
| | 17 | 60 | Yes | No | 2 | 2 |
| | 18 | 60 | Yes | No | 8 | 4 |
| | 19 | 62 | Yes | Yes | 9 | 0 |
| | 20 | 60 | Yes | No | 3 | 0 |
| | 21 | n/a[1] | Yes | Yes | 8 | 4 |
| | 22 | n/a[1] | Yes | Yes | 6 | 1 |
| | 23 | 45 | Yes | No | 6 | 2 |
| | 24 | 40 | Yes | No | 10 | 6 |
| | 25 | 60 | Yes | No | 3 | 3 |
| | 26 | 45 | Yes | No | 12 | 5 |
| | 27 | 30 | Yes | No | 8 | 3 |
| | 28 | 36 | Yes | No | 5 | 0 |
| | 29 | 65 | Yes | Yes | 5 | 0 |
| | 30 | 70 | Yes | Yes | 8 | 4 |
| | 31 | 60 | Yes | Yes | 10 | 3 |
| | 32 | 35 | Yes | Yes | 7 | 1 |
| | 33 | 50 | Yes | Yes | 9 | 2 |
| | 34 | 36 | Yes | Yes | 4 | 0 |
| | 35 | 65 | Yes | Yes | 8 | 2 |
| | 36 | 30 | Yes | Yes | 6 | 0 |
| | 37 | 70 | Yes | Yes | 9 | 1 |
| | 38 | 40 | Yes | Yes | 10 | 1 |
| | 39 | 85 | Yes | Yes | 3 | 1 |
| | 40 | 41 | Yes | Yes | 8 | 4 |
| | 41 | 70 | Yes | Yes | 6 | 4 |
| | 42 | 35 | Yes | no data | 3 | 0 |
| | 43 | 30 | Yes | no data | 5 | 0 |
| | 44 | 50 | Yes | no data | 12 | 5 |
| | 45 | 35 | Yes | Yes | 8 | 1 |
| | 46 | 56 | Yes | Yes | 12 | 8 |
| | 47 | 55 | Yes | Yes | 9 | 0 |
| | 48 | 60 | Yes | Yes | 12 | 3 |
| | 49 | 50 | Yes | Yes | 9 | 5 |
| | 50 | 60 | Yes | Yes | 8 | 5 |

[1] Age was not given. However, donor was over 50 years of age by appearance.

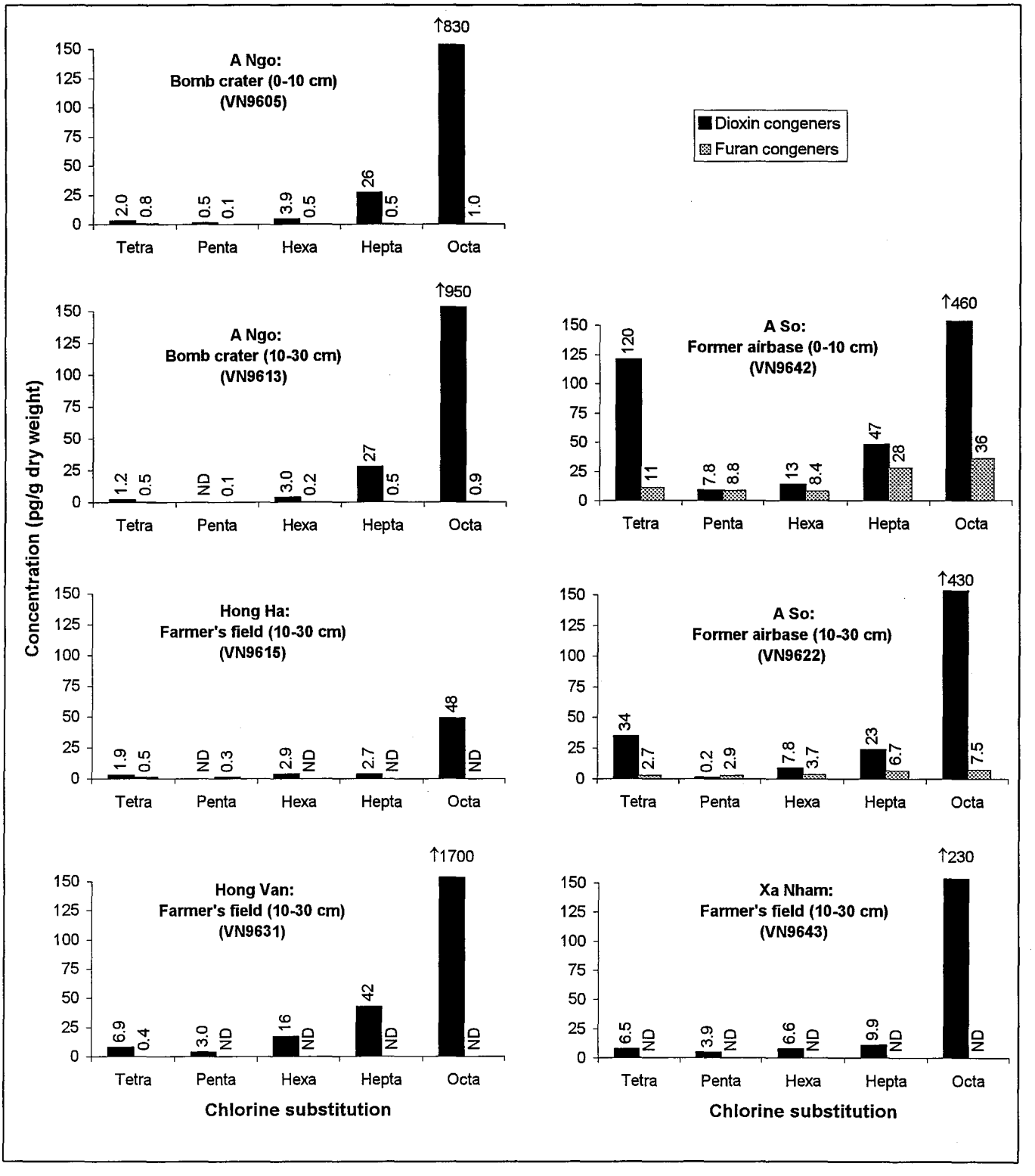
**Table A2.1.3 Cont'd.**

| Age Category | Donor Number | Age | Directly subjected to herbicide spray | Smoking | Number of Children | Child Mortality |
|---|---|---|---|---|---|---|
| **Males: 12-25 years old** | | | | | | |
| | 1 | 12 | No | No | 0 | 0 |
| | 2 | 23 | No | No | 1 | 0 |
| | 3 | 12 | No | No | 0 | 0 |
| | 4 | 18 | No | Yes | 0 | 0 |
| | 5 | 12 | No | No | 0 | 0 |
| | 6 | 19 | No | No | 0 | 0 |
| | 7 | 20 | No | Yes | 0 | 0 |
| | 8 | 20 | No | Yes | 1 | 0 |
| | 9 | 25 | No | Yes | 7 | 0 |
| | 10 | 15 | No | No | 0 | 0 |
| | 11 | 23 | No | Yes | 1 | 0 |
| | 12 | 12 | No | No | 0 | 0 |
| | 13 | 23 | No | Yes | 0 | 0 |
| | 14 | 16 | No | Yes | 4 | 0 |
| | 15 | 18 | No | No | 0 | 0 |
| | 16 | 15 | No | No | 0 | 0 |
| | 17 | 25 | No | Yes | 6 | 1 |
| | 18 | 15 | No | No | 0 | 0 |
| | 19 | 15 | No | No | 0 | 0 |
| | 20 | 18 | No | No | 0 | 0 |
| | 21 | 19 | No | No | 0 | 0 |
| | 22 | 16 | No | No | 0 | 0 |
| | 23 | 24 | No | No | 3 | 0 |
| | 24 | 23 | No | Yes | 1 | 0 |
| | 25 | 22 | No | Yes | 2 | 0 |
| | 26 | 19 | No | Yes | 0 | 0 |
| | 27 | 16 | No | Yes | 0 | 0 |
| | 28 | 24 | No | Yes | 5 | 2 |
| | 29 | 18 | No | Yes | 0 | 0 |
| | 30 | 15 | No | No | 0 | 0 |
| | 31 | 15 | No | No | 0 | 0 |
| | 32 | 24 | No | No | 1 | 0 |
| | 33 | 22 | No | Yes | 0 | 0 |
| | 34 | 18 | No | No | 0 | 0 |
| | 35 | 16 | No | Yes | 0 | 0 |
| | 36 | 18 | No | No | 0 | 0 |
| | 37 | 12 | No | No | 0 | 0 |
| | 38 | 15 | No | No | 0 | 0 |
| | 39 | 25 | No | Yes | 4 | 1 |
| | 40 | 25 | No | Yes | 3 | 2 |
| | 41 | 23 | No | No | 0 | 0 |
| | 42 | 15 | No | No | 0 | 0 |
| | 43 | 25 | No | No | 9 | 0 |
| | 44 | 22 | No | No | 0 | 0 |
| | 45 | 25 | No | Yes | 0 | 0 |
| | 46 | 23 | No | No | 0 | 0 |
| | 47 | 21 | No | No | 0 | 0 |
| | 48 | 25 | Yes | No | 0 | 0 |
| | 49 | 25 | No | No | 0 | 0 |
| | 50 | 15 | No | No | 0 | 0 |

**Table A2.1.3 Cont'd.**

| Age Category | Donor Number | Age | Directly subjected to herbicide spray | Smoking | Number of Children | Child Mortality |
|---|---|---|---|---|---|---|
| **Females: 12-25 years old** | | | | | | |
| | 1 | 25 | No | No | 5 | 4 |
| | 2 | 25 | No | No | 6 | 0 |
| | 3 | 25 | No | No | 1 | 0 |
| | 4 | 21 | No | No | 3 | 1 |
| | 5 | 23 | No | No | 4 | 1 |
| | 6 | 25 | No | Yes | 3 | 0 |
| | 7 | 25 | No | Yes | 3 | 0 |
| | 8 | 23 | No | No | 1 | 0 |
| | 9 | 24 | No | Yes | 1 | 0 |
| | 10 | 20 | No | Yes | 2 | 0 |
| | 11 | 22 | No | Yes | 3 | 0 |
| | 12 | 25 | No | Yes | 2 | 2 |
| | 13 | 25 | No | Yes | 5 | 0 |
| | 14 | 25 | No | Yes | 5 | 1 |
| | 15 | 23 | No | Yes | 5 | 2 |
| | 16 | 21 | No | No | 1 | 0 |
| | 17 | 22 | No | No | 3 | 1 |
| | 18 | 21 | No | No | 2 | 0 |
| | 19 | 21 | No | No | 2 | 0 |
| | 20 | 25 | No | Yes | 2 | 0 |
| | 21 | 18 | No | No | 0 | 0 |
| | 22 | 20 | No | No | 1 | 0 |
| | 23 | 25 | No | Yes | 4 | 2 |
| | 24 | 21 | No | Yes | 2 | 1 |
| | 25 | 25 | No | No | 0 | 0 |
| | 26 | 24 | No | No | 5 | 3 |
| | 27 | 25 | No | No | 0 | 0 |
| | 28 | 25 | No | No | 2 | 0 |
| | 29 | 21 | No | No | 7 | 0 |
| | 30 | 21 | No | No | 2 | 0 |
| | 31 | 25 | No | Yes | 3 | 1 |
| | 32 | 21 | No | No | 1 | 0 |
| | 33 | 25 | No | No | 3 | 2 |
| | 34 | 19 | No | No | 0 | 0 |
| | 35 | 20 | No | Yes | 3 | 2 |
| | 36 | 15 | No | No | 0 | 0 |
| | 37 | 12 | No | No | 0 | 0 |
| | 38 | 12 | No | No | 0 | 0 |
| | 39 | 18 | No | No | 0 | 0 |
| | 40 | 23 | No | No | 4 | 0 |
| | 41 | 20 | No | No | 2 | 0 |
| | 42 | 15 | No | No | 0 | 0 |
| | 43 | 15 | No | No | 0 | 0 |
| | 44 | 15 | No | No | 0 | 0 |
| | 45 | 15 | No | No | 0 | 0 |
| | 46 | 25 | No | No | 0 | 0 |
| | 47 | 25 | No | No | 2 | 0 |
| | 48 | 12 | No | No | 0 | 0 |
| | 49 | 24 | No | No | 0 | 0 |
| | 50 | 15 | No | No | 0 | 0 |

**Figure A2.1.1 Congener profiles of dioxins and furans in surficial soils collected from the Aluoi Valley, central Viet Nam, January 1996.**



## Figure A2.1.2 Congener profiles of dioxins and furans in surficial soils and aquatic sediments collected from central Viet Nam, January 1996

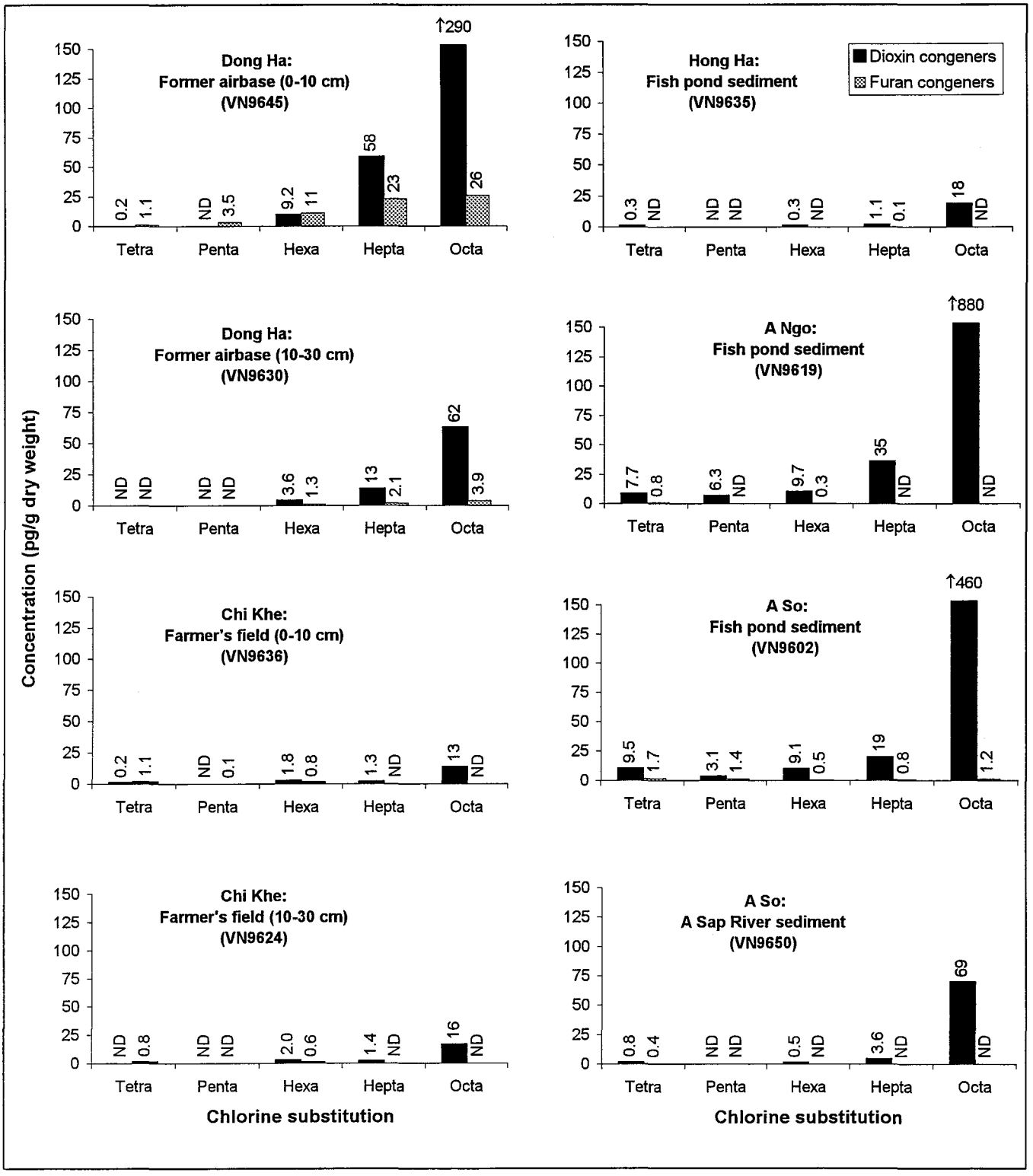


**Figure A2.1.3 Congener profiles of dioxins and furans in fish tissues collected from various locations in central Viet Nam, January 1996.**

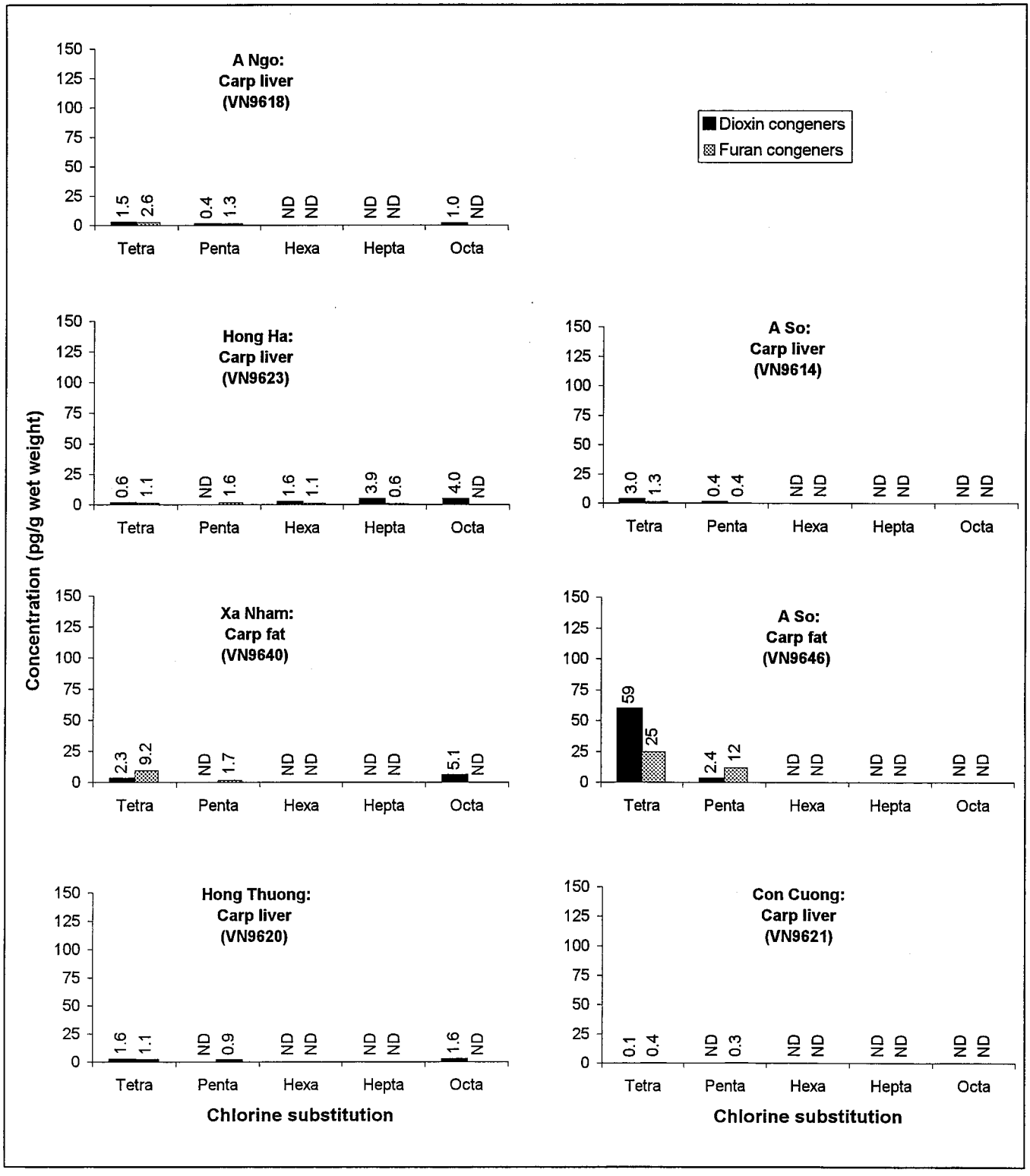


**Figure A2.1.4 Congener profiles of dioxins and furans in biological tissues collected from various locations in central Viet Nam, January 1996.**

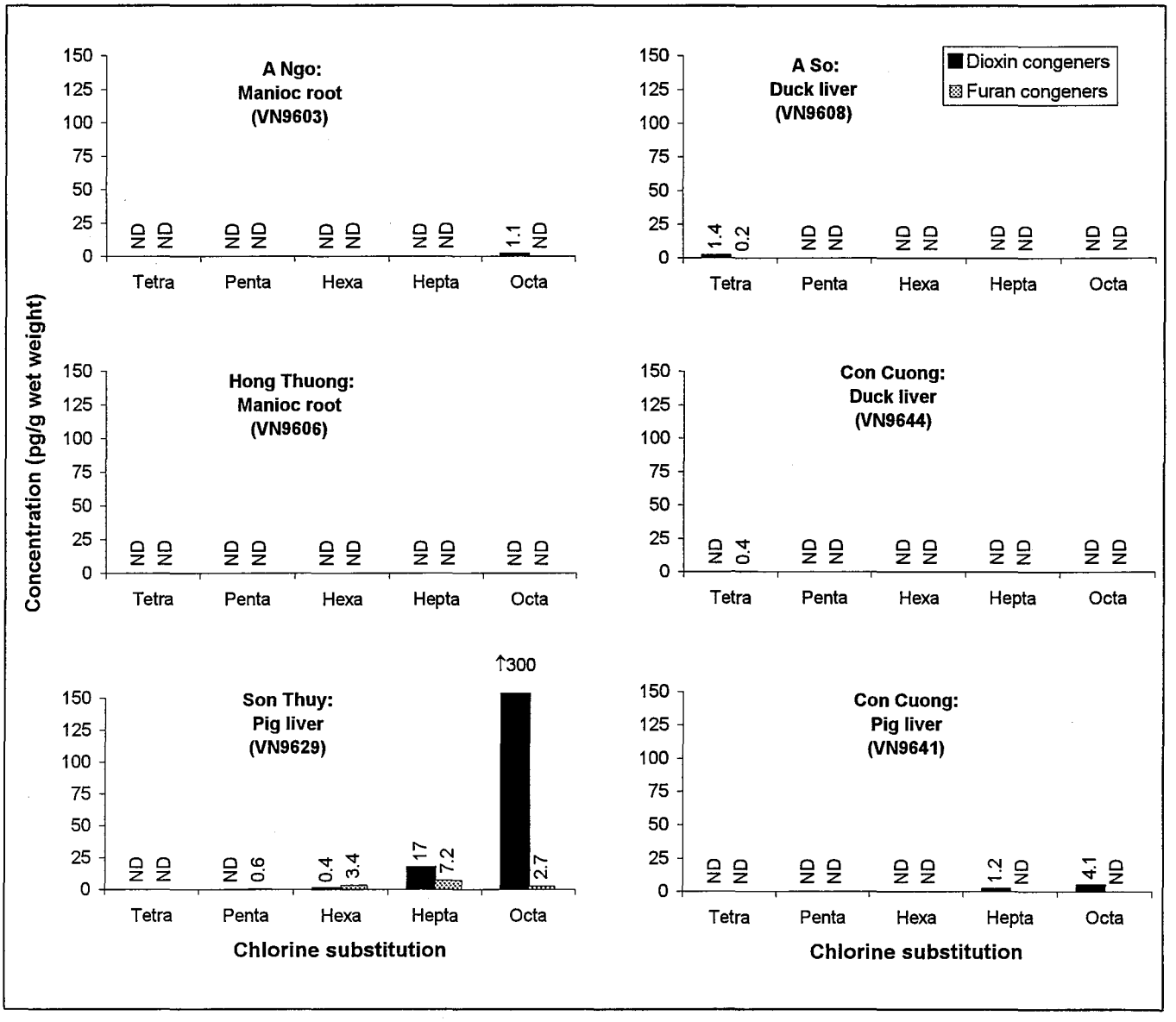
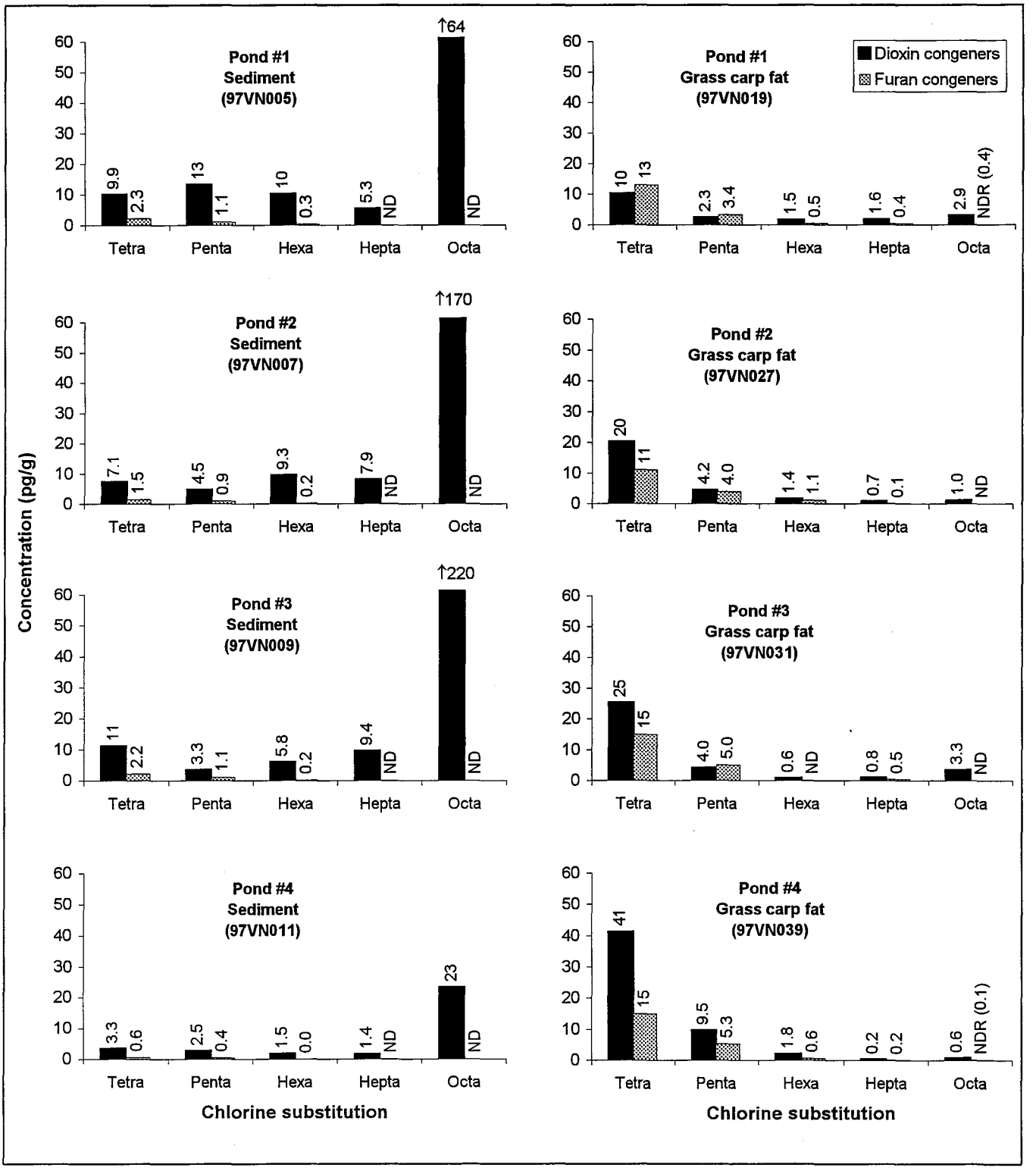
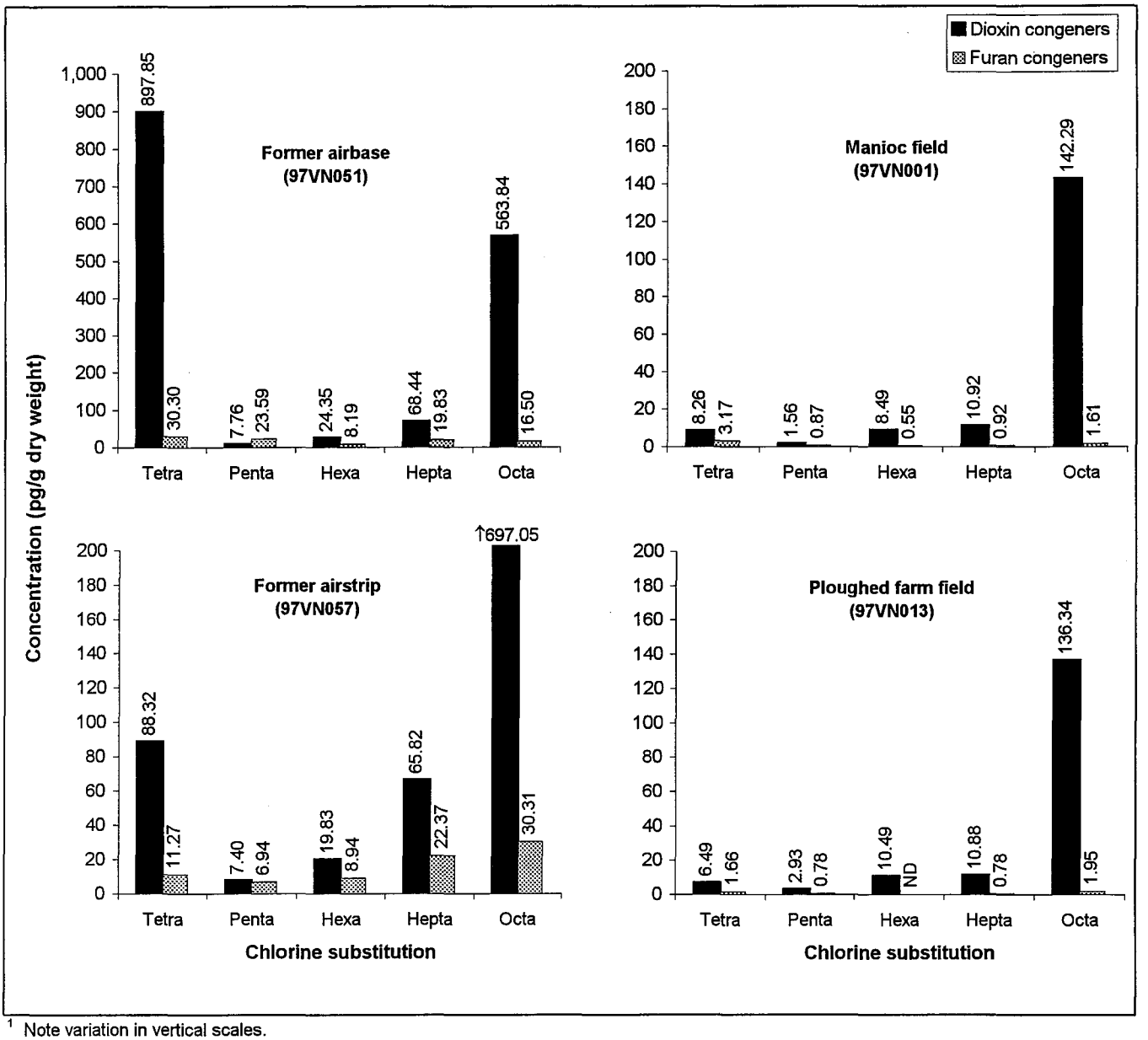


**Figure A2.1.5 Congener profiles of dioxins and furans in fish pond sediments (pg/g dry weight) and grass carp fat (pg/g wet weight) collected from A So, Aluoi Valley, central Viet Nam, November 1997.**




VN614:tbl4.4_97data_3.XLS

## Figure A2.1.6 Congener profiles of dioxins and furans in surficial soils (0 to 10 cm depth) collected from A So, Aluoi Valley, central Viet Nam, November 1997.[1]




[1] Note variation in vertical scales.

**Figure A2.1.7 Congener profiles of dioxins and furans in whole human blood (lipid fraction) collected from A So, Aluoi Valley, central Viet Nam, November 1997.**

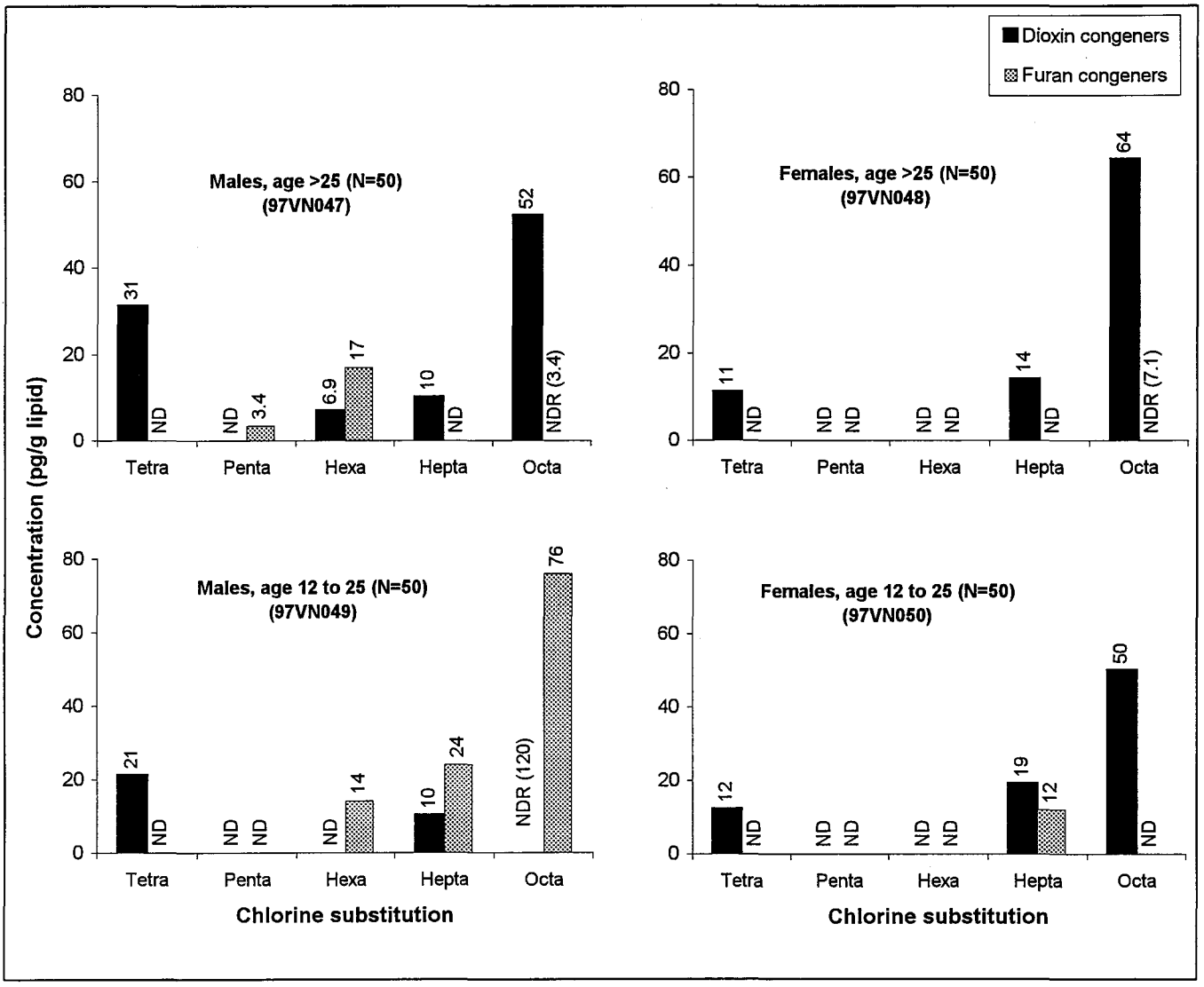


**Figure A2.1.8 Congener profiles of dioxins and furans in soils and fish pond sediments collected in the Ma Da forest region, southern Viet Nam, November 1997.**

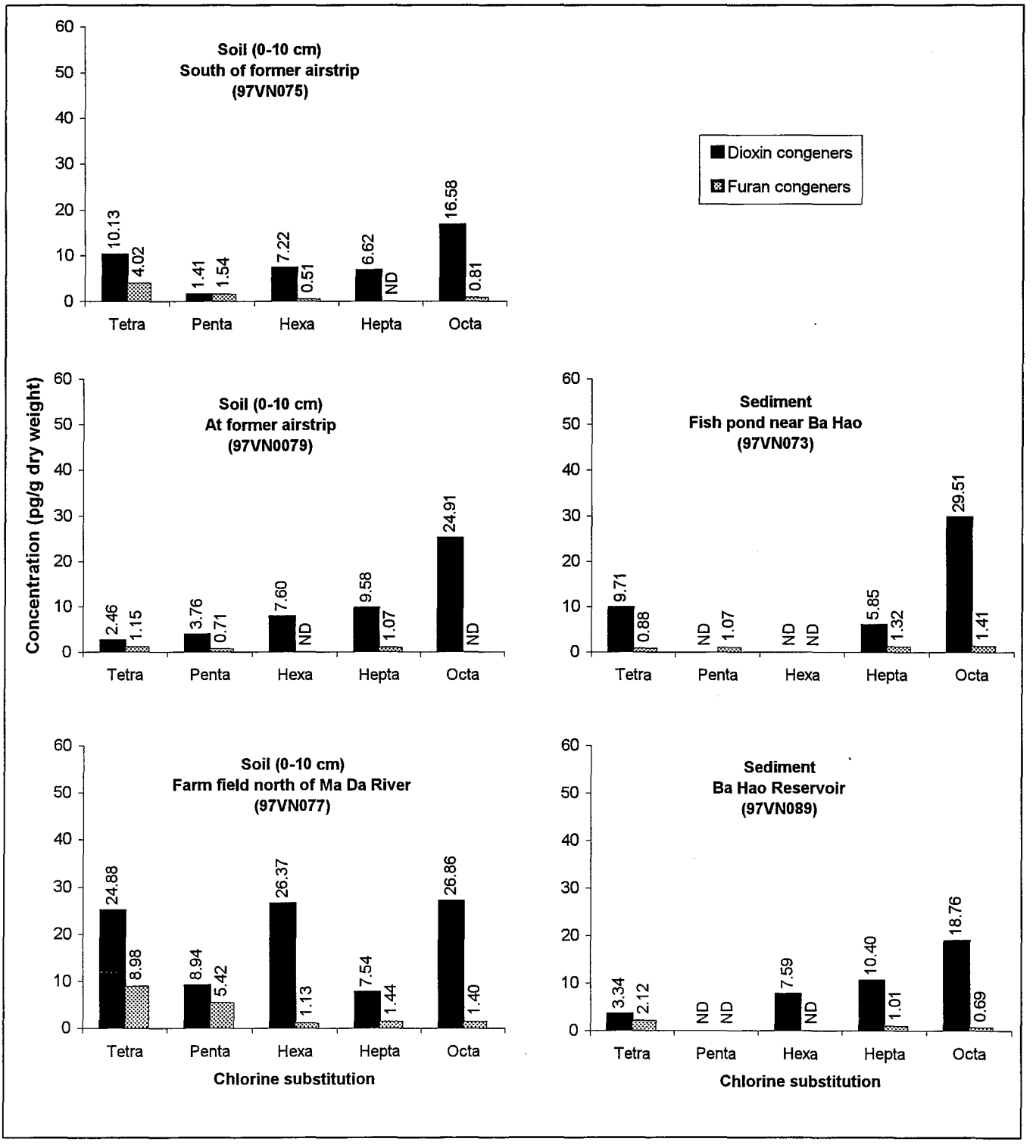
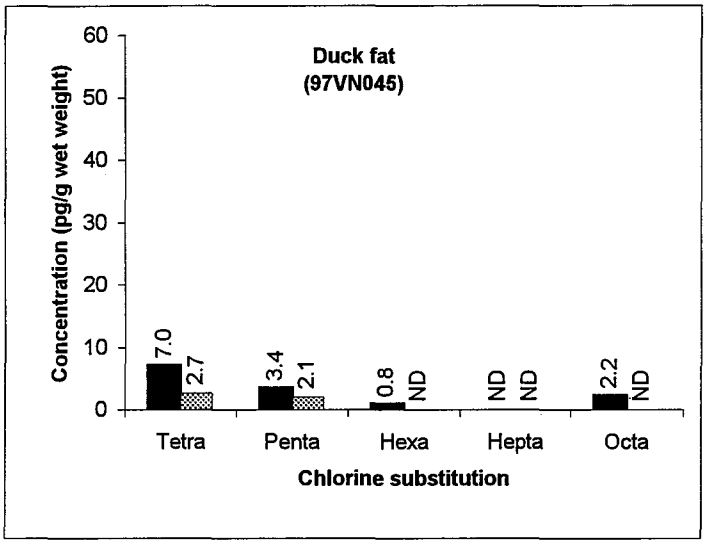


**Figure A2.1.9 Congener profiles of dioxins and furans in duck adipose tissue, collected at A So, Aluoi valley, central Viet Nam, November 1997.**



## Section 2

## Axys Analytical Report to Hatfield Consultants Ltd. October 1997

*Analytical Data on 1996 Viet Nam Samples*

# ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS, PCBs AND CHLORINATED PESTICIDES, AND HERBICIDES IN SAMPLES FROM VIETNAM

## FINAL REPORT

Prepared for:

HATFIELD CONSULTANTS LTD
Suite 201 - 1571 Bellevue Avenue
West Vancouver, BC V7V 3R6

Prepared by:

AXYS ANALYTICAL SERVICES
P.O. Box 2219, 2045 Mills Road West
Sidney, BC V8L 3S8

October 1997

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## 1. INTRODUCTION

Axys Analytical Services Ltd. was contracted by Hatfield Consultants Ltd. to conduct trace organic analyses on environmental samples from Vietnam. Fifteen soil and thirteen tissue samples were analyzed for polychlorinated dibenzodioxins and dibenzofurans. Six soil samples and three tissue samples were also analyzed for PCBs and chlorinated pesticides. Herbicide analyses on six soil samples were carried out by ASL Ltd, Vancouver, under subcontract to Axys. Table 1 presents a correlation between Axys ID and Hatfield sample descriptions and the analyses performed.

The sample handling protocols, analysis procedures and QA/QC results are documented in this final report. Complete data reports for all samples are presented. Results for QA/QC samples (procedural blanks, analysis duplicates, and internal reference material) are also presented.

## 2. SAMPLE HANDLING

The importation and storage of these samples were authorized by Agriculture Canada and all storage, sample handling and laboratory procedures satisfied the requirements of the Permit to Import Animal Specimens and Product Samples issued by Agriculture Canada.

All samples were shipped frozen to Axys. Upon receipt the samples were stored at -20°C. The samples were received and maintained using chain-of-custody procedures.

Just prior to analysis, samples were thawed and then homogenized using a Virtis blender or by hand stirring. A percent moisture determination was carried out on each sample. The thawing, homogenization, moisture determination and extraction procedures were carried out in a fumehood equipped with a HEPA filter. Once the extraction procedures were complete, the fumehood and glassware were washed with a phenol based disinfectant soap.

In addition, analysts wore disposable protective clothing and plastic gloves which were autoclaved after use. Residual extracted sample and spent reagents were also autoclaved. These materials were stored at Axys until disposal by Agriculture Canada.

## Table 1

## Correlation Betwen Axys Sample Number and Hatfield Sample Identification

| AXYS ID | Hatfield ID | MATRIX | ANALYSES* |
|---|---|---|---|
| 2607-01 | VN9615 | Sediment | DX |
| 2607-02 | VN9622 | Sediment | DX, OCP, HERB |
| 2607-03 | VN9624 | Sediment | DX, OCP, HERB |
| 2607-04 | VN9630 | Sediment | DX, OCP, HERB |
| 2607-05 | VN9631 | Sediment | DX |
| 2607-06 | VN9642 | Sediment | DX, OCP, HERB |
| 2607-07 | VN9643 | Sediment | DX |
| 2607-08 | VN9645 | Sediment | DX, OCP, HERB |
| 2607-09 | VN9650 | Sediment | DX |
| 2607-10 | VN9605 | Sediment | DX |
| 2607-11 | VN9613 | Sediment | DX |
| 2607-12 | VN9619 | Sediment | DX |
| 2607-13 | VN9635 | Sediment | DX |
| 2607-14 | VN9636 | Sediment | DX, OCP, HERB |
| 2607-15 | VN9603 | Plant | DX |
| 2607-16 | VN9614 | Tissue | DX |
| 2607-17 | VN9618 | Tissue | DX |
| 2607-18 | VN9620 | Tissue | DX |
| 2607-19 | VN9621 | Tissue | DX |
| 2607-20 | VN9623 | Tissue | DX |
| 2607-21 | VN9629 | Tissue | DX, OCP |
| 2607-22 | VN9640 | Tissue | DX |
| 2607-23 | VN9646 | Tissue | DX, OCP |
| 2607-24 | VN9606 | Plant | DX |
| 2607-25 | VN9608 | Tissue | DX |
| 2607-26 | VN9641 | Tissue | DX, OCP |
| 2607-27 | VN9644 | Tissue | DX |
| 2607-29 | VN9602 | Sediment | DX |

*DX = Dioxin/furan
OCP = PCB/pesticide
HERB = Herbicides

## 3. ANALYTICAL METHODS

A complete description of the analytical methods used is presented in Appendix I.

### 3.1 Polychlorinated Dibenzodioxins and Dibenzofurans

Each sample was spiked with an aliquot of surrogate standard solution containing nine $^{13}C$-labelled dioxin and furan congeners. Soil samples were soxhlet extracted. Tissue samples were ground with sodium sulphate and packed into an glass column which was eluted with solvent. Extracts were subject to a series of chromatographic cleanup steps prior to analysis by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).

A moisture determination was carried out on all samples. Tissue extracts were subsampled for percent lipid determination.

### 3.2 Chlorinated Pesticides and PCBs

Each samples was spiked with an aliquot of surrogate standard solution containing eight $^{13}C$-labelled pesticides and congeners and one deuterated pesticide. Soil samples were solvent extracted prior to cleanup and fractionation of silica gel. Tissue samples were ground with sodium sulphate and packed into a glass column which was eluted with solvent. One fraction was analyzed for PCBs and pesticides by gas chromatography with mass spectrometric detection. A second fraction was analyzed for the most polar pesticides by gas chromatography with electron capture detection (GC/ECD).

A moisture determination was carried out on all samples. Tissue extracts were subsampled for percent lipid determination.

### 3.3 Acid Extractable Herbicides

Soil samples were extracted at Axys using the protocols provided by ASL Ltd. Extracts were then shipped to ASL for analysis by GC/MS for herbicides.

## 4. ANALYTICAL RESULTS

Results were reported to Hatfield Consultants as the analyses were completed.

Dioxin/furan analysis reports for all samples and QA/QC samples are reported in Appendix II. Percent moisture and percent lipid are presented on each analysis report.

PCB/pesticide analysis reports for all samples and QA/QC samples are reported in Appendix III. Percent moisture and percent lipid are presented on each analysis report.

All concentrations have been corrected based on the percent recovery of surrogate standard. Concentrations are reported on a dry weight basis for soils and wet weight basis for tissues.

It should be noted that two samples analyzed for PCBs and pesticides (2607-03 and -14) required dilution and additional aliquots of surrogate standard. It was therefore not possible to report percent surrogate recoveries for these sample or to report recovery corrected concentrations. The concentrations reported for these two samples should be considered minimum concentrations.

The herbicide data report received from ASL is presented in Appendix IV. The data for the percent moisture determination is presented in Table 2 in Appendix IV.

## 5. QUALITY ASSURANCE/QUALITY CONTROL

Samples were worked up in batches with accompanying QC samples. Each batch progressed from sample workup through instrumental analysis and onto data interpretation and final reports as a unit. The sample results were reviewed and evaluated in relation to the QA/QC samples worked up at the same time.

The composition of each batch of samples analyzed is detailed in a Batch Summary presented in Appendix V. A procedural blank, analysis duplicate and reference sample were analyzed with each batch of samples.

### 5.1 Procedural Blanks

Overall, procedural blanks demonstrated non-detectable or low background levels of target compounds. It should be noted that for samples with low concentration of PCBs and

pesticides, the background level of hexachlorobenzene in blank CL-S-BLK 1107i may be significant and should be considered when reviewing the sample data.

### 5.2 Duplicates

Results for duplicates are reported along with the sample analysis results. Agreement within each set of duplicates satisfied Axys' criterion of ±(20% of the mean + Detection Limit)

### 5.3 Surrogate Standard Recoveries

The recovery of each surrogate standard was monitored by comparing its response to that of the recovery standard added just prior to instrumental analysis. The calculation of percent recovery is explained in Section 6.

Surrogate standard recoveries for each sample are presented along with the sample data, on each analysis report. Surrogate standard recoveries satisfied Axys' quality control standards criterion that they must be within an established acceptable range.

### 5.4 Reference Samples

A reference sample, either a spiked sample or certified reference material, was worked up with each batch of samples and used to demonstrate the accuracy of the data. Spiked samples were prepared at Axys by adding a solution of authentic target analytes into a weighed amount of in-house reference material. A sample of NIST 1588 Cod Oil was analyzed as a tissue reference sample for the PCB/pesticide analysis. The percent recovery of the target analytes generally fell within 70% - 130%, which meets Axys' criterion for acceptability.

### 5.5 Detection Limits

Detection limits were calculated on a sample-specific basis and are reported for each sample on the analysis report.

Detection limits were calculated using a minimum area based on the noise level in the chromatogram. The minimum area is the area of a peak with a height three times the maximum height of the noise. Only peaks with responses greater than three times the

background noise level were quantified. The calculation of detection limits is described in Section 6.

## 6. CALCULATIONS

The internal standard method was used to quantify components in the samples. $Conc_i$, the concentration of a component in a sample, was calculated using the following equations:

$$Conc_i = \frac{A_i}{A_{si}} \times \frac{W_{si}}{W_i} \times RRF_{i,si}$$

where $A_i$ = area of the analyte peak of interest to quantify

$A_{si}$ = area of labelled surrogate used to quantify i

$W_i$ = weight of sample taken for analysis

$W_{si}$ = weight of labelled surrogate added to sample

$RRF_{i,si}$ = relative response factor of i to si as determined by daily runs of the calibration standard solution and defined as

$$\frac{A_i}{A_{si}} \times \frac{W_{si}}{W_i}$$

Detection limits were also calculated using the above equations with the minimum detectable peak area used for $A_i$. The minimum detectable peak area was calculated as three times the maximum noise in the chromatogram (height of noise x area / height ratio of a typical peak x 3).

Recoveries of internal standards were calculated using the following equation.

$$\%Recovery = \frac{A_{si}}{A_{rs}} \times \frac{W_{rs}}{W_{si}} \times RRF_{si,rs}$$

where $A_{si}$ and $A_{rs}$ are the areas of the labelled surrogate and the recovery standard in the sample run and $W_{rs}$, $W_{si}$ are the weights of recovery standard and labelled surrogate added to the sample. $RRF_{si,rs}$ is the relative response factor of the labelled surrogate to the recovery standard as determined by daily runs of the quantification solution and defined by

$$\frac{A_{si}}{A_{rs}} \times \frac{W_{rs}}{W_{si}}$$

# Appendix I

# Analytical Methods

# ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS IN SOIL AND TISSUE SAMPLES


## Summary

All samples were spiked with $^{13}C$-labelled surrogate standards (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran, and octachlorodioxin) prior to analysis. Soil samples were soxhlet extracted. Tissue samples were ground with sodium sulphate, loaded into a glass chromatographic column and eluted with solvent. All extracts were subject to a series of chromatographic cleanup steps prior to analysis for polychlorinated dibenzodioxins and dibenzofurans by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).


## 1. EXTRACTION PROCEDURES

### Soils

A subsample of soil was dried overnight at 105°C to determine moisture content.

Soil sample was ground with anhydrous sodium sulphate, the mixture was transferred to a soxhlet thimble and an aliquot of surrogate standard solution added. The soxhlet was allowed to reflux for 16 hours with 80:20 toluene:acetone. The cooled extract was transferred to a separatory funnel and sequentially washed with potassium hydroxide solution, distilled water, concentrated sulphuric acid and distilled water. The organic layer was dried over anhydrous sodium sulphate, the solvent evaporated to dryness and the residue redissolved in hexane. The extract was ready for chromatographic cleanup procedures.

### Tissues

A subsample of tissue was dried overnight at 105°C to determine moisture content.

Tissue sample was ground with anhydrous sodium sulphate. The mixture was transferred to a glass chromatographic column containing 1:1 dichloromethane:hexane and an aliquot of surrogate standard solution was added. The column was eluted with additional solvent. The eluate was subsampled for gravimetric lipid determination. The remaining extract was concentrated, loaded onto a gel permeation column (to remove lipids and high molecular weight interferences) and eluted with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated prior to chromatographic cleanup procedures.

## 2. CHROMATOGRAPHIC CLEANUP PROCEDURES

a) Silica Gel Column

The extract was transferred to a layered silica gel column. Soil extracts were eluted with hexane. Tissue extracts were eluted with 1:1 dichloromethane:hexane. The eluate was concentrated by rotary evaporation.

b) Alumina Column

The extract from the silica gel column was loaded onto a basic alumina column. The first fraction, eluted with 3% dichloromethane:hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated by rotary evaporation.

c) Carbon/Celite Column

The extract from the alumina column was loaded onto a carbon/Celite column. The column was eluted with 1:1 cyclohexane:dichloromethane (discard) followed by 1:1 ethylacetate:toluene (discard). The column was inverted and eluted with toluene (collected). The fraction was evaporated to near dryness and redissolved in hexane.

d) Alumina Column

The extract from the carbon/Celite column was loaded onto a basic alumina column. The first fraction, eluted with hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated.

e) Preparation for GC/MS Analysis

The extract was evaporated just to dryness and aliquots of recovery standards ($^{13}$C-labelled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin) were added.

## 3. HIGH RESOLUTION GC/MS ANALYSIS

Polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF) were analyzed on an Ultima Autospec mass spectrometer equipped with a Hewlett Packard 5890 gas chromatograph, a DB-5 capillary chromatography column (60 m, 0.25 mm i.d x 0.1 $\mu$m film thickness) and a CTC autosampler. Data were acquired in the voltage selected ion recording mode (SIR) to enhance sensitivity. At least two ions were used to monitor each of the target analytes and $^{13}$C-labelled surrogate standards. Five additional ions were monitored to check for interference from chlorinated diphenyl ethers.

The instrumental conditions, analyte identification and quantification protocols for PCDDs/PCDFs, as described in Environment Canada Report EPS 1/RM/19, February 1992[1] were strictly adhered to.

## 4. QUANTITATION PROCEDURES

Concentrations of target analytes were calculated using the isotope dilution method of quantitation. PCDDs and PCDFs were quantified by comparing the area of the quantification ion to that of the corresponding $^{13}$C-labelled surrogate standard and correcting for response factors. Response factors were determined daily using authentic PCDDS and PCDFs.

Concentrations of analytes were corrected based on the percent recovery of surrogate standards. Concentrations are reported in pg/g dry weight for soils and pg/g wet weight for

tissues.

Sample detection limits are reported for each target analyte, based on a minimum detectable area for that compound in the chromatogram.

## REFERENCES

1. Environment Canada Reference Method EPS 1/RM/19, *Reference Method for the Determination of Polychlorinated Dibenzo-para-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) in Pulp and Paper Mill Effluents,* February 1992.

# ANALYSIS OF PCBs AND CHLORINATED PESTICIDES IN SOIL AND TISSUE SAMPLES


## Summary

All samples were spiked with a suite of $^{13}C$-labelled surrogate standards (hexachlorobenzene, gamma-BHC, p,p'-DDE, p,p'-DDT, Mirex, PCB 101, PCB 180, and PCB 209) and per-deuterated alpha-endosulphan. Soil samples were solvent extracted. Tissue samples were extracted by grinding with sodium sulphate followed by elution through a glass column with solvent. The final extracts were separated into two fractions on a Florisil column. One fraction was analyzed by high resolution gas chromatography with detection by either quadrupole or high resolution mass spectrometry for PCBs (as Aroclors) and non-polar and moderately polar chlorinated pesticides. A second fraction was analyzed for the most polar chlorinated pesticides by gas chromatography with election capture detection (GC/ECD).


## 1. EXTRACTION PROCEDURES

### Soils

A moisture determination was carried out on a subsample by drying overnight at 105°C.

A homogenized soil sample was spiked with an aliquot of surrogate standard. The sample was extracted by shaking with 1:1 dichloromethane:methanol followed by dichloromethane. The extracts were combined. The extract was washed with solvent-extracted distilled water to remove methanol. The dichloromethane extract was dried over anhydrous sodium sulphate and concentrated. The extract was ready for chromatographic cleanup procedures.

### Tissue

A moisture determination was carried out on a subsample by drying overnight at 105°C.

A homogenized wet tissue sample was ground with anhydrous sodium sulphate. The mixture was transferred to a glass chromatographic column containing dichloromethane and an aliquot of surrogate standard solution added. The column was eluted with additional solvent. The eluate was collected and concentrated. The extract was subsampled for gravimetric lipid determination.

The remaining extract was loaded in dichloromethane onto a calibrated gel permeation which was eluted with 1:1 dichloromethane:hexane. The 160 - 320 mL fraction was collected and concentrated by rotary evaporation. The extract was ready for chromatographic cleanup procedures.

## 2. CHROMATOGRAPHIC CLEANUP PROCEDURES

The extract was applied to a Florisil column. The column was eluted with hexane (F1) followed by 15:85 dichloromethane:hexane (F2). The eluates were combined (F1 + F2). The column was eluted with 1:1 dichloromethane:hexane (F3) and the eluate collected. Each fraction was concentrated.

F1 + F2 was transferred to an autosampler vial and an aliquot of recovery standard ($^{13}$C-labelled PCB 153) added. The autosampler vial was capped ready for analysis of non-polar and moderately polar chlorinated pesticides.

F3 + F4 was transferred to an autosampler vial and an aliquot of recovery standard ($^{13}$C-labelled PCB 153) added. The autosampler vial was capped ready for GC/ECD analysis of polar chlorinated pesticides.

## 3. INSTRUMENTAL ANALYSIS

The GC/MS analysis of tissue extracts (F1 + F2) for PCBs and chlorinated pesticides was carried out using a Finnigan INCOS 50 mass spectrometer equipped with a Varian 3400 GC, a CTC autosampler and a DG 10 data system running Incos 50 (Rev 11) software or a VG SE 70 high resolution mass spectrometer (MS) equipped with a Hewlett Packard 5890 gas chromatograph, a CTC autosampler and a VAX work station. Data were acquired in the Multiple Ion Detection (MID) mode to enhance sensitivity. Two characteristic ions for each target analyte and surrogate standard were monitored.

Chromatographic separation was achieved with a DB-5 capillary chromatography column (60 m, 0.25 mm i.d x 0.1 $\mu$m film thickness). A splitless/split injection sequence was used.

### GC/ECD Analysis

Chlorinated pesticides in F3 + F4 were analyzed by GC/ECD using a Hewlett Packard 5890 gas chromatograph, with a $^{63}$Ni electron capture detector and a DB5 Durabond Fused Silica capillary column (60 m x 0.25 mm, 0.10 $\mu$m film).

## 4. QUANTITATION PROCEDURES

Concentrations of target analytes were calculated using the isotope dilution method of quantitation. Compounds were quantified by comparing the area of the quantification ion to that of the corresponding $^{13}$C-labelled standard and correcting for response factors. Response factors were determined daily using authentic pesticides.

Concentrations of analytes have been corrected based on the percent recovery of surrogate standards. Concentrations have been reported in ng/g dry weight for soils and ng/g wet weight for tissues.

PCBs are reported as concentrations of Aroclor 1242, 1254, and 1260.

## EXTRACTION OF SOILS FOR ACID EXTRACTABLE HERBICIDES

A subsample of soil was dried overnight at 105°C to determine moisture content.

An aliquot of surrogate standard solution (2,4-dichlorophenylacetic acid, 100 ppm) was added to an accurately weighed sample (15 g) in a clean centrifuge tube. The mixture was extracted by shaking for 30 minutes with acidified acetone (25 mL, 1% HCl). The mixture was spun in a centrifuge and the acetone decanted into a clean glass container. The extraction step was repeated twice more with acidified 1:1 acetone:diethylether (25 mL, 1% HCl). The organic extracts were combined and shipped to ASL for analysis of acid extractable herbicides by GC/MS

# Appendix II

# Dioxin/Furan Analysis Reports

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9615**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.53 g dry**

**% MOISTURE: 16**

**Hong Ha**
Soil (10 – 30 cm)
Farmer's Field

**AXYS FILE: 2607-01 A**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 1.9 | 0.2 | T4CDF - Total | 0.5 | 0.2 |
| 2,3,7,8 | 1.7 | 0.2 | 2,3,7,8 | 0.2 | 0.2 |
| P5CDD - Total | ND | 0.2 | P5CDF - Total | 0.3 | 0.2 |
| 1,2,3,7,8 | ND | 0.2 | 1,2,3,7,8 | ND | 0.2 |
| | | | 2,3,4,7,8 | ND | 0.2 |
| H6CDD - Total | 2.9 | 0.4 | H6CDF - Total | ND | 0.4 |
| 1,2,3,4,7,8 | ND | 0.4 | 1,2,3,4,7,8 | ND | 0.4 |
| 1,2,3,6,7,8 | ND | 0.4 | 1,2,3,6,7,8 | ND | 0.4 |
| 1,2,3,7,8,9 | 0.6 | 0.4 | 2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,7,8,9 | ND | 0.4 |
| H7CDD - Total | 2.7 | 0.6 | H7CDF - Total | ND | 0.6 |
| 1,2,3,4,6,7,8 | 1.6 | 0.6 | 1,2,3,4,6,7,8 | ND | 0.6 |
| | | | 1,2,3,4,7,8,9 | ND | 0.6 |
| O8CDD - Total | 48 | 0.9 | O8CDF - Total | ND | 0.9 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 77 |
| 13C-T4CDD | 69 |
| 13C-P5CDF | 68 |
| 13C-P5CDD | 59 |
| 13C-H6CDF | 79 |
| 13C-H6CDD | 63 |
| 13C-H7CDF | 69 |
| 13C-H7CDD | 77 |
| 13C-O8CDD | 42 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.1 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9615**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.60 g dry**

**% MOISTURE: 16**

**Hong Ha**
Soil (10 – 30 cm)
Farmer's Field

**AXYS FILE: 2607-01 B**
**Duplicate**
**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.9 | 0.2 | **T4CDF - Total** | 0.2 | 0.2 |
| **2,3,7,8** | 1.7 | 0.2 | **2,3,7,8** | 0.2 | 0.2 |
| **P5CDD - Total** | ND | 0.2 | **P5CDF - Total** | 0.4 | 0.2 |
| **1,2,3,7,8** | ND | 0.2 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | ND | 0.2 |
| **H6CDD - Total** | 2.5 | 0.4 | **H6CDF - Total** | ND | 0.4 |
| **1,2,3,4,7,8** | ND | 0.4 | **1,2,3,4,7,8** | ND | 0.4 |
| **1,2,3,6,7,8** | ND | 0.4 | **1,2,3,6,7,8** | ND | 0.4 |
| **1,2,3,7,8,9** | 0.6 | 0.4 | **2,3,4,6,7,8** | ND | 0.4 |
| | | | **1,2,3,7,8,9** | ND | 0.4 |
| **H7CDD - Total** | 2.5 | 0.6 | **H7CDF - Total** | ND | 0.6 |
| **1,2,3,4,6,7,8** | 1.4 | 0.6 | **1,2,3,4,6,7,8** | ND | 0.6 |
| | | | **1,2,3,4,7,8,9** | ND | 0.6 |
| **O8CDD - Total** | 52 | 0.9 | **O8CDF - Total** | ND | 0.9 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 100 |
| **13C-T4CDD** | 87 |
| **13C-P5CDF** | 92 |
| **13C-P5CDD** | 82 |
| **13C-H6CDF** | 89 |
| **13C-H6CDD** | 82 |
| **13C-H7CDF** | 110 |
| **13C-H7CDD** | 100 |
| **13C-O8CDD** | 70 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.1 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9622**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.89 g dry**

**% MOISTURE: 15**

**A So**
Soil (10 – 30 cm)
Abandoned Airbase

**AXYS FILE: 2607-02**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 34 | 0.2 | T4CDF - Total | 2.7 | 0.2 |
| 2,3,7,8 | 32 | 0.2 | 2,3,7,8 | 1.1 | 0.2 |
| P5CDD - Total | 0.2 | 0.2 | P5CDF - Total | 2.9 | 0.2 |
| 1,2,3,7,8 | NDR(0.4) | 0.2 | 1,2,3,7,8 | 0.2 | 0.2 |
| | | | 2,3,4,7,8 | 0.2 | 0.2 |
| H6CDD - Total | 7.8 | 0.3 | H6CDF - Total | 3.7 | 0.3 |
| 1,2,3,4,7,8 | 0.3 | 0.3 | 1,2,3,4,7,8 | 0.7 | 0.3 |
| 1,2,3,6,7,8 | 0.7 | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | 2.2 | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | 23 | 0.6 | H7CDF - Total | 6.7 | 0.6 |
| 1,2,3,4,6,7,8 | 12 | 0.6 | 1,2,3,4,6,7,8 | 2.4 | 0.6 |
| | | | 1,2,3,4,7,8,9 | ND | 0.6 |
| O8CDD - Total | 430 | 0.9 | O8CDF - Total | 7.5 | 0.9 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 93 |
| 13C-T4CDD | 83 |
| 13C-P5CDF | 86 |
| 13C-P5CDD | 77 |
| 13C-H6CDF | 89 |
| 13C-H6CDD | 80 |
| 13C-H7CDF | 97 |
| 13C-H7CDD | 85 |
| 13C-O8CDD | 46 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

| | |
|---|---|
| 2,3,7,8 - TCDD TEQs (ND=1/2 DL) = | 33.3 pg/g |
| 2,3,7,8 - TCDD TEQs (ND=0) = | 33.2 pg/g |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9624**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.82 g dry**

**% MOISTURE: 12**

**Chi Khe**
Soil (10 – 30 cm)
Farmer's Field
(Reference)

**AXYS FILE: 2607-03**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | ND | 0.2 | **T4CDF - Total** | 0.8 | 0.2 |
| **2,3,7,8** | ND | 0.2 | **2,3,7,8** | ND | 0.2 |
| **P5CDD - Total** | ND | 0.2 | **P5CDF - Total** | ND | 0.2 |
| **1,2,3,7,8** | ND | 0.2 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | ND | 0.2 |
| **H6CDD - Total** | 2.0 | 0.3 | **H6CDF - Total** | 0.6 | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | 0.7 | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | 1.3 | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | 0.6 | 0.3 |
| **H7CDD - Total** | 1.4 | 0.6 | **H7CDF - Total** | ND | 0.6 |
| **1,2,3,4,6,7,8** | 0.7 | 0.6 | **1,2,3,4,6,7,8** | ND | 0.6 |
| | | | **1,2,3,4,7,8,9** | ND | 0.6 |
| **O8CDD - Total** | 16 | 0.9 | **O8CDF - Total** | ND | 0.9 |

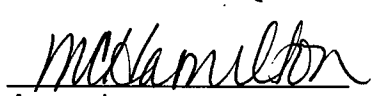
| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 83 |
| **13C-T4CDD** | 79 |
| **13C-P5CDF** | 79 |
| **13C-P5CDD** | 67 |
| **13C-H6CDF** | 100 |
| **13C-H6CDD** | 85 |
| **13C-H7CDF** | 96 |
| **13C-H7CDD** | 92 |
| **13C-O8CDD** | 94 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.3 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.



**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9630**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.88 g dry**

**% MOISTURE: 23**

**Dong Ha**
Soil (10 – 30 cm)
Abandoned Airbase

**AXYS FILE: 2607-04**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.2 | T4CDF - Total | ND | 0.2 |
| 2,3,7,8 | ND | 0.2 | 2,3,7,8 | ND | 0.2 |
| P5CDD - Total | ND | 0.2 | P5CDF - Total | ND | 0.2 |
| 1,2,3,7,8 | ND | 0.2 | 1,2,3,7,8 | ND | 0.2 |
| | | | 2,3,4,7,8 | ND | 0.2 |
| H6CDD - Total | 3.6 | 0.4 | H6CDF - Total | 1.3 | 0.4 |
| 1,2,3,4,7,8 | ND | 0.4 | 1,2,3,4,7,8 | ND | 0.4 |
| 1,2,3,6,7,8 | 0.5 | 0.4 | 1,2,3,6,7,8 | ND | 0.4 |
| 1,2,3,7,8,9 | 0.5 | 0.4 | 2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,7,8,9 | ND | 0.4 |
| H7CDD - Total | 13 | 0.6 | H7CDF - Total | 2.1 | 0.6 |
| 1,2,3,4,6,7,8 | 6.5 | 0.6 | 1,2,3,4,6,7,8 | NDR(1.5) | 0.6 |
| | | | 1,2,3,4,7,8,9 | ND | 0.6 |
| O8CDD - Total | 62 | 1.0 | O8CDF - Total | 3.9 | 1.0 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 100 |
| 13C-T4CDD | 88 |
| 13C-P5CDF | 79 |
| 13C-P5CDD | 73 |
| 13C-H6CDF | 110 |
| 13C-H6CDD | 86 |
| 13C-H7CDF | 92 |
| 13C-H7CDD | 89 |
| 13C-O8CDD | 79 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9631**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.78 g dry**

**% MOISTURE: 23**

**Xa Nham**
Soil (10 – 30 cm)
Farmer's Field

**AXYS FILE: 2607-05**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 6.5 | 0.2 | T4CDF - Total | ND | 0.2 |
| 2,3,7,8 | 4.3 | 0.2 | 2,3,7,8 | ND | 0.2 |
| P5CDD - Total | 3.9 | 0.2 | P5CDF - Total | ND | 0.2 |
| 1,2,3,7,8 | NDR(0.4) | 0.2 | 1,2,3,7,8 | ND | 0.2 |
| | | | 2,3,4,7,8 | ND | 0.2 |
| H6CDD - Total | 6.6 | 0.4 | H6CDF - Total | ND | 0.4 |
| 1,2,3,4,7,8 | ND | 0.4 | 1,2,3,4,7,8 | ND | 0.4 |
| 1,2,3,6,7,8 | 0.5 | 0.4 | 1,2,3,6,7,8 | ND | 0.4 |
| 1,2,3,7,8,9 | 1.0 | 0.4 | 2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,7,8,9 | ND | 0.4 |
| H7CDD - Total | 9.9 | 0.6 | H7CDF - Total | ND | 0.6 |
| 1,2,3,4,6,7,8 | 5.3 | 0.6 | 1,2,3,4,6,7,8 | NDR(0.8) | 0.6 |
| | | | 1,2,3,4,7,8,9 | ND | 0.6 |
| O8CDD - Total | 230 | 1.0 | O8CDF - Total | ND | 1.0 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 100 |
| 13C-T4CDD | 88 |
| 13C-P5CDF | 110 |
| 13C-P5CDD | 73 |
| 13C-H6CDF | 92 |
| 13C-H6CDD | 92 |
| 13C-H7CDF | 86 |
| 13C-H7CDD | 88 |
| 13C-O8CDD | 90 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

| | |
|---|---|
| 2,3,7,8 - TCDD TEQs (ND=1/2 DL) = | 5.0 pg/g |
| 2,3,7,8 - TCDD TEQs (ND=0) = | 4.7 pg/g |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9642**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.18 g dry**

**% MOISTURE: 21**

**A So**
Soil (0 – 10 cm)
Abandoned Airbase

**AXYS FILE: 2607-06**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 120 | 0.2 | **T4CDF - Total** | 11 | 0.2 |
| **2,3,7,8** | 110 | 0.2 | **2,3,7,8** | 3.6 | 0.2 |
| **P5CDD - Total** | 7.8 | 0.2 | **P5CDF - Total** | 8.8 | 0.2 |
| **1,2,3,7,8** | 1.1 | 0.2 | **1,2,3,7,8** | 0.4 | 0.2 |
| | | | **2,3,4,7,8** | 0.5 | 0.2 |
| **H6CDD - Total** | 13 | 0.4 | **H6CDF - Total** | 8.4 | 0.4 |
| **1,2,3,4,7,8** | 0.6 | 0.4 | **1,2,3,4,7,8** | 0.7 | 0.4 |
| **1,2,3,6,7,8** | 1.5 | 0.4 | **1,2,3,6,7,8** | 0.4 | 0.4 |
| **1,2,3,7,8,9** | 1.7 | 0.4 | **2,3,4,6,7,8** | ND | 0.4 |
| | | | **1,2,3,7,8,9** | ND | 0.4 |
| **H7CDD - Total** | 47 | 0.6 | **H7CDF - Total** | 28 | 0.6 |
| **1,2,3,4,6,7,8** | 27 | 0.6 | **1,2,3,4,6,7,8** | 7.8 | 0.6 |
| | | | **1,2,3,4,7,8,9** | ND | 0.6 |
| **O8CDD - Total** | 460 | 1.0 | **O8CDF - Total** | 36 | 1.0 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 77 |
| **13C-T4CDD** | 55 |
| **13C-P5CDF** | 66 |
| **13C-P5CDD** | 61 |
| **13C-H6CDF** | 76 |
| **13C-H6CDD** | 80 |
| **13C-H7CDF** | 75 |
| **13C-H7CDD** | 77 |
| **13C-O8CDD** | 57 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 112.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 112.5 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9643**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.14 g dry**

**% MOISTURE: 20**

**Hong Van**
Soil (10 – 30 cm)
Farmer's Field

**AXYS FILE: 2607-07**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 6.9 | 0.2 | **T4CDF - Total** | 0.4 | 0.2 |
| **2,3,7,8** | 0.7 | 0.2 | **2,3,7,8** | ND | 0.2 |
| **P5CDD - Total** | 3.0 | 0.2 | **P5CDF - Total** | ND | 0.2 |
| **1,2,3,7,8** | 0.2 | 0.2 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | ND | 0.2 |
| **H6CDD - Total** | 16 | 0.4 | **H6CDF - Total** | ND | 0.4 |
| **1,2,3,4,7,8** | ND | 0.4 | **1,2,3,4,7,8** | ND | 0.4 |
| **1,2,3,6,7,8** | ND | 0.4 | **1,2,3,6,7,8** | ND | 0.4 |
| **1,2,3,7,8,9** | NDR(0.6) | 0.4 | **2,3,4,6,7,8** | ND | 0.4 |
| | | | **1,2,3,7,8,9** | ND | 0.4 |
| **H7CDD - Total** | 42 | 0.6 | **H7CDF - Total** | ND | 0.6 |
| **1,2,3,4,6,7,8** | 18 | 0.6 | **1,2,3,4,6,7,8** | ND | 0.6 |
| | | | **1,2,3,4,7,8,9** | ND | 0.6 |
| **O8CDD - Total** | 1700 | 1.0 | **O8CDF - Total** | ND | 1.0 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 100 |
| **13C-T4CDD** | 90 |
| **13C-P5CDF** | 82 |
| **13C-P5CDD** | 85 |
| **13C-H6CDF** | 95 |
| **13C-H6CDD** | 84 |
| **13C-H7CDF** | 90 |
| **13C-H7CDD** | 89 |
| **13C-O8CDD** | 75 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.9 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 2.7 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.K. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9645**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.94 g dry**

**% MOISTURE: 23**

## Dong Ha
Soil (0 – 10 cm)
Abandoned Airbase

**AXYS FILE: 2607-08**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.2 | 0.2 | **T4CDF - Total** | 1.1 | 0.2 |
| **2,3,7,8** | ND | 0.2 | **2,3,7,8** | 0.4 | 0.2 |
| **P5CDD - Total** | ND | 0.2 | **P5CDF - Total** | 3.5 | 0.2 |
| **1,2,3,7,8** | ND | 0.2 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | 0.3 | 0.2 |
| **H6CDD - Total** | 9.2 | 0.4 | **H6CDF - Total** | 11 | 0.4 |
| **1,2,3,4,7,8** | 0.7 | 0.4 | **1,2,3,4,7,8** | 0.7 | 0.4 |
| **1,2,3,6,7,8** | 1.6 | 0.4 | **1,2,3,6,7,8** | 0.5 | 0.4 |
| **1,2,3,7,8,9** | 1.4 | 0.4 | **2,3,4,6,7,8** | 0.4 | 0.4 |
| | | | **1,2,3,7,8,9** | ND | 0.4 |
| **H7CDD - Total** | 58 | 0.6 | **H7CDF - Total** | 23 | 0.6 |
| **1,2,3,4,6,7,8** | 31 | 0.6 | **1,2,3,4,6,7,8** | 7.7 | 0.6 |
| | | | **1,2,3,4,7,8,9** | 0.6 | 0.6 |
| **O8CDD - Total** | 290 | 1.0 | **O8CDF - Total** | 26 | 1.0 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 110 |
| **13C-T4CDD** | 96 |
| **13C-P5CDF** | 94 |
| **13C-P5CDD** | 100 |
| **13C-H6CDF** | 88 |
| **13C-H6CDD** | 95 |
| **13C-H7CDF** | 73 |
| **13C-H7CDD** | 77 |
| **13C-O8CDD** | 76 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.4 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9650**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 6.11 g dry**

**% MOISTURE: 41**

**A So**
A Sap River Sediment

**AXYS FILE: 2607-09**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.8 | 0.2 | **T4CDF - Total** | 0.4 | 0.2 |
| **2,3,7,8** | 0.8 | 0.2 | **2,3,7,8** | ND | 0.2 |
| **P5CDD - Total** | ND | 0.2 | **P5CDF - Total** | ND | 0.2 |
| **1,2,3,7,8** | ND | 0.2 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | ND | 0.2 |
| **H6CDD - Total** | 0.5 | 0.5 | **H6CDF - Total** | ND | 0.5 |
| **1,2,3,4,7,8** | ND | 0.5 | **1,2,3,4,7,8** | ND | 0.5 |
| **1,2,3,6,7,8** | ND | 0.5 | **1,2,3,6,7,8** | ND | 0.5 |
| **1,2,3,7,8,9** | ND | 0.5 | **2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,7,8,9** | ND | 0.5 |
| **H7CDD - Total** | 3.6 | 0.8 | **H7CDF - Total** | ND | 0.8 |
| **1,2,3,4,6,7,8** | 1.5 | 0.8 | **1,2,3,4,6,7,8** | ND | 0.8 |
| | | | **1,2,3,4,7,8,9** | ND | 0.8 |
| **O8CDD - Total** | 69 | 1.3 | **O8CDF - Total** | ND | 1.3 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 77 |
| **13C-T4CDD** | 90 |
| **13C-P5CDF** | 70 |
| **13C-P5CDD** | 78 |
| **13C-H6CDF** | 84 |
| **13C-H6CDD** | 89 |
| **13C-H7CDF** | 79 |
| **13C-H7CDD** | 75 |
| **13C-O8CDD** | 69 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.9 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9605**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.54 g dry**

**% MOISTURE: 25**

**A Ngo**
Soil (0 – 10 cm)
Bomb Crater

**AXYS FILE: 2607-10**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 2.0 | 0.1 | **T4CDF - Total** | 0.8 | 0.1 |
| **2,3,7,8** | 1.1 | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | 0.5 | 0.1 | **P5CDF - Total** | 0.1 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | 0.1 | 0.1 |
| **H6CDD - Total** | 3.9 | 0.1 | **H6CDF - Total** | 0.5 | 0.1 |
| **1,2,3,4,7,8** | ND | 0.1 | **1,2,3,4,7,8** | ND | 0.1 |
| **1,2,3,6,7,8** | 0.4 | 0.1 | **1,2,3,6,7,8** | 0.1 | 0.1 |
| **1,2,3,7,8,9** | 0.8 | 0.1 | **2,3,4,6,7,8** | 0.1 | 0.1 |
| | | | **1,2,3,7,8,9** | ND | 0.1 |
| **H7CDD - Total** | 26 | 0.1 | **H7CDF - Total** | 0.5 | 0.1 |
| **1,2,3,4,6,7,8** | 11 | 0.1 | **1,2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 830 | 0.5 | **O8CDF - Total** | 1.0 | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 80 |
| **13C-T4CDD** | 87 |
| **13C-P5CDF** | 85 |
| **13C-P5CDD** | 90 |
| **13C-H6CDF** | 96 |
| **13C-H6CDD** | 89 |
| **13C-H7CDF** | 81 |
| **13C-H7CDD** | 77 |
| **13C-O8CDD** | 66 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 2.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9613**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.88 g dry**

**% MOISTURE: 23**

**A Ngo**
Soil (10 – 30 cm)
Bomb Crater

**AXYS FILE: 2607-11**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.2 | 0.1 | **T4CDF - Total** | 0.5 | 0.1 |
| **2,3,7,8** | 0.9 | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | 0.1 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | 3.0 | 0.1 | **H6CDF - Total** | 0.2 | 0.1 |
| **1,2,3,4,7,8** | ND | 0.1 | **1,2,3,4,7,8** | ND | 0.1 |
| **1,2,3,6,7,8** | 0.3 | 0.1 | **1,2,3,6,7,8** | ND | 0.1 |
| **1,2,3,7,8,9** | 0.7 | 0.1 | **2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,7,8,9** | ND | 0.1 |
| **H7CDD - Total** | 27 | 0.1 | **H7CDF - Total** | 0.5 | 0.1 |
| **1,2,3,4,6,7,8** | 11 | 0.1 | **1,2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 950 | 0.5 | **O8CDF - Total** | 0.9 | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 81 |
| **13C-T4CDD** | 83 |
| **13C-P5CDF** | 80 |
| **13C-P5CDD** | 84 |
| **13C-H6CDF** | 81 |
| **13C-H6CDD** | 76 |
| **13C-H7CDF** | 71 |
| **13C-H7CDD** | 70 |
| **13C-O8CDD** | 72 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.1 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 2.1 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9619**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.07 g dry**

**% MOISTURE: 32**

**A Ngo**
Fish Pond Sediment

**AXYS FILE: 2607-12 A**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 7.7 | 0.1 | **T4CDF - Total** | 0.8 | 0.1 |
| **2,3,7,8** | 5.3 | 0.1 | **2,3,7,8** | 0.2 | 0.1 |
| **P5CDD - Total** | 6.3 | 0.1 | **P5CDF - Total** | ND | 0.1 |
| **1,2,3,7,8** | 0.5 | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | 9.7 | 0.1 | **H6CDF - Total** | 0.3 | 0.1 |
| **1,2,3,4,7,8** | ND | 0.1 | **1,2,3,4,7,8** | ND | 0.1 |
| **1,2,3,6,7,8** | 0.4 | 0.1 | **1,2,3,6,7,8** | ND | 0.1 |
| **1,2,3,7,8,9** | 1.3 | 0.1 | **2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,7,8,9** | 0.2 | 0.1 |
| **H7CDD - Total** | 35 | 0.1 | **H7CDF - Total** | ND | 0.1 |
| **1,2,3,4,6,7,8** | 15 | 0.1 | **1,2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 880 | 0.6 | **O8CDF - Total** | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 74 |
| **13C-T4CDD** | 100 |
| **13C-P5CDF** | 78 |
| **13C-P5CDD** | 87 |
| **13C-H6CDF** | 75 |
| **13C-H6CDD** | 76 |
| **13C-H7CDF** | 72 |
| **13C-H7CDD** | 67 |
| **13C-O8CDD** | 62 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 6.8 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 6.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.:** VN9619
**CLIENT:** Hatfield Consultants Ltd.
**SAMPLE TYPE:** Sediment
**SAMPLE SIZE:** 6.59 g dry
**% MOISTURE:** 34

**AXYS FILE:** 2607-12 B
Duplicate
**DATE:** 05/Sep/97
**METHOD NO.:** DX-S-01/Ver.2
**INSTRUMENT:** GC-HRMS
**CONCENTRATION IN:** pg/g

**A Ngo**
Fish Pond Sediment

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 7.9 | 0.2 | T4CDF - Total | 0.7 | 0.2 |
| 2,3,7,8 | 5.1 | 0.2 | 2,3,7,8 | 0.2 | 0.2 |
| P5CDD - Total | 6.2 | 0.2 | P5CDF - Total | ND | 0.2 |
| 1,2,3,7,8 | 0.5 | 0.2 | 1,2,3,7,8 | ND | 0.2 |
| | | | 2,3,4,7,8 | ND | 0.2 |
| H6CDD - Total | 9.0 | 0.2 | H6CDF - Total | 0.2 | 0.2 |
| 1,2,3,4,7,8 | ND | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | 0.3 | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | 1.2 | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 34 | 0.2 | H7CDF - Total | ND | 0.2 |
| 1,2,3,4,6,7,8 | 16 | 0.2 | 1,2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,4,7,8,9 | ND | 0.2 |
| O8CDD - Total | 860 | 0.6 | O8CDF - Total | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 85 |
| 13C-T4CDD | 85 |
| 13C-P5CDF | 84 |
| 13C-P5CDD | 90 |
| 13C-H6CDF | 80 |
| 13C-H6CDD | 82 |
| 13C-H7CDF | 77 |
| 13C-H7CDD | 81 |
| 13C-O8CDD | 74 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 6.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 6.5 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9635**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.89 g dry**

**% MOISTURE: 23**

## Hong Ha
Fish Pond Sediment

**AXYS FILE: 2607-13**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.3 | 0.1 | **T4CDF - Total** | ND | 0.1 |
| **2,3,7,8** | 0.3 | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | ND | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | 0.3 | 0.1 | **H6CDF - Total** | ND | 0.1 |
| **1,2,3,4,7,8** | ND | 0.1 | **1,2,3,4,7,8** | ND | 0.1 |
| **1,2,3,6,7,8** | ND | 0.1 | **1,2,3,6,7,8** | ND | 0.1 |
| **1,2,3,7,8,9** | 0.2 | 0.1 | **2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,7,8,9** | ND | 0.1 |
| **H7CDD - Total** | 1.1 | 0.1 | **H7CDF - Total** | 0.1 | 0.1 |
| **1,2,3,4,6,7,8** | 0.6 | 0.1 | **1,2,3,4,6,7,8** | 0.1 | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 18 | 0.5 | **O8CDF - Total** | ND | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 85 |
| **13C-T4CDD** | 86 |
| **13C-P5CDF** | 82 |
| **13C-P5CDD** | 91 |
| **13C-H6CDF** | 62 |
| **13C-H6CDD** | 84 |
| **13C-H7CDF** | 67 |
| **13C-H7CDD** | 70 |
| **13C-O8CDD** | 58 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.3 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.C. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9636**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 8.75 g dry**

**% MOISTURE: 14**

**Chi Khe**
Soil (0 – 10 cm)
Farmer's Field
(Reference)

**AXYS FILE: 2607-14**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.2 | 0.1 | **T4CDF - Total** | 1.1 | 0.1 |
| **2,3,7,8** | ND | 0.1 | **2,3,7,8** | 0.2 | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | 0.1 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | 1.8 | 0.1 | **H6CDF - Total** | 0.8 | 0.1 |
| **1,2,3,4,7,8** | ND | 0.1 | **1,2,3,4,7,8** | ND | 0.1 |
| **1,2,3,6,7,8** | 0.6 | 0.1 | **1,2,3,6,7,8** | ND | 0.1 |
| **1,2,3,7,8,9** | 1.2 | 0.1 | **2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,7,8,9** | 0.7 | 0.1 |
| **H7CDD - Total** | 1.3 | 0.1 | **H7CDF - Total** | ND | 0.1 |
| **1,2,3,4,6,7,8** | 0.6 | 0.1 | **1,2,3,4,6,7,8** | ND | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 13 | 0.5 | **O8CDF - Total** | ND | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 64 |
| **13C-T4CDD** | 88 |
| **13C-P5CDF** | 63 |
| **13C-P5CDD** | 68 |
| **13C-H6CDF** | 77 |
| **13C-H6CDD** | 90 |
| **13C-H7CDF** | 69 |
| **13C-H7CDD** | 70 |
| **13C-O8CDD** | 53 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.3 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9603**

**AXYS FILE: 2607-15**

**CLIENT: Hatfield Consultants**

A Ngo
Manioc Root

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**

**SAMPLE TYPE: Plant**

**METHOD NO.: DX-T-03/Ver.2**

**SAMPLE SIZE: 10.9 g wet**

**INSTRUMENT: GC-HRMS**

**% MOISTURE: 66**

**% LIPID: 0.11**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | ND | 0.1 | **T4CDF - Total** | ND | 0.1 |
| **2,3,7,8** | ND | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | ND | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | 1.1 | 0.7 | **O8CDF - Total** | ND | 0.7 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 82 |
| **13C-T4CDD** | 84 |
| **13C-P5CDF** | 69 |
| **13C-P5CDD** | 74 |
| **13C-H6CDF** | 85 |
| **13C-H6CDD** | 84 |
| **13C-H7CDF** | 81 |
| **13C-H7CDD** | 83 |
| **13C-O8CDD** | 78 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

| | |
|---|---|
| 2,3,7,8 - TCDD TEQs (ND=1/2 DL) = | 0.2 pg/g |
| 2,3,7,8 - TCDD TEQs (ND=0) = | 0.0 pg/g |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.G. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9614**

**AXYS FILE: 2607-16**

**CLIENT: Hatfield Consultants**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**

A So
Carp Liver

**SAMPLE TYPE: Tissue**

**METHOD NO.: DX-T-03/Ver.2**

**SAMPLE SIZE: 10.4 g wet**

**INSTRUMENT: GC-HRMS**

**% MOISTURE: 67**

**% LIPID: 4.0**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 3.0 | 0.1 | **T4CDF - Total** | 1.3 | 0.1 |
| **2,3,7,8** | 2.4 | 0.1 | **2,3,7,8** | 0.4 | 0.1 |
| **P5CDD - Total** | 0.4 | 0.1 | **P5CDF - Total** | 0.4 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | ND | 0.8 | **O8CDF - Total** | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 81 |
| **13C-T4CDD** | 70 |
| **13C-P5CDF** | 70 |
| **13C-P5CDD** | 72 |
| **13C-H6CDF** | 81 |
| **13C-H6CDD** | 84 |
| **13C-H7CDF** | 78 |
| **13C-H7CDD** | 78 |
| **13C-O8CDD** | 71 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 2.4 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9618**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.3 g wet**

**% MOISTURE: 65**

A Ngo
Carp Liver

**% LIPID: 8.5**

**AXYS FILE: 2607-17 A**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.5 | 0.1 | **T4CDF - Total** | 2.6 | 0.1 |
| **2,3,7,8** | 1.0 | 0.1 | **2,3,7,8** | 0.4 | 0.1 |
| **P5CDD - Total** | 0.4 | 0.1 | **P5CDF - Total** | 1.3 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | 0.1 | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | 1.0 | 0.8 | **O8CDF - Total** | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 91 |
| **13C-T4CDD** | 98 |
| **13C-P5CDF** | 78 |
| **13C-P5CDD** | 78 |
| **13C-H6CDF** | 91 |
| **13C-H6CDD** | 91 |
| **13C-H7CDF** | 89 |
| **13C-H7CDD** | 89 |
| **13C-O8CDD** | 93 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.1 pg/g

M Hamilton
**Approved**

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9618**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.2 g wet**

**% MOISTURE: 65**

**A Ngo**
Carp Liver

**% LIPID: 8.1**

**AXYS FILE: 2607-17 B**
**Duplicate**
**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.4 | 0.1 | **T4CDF - Total** | 2.8 | 0.1 |
| **2,3,7,8** | 0.8 | 0.1 | **2,3,7,8** | 0.3 | 0.1 |
| **P5CDD - Total** | 0.3 | 0.1 | **P5CDF - Total** | 1.1 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | 0.1 | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | 0.9 | 0.8 | **O8CDF - Total** | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 86 |
| **13C-T4CDD** | 91 |
| **13C-P5CDF** | 78 |
| **13C-P5CDD** | 78 |
| **13C-H6CDF** | 83 |
| **13C-H6CDD** | 79 |
| **13C-H7CDF** | 75 |
| **13C-H7CDD** | 74 |
| **13C-O8CDD** | 69 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

| | |
|---|---|
| 2,3,7,8 - TCDD TEQs (ND=1/2 DL) = | 1.0 pg/g |
| 2,3,7,8 - TCDD TEQs (ND=0) = | 0.9 pg/g |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9620**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.7 g wet**

**% MOISTURE: 76**

Hong Thuong
Carp Liver

**% LIPID: 3.2**

**AXYS FILE: 2607-18**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.6 | 0.1 | **T4CDF - Total** | 1.1 | 0.1 |
| **2,3,7,8** | 1.6 | 0.1 | **2,3,7,8** | 0.7 | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | 0.9 | 0.1 |
| **1,2,3,7,8** | NDR(0.2) | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | 0.2 | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | 1.6 | 0.7 | **O8CDF - Total** | ND | 0.7 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 76 |
| **13C-T4CDD** | 82 |
| **13C-P5CDF** | 66 |
| **13C-P5CDD** | 67 |
| **13C-H6CDF** | 71 |
| **13C-H6CDD** | 76 |
| **13C-H7CDF** | 67 |
| **13C-H7CDD** | 63 |
| **13C-O8CDD** | 48 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.9 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9621**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 9.88 g wet**

**% MOISTURE: 79**

## Con Cuong
Carp Liver
(Reference)

**% LIPID: 1.6**

**AXYS FILE: 2607-19**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 0.1 | 0.1 | T4CDF - Total | 0.4 | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | 0.2 | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | 0.3 | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 79 |
| 13C-T4CDD | 83 |
| 13C-P5CDF | 69 |
| 13C-P5CDD | 69 |
| 13C-H6CDF | 89 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 78 |
| 13C-H7CDD | 74 |
| 13C-O8CDD | 69 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9623**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.3 g wet**

**% MOISTURE: 69**

**Hong Ha**
Carp Liver

**% LIPID: 5.6**

**AXYS FILE: 2607-20**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 0.6 | 0.1 | T4CDF - Total | 1.1 | 0.1 |
| 2,3,7,8 | 0.3 | 0.1 | 2,3,7,8 | 0.3 | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | 1.6 | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | 0.1 | 0.1 |
| H6CDD - Total | 1.6 | 0.3 | H6CDF - Total | 1.1 | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | 3.9 | 0.5 | H7CDF - Total | 0.6 | 0.5 |
| 1,2,3,4,6,7,8 | 1.5 | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | 4.0 | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 67 |
| 13C-T4CDD | 57 |
| 13C-P5CDF | 59 |
| 13C-P5CDD | 61 |
| 13C-H6CDF | 71 |
| 13C-H6CDD | 71 |
| 13C-H7CDF | 66 |
| 13C-H7CDD | 59 |
| 13C-O8CDD | 49 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.4 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9629**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.1 g wet**

**% MOISTURE: 62**

**Son Thuy**
Pig Liver

**% LIPID: 3.0**

**AXYS FILE: 2607-21**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | ND | 0.1 | **T4CDF - Total** | ND | 0.1 |
| **2,3,7,8** | ND | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | 0.6 | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | 0.6 | 0.1 |
| **H6CDD - Total** | 0.4 | 0.3 | **H6CDF - Total** | 3.4 | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | 1.7 | 0.3 |
| **1,2,3,6,7,8** | 0.4 | 0.3 | **1,2,3,6,7,8** | 1.1 | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | 0.6 | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | 17 | 0.5 | **H7CDF - Total** | 7.2 | 0.5 |
| **1,2,3,4,6,7,8** | 16 | 0.5 | **1,2,3,4,6,7,8** | 6.4 | 0.5 |
| | | | **1,2,3,4,7,8,9** | 0.8 | 0.5 |
| **O8CDD - Total** | 300 | 0.8 | **O8CDF - Total** | 2.7 | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 74 |
| **13C-T4CDD** | 76 |
| **13C-P5CDF** | 61 |
| **13C-P5CDD** | 61 |
| **13C-H6CDF** | 72 |
| **13C-H6CDD** | 71 |
| **13C-H7CDF** | 61 |
| **13C-H7CDD** | 55 |
| **13C-O8CDD** | 55 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9640**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 2.57 g wet**

**% MOISTURE: 11**

**Xa Nham**
Carp Fat

**% LIPID: 85**

**AXYS FILE: 2607-22**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 2.3 | 0.4 | **T4CDF - Total** | 9.2 | 0.4 |
| **2,3,7,8** | 0.7 | 0.4 | **2,3,7,8** | 1.2 | 0.4 |
| **P5CDD - Total** | ND | 0.4 | **P5CDF - Total** | 1.7 | 0.4 |
| **1,2,3,7,8** | ND | 0.4 | **1,2,3,7,8** | 0.4 | 0.4 |
| | | | **2,3,4,7,8** | ND | 0.4 |
| **H6CDD - Total** | ND | 1.2 | **H6CDF - Total** | ND | 1.2 |
| **1,2,3,4,7,8** | ND | 1.2 | **1,2,3,4,7,8** | ND | 1.2 |
| **1,2,3,6,7,8** | ND | 1.2 | **1,2,3,6,7,8** | ND | 1.2 |
| **1,2,3,7,8,9** | ND | 1.2 | **2,3,4,6,7,8** | ND | 1.2 |
| | | | **1,2,3,7,8,9** | ND | 1.2 |
| **H7CDD - Total** | ND | 1.9 | **H7CDF - Total** | ND | 1.9 |
| **1,2,3,4,6,7,8** | ND | 1.9 | **1,2,3,4,6,7,8** | ND | 1.9 |
| | | | **1,2,3,4,7,8,9** | ND | 1.9 |
| **O8CDD - Total** | 5.1 | 3.1 | **O8CDF - Total** | ND | 3.1 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 75 |
| **13C-T4CDD** | 79 |
| **13C-P5CDF** | 66 |
| **13C-P5CDD** | 64 |
| **13C-H6CDF** | 72 |
| **13C-H6CDD** | 71 |
| **13C-H7CDF** | 70 |
| **13C-H7CDD** | 61 |
| **13C-O8CDD** | 52 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.5 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M K Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9646**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 2.58 g wet**

**% MOISTURE: 7.6**

**AXYS FILE: 2607-23**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

A So
Carp Fat

**% LIPID: 87**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 59 | 0.4 | **T4CDF - Total** | 25 | 0.4 |
| **2,3,7,8** | 51 | 0.4 | **2,3,7,8** | 6.6 | 0.4 |
| **P5CDD - Total** | 2.4 | 0.4 | **P5CDF - Total** | 12 | 0.4 |
| **1,2,3,7,8** | 1.9 | 0.4 | **1,2,3,7,8** | 0.9 | 0.4 |
| | | | **2,3,4,7,8** | 1.2 | 0.4 |
| **H6CDD - Total** | ND | 1.2 | **H6CDF - Total** | ND | 1.2 |
| **1,2,3,4,7,8** | ND | 1.2 | **1,2,3,4,7,8** | ND | 1.2 |
| **1,2,3,6,7,8** | ND | 1.2 | **1,2,3,6,7,8** | ND | 1.2 |
| **1,2,3,7,8,9** | ND | 1.2 | **2,3,4,6,7,8** | ND | 1.2 |
| | | | **1,2,3,7,8,9** | ND | 1.2 |
| **H7CDD - Total** | ND | 1.9 | **H7CDF - Total** | ND | 1.9 |
| **1,2,3,4,6,7,8** | ND | 1.9 | **1,2,3,4,6,7,8** | ND | 1.9 |
| | | | **1,2,3,4,7,8,9** | ND | 1.9 |
| **O8CDD - Total** | ND | 3.1 | **O8CDF - Total** | ND | 3.1 |

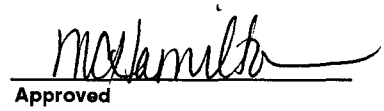
| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 94 |
| **13C-T4CDD** | 100 |
| **13C-P5CDF** | 84 |
| **13C-P5CDD** | 84 |
| **13C-H6CDF** | 89 |
| **13C-H6CDD** | 90 |
| **13C-H7CDF** | 69 |
| **13C-H7CDD** | 76 |
| **13C-O8CDD** | 68 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 53.7 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 53.3 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.



**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9606**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.7 g wet**

**% MOISTURE: 54**

**Hong Thuong**
Manioc Root

**% LIPID: 0.19**

**AXYS FILE: 2607-24 A**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 66 |
| 13C-T4CDD | 68 |
| 13C-P5CDF | 60 |
| 13C-P5CDD | 64 |
| 13C-H6CDF | 67 |
| 13C-H6CDD | 67 |
| 13C-H7CDF | 55 |
| 13C-H7CDD | 55 |
| 13C-O8CDD | 45 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.G. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9606**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.4 g wet**

**% MOISTURE: 55**

Hong Thuong
Manioc Root

**% LIPID: 0.17**

**AXYS FILE: 2607-24 B**
**Duplicate**
**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 79 |
| 13C-T4CDD | 84 |
| 13C-P5CDF | 70 |
| 13C-P5CDD | 75 |
| 13C-H6CDF | 77 |
| 13C-H6CDD | 77 |
| 13C-H7CDF | 62 |
| 13C-H7CDD | 71 |
| 13C-O8CDD | 56 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9608**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.1 g wet**

**% MOISTURE: 67**

A So
Duck Liver

**% LIPID: 2.2**

**AXYS FILE: 2607-25**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 1.4 | 0.1 | **T4CDF - Total** | 0.2 | 0.1 |
| **2,3,7,8** | 1.4 | 0.1 | **2,3,7,8** | 0.2 | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | ND | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | ND | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | ND | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | ND | 0.8 | **O8CDF - Total** | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 83 |
| **13C-T4CDD** | 93 |
| **13C-P5CDF** | 81 |
| **13C-P5CDD** | 86 |
| **13C-H6CDF** | 82 |
| **13C-H6CDD** | 81 |
| **13C-H7CDF** | 72 |
| **13C-H7CDD** | 75 |
| **13C-O8CDD** | 74 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 1.6 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.4 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9641**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.0 g wet**

**% MOISTURE: 70**

## Con Cuong
Pig Liver
(Reference)

**% LIPID: 3.3**

**AXYS FILE: 2607-26**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | ND | 0.1 | **T4CDF - Total** | ND | 0.1 |
| **2,3,7,8** | ND | 0.1 | **2,3,7,8** | ND | 0.1 |
| **P5CDD - Total** | ND | 0.1 | **P5CDF - Total** | ND | 0.1 |
| **1,2,3,7,8** | ND | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | ND | 0.3 | **H6CDF - Total** | ND | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | ND | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | ND | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | 1.2 | 0.5 | **H7CDF - Total** | ND | 0.5 |
| **1,2,3,4,6,7,8** | 0.7 | 0.5 | **1,2,3,4,6,7,8** | ND | 0.5 |
| | | | **1,2,3,4,7,8,9** | ND | 0.5 |
| **O8CDD - Total** | 4.1 | 0.8 | **O8CDF - Total** | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 61 |
| **13C-T4CDD** | 59 |
| **13C-P5CDF** | 64 |
| **13C-P5CDD** | 67 |
| **13C-H6CDF** | 81 |
| **13C-H6CDD** | 76 |
| **13C-H7CDF** | 71 |
| **13C-H7CDD** | 62 |
| **13C-O8CDD** | 54 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9644**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.2 g wet**

**% MOISTURE: 66**

## Con Cuong
Duck Liver
(Reference)

**% LIPID: 3.7**

**AXYS FILE: 2607-27**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | 0.4 | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | 0.2 | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 78 |
| 13C-T4CDD | 86 |
| 13C-P5CDF | 84 |
| 13C-P5CDD | 87 |
| 13C-H6CDF | 79 |
| 13C-H6CDD | 78 |
| 13C-H7CDF | 76 |
| 13C-H7CDD | 70 |
| 13C-O8CDD | 64 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 0.0 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.G. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: VN9602**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 7.09 g dry**

**% MOISTURE: 30**

**A So**
Fish Pond Sediment

**AXYS FILE: 2607-29**

**DATE: 14/Oct/97**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 9.5 | 0.1 | **T4CDF - Total** | 1.7 | 0.1 |
| **2,3,7,8** | 6.9 | 0.1 | **2,3,7,8** | 0.6 | 0.1 |
| **P5CDD - Total** | 3.1 | 0.1 | **P5CDF - Total** | 1.4 | 0.2 |
| **1,2,3,7,8** | NDR(0.4) | 0.1 | **1,2,3,7,8** | ND | 0.2 |
| | | | **2,3,4,7,8** | ND | 0.2 |
| **H6CDD - Total** | 9.1 | 0.3 | **H6CDF - Total** | 0.5 | 0.3 |
| **1,2,3,4,7,8** | ND | 0.3 | **1,2,3,4,7,8** | ND | 0.3 |
| **1,2,3,6,7,8** | 0.3 | 0.3 | **1,2,3,6,7,8** | ND | 0.3 |
| **1,2,3,7,8,9** | 0.7 | 0.3 | **2,3,4,6,7,8** | ND | 0.3 |
| | | | **1,2,3,7,8,9** | ND | 0.3 |
| **H7CDD - Total** | 19 | 0.4 | **H7CDF - Total** | 0.8 | 0.4 |
| **1,2,3,4,6,7,8** | 7.9 | 0.4 | **1,2,3,4,6,7,8** | 0.8 | 0.4 |
| | | | **1,2,3,4,7,8,9** | ND | 0.4 |
| **O8CDD - Total** | 460 | 2.6 | **O8CDF - Total** | 1.2 | 0.7 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 79 |
| **13C-T4CDD** | 76 |
| **13C-P5CDF** | 76 |
| **13C-P5CDD** | 79 |
| **13C-H6CDF** | 86 |
| **13C-H6CDD** | 73 |
| **13C-H7CDF** | 71 |
| **13C-H7CDD** | 61 |
| **13C-O8CDD** | 59 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 7.8 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 7.6 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-SPM 823**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

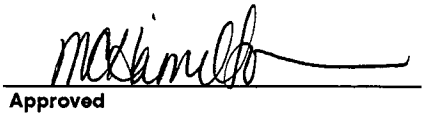
**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 1.7 | 1.8 | 94 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.0 | 5.0 | 100 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 5.0 | 5.4 | 93 |
| **1,2,3,6,7,8** | 4.7 | 5.0 | 94 |
| **1,2,3,7,8,9** | 3.4 | 5.2 | 65 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 5.0 | 5.5 | 91 |
| **O8CDD - Total** | 15 | 14 | 107 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 1.8 | 1.9 | 95 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 4.6 | 4.6 | 100 |
| **2,3,4,7,8** | 4.6 | 4.6 | 100 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 4.6 | 4.6 | 100 |
| **1,2,3,6,7,8** | 4.5 | 4.6 | 98 |
| **2,3,4,6,7,8** | 4.0 | 4.6 | 87 |
| **1,2,3,7,8,9** | 3.2 | 4.6 | 70 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 4.9 | 5.0 | 98 |
| **1,2,3,4,7,8,9** | 4.4 | 4.6 | 96 |
| **O8CDF - Total** | 9.5 | 7.9 | 120 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 47 |
| **13C-T4CDD** | 44 |
| **13C-P5CDF** | 36 |
| **13C-P5CDD** | 36 |
| **13C-H6CDF** | 41 |
| **13C-H6CDD** | 36 |
| **13C-H7CDF** | 29 |
| **13C-H7CDD** | 20 |
| **13C-O8CDD** | 13 |

1. Concentrations are recovery corrected.



**Approved**

## ANALYSIS REPORT
## POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

**CLIENT SAMPLE I.D.:** Spiked Matrix

**CLIENT:** Hatfield Consultants Ltd.

**SAMPLE TYPE:** Sediment

**SAMPLE SIZE:** 10.0 g

**AXYS FILE:** DX-S-SPM 840

**DATE:** 05/Sep/97

**METHOD NO.:** DX-S-01/Ver.2

**INSTRUMENT:** GC-HRMS

**CONCENTRATION IN:** pg/g

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 19 | 18 | 106 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 53 | 50 | 106 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 51 | 54 | 94 |
| **1,2,3,6,7,8** | 49 | 50 | 98 |
| **1,2,3,7,8,9** | 56 | 52 | 108 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 52 | 55 | 95 |
| **O8CDD - Total** | 137 | 140 | 98 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 19 | 20 | 95 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 48 | 46 | 104 |
| **2,3,4,7,8** | 51 | 46 | 111 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 49 | 46 | 107 |
| **1,2,3,6,7,8** | 51 | 46 | 111 |
| **2,3,4,6,7,8** | 52 | 46 | 113 |
| **1,2,3,7,8,9** | 64 | 46 | 139 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 52 | 66 | 79 |
| **1,2,3,4,7,8,9** | 53 | 46 | 115 |
| **O8CDF - Total** | 76 | 78 | 97 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 75 |
| **13C-T4CDD** | 85 |
| **13C-P5CDF** | 71 |
| **13C-P5CDD** | 78 |
| **13C-H6CDF** | 63 |
| **13C-H6CDD** | 77 |
| **13C-H7CDF** | 70 |
| **13C-H7CDD** | 71 |
| **13C-O8CDD** | 62 |

1. Concentrations are recovery corrected.

MC Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-T-SPM 845**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 1.8 | 1.8 | 100 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.9 | 5.0 | 118 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 5.1 | 5.4 | 94 |
| **1,2,3,6,7,8** | 5.7 | 5.0 | 114 |
| **1,2,3,7,8,9** | 4.8 | 5.2 | 92 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 4.4 | 4.4 | 100 |
| **O8CDD - Total** | 7.5 | 7.4 | 101 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 4.4 | 4.4 | 100 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 4.9 | 4.6 | 107 |
| **2,3,4,7,8** | 5.2 | 4.6 | 113 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 4.8 | 4.6 | 104 |
| **1,2,3,6,7,8** | 5.0 | 4.6 | 109 |
| **2,3,4,6,7,8** | 4.3 | 4.6 | 93 |
| **1,2,3,7,8,9** | 3.6 | 4.6 | 78 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 4.8 | 4.6 | 104 |
| **1,2,3,4,7,8,9** | 4.2 | 4.6 | 91 |
| **O8CDF - Total** | 8.1 | 7.4 | 109 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 66 |
| **13C-T4CDD** | 49 |
| **13C-P5CDF** | 74 |
| **13C-P5CDD** | 75 |
| **13C-H6CDF** | 81 |
| **13C-H6CDD** | 78 |
| **13C-H7CDF** | 68 |
| **13C-H7CDD** | 59 |
| **13C-O8CDD** | 47 |

1. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-T-SPM 847**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 2.0 | 1.8 | 111 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.9 | 5.0 | 118 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 5.0 | 5.4 | 93 |
| **1,2,3,6,7,8** | 5.7 | 5.0 | 114 |
| **1,2,3,7,8,9** | 5.5 | 5.2 | 106 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 4.4 | 4.4 | 100 |
| **O8CDD - Total** | 7.4 | 7.4 | 100 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 4.8 | 4.4 | 109 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 5.2 | 4.6 | 113 |
| **2,3,4,7,8** | 5.4 | 4.6 | 117 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 5.1 | 4.6 | 111 |
| **1,2,3,6,7,8** | 5.0 | 4.6 | 109 |
| **2,3,4,6,7,8** | 4.5 | 4.6 | 98 |
| **1,2,3,7,8,9** | 4.8 | 4.6 | 104 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 4.9 | 4.6 | 107 |
| **1,2,3,4,7,8,9** | 5.3 | 4.6 | 115 |
| **O8CDF - Total** | 7.8 | 7.4 | 105 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 85 |
| **13C-T4CDD** | 90 |
| **13C-P5CDF** | 81 |
| **13C-P5CDD** | 87 |
| **13C-H6CDF** | 90 |
| **13C-H6CDD** | 87 |
| **13C-H7CDF** | 76 |
| **13C-H7CDD** | 74 |
| **13C-O8CDD** | 74 |

1. Concentrations are recovery corrected.

MC Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-SPM 858**

**DATE: 14/Oct/97**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 2.0 | 1.8 | 111 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.7 | 5.0 | 114 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 5.3 | 5.4 | 98 |
| **1,2,3,6,7,8** | 5.1 | 5.0 | 102 |
| **1,2,3,7,8,9** | 5.5 | 5.2 | 106 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 4.7 | 5.5 | 85 |
| **O8CDD - Total** | 11 | 14 | 79 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 1.9 | 2.0 | 95 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 5.0 | 4.6 | 109 |
| **2,3,4,7,8** | 5.0 | 4.6 | 109 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 5.2 | 4.6 | 113 |
| **1,2,3,6,7,8** | 5.3 | 4.6 | 115 |
| **2,3,4,6,7,8** | 4.5 | 4.6 | 98 |
| **1,2,3,7,8,9** | 4.8 | 4.6 | 104 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 5.2 | 6.6 | 79 |
| **1,2,3,4,7,8,9** | 4.8 | 4.6 | 104 |
| **O8CDF - Total** | 7.9 | 7.8 | 101 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 73 |
| **13C-T4CDD** | 78 |
| **13C-P5CDF** | 70 |
| **13C-P5CDD** | 74 |
| **13C-H6CDF** | 82 |
| **13C-H6CDD** | 79 |
| **13C-H7CDF** | 82 |
| **13C-H7CDD** | 75 |
| **13C-O8CDD** | 69 |

1. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-BLK 1618**

**DATE: 13/Aug/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 83 |
| 13C-T4CDD | 75 |
| 13C-P5CDF | 71 |
| 13C-P5CDD | 64 |
| 13C-H6CDF | 78 |
| 13C-H6CDD | 64 |
| 13C-H7CDF | 61 |
| 13C-H7CDD | 68 |
| 13C-O8CDD | 36 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-BLK 1635**

**DATE: 05/Sep/97**

**METHOD NO.: DX-S-01/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.1 | H6CDF - Total | ND | 0.1 |
| 1,2,3,4,7,8 | ND | 0.1 | 1,2,3,4,7,8 | ND | 0.1 |
| 1,2,3,6,7,8 | ND | 0.1 | 1,2,3,6,7,8 | ND | 0.1 |
| 1,2,3,7,8,9 | ND | 0.1 | 2,3,4,6,7,8 | ND | 0.1 |
| | | | 1,2,3,7,8,9 | ND | 0.1 |
| H7CDD - Total | ND | 0.1 | H7CDF - Total | ND | 0.1 |
| 1,2,3,4,6,7,8 | ND | 0.1 | 1,2,3,4,6,7,8 | ND | 0.1 |
| | | | 1,2,3,4,7,8,9 | ND | 0.1 |
| O8CDD - Total | ND | 0.4 | O8CDF - Total | ND | 0.4 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 66 |
| 13C-T4CDD | 80 |
| 13C-P5CDF | 59 |
| 13C-P5CDD | 65 |
| 13C-H6CDF | 65 |
| 13C-H6CDD | 62 |
| 13C-H7CDF | 49 |
| 13C-H7CDD | 50 |
| 13C-O8CDD | 34 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.Hamilton
Approved

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-T-BLK 1639**

**DATE: 23/Sep/97**
**REVISED: 24/Sep/97**
**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 55 |
| 13C-T4CDD | 57 |
| 13C-P5CDF | 39 |
| 13C-P5CDD | 45 |
| 13C-H6CDF | 53 |
| 13C-H6CDD | 54 |
| 13C-H7CDF | 41 |
| 13C-H7CDD | 41 |
| 13C-O8CDD | 29 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-T-BLK 1641**

**DATE: 26/Sep/97**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 86 |
| 13C-T4CDD | 89 |
| 13C-P5CDF | 75 |
| 13C-P5CDD | 79 |
| 13C-H6CDF | 87 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 78 |
| 13C-H7CDD | 84 |
| 13C-O8CDD | 81 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.


Approved

## ANALYSIS REPORT
## POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

**CLIENT SAMPLE I.D.:** Procedural Blank

**CLIENT:** Hatfield Consultants

**SAMPLE TYPE:** Blank

**SAMPLE SIZE:** 10.0 g

**AXYS FILE:** DX-S-BLK 1658

**DATE:** 14/Oct/97

**METHOD NO.:** DX-S-01/Ver.3

**INSTRUMENT:** GC-HRMS

**CONCENTRATION IN:** pg/g

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.2 | H6CDF - Total | ND | 0.2 |
| 1,2,3,4,7,8 | ND | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | ND | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | ND | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | ND | 0.3 | H7CDF - Total | ND | 0.3 |
| 1,2,3,4,6,7,8 | ND | 0.3 | 1,2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,4,7,8,9 | ND | 0.3 |
| O8CDD - Total | ND | 0.6 | O8CDF - Total | ND | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 67 |
| 13C-T4CDD | 59 |
| 13C-P5CDF | 68 |
| 13C-P5CDD | 74 |
| 13C-H6CDF | 89 |
| 13C-H6CDD | 76 |
| 13C-H7CDF | 76 |
| 13C-H7CDD | 65 |
| 13C-O8CDD | 52 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.B. Hamilton
Approved

# Appendix III

# PCB/Pesticide Analysis Reports

## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9622**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 13.1 g dry**

**% MOISTURE: 15**

**A So**
Soil (10 – 30 cm)
Abandoned Airbase

**AXYS ID: 2607-02 I**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.18 | 0.006 |
| alpha HCH | ND | 0.01 |
| beta HCH | ND | 0.02 |
| gamma HCH | ND | 0.02 |
| Heptachlor | ND | 0.01 |
| Aldrin | ND | 0.004 |
| Oxychlordane | ND | 0.01 |
| trans-Chlordane | ND | 0.003 |
| cis-Chlordane | ND | 0.003 |
| o,p'-DDE | 0.05 | 0.01 |
| p,p'-DDE | 11 | 0.02 |
| trans-Nonachlor | ND | 0.003 |
| cis-Nonachlor | ND | 0.004 |
| o,p'-DDD | 0.46 | 0.02 |
| p,p'-DDD | 5.9 | 0.02 |
| o,p'-DDT | 1.0 | 0.02 |
| p,p'-DDT | 24 | 0.03 |
| Mirex | ND | 0.003 |
| Heptachlor Epoxide | ND | 0.03 |
| alpha-Endosulphan (I) | ND | 0.02 |
| Dieldrin | ND | 0.03 |
| Endrin | ND | 0.09 |
| Methoxychlor | ND | 0.12 |
| Aroclor 1242 | ND | 0.29 |
| Aroclor 1254 | ND | 0.2 |
| Aroclor 1260 | 2.5 | 0.02 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 63 |
| 13C-gamma HCH | 63 |
| 13C-p,p'-DDE | 90 |
| 13C-p,p'-DDT | 130 |
| 13C-Mirex | 62 |
| 13C-PCB 101 | 66 |
| 13C-PCB 180 | 77 |
| 13C-PCB 209 | 56 |
| d4-alpha-Endosulphan | 100 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9624**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 13.1 g dry**

**% MOISTURE: 13**

**Chi Khe**
Soil (10 – 30 cm)
Farmer's Field
(Reference)

**AXYS ID: 2607-03 ki**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 8.4 | 1.3 |
| alpha HCH | ND | 3.2 |
| beta HCH | ND | 4.5 |
| gamma HCH | ND | 3.8 |
| Heptachlor | ND | 3.1 |
| Aldrin | ND | 1.0 |
| Oxychlordane | ND | 3.4 |
| trans-Chlordane | ND | 0.92 |
| cis-Chlordane | ND | 0.99 |
| o,p'-DDE | 62 | 3.9 |
| p,p'-DDE | 2300 | 4.6 |
| trans-Nonachlor | ND | 0.98 |
| cis-Nonachlor | ND | 1.2 |
| o,p'-DDD | 320 | 5.5 |
| p,p'-DDD | 1900 | 6.0 |
| o,p'-DDT | 1100 | 5.4 |
| p,p'-DDT | 15000 | 7.0 |
| Mirex | ND | 0.8 |
| Heptachlor Epoxide | ND | 0.04 |
| alpha-Endosulphan (I) | ND | 0.08 |
| Dieldrin | ND | 0.03 |
| Endrin | ND | 0.08 |
| Methoxychlor | ND | 1.5 |
| Aroclor 1242 | ND | 87 |
| Aroclor 1254 | ND | 8.0 |
| Aroclor 1260 | ND | 7.6 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected
6. Data are not recovery corrected; results represent minimum concentrations

Approved

## PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: VN9630

CLIENT: Hatfield Consultants

SAMPLE TYPE: Soil

SAMPLE SIZE: 11.9 g dry

% MOISTURE: 23

**Dong Ha**
Soil (10 – 30 cm)
Abandoned Airbase

AXYS ID: 2607-04 i

DATE: 29/Aug/97

METHOD NO.: CL-S-01/Ver.2

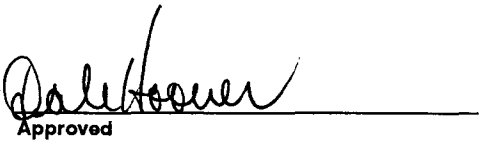
INSTRUMENT: GC-HRMS/GC-ECD

CONCENTRATION IN: ng/g

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.04 | 0.005 |
| alpha HCH | ND | 0.01 |
| beta HCH | ND | 0.02 |
| gamma HCH | ND | 0.01 |
| Heptachlor | ND | 0.009 |
| Aldrin | ND | 0.003 |
| Oxychlordane | 0.01 | 0.01 |
| trans-Chlordane | 0.1 | 0.003 |
| cis-Chlordane | 0.09 | 0.003 |
| o,p'-DDE | ND | 0.01 |
| p,p'-DDE | 0.08 | 0.02 |
| trans-Nonachlor | 0.05 | 0.003 |
| cis-Nonachlor | 0.05 | 0.003 |
| o,p'-DDD | 0.07 | 0.02 |
| p,p'-DDD | 0.2 | 0.02 |
| o,p'-DDT | 0.03 | 0.02 |
| p,p'-DDT | 0.36 | 0.03 |
| Mirex | ND | 0.003 |
| Heptachlor Epoxide | ND | 0.14 |
| alpha-Endosulphan (I) | ND | 0.13 |
| Dieldrin | ND | 0.16 |
| Endrin | ND | 0.47 |
| Methoxychlor | ND | 0.6 |
| Aroclor 1242 | ND | 0.32 |
| Aroclor 1254 | 0.13 | 0.03 |
| Aroclor 1260 | 0.53 | 0.03 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 73 |
| 13C-gamma HCH | 69 |
| 13C-p,p'-DDE | 87 |
| 13C-p,p'-DDT | 100 |
| 13C-Mirex | 61 |
| 13C-PCB 101 | 68 |
| 13C-PCB 180 | 74 |
| 13C-PCB 209 | 60 |
| d4-alpha-Endosulphan | 90 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected



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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9642**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 12.0 g dry**

**% MOISTURE: 22**

**A So**
Soil (0 – 10 cm)
Abandoned Airbase

**AXYS ID: 2607-06 I**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.03 | 0.005 |
| alpha HCH | ND | 0.01 |
| beta HCH | ND | 0.02 |
| gamma HCH | ND | 0.01 |
| Heptachlor | ND | 0.009 |
| Aldrin | ND | 0.003 |
| Oxychlordane | ND | 0.01 |
| trans-Chlordane | 0.006 | 0.003 |
| cis-Chlordane | 0.007 | 0.003 |
| o,p'-DDE | 0.25 | 0.01 |
| p,p'-DDE | 36 | 0.01 |
| trans-Nonachlor | 0.008 | 0.003 |
| cis-Nonachlor | 0.004 | 0.004 |
| o,p'-DDD | 1.9 | 0.02 |
| p,p'-DDD | 16 | 0.02 |
| o,p'-DDT | 2.2 | 0.02 |
| p,p'-DDT | 18 | 0.02 |
| Mirex | ND | 0.002 |
| Heptachlor Epoxide | ND | 0.04 |
| alpha-Endosulphan (I) | ND | 0.03 |
| Dieldrin | ND | 0.06 |
| Endrin | ND | 0.12 |
| Methoxychlor | ND | 0.22 |
| Aroclor 1242 | ND | 0.29 |
| Aroclor 1254 | 0.37 | 0.03 |
| Aroclor 1260 | 0.42 | 0.02 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 62 |
| 13C-gamma HCH | 58 |
| 13C-p,p'-DDE | 94 |
| 13C-p,p'-DDT | 100 |
| 13C-Mirex | 60 |
| 13C-PCB 101 | 56 |
| 13C-PCB 180 | 80 |
| 13C-PCB 209 | 64 |
| d4-alpha-Endosulphan | 90 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9645**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 12.1 g dry**

**% MOISTURE: 21**

**Dong Ha**
Soil (0 – 10 cm)
Abandoned Airbase

**AXYS ID: 2607-08A i**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.03 | 0.004 |
| alpha HCH | 0.02 | 0.01 |
| beta HCH | 0.05 | 0.02 |
| gamma HCH | ND | 0.01 |
| Heptachlor | ND | 0.008 |
| Aldrin | ND | 0.003 |
| Oxychlordane | 0.02 | 0.009 |
| trans-Chlordane | 0.47 | 0.003 |
| cis-Chlordane | 0.47 | 0.003 |
| o,p'-DDE | 0.02 | 0.01 |
| p,p'-DDE | 0.31 | 0.01 |
| trans-Nonachlor | 0.44 | 0.003 |
| cis-Nonachlor | 0.26 | 0.003 |
| o,p'-DDD | 0.31 | 0.02 |
| p,p'-DDD | 0.84 | 0.02 |
| o,p'-DDT | 0.04 | 0.02 |
| p,p'-DDT | 0.21 | 0.03 |
| Mirex | ND | 0.002 |
| Heptachlor Epoxide | ND | 0.11 |
| alpha-Endosulphan (I) | ND | 0.1 |
| Dieldrin | ND | 0.12 |
| Endrin | ND | 0.34 |
| Methoxychlor | ND | 0.43 |
| Aroclor 1242 | ND | 0.26 |
| Aroclor 1254 | 0.4 | 0.02 |
| Aroclor 1260 | 0.66 | 0.02 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 75 |
| 13C-gamma HCH | 69 |
| 13C-p,p'-DDE | 100 |
| 13C-p,p'-DDT | 100 |
| 13C-Mirex | 71 |
| 13C-PCB 101 | 73 |
| 13C-PCB 180 | 84 |
| 13C-PCB 209 | 77 |
| d4-alpha-Endosulphan | 80 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9645**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 12.0 g dry**

**% MOISTURE: 22**

**Dong Ha**
Soil (0 – 10 cm)
Abandoned Airbase

**AXYS ID: 2607-08B I**
**DUPLICATE**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.03 | 0.005 |
| alpha HCH | 0.02 | 0.01 |
| beta HCH | 0.03 | 0.01 |
| gamma HCH | ND | 0.01 |
| Heptachlor | ND | 0.008 |
| Aldrin | ND | 0.002 |
| Oxychlordane | 0.03 | 0.009 |
| trans-Chlordane | 0.43 | 0.002 |
| cis-Chlordane | 0.39 | 0.002 |
| o,p'-DDE | 0.04 | 0.01 |
| p,p'-DDE | 0.29 | 0.01 |
| trans-Nonachlor | 0.32 | 0.002 |
| cis-Nonachlor | 0.27 | 0.003 |
| o,p'-DDD | 0.26 | 0.01 |
| p,p'-DDD | 0.81 | 0.02 |
| o,p'-DDT | 0.05 | 0.02 |
| p,p'-DDT | 0.48 | 0.02 |
| Mirex | ND | 0.002 |
| Heptachlor Epoxide | ND | 0.12 |
| alpha-Endosulphan (I) | ND | 0.11 |
| Dieldrin | ND | 0.13 |
| Endrin | ND | 0.38 |
| Methoxychlor | ND | 0.48 |
| Aroclor 1242 | ND | 0.24 |
| Aroclor 1254 | 0.33 | 0.02 |
| Aroclor 1260 | 0.85 | 0.02 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 65 |
| 13C-gamma HCH | 66 |
| 13C-p,p'-DDE | 90 |
| 13C-p,p'-DDT | 88 |
| 13C-Mirex | 67 |
| 13C-PCB 101 | 70 |
| 13C-PCB 180 | 85 |
| 13C-PCB 209 | 78 |
| d4-alpha-Endosulphan | 90 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9636**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Soil**

**SAMPLE SIZE: 13.0 g dry**

**% MOISTURE: 14**

**Chi Khe**
Soil (0 – 10 cm)
Farmer's Field
(Reference)

**AXYS ID: 2607-14 ki**

**DATE: 29/Aug/97**

**METHOD NO.: CL-S-01/Ver.2**

**INSTRUMENT: GC-HRMS/GC-ECD**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 7.8 | 1.2 |
| alpha HCH | ND | 3.0 |
| beta HCH | ND | 4.2 |
| gamma HCH | ND | 3.6 |
| Heptachlor | ND | 2.5 |
| Aldrin | ND | 0.85 |
| Oxychlordane | ND | 2.8 |
| trans-Chlordane | ND | 0.75 |
| cis-Chlordane | ND | 0.8 |
| o,p'-DDE | 60 | 3.2 |
| p,p'-DDE | 2500 | 3.8 |
| trans-Nonachlor | ND | 0.79 |
| cis-Nonachlor | ND | 0.98 |
| o,p'-DDD | 290 | 4.4 |
| p,p'-DDD | 1700 | 5.1 |
| o,p'-DDT | 1200 | 4.6 |
| p,p'-DDT | 11000 | 6.0 |
| Mirex | ND | 0.64 |
| Heptachlor Epoxide | ND | 0.01 |
| alpha-Endosulphan (I) | ND | 0.04 |
| Dieldrin | ND | 0.01 |
| Endrin | ND | 0.03 |
| Methoxychlor | ND | 0.52 |
| Aroclor 1242 | ND | 83 |
| Aroclor 1254 | ND | 7.7 |
| Aroclor 1260 | ND | 6.2 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected
6. Data are not recovery corrected; results represent minimum concentrations

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9629**

**AXYS ID: 2607-21**

**CLIENT: Hatfield Consultants**

**DATE: 14/Oct/97**
**REVISED: 20/Oct/97**

**SAMPLE TYPE: Tissue**

**Son Thuy**
Pig Liver

**METHOD NO.: CL-T-02/Ver. 2**

**SAMPLE SIZE: 5.19 g wet**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL762469.D**

**% MOISTURE: 63**

**% LIPID: 2.8**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.16 |
| alpha HCH | ND | 0.27 |
| beta HCH | ND | 0.42 |
| gamma HCH | ND | 0.44 |
| Heptachlor | ND | 1.0 |
| Aldrin | ND | 0.34 |
| Oxychlordane | ND | 0.78 |
| trans-Chlordane | ND | 0.17 |
| cis-Chlordane | ND | 0.11 |
| o,p'-DDE | ND | 0.1 |
| p,p'-DDE | 1.5 | 0.1 |
| trans-Nonachlor | ND | 0.06 |
| cis-Nonachlor | ND | 0.1 |
| o,p'-DDD | ND | 0.1 |
| p,p'-DDD | 0.92 | 0.1 |
| o,p'-DDT | ND | 0.08 |
| p,p'-DDT | ND | 0.09 |
| Mirex | ND | 0.20 |
| Heptachlor Epoxide | ND | 0.03 |
| alpha-Endosulphan (I) | ND | 0.02 |
| Dieldrin | ND | 0.03 |
| Endrin | ND | 0.08 |
| Methoxychlor | ND | 0.17 |
| Aroclor 1242 | ND | 4.0 |
| Aroclor 1254 | ND | 3.4 |
| Aroclor 1260 | ND | 0.91 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 61 |
| 13C-gamma HCH | 85 |
| 13C-p,p'-DDE | 91 |
| 13C-p,p'-DDT | 90 |
| 13C-Mirex | 88 |
| 13C-PCB 101 | 90 |
| 13C-PCB 180 | 100 |
| 13C-PCB 209 | 98 |
| d4-alpha-Endosulphan | 98 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hoover
**Approved**

## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9646**

**CLIENT: Hatfield Consultants**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 1.06 g wet**

**% MOISTURE: 8.3**

A So
Carp Fat

**% LIPID: 96**

**AXYS ID: 2607-23**

**DATE: 14/Oct/97**

**METHOD NO.: CL-T-02/Ver. 2**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL762470.D**
**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 3.2 | 0.33 |
| alpha HCH | 11 | 0.84 |
| beta HCH | 3.4 | 0.95 |
| gamma HCH | 2.7 | 1.0 |
| Heptachlor | ND | 2.8 |
| Aldrin | ND | 1.4 |
| Oxychlordane | ND | 3.0 |
| trans-Chlordane | ND | 0.69 |
| cis-Chlordane | ND | 0.85 |
| o,p'-DDE | 9.3 | 0.35 |
| p,p'-DDE | 450 | 0.36 |
| trans-Nonachlor | 0.38 | 0.37 |
| cis-Nonachlor | ND | 0.46 |
| o,p'-DDD | 79 | 0.29 |
| p,p'-DDD | 500 | 0.23 |
| o,p'-DDT | 43 | 0.67 |
| p,p'-DDT | 13 | 0.28 |
| Mirex | ND | 0.70 |
| Heptachlor Epoxide | 0.27 | 0.16 |
| alpha-Endosulphan (I) | 3.1 | 0.25 |
| Dieldrin | 0.83 | 0.19 |
| Endrin | ND | 0.37 |
| Methoxychlor | ND | 0.77 |
| Aroclor 1242 | ND | 12 |
| Aroclor 1254 | ND | 16 |
| Aroclor 1260 | ND | 4.7 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 71 |
| 13C-gamma HCH | 96 |
| 13C-p,p'-DDE | 79 |
| 13C-p,p'-DDT | 70 |
| 13C-Mirex | 84 |
| 13C-PCB 101 | 82 |
| 13C-PCB 180 | 100 |
| 13C-PCB 209 | 96 |
| d4-alpha-Endosulphan | 52 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: VN9641**

**AXYS ID: 2607-26**

**CLIENT: Hatfield Consultants**

**DATE: 14/Oct/97**
**REVISED: 20/Oct/97**

**Con Cuong**
Pig Liver
(Reference)

**SAMPLE TYPE: Tissue**

**METHOD NO.: CL-T-02/Ver. 2**

**SAMPLE SIZE: 5.75 g wet**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL762471.D**

**% MOISTURE: 69**

**% LIPID: 3.2**

**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.2 |
| alpha HCH | ND | 0.34 |
| beta HCH | ND | 0.52 |
| gamma HCH | ND | 0.16 |
| Heptachlor | ND | 1.5 |
| Aldrin | ND | 0.25 |
| Oxychlordane | ND | 0.82 |
| trans-Chlordane | ND | 0.16 |
| cis-Chlordane | ND | 0.17 |
| o,p'-DDE | ND | 0.1 |
| p,p'-DDE | 0.76 | 0.1 |
| trans-Nonachlor | ND | 0.04 |
| cis-Nonachlor | ND | 0.12 |
| o,p'-DDD | ND | 0.1 |
| p,p'-DDD | 0.40 | 0.1 |
| o,p'-DDT | ND | 0.17 |
| p,p'-DDT | ND | 0.13 |
| Mirex | ND | 0.15 |
| Heptachlor Epoxide | ND | 0.03 |
| alpha-Endosulphan (I) | ND | 0.05 |
| Dieldrin | ND | 0.03 |
| Endrin | ND | 0.08 |
| Methoxychlor | ND | 0.16 |
| Aroclor 1242 | ND | 3.3 |
| Aroclor 1254 | ND | 5.0 |
| Aroclor 1260 | ND | 1.5 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 82 |
| 13C-gamma HCH | 100 |
| 13C-p,p'-DDE | 73 |
| 13C-p,p'-DDT | 80 |
| 13C-Mirex | 94 |
| 13C-PCB 101 | 92 |
| 13C-PCB 180 | 110 |
| 13C-PCB 209 | 110 |
| d4-alpha-Endosulphan | 59 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: Spiked Matrix**

**AXYS ID: CL-S-SPM 781 i**

**CLIENT: Hatfield Consultants**

**DATE: 29/Aug/97**

**SAMPLE TYPE: Sediment**

**METHOD NO.: CL-S-02/Ver.2**

**SAMPLE SIZE: 10.0 g**

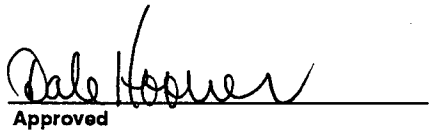
**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: ng/g**

| Compounds | Determined | Expected | % Recovery |
|---|---|---|---|
| Hexachlorobenzene | 5.1 | 5.1 | 100 |
| alpha HCH | 4.6 | 5.2 | 88 |
| beta HCH | 6.1 | 7.3 | 84 |
| gamma HCH | 4.6 | 5.2 | 88 |
| Heptachlor | 6.3 | 5.3 | 119 |
| Aldrin | 3.8 | 3.7 | 103 |
| Oxychlordane | 6.3 | 4.9 | 129 |
| trans-Chlordane | 3.3 | 2.8 | 118 |
| cis-Chlordane | 4.6 | 4.6 | 100 |
| o,p'-DDE | 4.8 | 5.2 | 92 |
| p,p'-DDE | 4.8 | 5.1 | 94 |
| trans-Nonachlor | 4.3 | 3.9 | 110 |
| cis-Nonachlor | 3.8 | 3.5 | 109 |
| o,p'-DDD | 6.3 | 4.7 | 134 |
| p,p'-DDD | 8.2 | 6.2 | 132 |
| o,p'-DDT | 5.5 | 5.7 | 96 |
| p,p'-DDT | 6.0 | 5.7 | 105 |
| Mirex | 5.2 | 5.2 | 100 |
| Heptachlor Epoxide | 2.9 | 4.7 | 62 |
| alpha-Endosulphan (I) | 3.3 | 3.7 | 89 |
| Dieldrin | 3.2 | 5.5 | 58 |
| Endrin | 9.8 | 10 | 98 |
| Methoxychlor | 14 | 21 | 67 |
| Aroclor 1242 | 51 | 46 | 111 |
| Aroclor 1254 | 52 | 42 | 124 |
| Aroclor 1260 | 44 | 43 | 102 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 65 |
| 13C-gamma HCH | 70 |
| 13C-p,p'-DDE | 86 |
| 13C-p,p'-DDT | 99 |
| 13C-Mirex | 66 |
| 13C-PCB 101 | 68 |
| 13C-PCB 180 | 83 |
| 13C-PCB 209 | 86 |
| d4-alpha-Endosulphan | 73 |

1. Concentrations are recovery corrected



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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D:** Procedural Blank

**AXYS ID:** CL-S-BLK 1107 i

**CLIENT:** Hatfield Consultants

**DATE:** 29/Aug/97

**SAMPLE TYPE:** Blank

**METHOD NO.:** CL-S-01/Ver.2

**SAMPLE SIZE:** 12.0 g

**INSTRUMENT:** GC-HRMS/GC-ECD

**CONCENTRATION IN:** ng/g

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | 0.02 | 0.006 |
| alpha HCH | ND | 0.01 |
| beta HCH | ND | 0.02 |
| gamma HCH | ND | 0.02 |
| Heptachlor | ND | 0.01 |
| Aldrin | ND | 0.004 |
| Oxychlordane | ND | 0.01 |
| trans-Chlordane | ND | 0.004 |
| cis-Chlordane | ND | 0.004 |
| o,p'-DDE | ND | 0.02 |
| p,p'-DDE | ND | 0.02 |
| trans-Nonachlor | ND | 0.004 |
| cis-Nonachlor | ND | 0.005 |
| o,p'-DDD | ND | 0.02 |
| p,p'-DDD | ND | 0.03 |
| o,p'-DDT | ND | 0.03 |
| p,p'-DDT | ND | 0.04 |
| Mirex | ND | 0.004 |
| Heptachlor Epoxide | ND | 0.02 |
| alpha-Endosulphan (I) | ND | 0.05 |
| Dieldrin | ND | 0.02 |
| Endrin | ND | 0.04 |
| Methoxychlor | ND | 0.76 |
| Aroclor 1242 | ND | 0.17 |
| Aroclor 1254 | ND | 0.02 |
| Aroclor 1260 | ND | 0.03 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 75 |
| 13C-gamma HCH | 81 |
| 13C-p,p'-DDE | 95 |
| 13C-p,p'-DDT | 90 |
| 13C-Mirex | 72 |
| 13C-PCB 101 | 73 |
| 13C-PCB 180 | 84 |
| 13C-PCB 209 | 59 |
| d4-alpha-Endosulphan | 75 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected

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## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: Procedural Blank**

**AXYS ID: CL-T-BLK 1139**

**CLIENT: Hatfield Consultants**

**DATE: 14/Oct/97**

**SAMPLE TYPE: Blank**

**METHOD NO.: CL-T-02/Ver.2**

**SAMPLE SIZE: 5.0 g**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL762461.D**
**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.09 |
| alpha HCH | ND | 0.33 |
| beta HCH | ND | 0.34 |
| gamma HCH | ND | 0.2 |
| Heptachlor | ND | 0.84 |
| Aldrin | ND | 0.25 |
| Oxychlordane | ND | 0.34 |
| trans-Chlordane | ND | 0.14 |
| cis-Chlordane | ND | 0.13 |
| o,p'-DDE | ND | 0.11 |
| p,p'-DDE | 0.14 | 0.09 |
| trans-Nonachlor | ND | 0.1 |
| cis-Nonachlor | ND | 0.08 |
| o,p'-DDD | ND | 0.06 |
| p,p'-DDD | ND | 0.06 |
| o,p'-DDT | ND | 0.1 |
| p,p'-DDT | ND | 0.03 |
| Mirex | ND | 0.25 |
| Heptachlor Epoxide | ND | 0.03 |
| alpha-Endosulphan (I) | ND | 0.05 |
| Dieldrin | ND | 0.03 |
| Endrin | ND | 0.05 |
| Methoxychlor | ND | 0.1 |
| Aroclor 1242 | ND | 9.2 |
| Aroclor 1254 | ND | 3.4 |
| Aroclor 1260 | ND | 0.83 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 49 |
| 13C-gamma HCH | 75 |
| 13C-p,p'-DDE | 68 |
| 13C-p,p'-DDT | 72 |
| 13C-Mirex | 73 |
| 13C-PCB 101 | 73 |
| 13C-PCB 180 | 89 |
| 13C-PCB 209 | 76 |
| d4-alpha-Endosulphan | 41 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected

Dale Hoover
**Approved**

## PCB/PESTICIDE ANALYSIS REPORT

**CLIENT SAMPLE I.D: SRM 1588 N.I.S.T. Certified Cod Liver Oil**

**AXYS ID: CL-T-CRM 421**

**CLIENT: Hatfield Consultants**

**DATE: 14/Oct/97**

**SAMPLE TYPE: Tissue**

**METHOD NO.: CL-T-02/Ver. 2**

**SAMPLE SIZE: 0.297 g wet**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL762472.D**
**CONCENTRATION IN: ng/g**

| Compounds | Determined | Certified |
|---|---|---|
| Hexachlorobenzene | 170 | 148 +/- 21 |
| alpha HCH | 90 | 86 +/- 19 |
| gamma HCH | 23 | 24 +/- 6* |
| trans-Chlordane | 50 | 50 +/- 13 |
| cis-Chlordane | 200 | 158 +/- 8 |
| p,p'-DDE | 620 | 641 +/- 62 |
| trans-Nonachlor | 250 | 209 +/- 11 |
| o,p'-DDD | 41 | 37 +/- 8* |
| p,p'-DDD | 250 | 277 +/- 15 |
| o,p'-DDT | 180 | 156 +/- 5 |
| p,p'-DDT | 560 | 529 +/- 45 |
| Dieldrin | 140 | 150 +/- 12 |
| Aroclor 1242 | 190 | 150 +/- 60** |
| Aroclor 1254 | 1700 | 1500 +/- 500** |
| Aroclor 1260 | 1100 | 840 +/- 210** |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 81 |
| 13C-gamma HCH | 110 |
| 13C-p,p'-DDE | 100 |
| 13C-p,p'-DDT | 93 |
| 13C-Mirex | 82 |
| 13C-PCB 101 | 100 |
| 13C-PCB 180 | 84 |
| 13C-PCB 209 | 94 |
| d4-alpha-Endosulphan | 71 |

* Information value supplied by N.I.S.T. in 1992

** In-house concensus value determined through repetitive analysis

1. Concentrations are recovery corrected

Approved

# Appendix IV

# Acid Extractable Herbicide Report

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

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# CHEMICAL ANALYSIS REPORT

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**Date:** August 21, 1997

**ASL File No.** H5788

**Report On:** 2607 Soil Analysis

**Report To:** **Axys Analytical Services Ltd.**
P.O. Box 2219
2045 Mills Road
Sidney, BC
V8L 3S8

**Attention:** **Ms. Georgina Brooks**

**Received:** July 31, 1997

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**ASL ANALYTICAL SERVICE LABORATORIES LTD.**
per:

Heather A. Ross, B.Sc.
Project Chemist

Joanne Patrick, B.Sc.
Project Chemist

**REMARKS** File No. H5788

Six soil sample extracts were received from AXYS Analytical Services Ltd. for Herbicide analysis. These extracts were prepared by AXYS according to methodology supplied by ASL.

The extracts were subsequently prepared for analysis using clean up and derivatization procedure for Herbicides, as described in the methodology section of this report. In addition to the extracts provided, a reagent blank and spike were carried through the same clean up and derivatization procedure and the results for these samples are reported in the following data tables.

## RESULTS OF ANALYSIS - Sediment/Soil

File No. H5788

| | Blank | Spike[1] Matrix | 2607-02 | 2607-03 | 2607-04 |
|---|---|---|---|---|---|
| **Herbicides** | | | | | |
| 2,4-Dichlorophenoxy Acetic Acid | <0.01 | 70 | <0.01 | <0.01 | <0.01 |
| Dicamba | <0.01 | 85 | <0.01 | <0.01 | <0.01 |
| 2,4-DB | <0.01 | 112 | <0.01 | <0.01 | <0.01 |
| Dichlorprop | <0.01 | 60 | <0.01 | <0.01 | <0.01 |
| Dinoseb | <0.01 | 22 | <0.01 | <0.01 | <0.01 |
| MCPA | <0.50 | 65 | <0.50 | <0.50 | <0.50 |
| Picloram | <0.01 | 83 | <0.01 | <0.01 | <0.01 |
| Silvex (2,4,5-TP) | <0.01 | 83 | <0.01 | <0.01 | <0.01 |
| 2,4,5-T | <0.01 | 85 | <0.01 | <0.01 | <0.01 |

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
[1]Spike Matrix results are expressed as percent recovery.

**RESULTS OF ANALYSIS - Sediment/Soil** File No. H5788

| | 2607-06 | 2607-08A | 2607-08B |
|---|---|---|---|
| **Herbicides** | | | |
| 2,4-Dichlorophenoxy Acetic Acid | <0.01 | <0.01 | <0.01 |
| Dicamba | <0.01 | <0.01 | <0.01 |
| 2,4-DB | <0.01 | <0.01 | <0.01 |
| Dichlorprop | <0.01 | <0.01 | <0.01 |
| Dinoseb | <0.01 | <0.01 | <0.01 |
| MCPA | <0.50 | <0.50 | <0.50 |
| Picloram | <0.01 | <0.01 | <0.01 |
| Silvex (2,4,5-TP) | <0.01 | <0.01 | <0.01 |
| 2,4,5-T | <0.01 | <0.01 | <0.01 |

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.

## RESULTS OF ANALYSIS - Quality Control[1]

File No. H5788

| | Reagent Blank | Reagent Spike % |
|---|---|---|
| **Herbicides** | | |
| 2,4-Dichlorophenoxy Acetic Acid | <0.01 | 87 |
| Dicamba | <0.01 | 105 |
| 2,4-DB | <0.01 | 113 |
| Dichlorprop | <0.01 | 82 |
| Dinoseb | <0.01 | 78 |
| MCPA | <0.50 | 63 |
| Picloram | <0.01 | 117 |
| Silvex (2,4,5-TP) | <0.01 | 79 |
| 2,4,5-T | <0.01 | 92 |

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
[1]Reagent Spike results are expressed as percent recovery.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

**Phenoxy Acid Herbicides in Soil/Sediment**

This analysis is adapted from U.S. EPA Method 8151A (Publ. #SW-846 3rd ed., Washington, DC 20460). The procedure involves a liquid-solid extraction of the sediment/soil sample with a mixture of acidified acetone and diethyl ether. The acetone/diethyl ether extracts are combined into a separatory funnel and reagent water is added. Additional diethyl ether is added and the herbicides are extracted by liquid-liquid extraction. The diethyl ether extract is then concentrated, methylated with diazomethane and analysed by capillary column gas chromatography with mass spectrometric detection.

**End of Report**

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

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# CHEMICAL ANALYSIS REPORT

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**Date:** September 15, 1997

**ASL File No.** H6544

**Report On:** 2607 Extract Analysis

**Report To:** **Axys Analytical Services Ltd.**
P.O. Box 2219
2045 Mills Road
Sidney, BC
V8L 3S8

**Attention:** **Ms. Georgina Brooks**

**Received:** August 26, 1997

---

**ASL ANALYTICAL SERVICE LABORATORIES LTD.**
per:

Heather A. Ross, B.Sc.
Project Chemist

Joanne Patrick, B.Sc.
Project Chemist

**REMARKS** File No. H6544

One soil sample extract was received from AXYS Analytical Services Ltd. for Herbicide analysis. This extract was prepared by AXYS according to methodology supplied by ASL.

The extract was subsequently prepared for analysis using clean up and derivatization procedures for Herbicides, as described in the methodology section of this report. In addition to the soil extract provided, a method blank and a spiked matrix extract were also provided and were carried through the same procedure. The results for these samples are reported in the following data tables.

## RESULTS OF ANALYSIS - Sediment/Soil

File No. H6544

| | 2607-14 VN9636 | Blank | Spiked[1] Matrix |
|---|---|---|---|
| **Herbicides** | | | |
| 2,4-Dichlorophenoxy Acetic Acid | <0.01 | <0.01 | 60 |
| Dicamba | <0.01 | <0.01 | 82 |
| 2,4-DB | <0.01 | <0.01 | 59 |
| Dichlorprop | <0.01 | <0.01 | 82 |
| Dinoseb | <0.02 | <0.02 | 56 |
| MCPA | <0.50 | <0.50 | 96 |
| Picloram | <0.01 | <0.01 | 62 |
| Silvex (2,4,5-TP) | <0.01 | <0.01 | 86 |
| 2,4,5-T | <0.01 | <0.01 | 64 |

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
[1]Spiked Matrix results are expressed as percent recovery.

**METHODOLOGY** File No. H6544

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

**Phenoxy Acid Herbicides in Soil/Sediment**

This analysis is adapted from U.S. EPA Method 8151A (Publ. #SW-846 3rd ed., Washington, DC 20460). The procedure involves a liquid-solid extraction of the sediment/soil sample with a mixture of acidified acetone and diethyl ether. The acetone/diethyl ether extracts are combined into a separatory funnel and reagent water is added. Additional diethyl ether is added and the herbicides are extracted by liquid-liquid extraction. The diethyl ether extract is then concentrated, methylated with diazomethane and analysed by capillary column gas chromatography with mass spectrometric detection.

**End of Report**

# Appendix V

# Batch Summary Sheets

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1618 | ***Date:*** 13 August 1997 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Sediment |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -01 A<br>-02<br>-03<br>-04<br>-05<br>-06<br>-07<br>-08<br>-09 | ***Blank:*** DX-S-BLK 1618 |
| | ***Reference or Spike:***<br>DX-S-SPM 823 |
| | ***Duplicate:***<br>2607-01 B |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1635 | ***Date:*** 05 September 1997 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Sediment |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -10<br>-11<br>-12 A<br>-13<br>-14 | ***Blank:*** DX-S-BLK 1635 |
| | ***Reference or Spike:***<br>DX-S-SPM 840 |
| | ***Duplicate:***<br>2607-12 B |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1639 | ***Date:*** 24 September 1997 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Plant / Tissue |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -15<br>-16<br>-17 A<br>-18<br>-19<br>-20 | ***Blank:*** DX-T-BLK 1639 |
| | ***Reference or Spike:***<br>DX-T-SPM 845 |
| | ***Duplicate:***<br>2607-17 B |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1641 | ***Date:*** 26 September 1997 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Tissue |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -21<br>-22<br>-23<br>-24 A<br>-25<br>-26<br>-27 | ***Blank:*** DX-T-BLK 1641 |
| | ***Reference or Spike:***<br>DX-T-SPM 847 |
| | ***Duplicate:***<br>2607-24 B |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1658 | ***Date:*** 14 October 1997 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Sediment |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -19 | ***Blank:*** DX-S-BLK 1658 |
| | ***Reference or Spike:*** DX-S-SPM 858 |
| | ***Duplicate:*** |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** CL-1107 | ***Date:*** August 29, 1997 |
| ***Analysis Type:*** PCB Aroclors/Pesticide | ***Matrix Type:*** Soil |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 - 02 i<br>- 03 ki<br>- 04 i<br>- 06 i<br>- 08A i<br>- 14 ki | ***Blank:***<br>CL-S-BLK 1107 |
| | ***Reference or Spike:***<br>CL-S-SPM 781 |
| | ***Duplicate:***<br>2607 - 08B i |

***Comments***:

1. Due to the high concentrations of pesticides in samples 2607-03 & -14 (VN9624 & VN9636), the extracts required dilution and respiking with surrogate standard. The results, therefore, are not recovery corrected and should be interpreted as minimum concentrations. If confirmation is required, the analyses can be repeated using a smaller sample.

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** CL-1139 | ***Date:*** October 14, 1997 |
| ***Analysis Type:*** PCB/Pesticide | ***Matrix Type:*** Tissue |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 - 21<br>- 23<br>- 25 | ***Blank:***<br>CL-T-BLK 1139 |
| | ***Reference or Spike:***<br>CL-T-CRM 421 |
| | ***Duplicate:*** |
| ***Comments*** | |

## Section 3

- **Axys Analytical Report to Hatfield Consultants Ltd. April 1998**

*Analytical Data on 1997 Viet Nam Samples*

- **Addendum**

**Analytical Data on 1997 PCB/Pesticide Analyses - Reports and Batch Summary Sheets**

**(See Appendix A2.2 for Analytical Protocols)**

AAS 2607

# ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS IN SAMPLES FROM VIETNAM

## FINAL REPORT

**Prepared for:**

HATFIELD CONSULTANTS LTD
Suite 201 - 1571 Bellevue Avenue
West Vancouver, BC V7V 3R6

**Prepared by:**

AXYS ANALYTICAL SERVICES
PO Box 2219, 2045 Mills Road West
Sidney, BC V8L 3S8

April 1998

## TABLE OF CONTENTS



### List of Tables

## 1. INTRODUCTION

Axys Analytical Services Ltd. was contracted by Hatfield Consultants Ltd. to conduct polychlorinated dibenzodioxin and dibenzofuran analyses on environmental samples from Vietnam. These samples included four sediment, five animal adipose tissue and four human blood samples. Table 1 presents a correlation between the Axys ID and the corresponding Hatfield sample description for each sample.

The sample handling protocols, analysis procedures and QA/QC results are documented in this final report. Complete data reports for all samples are presented. Results for QA/QC samples (procedural blanks, analysis duplicates, and internal reference material) are also presented.

## 2. SAMPLE HANDLING

The importation and storage of these samples were authorized by the Government of Canada and all storage, sample handling and laboratory procedures satisfied the requirements of the Permit to Import Animal Specimens and Product Samples issued by the Canadian Food Inspection Agency (98-02-SPB-08) and the Permit to Import Human Pathogen(s) issued by the Health Protection Branch, Laboratory Centre for Disease Control (P-02881).

Whole blood samples were collected in Vietnam and stored there for several months before being shipped to Hatfield Consultants' offices in Vancouver. Hatfield personnel then selected and shipped the samples for analysis to Axys. Some of the samples were noted to have leaked slightly prior to arrival and all of the samples were clotted. Upon receipt the samples were stored at -20°C. The samples were received and maintained using chain-of-custody procedures.

Samples were homogenized using a Virtis blender (adipose) or by hand stirring (sediments). The whole blood samples were not subsampled but analyzed in their entirety. Separate subsamples were taken for percent moisture determination for each sediment sample. The thawing, homogenization, moisture determination and extraction procedures were all conducted in a fumehood equipped with a HEPA filter. Once the procedures were complete, the fumehood and glassware were washed with a phenol-based disinfectant soap.

In addition, analysts wore disposable protective clothing and plastic gloves which were autoclaved after use. Residual extracted sample and spent reagents were also autoclaved. These materials were stored at Axys until disposal by Agriculture Canada.

**Table 1**

**Correlation Between Axys Sample Identification and Hatfield Sample Description**

| AXYS SAMPLE ID | HATFIELD SAMPLE DESCRIPTION | | |
|---|---|---|---|
| | HATFIELD ID | MEDIA | SAMPLE TYPE |
| 2607-50 | 97NV005 | Fish Pond Sediment | 60 cm water depth |
| 2607-51 | 97NV007 | Fish Pond Sediment | 60 cm water depth |
| 2607-52 | 97NV009 | Fish Pond Sediment | 60 cm water depth |
| 2607-53 | 97NV011 | Fish Pond Sediment | 60 cm water depth |
| 2607-54 | 97NV019 | Grass Carp Fat | Fat |
| 2607-55 | 97NV027 | Grass Carp Fat | Fat |
| 2607-56 | 97NV031 | Grass Carp Fat | Fat |
| 2607-57 | 97NV039 | Grass Carp Fat | Fat |
| 2607-58 | 97NV045 | Duck Fat | Fat |
| 2607-59 | 97NV047 | Human Whole Blood | Males, >26 |
| 2607-60 | 97NV048 | Human Whole Blood | Females, >26 |
| 2607-61 | 97NV049 | Human Whole Blood | Males, 15-25 |
| 2607-62 | 97NV050 | Human Whole Blood | Females, 15-25 |

## 3. ANALYTICAL METHOD FOR THE ANALYSIS OF POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

Complete descriptions of the analytical method used are presented in Appendix I.

Each sample was spiked with an aliquot of surrogate standard solution containing nine $^{13}C$-labelled dioxin and furan congeners. Soil samples were soxhlet extracted. Adipose (fat) samples were ground with sodium sulphate and packed into a glass column which was eluted with solvent. Whole blood samples were liquid/liquid extracted by shaking with hexane, methanol and saturated ammonium sulphate. Extracts were subject to a series of chromatographic cleanup steps prior to analysis by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).

Gravimetric moisture determination was conducted on the sediment samples. Tissue extracts were subsampled for percent lipid determination.

## 4. ANALYTICAL RESULTS

Results were reported to Hatfield Consultants as the analyses were completed.

The original dioxin/furan analysis reports for all samples are included in Appendix II. Percent moisture and percent lipid data are also reported on the appropriate sheets. Reports for QA/QC samples are included in Appendix III.

All concentrations have been corrected based on the percent recovery of the surrogate standard. Concentrations are reported on a dry weight basis for soil, a wet weight basis for adipose tissue and both a wet weight and lipid weight basis for whole blood.

## 5. QUALITY ASSURANCE/QUALITY CONTROL

Samples were worked up in batches with accompanying QC samples. Each batch progressed from sample workup through instrumental analysis and onto data interpretation and final reports as a unit. The sample results were reviewed and evaluated in relation to the QA/QC samples worked up at the same time.

The composition of each batch of samples analyzed is detailed in a Batch Summary presented in Appendix IV. A procedural blank, analysis duplicate and reference sample were analyzed with each batch of samples, with the exception of the blood samples. A duplicate sample was not analyzed with the blood samples because of insufficient sample.

## 5.1 Procedural Blanks

Overall, procedural blanks demonstrated non-detectable or low background levels of target compounds.

## 5.2 Duplicates

Results for two duplicate analyses are reported along with the sample analysis results. Agreement within both sets of duplicates satisfied Axys' criterion of ±(20% of the mean + Detection Limit).

## 5.3 Surrogate Standard Recoveries

The recovery of each surrogate standard was monitored by comparing its response to that of the recovery standard added just prior to instrumental analysis. The calculation of percent recovery is explained in Section 6.

Surrogate standard recoveries for each sample are presented along with the sample data, on each analysis report. The percent recoveries reported for most of the surrogates satisfied Axys' quality control standards criterion that they must be within an established acceptable range. One sample (2581-61, 97VN049) had low surrogate recoveries, however comparison of the data for the four samples implies that the isotope dilution quantification was still in control for this sample. Normally samples with low recoveries are repeated, however due to the limited amount of sample provided, the entire sample was consumed for the original analysis.

## 5.4 Laboratory Reference Samples

A "known" sample, a spiked in-house sample, was worked up with each batch of samples and used to demonstrate the accuracy of the data. Spiked samples were prepared at Axys by adding a solution of authentic target analytes into a weighed amount of in-house reference material. The percent recovery of the target analytes generally fell within 70% - 130%, which meets Axys' criterion for acceptability.

## 5.5 Detection Limits

Detection limits were calculated on a sample-specific basis and are reported for each sample on the analysis report.

Detection limits were calculated using a minimum area based on the noise level in the chromatogram. The minimum area is the area of a peak with a height three times the maximum height of the noise. Only peaks with responses greater than three times the background noise level were quantified. The calculation of detection limits is described in Section 6.

## 6. CALCULATIONS

The isotope dilution method was used to quantify components in the samples. $Conc_i$, the concentration of a component in a sample, was calculated using the following equations:

$$Conc_i = \frac{A_i}{A_{si}} \times \frac{W_{si}}{W_i} \times \frac{1}{RRF_{i,si}}$$

where $A_i$ = area of the analyte peak of interest to quantify
$A_{si}$ = area of labelled surrogate used to quantify i
$W_i$ = weight of sample taken for analysis
$W_{si}$ = weight of labelled surrogate added to sample
$RRF_{i,si}$ = relative response factor of i to si as determined by daily runs of the calibration standard solution and defined as

$$\frac{A_i}{A_{si}} \times \frac{W_{si}}{W_i}$$

Detection limits were also calculated using the above equations with the minimum detectable peak area used for $A_i$. The minimum detectable peak area was calculated as three times the maximum noise in the chromatogram (height of noise x area / height ratio of a typical peak x 3).

Recoveries of internal standards were calculated by the internal standard method using the following equation.

$$\%Recovery = \frac{A_{si}}{A_{rs}} \times \frac{W_{rs}}{W_{si}} \times \frac{1}{RRF_{si,rs}} \times 100$$

where $A_{si}$ and $A_{rs}$ are the areas of the labelled surrogate and the recovery standard in the sample run and $W_{rs}$, $W_{si}$ are the weights of recovery standard and labelled surrogate added to the sample. $RRF_{si,rs}$ is the relative response factor of the labelled surrogate to the recovery standard as determined by daily runs of the quantification solution and defined by

$$\frac{A_{si}}{A_{rs}} \times \frac{W_{rs}}{W_{si}}$$

# Appendix I

# Analytical Method

# ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS IN SOIL AND TISSUE SAMPLES

All samples were spiked with $^{13}C$-labelled surrogate standards (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran, and octachlorodioxin) prior to analysis. Soil samples were soxhlet extracted. Tissue samples were ground with sodium sulphate, loaded into a glass chromatographic column and eluted with solvent. All extracts were subject to a series of chromatographic cleanup steps prior to analysis for polychlorinated dibenzodioxins and dibenzofurans by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).

## 1. EXTRACTION PROCEDURES

**Soils:** A subsample of soil was ground with anhydrous sodium sulphate, transferred to a soxhlet thimble and an aliquot of surrogate standard solution added. The soxhlet was allowed to reflux for 16 hours with 80:20 toluene:acetone. The cooled extract was transferred to a separatory funnel and sequentially washed with potassium hydroxide solution, distilled water, concentrated sulphuric acid and a second time with distilled water. The organic layer was dried over anhydrous sodium sulphate, the solvent evaporated just to dryness and the residue redissolved in hexane. The extract was ready for chromatographic cleanup procedures.

A separate subsample of soil was dried overnight at 105°C to determine moisture content.

**Tissues:** A subsample of adipose tissue was ground with anhydrous sodium sulphate. The mixture was transferred to a glass chromatographic column containing 1:1 dichloromethane:hexane and an aliquot of surrogate standard solution was added. The column was eluted with additional solvent. The eluate was subsampled for gravimetric lipid determination. The remaining extract was concentrated, loaded onto a gel permeation column (to remove lipids and high molecular weight interferences) and eluted with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated prior to chromatographic cleanup procedures.

## 2. CHROMATOGRAPHIC CLEANUP PROCEDURES

a) Silica Gel Column: The extracts were transferred to layered silica gel columns. Soil extracts were eluted with hexane. Tissue extracts were eluted with 1:1 dichloromethane:hexane. The eluate was concentrated by rotary evaporation.

b) Alumina Column: The extract from the silica gel column was loaded onto a basic alumina column. The first fraction, eluted with 3% dichloromethane:hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated by rotary evaporation.

c) Carbon/Celite Column: The extract from the alumina column was loaded onto a carbon/Celite column and eluted with 1:1 cyclohexane:dichloromethane (discarded) followed by 1:1 ethylacetate:toluene (discarded). The column was inverted and eluted with toluene (collected). This fraction was evaporated to near dryness and redissolved in hexane.

d) Alumina Column: The extract from the carbon/Celite column was loaded onto a basic alumina column. The first fraction, eluted with hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated.

e) Preparation for GC/MS Analysis: The extract was evaporated just to dryness and an aliquot of recovery standard solution containing $^{13}C$-labelled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin was added.

## 3. HIGH RESOLUTION GC/MS ANALYSIS

Polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF) were analyzed on an Ultima AutoSpec mass spectrometer equipped with a Hewlett Packard 5890 gas chromatograph, a DB-5 capillary chromatography column (60 m, 0.25 mm i.d x 0.1 $\mu$m film thickness) and a CTC autosampler. Data were acquired in the voltage selected ion recording mode (SIR) to enhance sensitivity. At least two ions were used to monitor each of the target analytes and $^{13}C$-labelled surrogate standards. Five additional ions were monitored to check for interference from chlorinated diphenyl ethers.

The instrumental conditions, analyte identification and quantification protocols for PCDDs/PCDFs, as described in Environment Canada Report EPS 1/RM/19, February 1992[1] were strictly adhered to.

## 4. QUANTITATION PROCEDURES

Concentrations of target analytes were calculated using the isotope dilution method of quantitation. PCDDs and PCDFs were quantified by comparing the area of the quantification ion to that of the corresponding $^{13}C$-labelled surrogate standard and correcting for response factors. Response factors were determined daily using authentic PCDDS and PCDFs.

Concentrations of analytes were corrected based on the percent recovery of surrogate standards. Concentrations are reported in pg/g dry weight for soils and pg/g wet weight for adipose samples.

Sample detection limits are reported for each target analyte, based on a minimum detectable area for that compound in the chromatogram.

## REFERENCES

1. Environment Canada Reference Method EPS 1/RM/19, *Reference Method for the Determination of Polychlorinated Dibenzo-para-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) in Pulp and Paper Mill Effluents,* February 1992.

## ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS IN WHOLE BLOOD

All samples were spiked with $^{13}C$-labelled surrogate standards (tetrachlorodioxin, tetrachlorofuran, pentachlorodioxin, pentachlorofuran, hexachlorodioxin, hexachlorofuran, heptachlorodioxin, heptachlorofuran, and octachlorodioxin) prior to analysis. Blood samples were liquid/liquid extracted by shaking with solvent and ammonium sulphate solution. All extracts were subject to a series of chromatographic cleanup steps prior to analysis for polychlorinated dibenzodioxins and dibenzofurans by high resolution gas chromatography with high resolution mass spectrometric detection (HRGC/HRMS).

### 1. Extraction

The entire sample (typically 30 - 50 g) of whole blood was accurately weighed into a round bottom flask, spiked with an aliquot of surrogate standard solution and allowed to equilibrate. Ethanol, hexane and saturated ammonium sulphate were added and the sample extracted by shaking on a shaker table for 30 minutes. The hexane layer was decanted into a separatory funnel and the extraction repeated with an additional portion of hexane. The hexane extracts were combined and the aqueous phase discarded. The hexane extract was back extracted with reagent water, dried over anhydrous sodium sulphate, filtered and reduced just to dryness. The extract was redissolved in 1:1 dichloromethane:hexane and two aliquots were removed for gravimetric lipid analysis. The remaining extract was concentrated, loaded onto a gel permeation column (to remove lipids and high molecular weight interferences) and eluted with 1:1 dichloromethane:hexane. The 150 - 300 mL fraction was collected and concentrated to about 1 mL prior to chromatographic cleanup procedures.

### 2. Chromatographic Cleanup Procedures

a) Silica Gel Column: The extract was transferred to a layered acid/base silica gel column and eluted with 1:1 dichloromethane:hexane. The eluate was collected and concentrated to about 1 mL.

b) Alumina Column: The extract from the silica gel column was loaded onto a basic alumina column. The first fraction, eluted with 3% dichloromethane:hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated to about 1 mL.

c) Carbon/Celite Column: The extract from the alumina column was loaded onto a carbon/Celite column. The column was eluted with 1:1 cyclohexane:dichloromethane (discarded) followed by 1:1 ethylacetate:toluene (discarded). The column was inverted and eluted with toluene (collected). The extract was evaporated to near dryness and redissolved in 2 mL hexane.

d) Alumina Column: The extract from the carbon/Celite column was loaded onto a basic alumina column. The first fraction, eluted with 3% dichloromethane:hexane was discarded. The second fraction, eluted with 1:1 dichloromethane:hexane was retained and concentrated to about 500 $\mu$L.

e) Preparation for GC/MS Analysis: The extract was evaporated just to dryness and an aliquot of recovery standard solution containing $^{13}C$-labelled 1,2,3,4-tetrachlorodibenzodioxin and 1,2,3,7,8,9-hexachlorodibenzodioxin was added.

## 3. HRGC/HRMS Analysis

Polychlorinated dibenzodioxins (PCDD) and dibenzofurans (PCDF) were analyzed on a high resolution AutoSpec Ultima mass spectrometer equipped with a Hewlett Packard 5890 gas chromatograph, a DB-5 capillary chromatography column (60 m, 0.25 mm i.d x 0.1 $\mu$m film thickness) and a CTC autosampler. Data were acquired in the voltage selected ion recording mode (SIR) to enhance sensitivity. At least two ions were used to monitor each of the target analytes and $^{13}C$-labelled surrogate standards. Five additional ions were monitored to check for interference from chlorinated diphenyl ethers.

The instrumental conditions, analyte identification and quantification protocols for PCDDs/PCDFs, as described in Environment Canada Report EPS 1/RM/19, February 1992 were strictly adhered to.

## 4. Quantification Procedures

Concentrations of target analytes were calculated using the isotope dilution method of quantification. PCDDs and PCDFs were quantified by comparing the area of the quantification ion to that of the corresponding $^{13}C$-labelled surrogate standard and correcting for response factors. Response factors were determined daily using authentic PCDDS and PCDFs.

Concentrations of analytes were corrected based on the percent recovery of surrogate standards. Concentrations were reported in pg/g on both a wet weight and a lipid weight basis.

Sample detection limits were reported for each target analyte, based on a minimum detectable area for that compound in the chromatogram.

## REFERENCES

1. DX-B-06/Ver.1, AXYS Method Doc. DX/01 Rev 4 January 9, 1998.

2. Environment Canada Reference Method EPS 1/RM/19, *Reference Method for the Determination of Polychlorinated Dibenzo-para-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) in Pulp and Paper Mill Effluents,* February 1992.

3. US EPA 1994 *Method 8290, Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS).* SW-846 Third Edition. Office of Solid Waste and Emergency Response, Washington, DC.

2607DXB

# Appendix II

# Dioxin/Furan Analysis Reports

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN005**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 14.6 g dry**

**% MOISTURE: 27**

**A So**
Fish Pond Sediment
Pond #1

**AXYS FILE: 2607-50 AL**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 6.7 | 0.1 | T4CDF - Total | 1.5 | 0.1 |
| 2,3,7,8 | 3.4 | 0.1 | 2,3,7,8 | 0.2 | 0.1 |
| P5CDD - Total | 8.9 | 0.1 | P5CDF - Total | 0.7 | 0.1 |
| 1,2,3,7,8 | 0.5 | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | 7.5 | 0.2 | H6CDF - Total | ND | 0.2 |
| 1,2,3,4,7,8 | 0.2 | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | ND | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | 0.2 | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 4.4 | 0.3 | H7CDF - Total | ND | 0.3 |
| 1,2,3,4,6,7,8 | 1.9 | 0.3 | 1,2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,4,7,8,9 | ND | 0.3 |
| O8CDD - Total | 49 | 0.5 | O8CDF - Total | ND | 0.5 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 63 |
| 13C-T4CDD | 64 |
| 13C-P5CDF | 59 |
| 13C-P5CDD | 62 |
| 13C-H6CDF | 75 |
| 13C-H6CDD | 76 |
| 13C-H7CDF | 67 |
| 13C-H7CDD | 59 |
| 13C-O8CDD | 61 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 3.9 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 3.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN005**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 13.0 g dry**

**% MOISTURE: 31**

A So
Fish Pond Sediment
Pond #1

**AXYS FILE: 2607-50 BL**
**Duplicate**
**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 9.9 | 0.1 | T4CDF - Total | 2.3 | 0.1 |
| 2,3,7,8 | 5.2 | 0.1 | 2,3,7,8 | 0.3 | 0.1 |
| P5CDD - Total | 13 | 0.1 | P5CDF - Total | 1.1 | 0.1 |
| 1,2,3,7,8 | 0.8 | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | 10 | 0.2 | H6CDF - Total | 0.3 | 0.2 |
| 1,2,3,4,7,8 | 0.3 | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | 0.2 | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | 0.3 | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 5.3 | 0.4 | H7CDF - Total | ND | 0.4 |
| 1,2,3,4,6,7,8 | 2.4 | 0.4 | 1,2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,4,7,8,9 | ND | 0.4 |
| O8CDD - Total | 64 | 0.6 | O8CDF - Total | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 71 |
| 13C-T4CDD | 76 |
| 13C-P5CDF | 73 |
| 13C-P5CDD | 70 |
| 13C-H6CDF | 83 |
| 13C-H6CDD | 91 |
| 13C-H7CDF | 74 |
| 13C-H7CDD | 81 |
| 13C-O8CDD | 81 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 5.9 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 5.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN007**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 12.1 g dry**

**% MOISTURE: 41**

**A So**
Fish Pond Sediment
Pond #2

**AXYS FILE: 2607-51 L**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 7.1 | 0.1 | **T4CDF - Total** | 1.5 | 0.1 |
| **2,3,7,8** | 5.4 | 0.1 | **2,3,7,8** | 0.3 | 0.1 |
| **P5CDD - Total** | 4.5 | 0.1 | **P5CDF - Total** | 0.9 | 0.1 |
| **1,2,3,7,8** | 0.4 | 0.1 | **1,2,3,7,8** | ND | 0.1 |
| | | | **2,3,4,7,8** | ND | 0.1 |
| **H6CDD - Total** | 9.3 | 0.2 | **H6CDF - Total** | 0.2 | 0.2 |
| **1,2,3,4,7,8** | ND | 0.2 | **1,2,3,4,7,8** | ND | 0.2 |
| **1,2,3,6,7,8** | 0.3 | 0.2 | **1,2,3,6,7,8** | ND | 0.2 |
| **1,2,3,7,8,9** | 0.5 | 0.2 | **2,3,4,6,7,8** | ND | 0.2 |
| | | | **1,2,3,7,8,9** | ND | 0.2 |
| **H7CDD - Total** | 7.9 | 0.4 | **H7CDF - Total** | ND | 0.4 |
| **1,2,3,4,6,7,8** | 3.5 | 0.4 | **1,2,3,4,6,7,8** | ND | 0.4 |
| | | | **1,2,3,4,7,8,9** | ND | 0.4 |
| **O8CDD - Total** | 170 | 0.6 | **O8CDF - Total** | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 76 |
| **13C-T4CDD** | 84 |
| **13C-P5CDF** | 71 |
| **13C-P5CDD** | 70 |
| **13C-H6CDF** | 100 |
| **13C-H6CDD** | 87 |
| **13C-H7CDF** | 85 |
| **13C-H7CDD** | 84 |
| **13C-O8CDD** | 94 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 6.0 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 5.9 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN009**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 13.0 g dry**

**% MOISTURE: 29**

**A So**
Fish Pond Sediment
Pond #3

**AXYS FILE: 2607-52 L**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 11 | 0.1 | T4CDF - Total | 2.2 | 0.1 |
| 2,3,7,8 | 8.5 | 0.1 | 2,3,7,8 | 0.5 | 0.1 |
| P5CDD - Total | 3.3 | 0.1 | P5CDF - Total | 1.1 | 0.1 |
| 1,2,3,7,8 | 0.4 | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | 5.8 | 0.2 | H6CDF - Total | 0.2 | 0.2 |
| 1,2,3,4,7,8 | ND | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | 0.3 | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | 0.4 | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 9.4 | 0.4 | H7CDF - Total | ND | 0.4 |
| 1,2,3,4,6,7,8 | 4.1 | 0.4 | 1,2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,4,7,8,9 | ND | 0.4 |
| O8CDD - Total | 220 | 0.6 | O8CDF - Total | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 70 |
| 13C-T4CDD | 73 |
| 13C-P5CDF | 65 |
| 13C-P5CDD | 64 |
| 13C-H6CDF | 82 |
| 13C-H6CDD | 88 |
| 13C-H7CDF | 71 |
| 13C-H7CDD | 69 |
| 13C-O8CDD | 68 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 9.2 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 9.1 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN011**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 14.1 g dry**

**% MOISTURE: 25**

**A So**
Fish Pond Sediment
Pond #4

**AXYS FILE: 2607-53 I**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 3.3 | 0.1 | T4CDF - Total | 0.6 | 0.1 |
| 2,3,7,8 | 1.8 | 0.1 | 2,3,7,8 | 0.1 | 0.1 |
| P5CDD - Total | 2.5 | 0.1 | P5CDF - Total | 0.4 | 0.1 |
| 1,2,3,7,8 | 0.1 | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | 1.5 | 0.2 | H6CDF - Total | ND | 0.2 |
| 1,2,3,4,7,8 | ND | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | ND | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | ND | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 1.4 | 0.4 | H7CDF - Total | ND | 0.4 |
| 1,2,3,4,6,7,8 | 0.6 | 0.4 | 1,2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,4,7,8,9 | ND | 0.4 |
| O8CDD - Total | 23 | 0.6 | O8CDF - Total | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 62 |
| 13C-T4CDD | 53 |
| 13C-P5CDF | 46 |
| 13C-P5CDD | 42 |
| 13C-H6CDF | 58 |
| 13C-H6CDD | 57 |
| 13C-H7CDF | 48 |
| 13C-H7CDD | 36 |
| 13C-O8CDD | 27 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 2.0 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 1.9 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.C. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN019**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 2.75 g wet**

**% LIPID: 72**

**A So**
Carp Fat
Pond #1

**AXYS FILE: 2607-54**

**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 10 | 0.3 | T4CDF - Total | 13 | 0.2 |
| 2,3,7,8 | 7.9 | 0.3 | 2,3,7,8 | 2.3 | 0.2 |
| P5CDD - Total | 2.3 | 0.2 | P5CDF - Total | 3.4 | 0.2 |
| 1,2,3,7,8 | NDR(0.6) | 0.2 | 1,2,3,7,8 | 0.3 | 0.2 |
| | | | 2,3,4,7,8 | 0.6 | 0.2 |
| H6CDD - Total | 1.5 | 0.3 | H6CDF - Total | 0.5 | 0.2 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | NDR(0.3) | 0.2 |
| 1,2,3,6,7,8 | 0.3 | 0.3 | 1,2,3,6,7,8 | NDR(0.2) | 0.2 |
| 1,2,3,7,8,9 | 0.4 | 0.3 | 2,3,4,6,7,8 | 0.3 | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | 1.6 | 0.3 | H7CDF - Total | 0.4 | 0.2 |
| 1,2,3,4,6,7,8 | 0.9 | 0.3 | 1,2,3,4,6,7,8 | 0.4 | 0.2 |
| | | | 1,2,3,4,7,8,9 | ND | 0.2 |
| O8CDD - Total | 2.9 | 0.4 | O8CDF - Total | NDR(0.4) | 0.4 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 63 |
| 13C-T4CDD | 70 |
| 13C-P5CDF | 56 |
| 13C-P5CDD | 57 |
| 13C-H6CDF | 64 |
| 13C-H6CDD | 61 |
| 13C-H7CDF | 56 |
| 13C-H7CDD | 52 |
| 13C-O8CDD | 39 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 8.7 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 8.6 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN027**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 5.36 g wet**

**% LIPID: 89**

A So
Carp Fat
Pond #2

**AXYS FILE: 2607-55**

**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 20 | 0.1 | **T4CDF - Total** | 11 | 0.1 |
| **2,3,7,8** | 16 | 0.1 | **2,3,7,8** | 2.4 | 0.1 |
| **P5CDD - Total** | 4.2 | 0.1 | **P5CDF - Total** | 4.0 | 0.1 |
| **1,2,3,7,8** | 0.7 | 0.1 | **1,2,3,7,8** | 0.3 | 0.1 |
| | | | **2,3,4,7,8** | NDR(0.4) | 0.1 |
| **H6CDD - Total** | 1.4 | 0.2 | **H6CDF - Total** | 1.1 | 0.1 |
| **1,2,3,4,7,8** | ND | 0.2 | **1,2,3,4,7,8** | 0.3 | 0.1 |
| **1,2,3,6,7,8** | NDR(0.3) | 0.2 | **1,2,3,6,7,8** | 0.2 | 0.1 |
| **1,2,3,7,8,9** | NDR(0.2) | 0.2 | **2,3,4,6,7,8** | 0.2 | 0.1 |
| | | | **1,2,3,7,8,9** | ND | 0.1 |
| **H7CDD - Total** | 0.7 | 0.1 | **H7CDF - Total** | 0.1 | 0.1 |
| **1,2,3,4,6,7,8** | 0.4 | 0.1 | **1,2,3,4,6,7,8** | 0.1 | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 1.0 | 0.1 | **O8CDF - Total** | ND | 0.1 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 77 |
| **13C-T4CDD** | 85 |
| **13C-P5CDF** | 67 |
| **13C-P5CDD** | 68 |
| **13C-H6CDF** | 77 |
| **13C-H6CDD** | 77 |
| **13C-H7CDF** | 73 |
| **13C-H7CDD** | 73 |
| **13C-O8CDD** | 67 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 16.7 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 16.7 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.:** 97VN031
**CLIENT:** Hatfield Consultants Ltd.
**SAMPLE TYPE:** Tissue
**SAMPLE SIZE:** 1.00 g wet
**% LIPID:** 61

A So
Carp Fat
Pond #3

**AXYS FILE:** 2607-56
**DATE:** 13/Mar/98
**METHOD NO.:** DX-T-03/Ver.2
**INSTRUMENT:** GC-HRMS
**CONCENTRATION IN:** pg/g

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 25 | 0.5 | T4CDF - Total | 15 | 0.4 |
| 2,3,7,8 | 21 | 0.5 | 2,3,7,8 | 4.0 | 0.4 |
| P5CDD - Total | 4.0 | 0.4 | P5CDF - Total | 5.0 | 0.5 |
| 1,2,3,7,8 | 0.8 | 0.4 | 1,2,3,7,8 | 0.6 | 0.5 |
| | | | 2,3,4,7,8 | 0.8 | 0.5 |
| H6CDD - Total | 0.6 | 0.5 | H6CDF - Total | ND | 0.4 |
| 1,2,3,4,7,8 | ND | 0.5 | 1,2,3,4,7,8 | NDR(0.4) | 0.4 |
| 1,2,3,6,7,8 | ND | 0.5 | 1,2,3,6,7,8 | ND | 0.4 |
| 1,2,3,7,8,9 | NDR(0.6) | 0.5 | 2,3,4,6,7,8 | ND | 0.4 |
| | | | 1,2,3,7,8,9 | ND | 0.4 |
| H7CDD - Total | 0.8 | 0.3 | H7CDF - Total | 0.5 | 0.5 |
| 1,2,3,4,6,7,8 | 0.8 | 0.3 | 1,2,3,4,6,7,8 | 0.5 | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | 3.3 | 0.6 | O8CDF - Total | ND | 0.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 79 |
| 13C-T4CDD | 86 |
| 13C-P5CDF | 69 |
| 13C-P5CDD | 72 |
| 13C-H6CDF | 69 |
| 13C-H6CDD | 72 |
| 13C-H7CDF | 62 |
| 13C-H7CDD | 60 |
| 13C-O8CDD | 59 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 22.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 22.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.C. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN039**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 5.14 g wet**

**% LIPID: 86**

A So
Carp Fat
Pond #4

**AXYS FILE: 2607-57 A**

**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 41 | 0.1 | **T4CDF - Total** | 15 | 0.1 |
| **2,3,7,8** | 33 | 0.1 | **2,3,7,8** | 4.3 | 0.1 |
| **P5CDD - Total** | 11 | 0.1 | **P5CDF - Total** | 4.0 | 0.1 |
| **1,2,3,7,8** | 1.4 | 0.1 | **1,2,3,7,8** | NDR(0.3) | 0.1 |
| | | | **2,3,4,7,8** | NDR(0.5) | 0.1 |
| **H6CDD - Total** | 2.5 | 0.1 | **H6CDF - Total** | 0.8 | 0.1 |
| **1,2,3,4,7,8** | 0.2 | 0.1 | **1,2,3,4,7,8** | 0.2 | 0.1 |
| **1,2,3,6,7,8** | 0.2 | 0.1 | **1,2,3,6,7,8** | 0.2 | 0.1 |
| **1,2,3,7,8,9** | NDR(0.2) | 0.1 | **2,3,4,6,7,8** | 0.1 | 0.1 |
| | | | **1,2,3,7,8,9** | ND | 0.1 |
| **H7CDD - Total** | 0.3 | 0.1 | **H7CDF - Total** | 0.2 | 0.1 |
| **1,2,3,4,6,7,8** | 0.3 | 0.1 | **1,2,3,4,6,7,8** | 0.2 | 0.1 |
| | | | **1,2,3,4,7,8,9** | ND | 0.1 |
| **O8CDD - Total** | 0.7 | 0.2 | **O8CDF - Total** | NDR(0.1) | 0.1 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 68 |
| **13C-T4CDD** | 71 |
| **13C-P5CDF** | 60 |
| **13C-P5CDD** | 62 |
| **13C-H6CDF** | 68 |
| **13C-H6CDD** | 66 |
| **13C-H7CDF** | 59 |
| **13C-H7CDD** | 54 |
| **13C-O8CDD** | 42 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 34.3 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 34.2 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN039**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 5.25 g wet**

**% LIPID: 84**

**A So**
Carp Fat
Pond #4

**AXYS FILE: 2607-57 B**
**Duplicate**
**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 41 | 0.1 | T4CDF - Total | 15 | 0.1 |
| 2,3,7,8 | 34 | 0.1 | 2,3,7,8 | 4.4 | 0.1 |
| P5CDD - Total | 9.5 | 0.1 | P5CDF - Total | 5.3 | 0.1 |
| 1,2,3,7,8 | 1.2 | 0.1 | 1,2,3,7,8 | NDR(0.3) | 0.1 |
| | | | 2,3,4,7,8 | 0.5 | 0.1 |
| H6CDD - Total | 1.8 | 0.1 | H6CDF - Total | 0.6 | 0.1 |
| 1,2,3,4,7,8 | 0.2 | 0.1 | 1,2,3,4,7,8 | 0.2 | 0.1 |
| 1,2,3,6,7,8 | NDR(0.2) | 0.1 | 1,2,3,6,7,8 | NDR(0.2) | 0.1 |
| 1,2,3,7,8,9 | 0.2 | 0.1 | 2,3,4,6,7,8 | 0.2 | 0.1 |
| | | | 1,2,3,7,8,9 | ND | 0.1 |
| H7CDD - Total | 0.2 | 0.1 | H7CDF - Total | 0.2 | 0.1 |
| 1,2,3,4,6,7,8 | 0.2 | 0.1 | 1,2,3,4,6,7,8 | 0.2 | 0.1 |
| | | | 1,2,3,4,7,8,9 | ND | 0.1 |
| O8CDD - Total | 0.6 | 0.1 | O8CDF - Total | 0.1 | 0.1 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 73 |
| 13C-T4CDD | 81 |
| 13C-P5CDF | 65 |
| 13C-P5CDD | 68 |
| 13C-H6CDF | 74 |
| 13C-H6CDD | 73 |
| 13C-H7CDF | 64 |
| 13C-H7CDD | 64 |
| 13C-O8CDD | 61 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 35.4 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 35.4 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.:** 97VN045

**CLIENT:** Hatfield Consultants Ltd.

**SAMPLE TYPE:** Tissue

**SAMPLE SIZE:** 5.00 g wet

**% LIPID:** 94

A So
Duck Fat

**AXYS FILE:** 2607-58

**DATE:** 13/Mar/98

**METHOD NO.:** DX-T-03/Ver.2

**INSTRUMENT:** GC-HRMS

**CONCENTRATION IN:** pg/g

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 6.1 | 0.1 | T4CDF - Total | 1.6 | 0.1 |
| 2,3,7,8 | 6.1 | 0.1 | 2,3,7,8 | 1.1 | 0.1 |
| P5CDD - Total | 0.9 | 0.1 | P5CDF - Total | 1.0 | 0.1 |
| 1,2,3,7,8 | 0.6 | 0.1 | 1,2,3,7,8 | 0.3 | 0.1 |
| | | | 2,3,4,7,8 | 0.4 | 0.1 |
| H6CDD - Total | 2.2 | 0.1 | H6CDF - Total | ND | 0.1 |
| 1,2,3,4,7,8 | 0.3 | 0.1 | 1,2,3,4,7,8 | ND | 0.1 |
| 1,2,3,6,7,8 | 0.4 | 0.1 | 1,2,3,6,7,8 | ND | 0.1 |
| 1,2,3,7,8,9 | 0.4 | 0.1 | 2,3,4,6,7,8 | ND | 0.1 |
| | | | 1,2,3,7,8,9 | ND | 0.1 |
| H7CDD - Total | 0.8 | 0.1 | H7CDF - Total | ND | 0.1 |
| 1,2,3,4,6,7,8 | 0.4 | 0.1 | 1,2,3,4,6,7,8 | ND | 0.1 |
| | | | 1,2,3,4,7,8,9 | ND | 0.1 |
| O8CDD - Total | 1.4 | 0.1 | O8CDF - Total | 0.2 | 0.1 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 74 |
| 13C-T4CDD | 74 |
| 13C-P5CDF | 60 |
| 13C-P5CDD | 64 |
| 13C-H6CDF | 15 |
| 13C-H6CDD | 66 |
| 13C-H7CDF | 17 |
| 13C-H7CDD | 65 |
| 13C-O8CDD | 53 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 6.9 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 6.8 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.C. Hamilton
**Approved**

## ANALYSIS REPORT
## POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D.:** | **97VN045** | **AXYS FILE:** | **2607-58 R** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **02/Apr/98** |
| **SAMPLE TYPE:** | **Tissue** | **METHOD NO.:** | **DX-T-03/Ver.2** |
| **SAMPLE SIZE:** | **4.77 g wet** | **INSTRUMENT:** | **GC-HRMS** |
| **% LIPID:** | **96** | **CONCENTRATION IN:** | **pg/g** |

A So
Duck Fat

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 7.0 | 0.3 | **T4CDF - Total** | 2.7 | 0.3 |
| **2,3,7,8** | 6.1 | 0.3 | **2,3,7,8** | 1.1 | 0.3 |
| **P5CDD - Total** | 3.4 | 0.3 | **P5CDF - Total** | 2.1 | 0.3 |
| **1,2,3,7,8** | 0.7 | 0.3 | **1,2,3,7,8** | 0.3 | 0.3 |
| | | | **2,3,4,7,8** | 0.3 | 0.3 |
| **H6CDD - Total** | 0.8 | 0.6 | **H6CDF - Total** | ND | 0.6 |
| **1,2,3,4,7,8** | ND | 0.6 | **1,2,3,4,7,8** | ND | 0.6 |
| **1,2,3,6,7,8** | ND | 0.6 | **1,2,3,6,7,8** | ND | 0.6 |
| **1,2,3,7,8,9** | ND | 0.6 | **2,3,4,6,7,8** | ND | 0.6 |
| | | | **1,2,3,7,8,9** | ND | 0.6 |
| **H7CDD - Total** | ND | 1.0 | **H7CDF - Total** | ND | 1.0 |
| **1,2,3,4,6,7,8** | ND | 1.0 | **1,2,3,4,6,7,8** | ND | 1.0 |
| | | | **1,2,3,4,7,8,9** | ND | 1.0 |
| **O8CDD - Total** | 2.2 | 1.7 | **O8CDF - Total** | ND | 1.7 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 60 |
| **13C-T4CDD** | 60 |
| **13C-P5CDF** | 58 |
| **13C-P5CDD** | 56 |
| **13C-H6CDF** | 63 |
| **13C-H6CDD** | 61 |
| **13C-H7CDF** | 55 |
| **13C-H7CDD** | 51 |
| **13C-O8CDD** | 48 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 7.0 pg/g

2,3,7,8 - TCDD TEQs (ND=0) = 6.7 pg/g

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN047**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 43.8 g**

**% LIPID: 0.29**

**A So**
Human Blood
Males >25 Years
(Whole Blood)

**AXYS FILE: 2607-59**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.1 | 0.01 | **T4CDF - Total** | ND | 0.01 |
| **2,3,7,8** | 0.1 | 0.01 | **2,3,7,8** | ND | 0.01 |
| **P5CDD - Total** | ND | 0.01 | **P5CDF - Total** | 0.01 | 0.01 |
| **1,2,3,7,8** | NDR(0.01) | 0.01 | **1,2,3,7,8** | ND | 0.01 |
| | | | **2,3,4,7,8** | 0.01 | 0.01 |
| **H6CDD - Total** | 0.02 | 0.01 | **H6CDF - Total** | 0.05 | 0.01 |
| **1,2,3,4,7,8** | ND | 0.01 | **1,2,3,4,7,8** | 0.03 | 0.01 |
| **1,2,3,6,7,8** | 0.02 | 0.01 | **1,2,3,6,7,8** | 0.02 | 0.01 |
| **1,2,3,7,8,9** | NDR(0.01) | 0.01 | **2,3,4,6,7,8** | ND | 0.01 |
| | | | **1,2,3,7,8,9** | ND | 0.01 |
| **H7CDD - Total** | 0.03 | 0.01 | **H7CDF - Total** | ND | 0.01 |
| **1,2,3,4,6,7,8** | 0.03 | 0.01 | **1,2,3,4,6,7,8** | NDR(0.05) | 0.01 |
| | | | **1,2,3,4,7,8,9** | ND | 0.01 |
| **O8CDD - Total** | 0.15 | 0.01 | **O8CDF - Total** | NDR(0.01) | 0.01 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 71 |
| **13C-T4CDD** | 84 |
| **13C-P5CDF** | 61 |
| **13C-P5CDD** | 75 |
| **13C-H6CDF** | 71 |
| **13C-H6CDD** | 70 |
| **13C-H7CDF** | 62 |
| **13C-H7CDD** | 55 |
| **13C-O8CDD** | 44 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.11 pg/g blood

2,3,7,8 - TCDD TEQs (ND=0) = 0.10 pg/g blood

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MC Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN047**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 43.8 g**

**% LIPID: 0.29**

**A So**
Human Blood
Males >25 Years
(Lipid Basis)

**AXYS FILE: 2607-59**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 31 | 3.4 | T4CDF - Total | ND | 3.4 |
| 2,3,7,8 | 31 | 3.4 | 2,3,7,8 | ND | 3.4 |
| P5CDD - Total | ND | 3.4 | P5CDF - Total | 3.4 | 3.4 |
| 1,2,3,7,8 | NDR(3.4) | 3.4 | 1,2,3,7,8 | ND | 3.4 |
| | | | 2,3,4,7,8 | 3.4 | 3.4 |
| H6CDD - Total | 6.9 | 3.4 | H6CDF - Total | 17 | 3.4 |
| 1,2,3,4,7,8 | ND | 3.4 | 1,2,3,4,7,8 | 10 | 3.4 |
| 1,2,3,6,7,8 | 6.9 | 3.4 | 1,2,3,6,7,8 | 6.9 | 3.4 |
| 1,2,3,7,8,9 | NDR(3.4) | 3.4 | 2,3,4,6,7,8 | ND | 3.4 |
| | | | 1,2,3,7,8,9 | ND | 3.4 |
| H7CDD - Total | 10 | 3.4 | H7CDF - Total | ND | 3.4 |
| 1,2,3,4,6,7,8 | 10 | 3.4 | 1,2,3,4,6,7,8 | NDR(17) | 3.4 |
| | | | 1,2,3,4,7,8,9 | ND | 3.4 |
| O8CDD - Total | 52 | 3.4 | O8CDF - Total | NDR(3.4) | 3.4 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 71 |
| 13C-T4CDD | 84 |
| 13C-P5CDF | 61 |
| 13C-P5CDD | 75 |
| 13C-H6CDF | 71 |
| 13C-H6CDD | 70 |
| 13C-H7CDF | 62 |
| 13C-H7CDD | 55 |
| 13C-O8CDD | 44 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 37.2 pg/g lipid

2,3,7,8 - TCDD TEQs (ND=0) = 35.3 pg/g lipid

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN048**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 40.8 g**

**% LIPID: 0.28**

**A So**
Human Blood
Females >25 Years
(Whole Blood)

**AXYS FILE: 2607-60**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 0.03 | 0.01 | T4CDF - Total | ND | 0.01 |
| 2,3,7,8 | 0.03 | 0.01 | 2,3,7,8 | ND | 0.01 |
| P5CDD - Total | ND | 0.01 | P5CDF - Total | ND | 0.01 |
| 1,2,3,7,8 | ND | 0.01 | 1,2,3,7,8 | ND | 0.01 |
| | | | 2,3,4,7,8 | ND | 0.01 |
| H6CDD - Total | ND | 0.01 | H6CDF - Total | ND | 0.01 |
| 1,2,3,4,7,8 | ND | 0.01 | 1,2,3,4,7,8 | ND | 0.01 |
| 1,2,3,6,7,8 | ND | 0.01 | 1,2,3,6,7,8 | ND | 0.01 |
| 1,2,3,7,8,9 | ND | 0.01 | 2,3,4,6,7,8 | ND | 0.01 |
| | | | 1,2,3,7,8,9 | ND | 0.01 |
| H7CDD - Total | 0.04 | 0.01 | H7CDF - Total | ND | 0.01 |
| 1,2,3,4,6,7,8 | 0.04 | 0.01 | 1,2,3,4,6,7,8 | NDR(0.02) | 0.01 |
| | | | 1,2,3,4,7,8,9 | NDR(0.01) | 0.01 |
| O8CDD - Total | 0.18 | 0.01 | O8CDF - Total | NDR(0.02) | 0.01 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 74 |
| 13C-T4CDD | 92 |
| 13C-P5CDF | 64 |
| 13C-P5CDD | 70 |
| 13C-H6CDF | 85 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 78 |
| 13C-H7CDD | 84 |
| 13C-O8CDD | 78 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.04 pg/g blood

2,3,7,8 - TCDD TEQs (ND=0) = 0.03 pg/g blood

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN048**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 40.8 g**

**% LIPID: 0.28**

**A So**
Human Blood
Females >25 Years
(Lipid Basis)

**AXYS FILE: 2607-60**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 11 | 3.6 | T4CDF - Total | ND | 3.6 |
| 2,3,7,8 | 11 | 3.6 | 2,3,7,8 | ND | 3.6 |
| P5CDD - Total | ND | 3.6 | P5CDF - Total | ND | 3.6 |
| 1,2,3,7,8 | ND | 3.6 | 1,2,3,7,8 | ND | 3.6 |
| | | | 2,3,4,7,8 | ND | 3.6 |
| H6CDD - Total | ND | 3.6 | H6CDF - Total | ND | 3.6 |
| 1,2,3,4,7,8 | ND | 3.6 | 1,2,3,4,7,8 | ND | 3.6 |
| 1,2,3,6,7,8 | ND | 3.6 | 1,2,3,6,7,8 | ND | 3.6 |
| 1,2,3,7,8,9 | ND | 3.6 | 2,3,4,6,7,8 | ND | 3.6 |
| | | | 1,2,3,7,8,9 | ND | 3.6 |
| H7CDD - Total | 14 | 3.6 | H7CDF - Total | ND | 3.6 |
| 1,2,3,4,6,7,8 | 14 | 3.6 | 1,2,3,4,6,7,8 | NDR(7.1) | 3.6 |
| | | | 1,2,3,4,7,8,9 | NDR(3.6) | 3.6 |
| O8CDD - Total | 64 | 3.6 | O8CDF - Total | NDR(7.1) | 3.6 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 74 |
| 13C-T4CDD | 92 |
| 13C-P5CDF | 64 |
| 13C-P5CDD | 70 |
| 13C-H6CDF | 85 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 78 |
| 13C-H7CDD | 84 |
| 13C-O8CDD | 78 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 14.3 pg/g lipid

2,3,7,8 - TCDD TEQs (ND=0) = 10.9 pg/g lipid

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN049**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 36.3 g**

**% LIPID: 0.29**

**A So**
Human Blood
Males 12 – 25 Years
(Whole Blood)

**AXYS FILE: 2607-61**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 0.06 | 0.01 | **T4CDF - Total** | ND | 0.01 |
| **2,3,7,8** | 0.06 | 0.01 | **2,3,7,8** | ND | 0.01 |
| **P5CDD - Total** | ND | 0.01 | **P5CDF - Total** | ND | 0.01 |
| **1,2,3,7,8** | ND | 0.01 | **1,2,3,7,8** | ND | 0.01 |
| | | | **2,3,4,7,8** | ND | 0.01 |
| **H6CDD - Total** | ND | 0.01 | **H6CDF - Total** | 0.04 | 0.01 |
| **1,2,3,4,7,8** | NDR(0.02) | 0.01 | **1,2,3,4,7,8** | 0.04 | 0.01 |
| **1,2,3,6,7,8** | NDR(0.01) | 0.01 | **1,2,3,6,7,8** | NDR(0.02) | 0.01 |
| **1,2,3,7,8,9** | NDR(0.03) | 0.01 | **2,3,4,6,7,8** | ND | 0.01 |
| | | | **1,2,3,7,8,9** | ND | 0.01 |
| **H7CDD - Total** | 0.03 | 0.01 | **H7CDF - Total** | 0.07 | 0.01 |
| **1,2,3,4,6,7,8** | 0.03 | 0.01 | **1,2,3,4,6,7,8** | 0.07 | 0.01 |
| | | | **1,2,3,4,7,8,9** | NDR(0.01) | 0.01 |
| **O8CDD - Total** | NDR(0.34) | 0.01 | **O8CDF - Total** | 0.22 | 0.01 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 28 |
| **13C-T4CDD** | 29 |
| **13C-P5CDF** | 17 |
| **13C-P5CDD** | 18 |
| **13C-H6CDF** | 22 |
| **13C-H6CDD** | 18 |
| **13C-H7CDF** | 11 |
| **13C-H7CDD** | 10 |
| **13C-O8CDD** | 10 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.07 pg/g blood

2,3,7,8 - TCDD TEQs (ND=0) = 0.07 pg/g blood

1. Surrogate recoveries are low, however, there is no sample available to repeat the analysis.

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MC Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN049**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 36.3 g**

**% LIPID: 0.29**

**A So**
Human Blood
Males 12 – 25 Years
(Lipid Basis)

**AXYS FILE: 2607-61**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| **T4CDD - Total** | 21 | 3.4 | **T4CDF - Total** | ND | 3.4 |
| **2,3,7,8** | 21 | 3.4 | **2,3,7,8** | ND | 3.4 |
| **P5CDD - Total** | ND | 3.4 | **P5CDF - Total** | ND | 3.4 |
| **1,2,3,7,8** | ND | 3.4 | **1,2,3,7,8** | ND | 3.4 |
| | | | **2,3,4,7,8** | ND | 3.4 |
| **H6CDD - Total** | ND | 3.4 | **H6CDF - Total** | 14 | 3.4 |
| **1,2,3,4,7,8** | NDR(6.9) | 3.4 | **1,2,3,4,7,8** | 14 | 3.4 |
| **1,2,3,6,7,8** | NDR(3.4) | 3.4 | **1,2,3,6,7,8** | NDR(6.9) | 3.4 |
| **1,2,3,7,8,9** | NDR(10) | 3.4 | **2,3,4,6,7,8** | ND | 3.4 |
| | | | **1,2,3,7,8,9** | ND | 3.4 |
| **H7CDD - Total** | 10 | 3.4 | **H7CDF - Total** | 24 | 3.4 |
| **1,2,3,4,6,7,8** | 10 | 3.4 | **1,2,3,4,6,7,8** | 24 | 3.4 |
| | | | **1,2,3,4,7,8,9** | NDR(3.4) | 3.4 |
| **O8CDD - Total** | NDR(120) | 3.4 | **O8CDF - Total** | 76 | 3.4 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 28 |
| **13C-T4CDD** | 29 |
| **13C-P5CDF** | 17 |
| **13C-P5CDD** | 18 |
| **13C-H6CDF** | 22 |
| **13C-H6CDD** | 18 |
| **13C-H7CDF** | 11 |
| **13C-H7CDD** | 10 |
| **13C-O8CDD** | 10 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 25.5 pg/g lipid

2,3,7,8 - TCDD TEQs (ND=0) = 22.5 pg/g lipid

1. Surrogate recoveries are low, however, there is no sample available to repeat the analysis.

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M C Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN050**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 43.8 g**

**% LIPID: 0.26**

**A So**
Human Blood
Females 12 – 25 Years
(Whole Blood)

**AXYS FILE: 2607-62**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 0.03 | 0.01 | T4CDF - Total | ND | 0.01 |
| 2,3,7,8 | 0.03 | 0.01 | 2,3,7,8 | ND | 0.01 |
| P5CDD - Total | ND | 0.01 | P5CDF - Total | ND | 0.01 |
| 1,2,3,7,8 | ND | 0.01 | 1,2,3,7,8 | ND | 0.01 |
| | | | 2,3,4,7,8 | ND | 0.01 |
| H6CDD - Total | ND | 0.01 | H6CDF - Total | ND | 0.01 |
| 1,2,3,4,7,8 | ND | 0.01 | 1,2,3,4,7,8 | NDR(0.01) | 0.01 |
| 1,2,3,6,7,8 | ND | 0.01 | 1,2,3,6,7,8 | ND | 0.01 |
| 1,2,3,7,8,9 | ND | 0.01 | 2,3,4,6,7,8 | ND | 0.01 |
| | | | 1,2,3,7,8,9 | ND | 0.01 |
| H7CDD - Total | 0.05 | 0.01 | H7CDF - Total | 0.03 | 0.01 |
| 1,2,3,4,6,7,8 | 0.02 | 0.01 | 1,2,3,4,6,7,8 | 0.03 | 0.01 |
| | | | 1,2,3,4,7,8,9 | ND | 0.01 |
| O8CDD - Total | 0.13 | 0.01 | O8CDF - Total | ND | 0.01 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 71 |
| 13C-T4CDD | 78 |
| 13C-P5CDF | 60 |
| 13C-P5CDD | 66 |
| 13C-H6CDF | 84 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 84 |
| 13C-H7CDD | 79 |
| 13C-O8CDD | 76 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 0.04 pg/g blood

2,3,7,8 - TCDD TEQs (ND=0) = 0.03 pg/g blood

M C Hamilton
**Approved**

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: 97VN050**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 43.8 g**

**% LIPID: 0.26**

**A So**
Human Blood
Females 12 – 25 Years
(Lipid Basis)

**AXYS FILE: 2607-62**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | 12 | 3.8 | T4CDF - Total | ND | 3.8 |
| 2,3,7,8 | 12 | 3.8 | 2,3,7,8 | ND | 3.8 |
| P5CDD - Total | ND | 3.8 | P5CDF - Total | ND | 3.8 |
| 1,2,3,7,8 | ND | 3.8 | 1,2,3,7,8 | ND | 3.8 |
| | | | 2,3,4,7,8 | ND | 3.8 |
| H6CDD - Total | ND | 3.8 | H6CDF - Total | ND | 3.8 |
| 1,2,3,4,7,8 | ND | 3.8 | 1,2,3,4,7,8 | NDR(3.8) | 3.8 |
| 1,2,3,6,7,8 | ND | 3.8 | 1,2,3,6,7,8 | ND | 3.8 |
| 1,2,3,7,8,9 | ND | 3.8 | 2,3,4,6,7,8 | ND | 3.8 |
| | | | 1,2,3,7,8,9 | ND | 3.8 |
| H7CDD - Total | 19 | 3.8 | H7CDF - Total | 12 | 3.8 |
| 1,2,3,4,6,7,8 | 7.7 | 3.8 | 1,2,3,4,6,7,8 | 12 | 3.8 |
| | | | 1,2,3,4,7,8,9 | ND | 3.8 |
| O8CDD - Total | 50 | 3.8 | O8CDF - Total | ND | 3.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 71 |
| 13C-T4CDD | 78 |
| 13C-P5CDF | 60 |
| 13C-P5CDD | 66 |
| 13C-H6CDF | 84 |
| 13C-H6CDD | 84 |
| 13C-H7CDF | 84 |
| 13C-H7CDD | 79 |
| 13C-O8CDD | 76 |

**2,3,7,8 - TCDD TEQs (Using NATO I-TEFs)**

2,3,7,8 - TCDD TEQs (ND=1/2 DL) = 15.4 pg/g lipid

2,3,7,8 - TCDD TEQs (ND=0) = 11.8 pg/g lipid

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
**Approved**

# Appendix III

# Laboratory Quality Control Sample Reports

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 50.0 g**

**% LIPID: 0.29**

**AXYS FILE: DX-B-BLK 77**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.01 | T4CDF - Total | ND | 0.01 |
| 2,3,7,8 | ND | 0.01 | 2,3,7,8 | ND | 0.01 |
| P5CDD - Total | ND | 0.01 | P5CDF - Total | ND | 0.01 |
| 1,2,3,7,8 | ND | 0.01 | 1,2,3,7,8 | ND | 0.01 |
| | | | 2,3,4,7,8 | ND | 0.01 |
| H6CDD - Total | ND | 0.01 | H6CDF - Total | ND | 0.01 |
| 1,2,3,4,7,8 | ND | 0.01 | 1,2,3,4,7,8 | ND | 0.01 |
| 1,2,3,6,7,8 | ND | 0.01 | 1,2,3,6,7,8 | ND | 0.01 |
| 1,2,3,7,8,9 | ND | 0.01 | 2,3,4,6,7,8 | ND | 0.01 |
| | | | 1,2,3,7,8,9 | ND | 0.01 |
| H7CDD - Total | 0.02 | 0.01 | H7CDF - Total | ND | 0.01 |
| 1,2,3,4,6,7,8 | 0.02 | 0.01 | 1,2,3,4,6,7,8 | ND | 0.01 |
| | | | 1,2,3,4,7,8,9 | ND | 0.01 |
| O8CDD - Total | 0.3 | 0.01 | O8CDF - Total | ND | 0.01 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 78 |
| 13C-T4CDD | 84 |
| 13C-P5CDF | 71 |
| 13C-P5CDD | 71 |
| 13C-H6CDF | 91 |
| 13C-H6CDD | 87 |
| 13C-H7CDF | 82 |
| 13C-H7CDD | 74 |
| 13C-O8CDD | 85 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

MCHamilton
Approved

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**AXYS FILE: DX-B-BLK 77**

**CLIENT: Hatfield Consultants Ltd.**

**DATE: 24/Mar/98**

**SAMPLE TYPE: Blank**

**METHOD NO.: DX-B-06/Ver.1**

**SAMPLE SIZE: 50.0 g**

**INSTRUMENT: GC-HRMS**

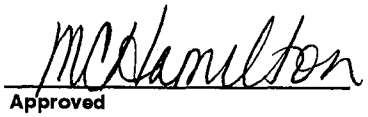
**% LIPID: 0.29**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 3.4 | T4CDF - Total | ND | 3.4 |
| 2,3,7,8 | ND | 3.4 | 2,3,7,8 | ND | 3.4 |
| P5CDD - Total | ND | 3.4 | P5CDF - Total | ND | 3.4 |
| 1,2,3,7,8 | ND | 3.4 | 1,2,3,7,8 | ND | 3.4 |
| | | | 2,3,4,7,8 | ND | 3.4 |
| H6CDD - Total | ND | 3.4 | H6CDF - Total | ND | 3.4 |
| 1,2,3,4,7,8 | ND | 3.4 | 1,2,3,4,7,8 | ND | 3.4 |
| 1,2,3,6,7,8 | ND | 3.4 | 1,2,3,6,7,8 | ND | 3.4 |
| 1,2,3,7,8,9 | ND | 3.4 | 2,3,4,6,7,8 | ND | 3.4 |
| | | | 1,2,3,7,8,9 | ND | 3.4 |
| H7CDD - Total | 6.9 | 3.4 | H7CDF - Total | ND | 3.4 |
| 1,2,3,4,6,7,8 | 6.9 | 3.4 | 1,2,3,4,6,7,8 | ND | 3.4 |
| | | | 1,2,3,4,7,8,9 | ND | 3.4 |
| O8CDD - Total | 110 | 3.4 | O8CDF - Total | ND | 3.4 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 78 |
| 13C-T4CDD | 84 |
| 13C-P5CDF | 71 |
| 13C-P5CDD | 71 |
| 13C-H6CDF | 91 |
| 13C-H6CDD | 87 |
| 13C-H7CDF | 82 |
| 13C-H7CDD | 74 |
| 13C-O8CDD | 85 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.



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**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-BLK 1717 L**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

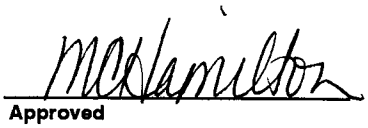
**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 63 |
| 13C-T4CDD | 69 |
| 13C-P5CDF | 61 |
| 13C-P5CDD | 63 |
| 13C-H6CDF | 74 |
| 13C-H6CDD | 68 |
| 13C-H7CDF | 63 |
| 13C-H7CDD | 57 |
| 13C-O8CDD | 44 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.



**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Procedural Blank**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Blank**

**SAMPLE SIZE: 5.00 g**

**AXYS FILE: DX-T-BLK 1734**

**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.2 | T4CDF - Total | ND | 0.2 |
| 2,3,7,8 | ND | 0.2 | 2,3,7,8 | ND | 0.2 |
| P5CDD - Total | ND | 0.1 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.1 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.2 | H6CDF - Total | ND | 0.2 |
| 1,2,3,4,7,8 | ND | 0.2 | 1,2,3,4,7,8 | ND | 0.2 |
| 1,2,3,6,7,8 | ND | 0.2 | 1,2,3,6,7,8 | ND | 0.2 |
| 1,2,3,7,8,9 | ND | 0.2 | 2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,7,8,9 | ND | 0.2 |
| H7CDD - Total | ND | 0.2 | H7CDF - Total | ND | 0.2 |
| 1,2,3,4,6,7,8 | ND | 0.2 | 1,2,3,4,6,7,8 | ND | 0.2 |
| | | | 1,2,3,4,7,8,9 | ND | 0.2 |
| O8CDD - Total | 0.6 | 0.1 | O8CDF - Total | 0.3 | 0.1 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 77 |
| 13C-T4CDD | 85 |
| 13C-P5CDF | 76 |
| 13C-P5CDD | 82 |
| 13C-H6CDF | 90 |
| 13C-H6CDD | 89 |
| 13C-H7CDF | 85 |
| 13C-H7CDD | 85 |
| 13C-O8CDD | 79 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

Approved

## ANALYSIS REPORT
## POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D.:** | **Procedural Blank** | **AXYS FILE:** | **DX-T-BLK 1744** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **02/Apr/98** |
| **SAMPLE TYPE:** | **Blank** | **METHOD NO.:** | **DX-T-03/Ver.2** |
| **SAMPLE SIZE:** | **10.0 g** | **INSTRUMENT:** | **GC-HRMS** |
| | | **CONCENTRATION IN:** | **pg/g** |

| Dioxins | Concentration | (SDL) | Furans | Concentration | (SDL) |
|---|---|---|---|---|---|
| T4CDD - Total | ND | 0.1 | T4CDF - Total | ND | 0.1 |
| 2,3,7,8 | ND | 0.1 | 2,3,7,8 | ND | 0.1 |
| P5CDD - Total | ND | 0.2 | P5CDF - Total | ND | 0.1 |
| 1,2,3,7,8 | ND | 0.2 | 1,2,3,7,8 | ND | 0.1 |
| | | | 2,3,4,7,8 | ND | 0.1 |
| H6CDD - Total | ND | 0.3 | H6CDF - Total | ND | 0.3 |
| 1,2,3,4,7,8 | ND | 0.3 | 1,2,3,4,7,8 | ND | 0.3 |
| 1,2,3,6,7,8 | ND | 0.3 | 1,2,3,6,7,8 | ND | 0.3 |
| 1,2,3,7,8,9 | ND | 0.3 | 2,3,4,6,7,8 | ND | 0.3 |
| | | | 1,2,3,7,8,9 | ND | 0.3 |
| H7CDD - Total | ND | 0.5 | H7CDF - Total | ND | 0.5 |
| 1,2,3,4,6,7,8 | ND | 0.5 | 1,2,3,4,6,7,8 | ND | 0.5 |
| | | | 1,2,3,4,7,8,9 | ND | 0.5 |
| O8CDD - Total | ND | 0.8 | O8CDF - Total | ND | 0.8 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-T4CDF | 52 |
| 13C-T4CDD | 59 |
| 13C-P5CDF | 51 |
| 13C-P5CDD | 51 |
| 13C-H6CDF | 58 |
| 13C-H6CDD | 60 |
| 13C-H7CDF | 49 |
| 13C-H7CDD | 47 |
| 13C-O8CDD | 46 |

1. SDL = Sample Detection Limit
2. ND = Not detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected.

M.C. Hamilton
**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Sediment**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-S-SPM 902**

**DATE: 02/Mar/98**

**METHOD NO.: DX-S-01/Ver.3**

**INSTRUMENT: GC-HRMS**

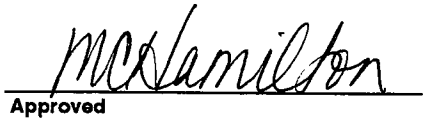
**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 1.8 | 1.8 | 100 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.4 | 5.0 | 108 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 4.8 | 5.4 | 89 |
| **1,2,3,6,7,8** | 4.9 | 5.0 | 98 |
| **1,2,3,7,8,9** | 3.3 | 5.2 | 63 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 5.1 | 5.5 | 93 |
| **O8CDD - Total** | 14 | 14 | 100 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 1.8 | 2.0 | 90 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 5.0 | 4.6 | 109 |
| **2,3,4,7,8** | 4.3 | 4.6 | 93 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 4.8 | 4.6 | 104 |
| **1,2,3,6,7,8** | 5.2 | 4.6 | 113 |
| **2,3,4,6,7,8** | 3.2 | 4.6 | 70 |
| **1,2,3,7,8,9** | 2.9 | 4.6 | 63 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 5.2 | 6.6 | 79 |
| **1,2,3,4,7,8,9** | 2.8 | 4.6 | 61 |
| **O8CDF - Total** | 8.2 | 7.8 | 105 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 52 |
| **13C-T4CDD** | 51 |
| **13C-P5CDF** | 51 |
| **13C-P5CDD** | 47 |
| **13C-H6CDF** | 55 |
| **13C-H6CDD** | 53 |
| **13C-H7CDF** | 45 |
| **13C-H7CDD** | 33 |
| **13C-O8CDD** | 25 |

1. Concentrations are recovery corrected.



**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Tissue**

**SAMPLE SIZE: 10.0 g**

**AXYS FILE: DX-T-SPM 918**

**DATE: 13/Mar/98**

**METHOD NO.: DX-T-03/Ver.2**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 1.9 | 1.8 | 106 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 5.9 | 5.0 | 118 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 5.4 | 5.4 | 100 |
| **1,2,3,6,7,8** | 5.6 | 5.0 | 112 |
| **1,2,3,7,8,9** | 4.9 | 5.2 | 94 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 4.3 | 4.4 | 98 |
| **O8CDD - Total** | 7.2 | 7.4 | 97 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 4.4 | 4.4 | 100 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 4.9 | 4.6 | 107 |
| **2,3,4,7,8** | 5.2 | 4.6 | 113 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 5.2 | 4.6 | 113 |
| **1,2,3,6,7,8** | 5.2 | 4.6 | 113 |
| **2,3,4,6,7,8** | 4.8 | 4.6 | 104 |
| **1,2,3,7,8,9** | 3.9 | 4.6 | 85 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 4.7 | 4.6 | 102 |
| **1,2,3,4,7,8,9** | 4.7 | 4.6 | 102 |
| **O8CDF - Total** | 7.8 | 7.4 | 105 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 71 |
| **13C-T4CDD** | 79 |
| **13C-P5CDF** | 64 |
| **13C-P5CDD** | 67 |
| **13C-H6CDF** | 78 |
| **13C-H6CDD** | 78 |
| **13C-H7CDF** | 66 |
| **13C-H7CDD** | 64 |
| **13C-O8CDD** | 51 |

1. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 38.6 g**

**% LIPID: 0.42**

**AXYS FILE: DX-B-SPM 922**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g lipid**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 2.4 | 2.4 | 100 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 14 | 17 | 86 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 12 | 12 | 100 |
| **1,2,3,6,7,8** | 67 | 69 | 97 |
| **1,2,3,7,8,9** | 14 | 19 | 75 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 76 | 71 | 107 |
| **O8CDD - Total** | 405 | 405 | 100 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 12 | 10 | 125 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 7.1 | 7.1 | 100 |
| **2,3,4,7,8** | 14 | 12 | 120 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 14 | 14 | 100 |
| **1,2,3,6,7,8** | 14 | 14 | 100 |
| **2,3,4,6,7,8** | 9.5 | 9.5 | 100 |
| **1,2,3,7,8,9** | 7.0 | 9.5 | 74 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 14 | 17 | 86 |
| **1,2,3,4,7,8,9** | 7.1 | 7.1 | 100 |
| **O8CDF - Total** | 19 | 17 | 114 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 52 |
| **13C-T4CDD** | 60 |
| **13C-P5CDF** | 45 |
| **13C-P5CDD** | 52 |
| **13C-H6CDF** | 53 |
| **13C-H6CDD** | 49 |
| **13C-H7CDF** | 43 |
| **13C-H7CDD** | 35 |
| **13C-O8CDD** | 25 |

1. Concentrations are recovery corrected.

**Approved**

**ANALYSIS REPORT**
**POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS**

**CLIENT SAMPLE I.D.: Spiked Matrix**

**CLIENT: Hatfield Consultants Ltd.**

**SAMPLE TYPE: Whole Blood**

**SAMPLE SIZE: 38.6 g**

**% LIPID: 0.42**

**AXYS FILE: DX-B-SPM 922**

**DATE: 24/Mar/98**

**METHOD NO.: DX-B-06/Ver.1**

**INSTRUMENT: GC-HRMS**

**CONCENTRATION IN: pg/g blood**

| Dioxins | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDD - Total** | | | |
| **2,3,7,8** | 0.01 | 0.01 | 100 |
| **P5CDD - Total** | | | |
| **1,2,3,7,8** | 0.06 | 0.07 | 86 |
| **H6CDD - Total** | | | |
| **1,2,3,4,7,8** | 0.05 | 0.05 | 100 |
| **1,2,3,6,7,8** | 0.28 | 0.29 | 97 |
| **1,2,3,7,8,9** | 0.06 | 0.08 | 75 |
| **H7CDD - Total** | | | |
| **1,2,3,4,6,7,8** | 0.32 | 0.30 | 107 |
| **O8CDD - Total** | 1.7 | 1.7 | 100 |

| Furans | Determined | Expected | % Recovery |
|---|---|---|---|
| **T4CDF - Total** | | | |
| **2,3,7,8** | 0.05 | 0.04 | 125 |
| **P5CDF - Total** | | | |
| **1,2,3,7,8** | 0.03 | 0.03 | 100 |
| **2,3,4,7,8** | 0.06 | 0.05 | 120 |
| **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 0.06 | 0.06 | 100 |
| **1,2,3,6,7,8** | 0.06 | 0.06 | 100 |
| **2,3,4,6,7,8** | 0.04 | 0.04 | 100 |
| **1,2,3,7,8,9** | 0.03 | 0.04 | 75 |
| **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 0.06 | 0.07 | 86 |
| **1,2,3,4,7,8,9** | 0.03 | 0.03 | 100 |
| **O8CDF - Total** | 0.08 | 0.07 | 114 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 52 |
| **13C-T4CDD** | 60 |
| **13C-P5CDF** | 45 |
| **13C-P5CDD** | 52 |
| **13C-H6CDF** | 53 |
| **13C-H6CDD** | 49 |
| **13C-H7CDF** | 43 |
| **13C-H7CDD** | 35 |
| **13C-O8CDD** | 25 |

1. Concentrations are recovery corrected.

**Approved**

## ANALYSIS REPORT
## POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D.:** | **Spiked Matrix** | **AXYS FILE:** | **DX-T-SPM 926** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **02/Apr/98** |
| **SAMPLE TYPE:** | **Tissue** | **METHOD NO.:** | **DX-T-03/Ver** |
| **SAMPLE SIZE:** | **10.8 g** | **INSTRUMENT:** | **GC-HRMS** |
| | | **CONCENTRATION IN:** | **pg/g** |

| Dioxins | Determined | Expected | % Recovery | Furans | Determined | Expected | % Recovery |
|---|---|---|---|---|---|---|---|
| **T4CDD - Total** | | | | **T4CDF - Total** | | | |
| **2,3,7,8** | 2.1 | 1.8 | 117 | **2,3,7,8** | 5.1 | 4.4 | 116 |
| **P5CDD - Total** | | | | **P5CDF - Total** | | | |
| **1,2,3,7,8** | 6.3 | 5.0 | 126 | **1,2,3,7,8** | 5.0 | 4.6 | 109 |
| | | | | **2,3,4,7,8** | 5.5 | 4.6 | 120 |
| **H6CDD - Total** | | | | **H6CDF - Total** | | | |
| **1,2,3,4,7,8** | 5.8 | 5.4 | 107 | **1,2,3,4,7,8** | 5.3 | 4.6 | 115 |
| **1,2,3,6,7,8** | 6.1 | 5.0 | 122 | **1,2,3,6,7,8** | 5.2 | 4.6 | 113 |
| **1,2,3,7,8,9** | 5.2 | 5.2 | 100 | **2,3,4,6,7,8** | 4.7 | 4.6 | 102 |
| | | | | **1,2,3,7,8,9** | 4.5 | 4.6 | 98 |
| **H7CDD - Total** | | | | **H7CDF - Total** | | | |
| **1,2,3,4,6,7,8** | 4.3 | 4.4 | 98 | **1,2,3,4,6,7,8** | 4.6 | 4.6 | 100 |
| | | | | **1,2,3,4,7,8,9** | 4.9 | 4.6 | 107 |
| **O8CDD - Total** | 7.3 | 7.4 | 99 | **O8CDF - Total** | 7.2 | 7.4 | 97 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-T4CDF** | 51 |
| **13C-T4CDD** | 52 |
| **13C-P5CDF** | 52 |
| **13C-P5CDD** | 48 |
| **13C-H6CDF** | 59 |
| **13C-H6CDD** | 55 |
| **13C-H7CDF** | 53 |
| **13C-H7CDD** | 48 |
| **13C-O8CDD** | 49 |

1. Concentrations are recovery corrected.

MCHamilton

**Approved**

# Appendix IV

# Batch Summary Sheets

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1739 | ***Date:*** 24 March 1998 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Whole Blood |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -59<br>-60<br>-61<br>-62 | ***Blank:*** DX-B-BLK 77 |
| | ***Reference or Spike:***<br>DX-B-SPM 922 |
| | ***Duplicate:*** |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1717 | ***Date:*** 02 March 1998 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Sediment |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -50 AL<br>-51 L<br>-52 L<br>-53 i | ***Blank:*** DX-S-BLK 1717 L |
| | ***Reference or Spike:***<br>DX-S-SPM 902 |
| | ***Duplicate:***<br>2607-50 BL |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1734 | ***Date:*** 13 March 1998 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Tissue |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -54<br>-55<br>-56<br>-57 A<br>-58 | ***Blank:*** DX-T-BLK 1734 |
| | ***Reference or Spike:***<br>DX-T-SPM 918 |
| | ***Duplicate:***<br>2607-57 B |
| ***Comments*** | |

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** DX-1744 | ***Date:*** 02 April 1998 |
| ***Analysis Type:*** Dioxins/Furans | ***Matrix Type:*** Tissue |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -58 | ***Blank:*** DX-T-BLK 1744 |
| | ***Reference or Spike:*** DX-T-SPM 926 |
| | ***Duplicate:*** |
| ***Comments*** | |

# ADDENDUM

## Analytical Data on 1997 PCB/Pesticide Analyses - Reports and Batch Summary Sheets

(See Appendix A2.3 for Analytical Protocols)

**PCB ANALYSIS REPORT** **CL010**

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D:** | **97VN003** | **AXYS ID:** | **2607-63** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **22/Jun/98** |
| **SAMPLE TYPE:** | **Sediment** | **METHOD NO.:** | **CL-S-01/Ver.1** |
| **SAMPLE SIZE:** | **14.5 g dry** | **INSTRUMENT:** | **GC-MS** |
| **% MOISTURE:** | **4.3** | **F1/F2 RUNFILE ID:** | **CL891734.D** |
| | | **CONCENTRATION IN:** | **ng/g** |

**A So**
**Soil (10 – 30 cm)**
**Manioc Field**

| Compounds | Concentration | (SDL) |
|---|---|---|
| **Aroclor 1242** | ND | 0.52 |
| **Aroclor 1254** | ND | 0.77 |
| **Aroclor 1260** | ND | 0.92 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-PCB 101** | 40 |
| **13C-PCB 180** | 42 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT CL001

CLIENT SAMPLE I.D: 97VN015

CLIENT: Hatfield Consultants Ltd.

SAMPLE TYPE: Sediment

SAMPLE SIZE: 14.3 g dry

% MOISTURE: 7.9

**A So**
**Soil (10 – 30 cm)**
**Ploughed, Sweet Potato Field**

AXYS ID: 2607-64

DATE: 18/Jun/98
REVISED: 22/Jun/98
METHOD NO.: CL-S-01/Ver.2

INSTRUMENT: GC-MS/GC-ECD
RUNFILE ID: CL891735.D
F3 RUNFILE ID: 53085
CONCENTRATION IN: ng/g

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.04 |
| alpha HCH | ND | 0.07 |
| beta HCH | ND | 0.2 |
| gamma HCH | ND | 0.3 |
| Heptachlor | ND | 0.4 |
| Aldrin | ND | 0.08 |
| Oxychlordane | ND | 1.0 |
| trans-Chlordane | ND | 0.08 |
| cis-Chlordane | ND | 0.08 |
| o,p'-DDE | ND | 0.04 |
| p,p'-DDE | 2.0 | 0.006 |
| trans-Nonachlor | ND | 0.03 |
| cis-Nonachlor | ND | 0.04 |
| o,p'-DDD | NDR 0.33 | 0.008 |
| p,p'-DDD | 1.1 | 1.2 |
| o,p'-DDT | 0.41 | 0.02 |
| p,p'-DDT | 1.0 | 0.02 |
| Mirex | ND | 0.07 |
| Heptachlor Epoxide | ND | 0.01 |
| alpha-Endosulphan (I) | ND | 0.01 |
| Dieldrin | ND | 0.01 |
| Endrin | ND | 0.02 |
| Methoxychlor | ND | 0.04 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 40 |
| 13C-gamma HCH | 45 |
| 13C-p,p'-DDE | 49 |
| 13C-p,p'-DDT | 56 |
| 13C-Mirex | 55 |
| 13C-PCB 101 | 54 |
| 13C-PCB 180 | 62 |
| 13C-PCB 209 | 77 |
| d4-alpha-Endosulphan | 79 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT CL001

CLIENT SAMPLE I.D: 97VN003

CLIENT: Hatfield Consultants Ltd.

SAMPLE TYPE: Sediment

SAMPLE SIZE: 14.5 g dry

% MOISTURE: 4.3

**A So**
**Soil (10 – 30 cm)**
**Manioc Field**

AXYS ID: 2607-63

DATE: 18/Jun/98
REVISED: 22/Jun/98
METHOD NO.: CL-S-01/Ver.2

INSTRUMENT: GC-MS/GC-ECD
RUNFILE ID: CL891734.D
F3 RUNFILE ID: 53084
CONCENTRATION IN: ng/g

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.03 |
| alpha HCH | ND | 0.4 |
| beta HCH | ND | 0.6 |
| gamma HCH | ND | 0.6 |
| Heptachlor | ND | 0.9 |
| Aldrin | ND | 0.2 |
| Oxychlordane | ND | 0.4 |
| trans-Chlordane | ND | 0.1 |
| cis-Chlordane | ND | 0.09 |
| o,p'-DDE | ND | 0.03 |
| p,p'-DDE | ND | 0.06 |
| trans-Nonachlor | ND | 0.08 |
| cis-Nonachlor | ND | 0.08 |
| o,p'-DDD | ND | 0.02 |
| p,p'-DDD | ND | 0.02 |
| o,p'-DDT | ND | 0.04 |
| p,p'-DDT | ND | 0.04 |
| Mirex | ND | 0.07 |
| Heptachlor Epoxide | ND | 0.01 |
| alpha-Endosulphan (I) | ND | 0.01 |
| Dieldrin | ND | 0.01 |
| Endrin | ND | 0.04 |
| Methoxychlor | ND | 0.04 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 32 |
| 13C-gamma HCH | 35 |
| 13C-p,p'-DDE | 33 |
| 13C-p,p'-DDT | 38 |
| 13C-Mirex | 41 |
| 13C-PCB 101 | 40 |
| 13C-PCB 180 | 42 |
| 13C-PCB 209 | 57 |
| d4-alpha-Endosulphan | 71 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hoover
Approved

**PCB ANALYSIS REPORT** **CL010**

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D:** | **97VN015** | **AXYS ID:** | **2607-64** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **22/Jun/98** |
| **SAMPLE TYPE:** | **Sediment** | **METHOD NO.:** | **CL-S-01/Ver.1** |
| **SAMPLE SIZE:** | **14.3 g dry** | **INSTRUMENT:** | **GC-MS** |
| **% MOISTURE:** | **7.9** | **F1/F2 RUNFILE ID:** | **CL891735.D** |
| | | **CONCENTRATION IN:** | **ng/g** |

**A So**
**Soil (10 – 30 cm)**
**Ploughed, Sweet**
**Potato Field**

| Compounds | Concentration | (SDL) |
|---|---|---|
| **Aroclor 1242** | ND | 0.39 |
| **Aroclor 1254** | ND | 0.74 |
| **Aroclor 1260** | ND | 0.65 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-PCB 101** | 54 |
| **13C-PCB 180** | 62 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hoover
**Approved**

## PCB ANALYSIS REPORT

CL010

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D:** | **Spiked Matrix** | **AXYS ID:** | **CL-S-SPM 1017** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **22/Jun/98** |
| **SAMPLE TYPE:** | **Sediment** | **METHOD NO.:** | **CL-S-01/Ver.1** |
| **SAMPLE SIZE:** | **10.0 g** | **INSTRUMENT:** | **GC-MS** |
| | | **F1/F2 RUNFILE ID:** | **CL891739.D** |
| | | **CONCENTRATION IN:** | **ng/g** |

| Compounds | Determined | Expected | % Recovery |
|---|---|---|---|
| **Aroclor 1242** | 33 | 52 | 63 |
| **Aroclor 1254** | 38 | 48 | 79 |
| **Aroclor 1260** | 39 | 49 | 80 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-PCB 101** | 31 |
| **13C-PCB 180** | 42 |

1. Concentrations are not recovery corrected

Approved

## PCB ANALYSIS REPORT

CL010

| | | | |
|---|---|---|---|
| **CLIENT SAMPLE I.D:** | **Procedural Blank** | **AXYS ID:** | **CL-S-BLK 1380** |
| **CLIENT:** | **Hatfield Consultants Ltd.** | **DATE:** | **22/Jun/98** |
| **SAMPLE TYPE:** | **Blank** | **METHOD NO.:** | **CL-S-01/Ver.1** |
| **SAMPLE SIZE:** | **15.0 g** | **INSTRUMENT:** | **GC-MS** |
| | | **F1/F2 RUNFILE ID:** | **CL891732.D** |
| | | **CONCENTRATION IN:** | **ng/g** |

| Compounds | Concentration | (SDL) |
|---|---|---|
| **Aroclor 1242** | ND | 0.19 |
| **Aroclor 1254** | ND | 0.74 |
| **Aroclor 1260** | ND | 0.74 |

| Surrogate Standards | % Recovery |
|---|---|
| **13C-PCB 101** | 66 |
| **13C-PCB 180** | 66 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are not recovery corrected

Approved

## PCB/PESTICIDE ANALYSIS REPORT

CL001

**CLIENT SAMPLE I.D: Procedural Blank**

**AXYS ID: CL-S-BLK 1380**

**CLIENT: Hatfield Consultants Ltd.**

**DATE: 18/Jun/98**
**REVISED: 22/Jun/98**

**SAMPLE TYPE: Blank**

**METHOD NO.: CL-S-01/Ver.2**

**SAMPLE SIZE: 15.0 g**

**INSTRUMENT: GC-MS/GC-ECD**
**F1/F2 RUNFILE ID: CL891732.D**
**F3 RUNFILE ID: 53082**
**CONCENTRATION IN: ng/g**

| Compounds | Concentration | (SDL) |
|---|---|---|
| Hexachlorobenzene | ND | 0.04 |
| alpha HCH | ND | 0.2 |
| beta HCH | ND | 0.4 |
| gamma HCH | ND | 0.3 |
| Heptachlor | ND | 0.7 |
| Aldrin | ND | 0.1 |
| Oxychlordane | ND | 0.2 |
| trans-Chlordane | ND | 0.07 |
| cis-Chlordane | ND | 0.07 |
| o,p'-DDE | ND | 0.04 |
| p,p'-DDE | ND | 0.02 |
| trans-Nonachlor | ND | 0.04 |
| cis-Nonachlor | ND | 0.05 |
| o,p'-DDD | ND | 0.01 |
| p,p'-DDD | ND | 0.01 |
| o,p'-DDT | ND | 0.009 |
| p,p'-DDT | ND | 0.02 |
| Mirex | ND | 0.08 |
| Heptachlor Epoxide | ND | 0.005 |
| alpha-Endosulphan (I) | ND | 0.006 |
| Dieldrin | ND | 0.005 |
| Endrin | ND | 0.009 |
| Methoxychlor | ND | 0.02 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 53 |
| 13C-gamma HCH | 56 |
| 13C-p,p'-DDE | 55 |
| 13C-p,p'-DDT | 61 |
| 13C-Mirex | 65 |
| 13C-PCB 101 | 66 |
| 13C-PCB 180 | 66 |
| 13C-PCB 209 | 88 |
| d4-alpha-Endosulphan | 81 |

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Concentrations are recovery corrected

Dale Hoover
Approved

## PCB/PESTICIDE ANALYSIS REPORT

CL001

**CLIENT SAMPLE I.D: Spiked Matrix**

**AXYS ID: CL-S-SPM 1017**

**CLIENT: Hatfield Consultants Ltd.**

**DATE: 18/Jun/98**
**REVISED: 22/Jun/98**

**SAMPLE TYPE: Sediment**

**METHOD NO.: CL-S-01/Ver.2**

**SAMPLE SIZE: 10.0 g**

**INSTRUMENT: GC-MS/GC-ECD**
**RUNFILE ID: CL891739.D**
**F3 RUNFILE ID: 53083**
**CONCENTRATION IN: ng/g**

| Compounds | Determined | Expected | % Recovery |
|---|---|---|---|
| Hexachlorobenzene | 4.8 | 5.8 | 82 |
| alpha HCH | 4.9 | 6.0 | 82 |
| beta HCH | 6.9 | 8.3 | 83 |
| gamma HCH | 4.8 | 5.9 | 81 |
| Heptachlor | 4.7 | 6.0 | 78 |
| Aldrin | 3.6 | 4.2 | 87 |
| Oxychlordane | 4.2 | 5.6 | 75 |
| trans-Chlordane | 2.9 | 3.2 | 90 |
| cis-Chlordane | 4.1 | 3.2 | 127 |
| o,p'-DDE | 5.0 | 6.0 | 84 |
| p,p'-DDE | 4.8 | 5.8 | 83 |
| trans-Nonachlor | 3.5 | 4.4 | 80 |
| cis-Nonachlor | 3.2 | 2.6 | 124 |
| o,p'-DDD | 4.3 | 5.4 | 79 |
| p,p'-DDD | 6.0 | 7.1 | 84 |
| o,p'-DDT | 5.5 | 6.5 | 84 |
| p,p'-DDT | 5.7 | 6.4 | 89 |
| Mirex | 4.6 | 5.9 | 77 |
| Heptachlor Epoxide | 4.7 | 5.4 | 87 |
| alpha-Endosulphan (I) | 5.2 | 4.2 | 124 |
| Dieldrin | 5.7 | 6.3 | 90 |
| Endrin | 15 | 12 | 125 |
| Methoxychlor | 24 | 24 | 100 |

| Surrogate Standards | % Recovery |
|---|---|
| 13C-Hexachlorobenzene | 52 |
| 13C-gamma HCH | 55 |
| 13C-p,p'-DDE | 64 |
| 13C-p,p'-DDT | 63 |
| 13C-Mirex | 68 |
| 13C-PCB 101 | 66 |
| 13C-PCB 180 | 71 |
| 13C-PCB 209 | 78 |
| d4-alpha-Endosulphan | 83 |

1. Concentrations are recovery corrected

Dale Hoover

Approved

# BATCH SUMMARY

| | |
|---|---|
| ***Batch ID:*** CL-1380 | ***Date:*** 22 June 1998 |
| ***Analysis Type:*** Pesticide/PCB | ***Matrix Type:*** Sediment |

## BATCH MAKEUP

| | |
|---|---|
| ***Samples:*** 2607 -63<br>-64 | ***Blank:***<br>CL-S-BLK 1380 |
| | ***Reference or Spike:***<br>CL-S-SPM 1017 |
| | ***Duplicate:*** |
| ***Comments*** | |

## Section 4

# Environmental Technology Centre (ETC) (Environment Canada) Report to Hatfield Consultants Ltd. February 1998

*Analytical Data on 1997 Viet Nam Samples*

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 4.36g
SAMPLE ID: CD97-0-00887
FIELD ID: 97VN001

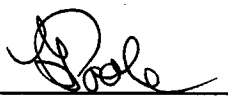
GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029801.DFN
Analysis Date: 30 Jan 98

**A So**
Soil (0 – 10 cm)
Farmer's Field

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 6.61 | 6.61 | Total TCDD | 8.26 | 0.41 | 3 |
| 12378-P5CDD* | [ 0.78] | [ 0.39] | Total P5CDD | 1.56 | 0.69 | 1 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 8.49 | 0.69 | 3 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | 10.92 | 0.69 | 2 |
| 123789-H6CDD* | 0.83 | 0.08 | OCDD | 142.29 | 1.38 | 1 |
| 1234678-H7CDD | 4.91 | 0.05 | | | | |
| OCDD | 142.29 | 0.14 | Total PCDD | 171.52 | | |
| 2378-TCDF | 0.64 | 0.06 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 3.17 | 0.23 | 6 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 0.87 | 0.46 | 1 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | 0.55 | 0.32 | 1 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 0.92 | 0.69 | 1 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 1.61 | 1.38 | 1 |
| 123789-H6CDF* | 0.55 | 0.06 | | | | |
| 1234678-H7CDF | 0.92 | 0.01 | Total PCDF | 7.12 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 1.61 | 0.00 | | | | |
| TOTAL TEQ | | 7.01 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 79 |
| 13C12-TCDF | 1.00 | 83 |
| 13C12-P5CDD | 1.00 | 69 |
| 13C12-P5CDF | 1.00 | 76 |
| 13C12-H6CDD | 1.00 | 74 |
| 13C12-H6CDF | 1.00 | 90 |
| 13C12-H7CDD | 1.00 | 62 |
| 13C12-H7CDF | 1.00 | 75 |
| 13C12-OCDD | 2.00 | 49 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.

 APPROVED BY: 

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770, VIETNAM
SAMPLE MATRIX: Soil 4.10g
SAMPLE ID: CD97-0-00888
FIELD ID: 97VN013

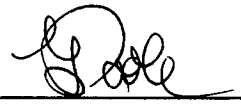
GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029802.DFN
Analysis Date: 30 Jan 98

**A So**
Soil (0 – 10 cm)
Farmer's Field (Ploughed)

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 4.20 | 4.20 | Total TCDD | 6.49 | 0.25 | 4 |
| 12378-P5CDD* | [ 0.73] | [ 0.37] | Total P5CDD | 2.93 | 0.73 | 1 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 10.49 | 0.73 | 3 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | 10.88 | 0.73 | 2 |
| 123789-H6CDD* | 1.12 | 0.11 | OCDD | 136.34 | 1.46 | 1 |
| 1234678-H7CDD | 4.63 | 0.05 | | | | |
| OCDD | 136.34 | 0.14 | Total PCDD | 167.13 | | |
| 2378-TCDF | 0.24 | 0.02 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 1.66 | 0.24 | 5 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 0.78 | 0.24 | 1 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 0.49 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 0.78 | 0.49 | 1 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 1.95 | 1.46 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 0.78 | 0.01 | Total PCDF | 5.17 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 1.95 | 0.00 | | | | |
| TOTAL TEQ | | 4.53 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 82 |
| 13C12-TCDF | 1.00 | 87 |
| 13C12-P5CDD | 1.00 | 68 |
| 13C12-P5CDF | 1.00 | 78 |
| 13C12-H6CDD | 1.00 | 81 |
| 13C12-H6CDF | 1.00 | 95 |
| 13C12-H7CDD | 1.00 | 58 |
| 13C12-H7CDF | 1.00 | 73 |
| 13C12-OCDD | 2.00 | 40 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


APPROVED BY: 

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 4.74g
SAMPLE ID: CD97-0-00889
FIELD ID: 97VN051

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029803.DFN
Analysis Date: 30 Jan 98

**A So**
Soil (0 – 10 cm)
Abandoned Airbase

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 897.85 | 897.85 | Total TCDD | 897.85 | 0.34 | 1 |
| 12378-P5CDD* | 1.69 | 0.85 | Total P5CDD | 7.76 | 0.42 | 2 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 24.35 | 0.63 | 4 |
| 123678-H6CDD* | 1.14 | 0.11 | Total H7CDD | 68.44 | 0.84 | 2 |
| 123789-H6CDD* | 1.65 | 0.17 | OCDD | 563.84 | 1.27 | 1 |
| 1234678-H7CDD | 32.03 | 0.32 | | | | |
| OCDD | 563.84 | 0.56 | Total PCDD | 1562.24 | | |
| 2378-TCDF | 10.46 | 1.05 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 30.30 | 0.21 | 12 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 23.59 | 0.63 | 3 |
| 123478-H6CDF* | 1.27 | 0.13 | Total H6CDF | 8.19 | 0.42 | 6 |
| 123678-H6CDF* | 0.42 | 0.04 | Total H7CDF | 19.83 | 0.63 | 3 |
| 234678-H6CDF* | 0.51 | 0.05 | OCDF | 16.50 | 1.27 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 6.96 | 0.07 | Total PCDF | 98.41 | | |
| 1234789-H7CDF | 0.63 | 0.01 | | | | |
| OCDF | 16.50 | 0.02 | | | | |
| TOTAL TEQ | | 901.22 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 86 |
| 13C12-TCDF | 1.00 | 85 |
| 13C12-P5CDD | 1.00 | 69 |
| 13C12-P5CDF | 1.00 | 76 |
| 13C12-H6CDD | 1.00 | 84 |
| 13C12-H6CDF | 1.00 | 98 |
| 13C12-H7CDD | 1.00 | 59 |
| 13C12-H7CDF | 1.00 | 71 |
| 13C12-OCDD | 2.00 | 43 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


APPROVED BY: 

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 4.81g
SAMPLE ID: CD97-0-00890
FIELD ID: 97VN057

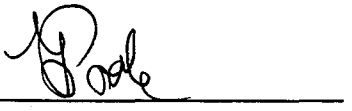
GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029804.DFN
Analysis Date: 30 Jan 98

**A So**
Soil (0 – 10 cm)
Abandoned Airstrip

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 88.32 | 88.32 | Total TCDD | 88.32 | 0.29 | 1 |
| 12378-P5CDD* | 2.91 | 1.46 | Total P5CDD | 7.40 | 0.62 | 2 |
| 123478-H6CDD* | 1.00 | 0.10 | Total H6CDD | 19.83 | 0.83 | 5 |
| 123678-H6CDD* | 2.12 | 0.21 | Total H7CDD | 65.82 | 0.83 | 2 |
| 123789-H6CDD* | 2.54 | 0.25 | OCDD | 697.05 | 1.25 | 1 |
| 1234678-H7CDD | 32.93 | 0.33 | | | | |
| OCDD | 697.05 | 0.70 | Total PCDD | 878.42 | | |
| 2378-TCDF | 3.08 | 0.31 | | | | |
| 12378-P5CDF* | 0.46 | 0.02 | Total TCDF | 11.27 | 0.21 | 10 |
| 23478-P5CDF* | 0.29 | 0.15 | Total P5CDF | 6.94 | 0.29 | 5 |
| 123478-H6CDF* | 1.50 | 0.15 | Total H6CDF | 8.94 | 0.46 | 7 |
| 123678-H6CDF* | 0.54 | 0.05 | Total H7CDF | 22.37 | 0.71 | 2 |
| 234678-H6CDF* | 0.62 | 0.06 | OCDF | 30.31 | 1.25 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 6.90 | 0.07 | Total PCDF | 79.83 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 30.31 | 0.03 | | | | |
| TOTAL TEQ | | 92.21 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 73 |
| 13C12-TCDF | 1.00 | 74 |
| 13C12-P5CDD | 1.00 | 62 |
| 13C12-P5CDF | 1.00 | 66 |
| 13C12-H6CDD | 1.00 | 68 |
| 13C12-H6CDF | 1.00 | 80 |
| 13C12-H7CDD | 1.00 | 49 |
| 13C12-H7CDF | 1.00 | 61 |
| 13C12-OCDD | 2.00 | 40 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


APPROVED BY: 

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Sediment 4.10g
SAMPLE ID: CD97-0-00891
FIELD ID: 97VN073

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029805.DFN
Analysis Date: 30 Jan 98

**Rang Rang**
Fish Pond Sediment
Near Ba Hao Reservoir

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 7.80 | 7.80 | Total TCDD | 9.71 | 0.49 | 2 |
| 12378-P5CDD* | N.D. | N.C. | Total P5CDD | N.D. | 0.49 | 0 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | N.D. | 0.73 | 0 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | 5.85 | 0.98 | 2 |
| 123789-H6CDD* | N.D. | N.C. | OCDD | 29.51 | 0.98 | 1 |
| 1234678-H7CDD | 2.98 | 0.03 | | | | |
| OCDD | 29.51 | 0.03 | Total PCDD | 45.07 | | |
| 2378-TCDF | 0.59 | 0.06 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 0.88 | 0.24 | 2 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 1.07 | 0.24 | 1 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 0.49 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 1.32 | 0.49 | 2 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 1.41 | 1.41 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 0.68 | 0.01 | Total PCDF | 4.68 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 1.41 | 0.00 | | | | |
| TOTAL TEQ | | 7.93 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 69 |
| 13C12-TCDF | 1.00 | 70 |
| 13C12-P5CDD | 1.00 | 64 |
| 13C12-P5CDF | 1.00 | 65 |
| 13C12-H6CDD | 1.00 | 59 |
| 13C12-H6CDF | 1.00 | 68 |
| 13C12-H7CDD | 1.00 | 45 |
| 13C12-H7CDF | 1.00 | 56 |
| 13C12-OCDD | 2.00 | 35 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.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DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 4.68g
SAMPLE ID: CD97-O-00892
FIELD ID: 97VN075

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029806.DFN
Analysis Date: 30 Jan 98

**Rang Rang**
Soil (0 – 10 cm)
South of Abandoned Airbase

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 7.86 | 7.86 | Total TCDD | 10.13 | 0.21 | 4 |
| 12378-P5CDD* | 0.60 | 0.30 | Total P5CDD | 1.41 | 0.43 | 2 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 7.22 | 0.60 | 4 |
| 123678-H6CDD* | 0.64 | 0.06 | Total H7CDD | 6.62 | 0.85 | 2 |
| 123789-H6CDD* | 0.60 | 0.06 | OCDD | 16.58 | 0.81 | 1 |
| 1234678-H7CDD | 3.29 | 0.03 | | | | |
| OCDD | 16.58 | 0.02 | Total PCDD | 41.96 | | |
| 2378-TCDF | 1.03 | 0.10 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 4.02 | 0.21 | 4 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 1.54 | 0.21 | 1 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | 0.51 | 0.26 | 2 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | N.D. | 0.64 | 0 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 0.81 | 0.81 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | N.D. | N.C. | Total PCDF | 6.88 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 0.81 | 0.00 | | | | |
| TOTAL TEQ | | 8.44 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 84 |
| 13C12-TCDF | 1.00 | 86 |
| 13C12-P5CDD | 1.00 | 69 |
| 13C12-P5CDF | 1.00 | 74 |
| 13C12-H6CDD | 1.00 | 81 |
| 13C12-H6CDF | 1.00 | 98 |
| 13C12-H7CDD | 1.00 | 55 |
| 13C12-H7CDF | 1.00 | 71 |
| 13C12-OCDD | 2.00 | 48 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


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DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 4.43g
SAMPLE ID: CD97-0-00893
FIELD ID: 97VN077

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029807.DFN
Analysis Date: 30 Jan 98

**Rang Rang**
Soil (0 – 10 cm)
North of Abandoned Airbase

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 19.10 | 19.10 | Total TCDD | 24.88 | 0.23 | 3 |
| 12378-P5CDD* | 1.76 | 0.88 | Total P5CDD | 8.94 | 0.32 | 2 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 26.37 | 0.90 | 2 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | 7.54 | 0.68 | 2 |
| 123789-H6CDD* | N.D. | N.C. | OCDD | 26.86 | 1.13 | 1 |
| 1234678-H7CDD | 4.38 | 0.04 | | | | |
| OCDD | 26.86 | 0.03 | Total PCDD | 94.59 | | |
| 2378-TCDF | 2.48 | 0.25 | | | | |
| 12378-P5CDF* | 0.32 | 0.02 | Total TCDF | 8.98 | 0.23 | 8 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 5.42 | 0.23 | 2 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | 1.13 | 0.32 | 2 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 1.44 | 0.45 | 2 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 1.40 | 1.13 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 0.95 | 0.01 | Total PCDF | 18.37 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 1.40 | 0.00 | | | | |
| TOTAL TEQ | | 20.33 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 84 |
| 13C12-TCDF | 1.00 | 86 |
| 13C12-P5CDD | 1.00 | 76 |
| 13C12-P5CDF | 1.00 | 78 |
| 13C12-H6CDD | 1.00 | 67 |
| 13C12-H6CDF | 1.00 | 82 |
| 13C12-H7CDD | 1.00 | 54 |
| 13C12-H7CDF | 1.00 | 69 |
| 13C12-OCDD | 2.00 | 44 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.

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DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Soil 5.05g
SAMPLE ID: CD97-0-00894
FIELD ID: 97VN079

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029808.DFN
Analysis Date: 30 Jan 98

**Rang Rang**
Soil (0 – 10 cm)
Abandoned Airbase

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 1.82 | 1.82 | Total TCDD | 2.46 | 0.20 | 2 |
| 12378-P5CDD* | 0.51 | 0.26 | Total P5CDD | 3.76 | 0.40 | 3 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 7.60 | 0.59 | 4 |
| 123678-H6CDD* | 0.99 | 0.10 | Total H7CDD | 9.58 | 0.40 | 2 |
| 123789-H6CDD* | 0.55 | 0.06 | OCDD | 24.91 | 0.79 | 1 |
| 1234678-H7CDD | 4.91 | 0.05 | | | | |
| OCDD | 24.91 | 0.02 | Total PCDD | 48.31 | | |
| 2378-TCDF | 0.59 | 0.06 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 1.15 | 0.20 | 3 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | 0.71 | 0.20 | 1 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 0.24 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 1.07 | 0.40 | 2 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | N.D. | 0.59 | 0 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 0.44 | 0.00 | Total PCDF | 2.93 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | N.D. | N.C. | | | | |
| TOTAL TEQ | | 2.37 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 83 |
| 13C12-TCDF | 1.00 | 88 |
| 13C12-P5CDD | 1.00 | 71 |
| 13C12-P5CDF | 1.00 | 77 |
| 13C12-H6CDD | 1.00 | 80 |
| 13C12-H6CDF | 1.00 | 97 |
| 13C12-H7CDD | 1.00 | 56 |
| 13C12-H7CDF | 1.00 | 70 |
| 13C12-OCDD | 2.00 | 48 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


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12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Sediment 3.77g
SAMPLE ID: CD97-0-00895
FIELD ID: 97VN089

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029812.DFN
Analysis Date: 30 Jan 98

**Rang Rang**
Ba Hao Reservoir Sediment

| Congener | pg/g | Maximum TEQ | Homologue | pg/g | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | 2.28 | 2.28 | Total TCDD | 3.34 | 0.27 | 2 |
| 12378-P5CDD* | [ 0.80] | [ 0.40] | Total P5CDD | N.D. | 0.37 | 0 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | 7.59 | 0.64 | 4 |
| 123678-H6CDD* | 1.06 | 0.11 | Total H7CDD | 10.40 | 0.69 | 2 |
| 123789-H6CDD* | 1.49 | 0.15 | OCDD | 18.46 | 0.53 | 1 |
| 1234678-H7CDD | 5.78 | 0.06 | | | | |
| OCDD | 18.46 | 0.02 | Total PCDD | 39.79 | | |
| 2378-TCDF | 0.27 | 0.03 | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | 2.12 | 0.27 | 4 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | N.D. | 0.27 | 0 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 0.27 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | 1.01 | 0.53 | 2 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | 0.69 | 0.53 | 1 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | 0.58 | 0.01 | Total PCDF | 3.82 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | 0.69 | 0.00 | | | | |
| TOTAL TEQ | | 2.64 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 77 |
| 13C12-TCDF | 1.00 | 82 |
| 13C12-P5CDD | 1.00 | 76 |
| 13C12-P5CDF | 1.00 | 78 |
| 13C12-H6CDD | 1.00 | 62 |
| 13C12-H6CDF | 1.00 | 73 |
| 13C12-H7CDD | 1.00 | 52 |
| 13C12-H7CDF | 1.00 | 64 |
| 13C12-OCDD | 2.00 | 45 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg/g /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


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12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

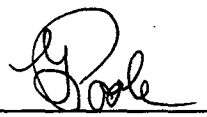
CLIENT: HATFIELD CSLT
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Method Blank
SAMPLE ID: CD97-O-00897
FIELD ID: B 26/01/1998

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029810.DFN
Analysis Date: 30 Jan 98

| Congener | pg | Maximum TEQ | Homologue | pg | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | N.D. | N.C. | Total TCDD | N.D. | 2.00 | 0 |
| 12378-P5CDD* | N.D. | N.C. | Total P5CDD | N.D. | 2.00 | 0 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | N.D. | 2.00 | 0 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | N.D. | 3.00 | 0 |
| 123789-H6CDD* | N.D. | N.C. | OCDD | 6.20 | 5.00 | 1 |
| 1234678-H7CDD | N.D. | N.C. | | | | |
| OCDD | 6.20 | 0.01 | Total PCDD | 6.20 | | |
| 2378-TCDF | N.D. | N.C. | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | N.D. | 1.00 | 0 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | N.D. | 1.00 | 0 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 1.00 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | N.D. | 3.00 | 0 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | N.D. | 5.00 | 0 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | N.D. | N.C. | Total PCDF | 0.00 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | N.D. | N.C. | | | | |
| TOTAL TEQ | | 0.01 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 80 |
| 13C12-TCDF | 1.00 | 85 |
| 13C12-P5CDD | 1.00 | 73 |
| 13C12-P5CDF | 1.00 | 80 |
| 13C12-H6CDD | 1.00 | 73 |
| 13C12-H6CDF | 1.00 | 86 |
| 13C12-H7CDD | 1.00 | 63 |
| 13C12-H7CDF | 1.00 | 83 |
| 13C12-OCDD | 2.00 | 45 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.


APPROVED BY: 

12/02/98

DIOXIN/FURAN ANALYTICAL REPORT

CLIENT:
PROJECT: CIDA 770,VIETNAM
SAMPLE MATRIX: Method Blank
SAMPLE ID: CD97-O-00898
FIELD ID: B27/01/1998 (HL)

GC/MS: 60M DB5/VG70S 10000
BATCH #: UTL-076
File: 12029811.DFN
Analysis Date: 30 Jan 98

| Congener | pg | Maximum TEQ | Homologue | pg | DL | NP |
|---|---|---|---|---|---|---|
| 2378-TCDD | N.D. | N.C. | Total TCDD | N.D. | 2.00 | 0 |
| 12378-P5CDD* | N.D. | N.C. | Total P5CDD | N.D. | 2.00 | 0 |
| 123478-H6CDD* | N.D. | N.C. | Total H6CDD | N.D. | 2.00 | 0 |
| 123678-H6CDD* | N.D. | N.C. | Total H7CDD | N.D. | 3.00 | 0 |
| 123789-H6CDD* | N.D. | N.C. | OCDD | 8.40 | 5.00 | 1 |
| 1234678-H7CDD | N.D. | N.C. | | | | |
| OCDD | 8.40 | 0.01 | Total PCDD | 8.40 | | |
| 2378-TCDF | N.D. | N.C. | | | | |
| 12378-P5CDF* | N.D. | N.C. | Total TCDF | N.D. | 1.00 | 0 |
| 23478-P5CDF* | N.D. | N.C. | Total P5CDF | N.D. | 1.00 | 0 |
| 123478-H6CDF* | N.D. | N.C. | Total H6CDF | N.D. | 1.00 | 0 |
| 123678-H6CDF* | N.D. | N.C. | Total H7CDF | N.D. | 2.00 | 0 |
| 234678-H6CDF* | N.D. | N.C. | OCDF | N.D. | 4.00 | 0 |
| 123789-H6CDF* | N.D. | N.C. | | | | |
| 1234678-H7CDF | N.D. | N.C. | Total PCDF | 0.00 | | |
| 1234789-H7CDF | N.D. | N.C. | | | | |
| OCDF | N.D. | N.C. | | | | |
| TOTAL TEQ | | 0.01 | | | | |

| Surrogate | Amount Added, ng | Recovery % |
|---|---|---|
| 13C12-TCDD | 1.00 | 75 |
| 13C12-TCDF | 1.00 | 76 |
| 13C12-P5CDD | 1.00 | 86 |
| 13C12-P5CDF | 1.00 | 79 |
| 13C12-H6CDD | 1.00 | 82 |
| 13C12-H6CDF | 1.00 | 90 |
| 13C12-H7CDD | 1.00 | 60 |
| 13C12-H7CDF | 1.00 | 73 |
| 13C12-OCDD | 2.00 | 41 |

Note: (1) Results are corrected for surrogate recovery
(2) DL = detection limit (pg /analyte peak); NP=number of analyte peaks.
(3) * represents maximum possible amount as this isomer could coelute with other isomer(s).
(4) N.D.=not detected.
(5) Numbers in brackets represent values not detected due to incorrect ratio.
These values are not included in Total TEQ.
(6) TEQ=Toxic Equivalents as 2,3,7,8-TCDD using International Toxic Equivalency Factors.
(7) N.C.=not calculable.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# Section 5

# Tabulation of Dioxin Analyses Summarized from Specific Reference Materials

**(Provided Courtesy of Axys Analytical Services, Sydney, British Columbia, Canada)**

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Exposed participants

| | Pulp Mill Workers | N. Quebec | S. Quebec | Trichloro-phenol Production | Trichloro-phenol Accident | Pentachloro-phenol Production | Metal Reclamation Plant Workers | Herbicide Plant Workers | Michigan Vietnam Vets | Pyrolysis Plant Residents | Incinerator Plant Residents (male) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 46<N>28 | 20 Pools (9-55) | 3 Pools (5) | N = 12 | N = 17 | N = 20 | N = 32 | N = 85 | N = 50 | N = 12 | N = 19 |
| **Dioxin** | | | | | | | | | | | |
| 2378-TCDD | 1.9 | 8.4 | <2 | 331.8 | 53 | 4.5 | 5.2 | 125.6 | 3.8 | 4.4 | 1.3 |
| 12378-PnCDD | 5.5 | 16.2 | 3.4 | 10.7 | 23.9 | 28.3 | 19.2 | 56.3 | 9.3 | 12.5 | 5.1 |
| 123478-HxCDD[1] | 6.5 | [1] | [1] | 5.7 | 14.9 | 47.9 | 17.3 | 69.9 | 9.8 | [3] | 4.4 |
| 123678-HxCDD | 73 | 64 | 32.3 | 26.9 | 51.9 | 240.6 | 49.5 | 351.2 | 72.1 | 59.5 [3] | 20.3 |
| 123789-HxCDD | 8.9 | 20.6 | 5.0 | 5.0 | 10.6 | 110.3 | 15.5 | 70.4 | 11.9 | [3] | 4.2 |
| 1234678-HpCDD | 83 | 95.6 | 62 | 44.3 | 82.4 | 2514.1 | 79.5 | 369.8 | 118.6 | 64.8 | 62 |
| OCDD | 610 | 1122 | 444.7 | 426.9 | 492.3 | 33191.5 | 505.9 | 1859.7 | 793.9 | 445.1 | 355 |
| **Dibenzofurans** | | | | | | | | | | | |
| 2378-TCDF | 1.4 | 5.6 | <3 | 2.5 | 3.5 | 2.6 | 4.2 | 2.1 | 2.3 | 1.8 | 7.3 |
| 12378-PnCDF | 1.3 | NR | NR | 1.2 | 1.2 | 3.5 | 2.6 | 0.9 | 1.2 | 50.8 [3] | 1.7 |
| 23478-PnCDF | 6.9 | 19.8 | 9.6 | 25.8 | 36.6 | 48.6 | 99.6 | 48.5 | 8.8 | [3] | 11.1 |
| 123478-HxCDF | 6.9 | 14.4 | 13.1 | 8.0 | 14 | 69.1 | 63.8 | 93.1 | 10.6 | 87.9 [3] | 5 |
| 123678-HxCDF[2] | 5.1 | [2] | [2] | 6.6 | 12 | 63.7 | 70.8 | 61.3 | 6.9 | [3] | 4.7 |
| 123789-HxCDF | 1.4 | NR | NR | 0.7 | 0.7 | 1.2 | 1.7 | 0.7 | 2.8 | [3] | ND |
| 234678-HxCDF | 4.7 | 3.7 | 2.4 | 1.7 | 2.8 | 12.6 | 13 | 4.1 | 2.8 | [3] | 2.3 |
| 1234678-HpCDF | 18.4 | 38.8 | 26.3 | 12.9 | 17 | 283.3 | 55.4 | 63.8 | 19.6 | 22.4 [3] | 10.4 |
| 1234789-HpCDF | 3.0 | NR | NR | 0.9 | 1.0 | 2.8 | 2.4 | 1.7 | 3.1 | [3] | <0.35 |
| OCDF | NR | NR | NR | 4.0 | 3.9 | 8.7 | 5.2 | 4.4 | 9.3 | 3.6 | 7 |
| PCDD & PCDF TEQ | 20 | 39.6 | 14.6 | 356.4 | 92.6 | 158.6 | 90.2 | 249.5 | 27 | 27 | 15.6 |
| % TEQ from 2378 TCDD | 9.5 | 21.0 | 14.0 | 93.0 | 57.0 | 2.8 | 5.8 | 50.0 | 14.1 | 16.3 | 8.3 |
| Matrix | Serum | Plasma | Plasma | WB | WB | WB | WB | WB | WB | NR | WB |
| **Reference** | 1 | 4 | 4 | 8 | 8 | 8 | 8 | 8 | 9 & 20 | 12 | 13 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
### Exposed participants

| | Incinerator Plant Residents (female) | Na-PCP Sprayed areas, 15-19 yrs | Na-PCP Sprayed areas, over 40 yrs | Individuals in contact with Na-PCP | Exposed lab personnel | Municipal Incinerator US workers | Municipal Incinerator German workers | Chemical Workers (mothers) | Chemical workers children | Bleaching Plant | Paper Mill |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N = 20 | N = 50 | N = 50 | N = 26 | N = 7 | Pool (56) | Pool (10) | N = 4 | N = 6 | N = 14 | N = 20 |
| **Dioxin** | | | | | | | | | | | |
| 2378-TCDD | 1.4 | 2.2 | 4.6 | 3 | 2 | NR | NR | 168 | 49 | 5.7 | 3.1 |
| 12378-PnCDD | 5.5 | 5.3 | 9.5 | 7.2 | 5.5 | 7.7 | 11 | 28 | 23 | 24 | 20 |
| 123478-HxCDD[1] | 4.7 | 14 | 27.8 | 22.1 | 2.8 | [3] | [3] | [1] | [1] | 3.9 | 3.3 |
| 123678-HxCDD | 23 | 4.2 | 8.9 | 9 | 52 | 74.9[3] | 85.9[3] | 11 | 11 | 160 | 168 |
| 123789-HxCDD | 5.6 | 1.7 | 2.3 | 2.9 | 9.3 | [3] | [3] | 3 | 4 | 12 | 15 |
| 1234678-HpCDD | 77.6 | 15.2 | 15.7 | 24.1 | 149 | NR | NR | 11 | 31 | 107 | 112 |
| OCDD | 465 | 568 | 748 | 1148 | 1294 | 695 | 1051 | 170 | 279 | 689 | 625 |
| **Dibenzofurans** | | | | | | | | | | | |
| 2378-TCDF | 8.5 | 2.1 | 1.4 | 1.5 | 0.9 | 8.1 | 2.7 | 1 | 3 | 3.8 | 2.4 |
| 12378-PnCDF | 1.7 | ND | ND | ND | 0.41 | NR | NR | NR | NR | 2.1 | 1.8 |
| 23478-PnCDF | 14.3 | 1.1 | 1.9 | 2.4 | 14.2 | NR | NR | 11 | 10 | 39 | 43 |
| 123478-HxCDF | 5.9 | 3.1 | 4.9 | 16.4 | 5.6 | 33.6[3] | 52.3[3] | 13 | 11 | 14 | 17 |
| 123678-HxCDF[2] | 5.9 | 1.5 | 2.1 | 2.3 | [2] | [3] | [3] | [2] | [2] | 13 | 13 |
| 123789-HxCDF | ND | ND | ND | ND | NR | [3] | [3] | NR | NR | 0.6 | 1.2 |
| 234678-HxCDF | 2.6 | 1 | 2 | 1.2 | ND | [3] | [3] | 2 | 4 | 4.4 | 4.9 |
| 1234678-HpCDF | 11 | 3.6 | 4.1 | 4.9 | ND | 50[3] | 43.9[3] | 16 | 33 | 75 | 61 |
| 1234789-HpCDF | <0.4 | ND | ND | ND | NR | [3] | [3] | NR | NR | 1.5 | 0.7 |
| OCDF | 7 | 5.9 | 7.5 | 5.2 | ND | NR | NR | NR | NR | NR | NR |
| PCDD & PCDF TEQ | 18.4 | 9 | 16.5 | 14.8 | 23 | 16.7 | 21.1 | 190.9 | 69.7 | 61 | 60 |
| % TEQ from 2378 TCDD | 7.6 | 24.4 | 27.9 | 20.3 | 8.7 | NR | NR | 88.0 | 70.3 | 9.3 | 5.2 |
| Matrix | WB | NR | NR | NR | Plasma | WB | WB | WB | WB | Plasma | Plasma |
| **Reference** | 13 | 14 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Exposed participants

| | Vietnam Vets | Involved in hospital Fire Incident | Involved in relay station Fire Incident | Involved in distillation plant Fire Incident | Cornwall Fish Eater <38 yrs | Cornwall Fish Eater 38-50 yrs | Cornwall Fish Eater >50 yrs | Mississauga Fish Eater, <38 yrs | Mississauga Fish Eater, 38-50 yrs |
|---|---|---|---|---|---|---|---|---|---|
| | N = 20 | N = 53 | N = 25 | N = 7 | Pool | Pool | Pool | Pool | Pool |
| **Dioxin** | | | | | | | | | |
| 2378-TCDD | 5.7 | 3.6 | 3 | 2.3 | 2.8 | 5.7 | 5.3 | 5.4 | 7.4 |
| 12378-PnCDD | 7.1 | 15.3 | 11.4 | 14 | 6.8 | 9.6 | 11.8 | ND | 17 |
| 123478-HxCDD[1] | [1] | [3] | [3] | [3] | [1] | [1] | [1] | [1] | [1] |
| 123678-HxCDD | 56 | 100.7 [3] | 49.4 [3] | 52.4 [3] | 47.2 | 76.5 | 91 | 56.8 | 80.1 |
| 123789-HxCDD | 8.5 | [3] | [3] | [3] | 10.1 | 12.5 | 12.3 | 12 | 16 |
| 1234678-HpCDD | 107.9 | 112.8 | 65.7 | 52.6 | 85.5 | 107.4 | 131.1 | 104 | 129 |
| OCDD | 843.1 | 688 | 469.2 | 396.7 | 367.7 | 593.7 | 575.5 | 422 | 532.2 |
| **Dibenzofurans** | | | | | | | | | |
| 2378-TCDF | 1.3 | NR | 2.5 | 1.9 | ND | ND | ND | ND | ND |
| 12378-PnCDF | NR | 49.6 [3] | 27 [3] | 31.9 [3] | NR | NR | NR | NR | NR |
| 23478-PnCDF | 6.1 | [3] | [3] | [3] | 12.1 | 13 | 15.7 | 24.8 | 18.5 |
| 123478-HxCDF | 6.9 | 43.8 [3] | 19.5 [3] | 23.4 [3] | 12.5 | 14.9 | 14.2 | 17.3 | 20 |
| 123678-HxCDF[2] | 5.4 | [3] | [3] | [3] | [2] | [2] | [2] | [2] | [2] |
| 123789-HxCDF | NR | [3] | [3] | [3] | NR | NR | NR | NR | NR |
| 234678-HxCDF | 1.2 | [3] | [3] | [3] | 6.7 | 4.7 | 3.8 | 14.1 | 9.7 |
| 1234678-HpCDF | 25.1 | 30.7 [3] | 14.7 [3] | 15.2 [3] | 20.8 | 20.4 | 18 | 22.4 | 17.3 |
| 1234789-HpCDF | NR | [3] | [3] | [3] | NR | NR | NR | NR | NR |
| OCDF | ND | NR | 2.1 | 3 | NR | NR | NR | NR | NR |
| PCDD & PCDF TEQ | 22.39 | 30.3 | 18.5 | 19.7 | 21.5 | 29.9 | 33.5 | 32.4 | 40.1 |
| % TEQ from 2378 TCDD | 25.5 | 11.9 | 16.2 | 11.7 | 13.0 | 19.1 | 15.8 | 16.7 | 18.5 |
| Matrix | Plasma | WB | WB | WB | Plasma | Plasma | Plasma | Plasma | Plasma |
| **Reference** | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Exposed participants

| | Mississauga Fish Eater, >50 yrs | phenolxyherbicide incident Male Factory Workers | phenolxyherbicide incident Female Factory Workers | Chemists | Paper & pulp plant workers | PCB exposure from fish | Worker | Office Workers (no chloracne) | Factory Worker (with chloracne ) |
|---|---|---|---|---|---|---|---|---|---|
| | Pool | N = 3 | N = 4 | N = 3 | N = 2 | N = 2 | 81<N<274 | N = 2 | N = 10 |
| **Dioxin** | | | | | | | | | |
| 2378-TCDD | 4.8 | 163 | 202 | 8.5 | 8.6 | 13 | 220 | 23.5 | 118 |
| 12378-PnCDD | 15.4 | 29 | 64 | NR | 15.1 | 23.2 | 13 | 17 | 27 |
| 123478-HxCDD[1] | [1] | [1] | [1] | [3] | 16 | 19.5 | 12 | [1] | [1] |
| 123678-HxCDD | 102 | 15 | 29 | 79.2 [3] | 91.1 | 122 | 90 | 7.7 | 15 |
| 123789-HxCDD | 16 | ND | ND | [3] | 15.6 | 19.3 | 13 | ND | ND |
| 1234678-HpCDD | 80.6 | 33 | 26 | 150 | 172 | 247 | 160 | 9.5 | 16 |
| OCDD | 574.1 | 113 | 165 | 985 | 1250 | 1291 | 1090 | 67 | 233 |
| **Dibenzofurans** | | | | | | | | | |
| 2378-TCDF | ND | ND | ND | ND | 3 | 4 | NR | ND | ND |
| 12378-PnCDF | NR | ND | ND | NR | ND | ND | NR | NR | NR |
| 23478-PnCDF | 24.4 | 19 | 35 | 15 | 12 | 29.4 | 15 | 10 | 13 |
| 123478-HxCDF | 21 | 21 | 30 | 22.3 [3] | 13 | 25.4 | 15 | 22 | 15 |
| 123678-HxCDF[2] | [2] | [2] | [2] | [3] | 13.1 | 17.3 | 10 | [2] | [2] |
| 123789-HxCDF | NR | NR | NR | [3] | ND | ND | NR | NR | NR |
| 234678-HxCDF | 7.8 | ND | 4.7 | [3] | 5.2 | 8.3 | NR | ND | ND |
| 1234678-HpCDF | 17.2 | 18 | 30 | 26 | 24.3 | 36.2 | 23 | 10.5 | 20 |
| 1234789-HpCDF | NR | NR | NR | NR | 7.6 | 7.7 | NR | NR | NR |
| OCDF | NR | 8 | 20 | NR | 23.8 | 23.1 | NR | NR | NR |
| PCDD & PCDF TEQ | 41.2 | 191.2 | 258.6 | 18.7 | 31.7 | 60 | 250.9 | 40.9 | 142 |
| % TEQ from 2378 TCDD | 11.7 | 85.3 | 78.1 | 45.5 | 27.1 | 21.7 | 87.7 | 57.5 | 83.1 |
| Matrix | Plasma | WB | WB | WB | WB | WB | Serum | WB | WB |
| **Reference** | 23 | 26 | 26 | 28 | 31 | 31 | 32 | 33 | 33 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# TABLE 5: DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Unexposed participants

| | Community Residents | Canada Pool I | Canada Pool II | Baikalsk | St. Petersburg | Germany | USA | Guam | Missouri | Spain, Male 18-29yrs | Spain, Male 30-49yrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10<N<17 | Pool | Pool | Pool (8) | Pool (60) | N = 102 | Pool (100) | N = 10 | Pool (6) | 2 Pools (20,14) | 2 Pools (16,22) |
| **Dioxin** | | | | | | | | | | | |
| 2378-TCDD | 1.8 | 8.5 | 7 | 3.7 | 4.5 | 3.6 | 5.2 | 2.6 | 3.4 | 1.5 | 1.5 |
| 12378-PnCDD | 5.6 | 24 | 13 | 4.7 | 9.3 | 13.8 | 21 | 14.7 | 7.1 | 3.2 | 4.7 |
| 123478-HxCDD[1] | 6.2 | [1] | [1] | 4.7 | 2.1 | 10.9 | 13 | 8.3 | [1] | [3] | [3] |
| 123678-HxCDD | 67 | 210 | 140 | 6.3 | 8.5 | 54.6 | 84 | 62.1 | 67.5 | 27.2 [3] | 38.8 [3] |
| 123789-HxCDD | 6.9 | 39 | 22 | 2 | 2.4 | 10.6 | 15 | 15.5 | 13.4 | [3] | [3] |
| 1234678-HpCDD | 95.2 | 204 | 187 | 9.6 | 14 | 92.4 | 187 | 162.9 | 155 | 46.4 | 62.2 |
| OCDD | 547 | 2070 | 1950 | 57 | 89 | 610.3 | 1174 | 748.6 | 1208 | 335.6 | 429 |
| **Dibenzofurans** | | | | | | | | | | | |
| 2378-TCDF | 1.3 | NR | NR | 3 | 2.3 | 2.3 | 3.1 | 3.9 | 3.19 | NR | 1.1 |
| 12378-PnCDF | 1.3 | NR | NR | <1.8 | ND | 2 | 2.8 | 0.5 | ND | 5.2 [3] | 5.5 [3] |
| 23478-PnCDF | 6.4 | 42 | 17 | 15 | 9.2 | 37 | 13 | 9.34 | 7 | [3] | [3] |
| 123478-HxCDF | 6.4 | NR | NR | 13 | 8.1 | 15.4 | 15 | 6.28 | 9.4 | 9.6 [3] | 9.3 [3] |
| 123678-HxCDF[2] | 4.8 | NR | NR | 6.8 | 3.9 | 13.3 | 14 | 5.38 | 6.04 | [3] | [3] |
| 123789-HxCDF | 1.6 | NR | NR | ND | ND | 1.7 | ND | 0.5 | ND | [3] | [3] |
| 234678-HxCDF | 3.9 | NR | NR | 2.1 | 1.2 | 4.3 | 3.6 | 1.16 | ND | [3] | [3] |
| 1234678-HpCDF | 15.5 | 83 | 54 | 4.6 | 6.3 | 23.4 | 36 | 34.1 | 20.2 | 7.9 [3] | 6.8 [3] |
| 1234789-HpCDF | 2.7 | NR | NR | ND | ND | 1.5 | ND | 0.85 | ND | [3] | [3] |
| OCDF | NR | NR | NR | <8 | NR | 4.2 | 4.2 | 6.39 | ND | 2.5 | 2.5 |
| PCDD & PCDF TEQ | 19.4 | 71.3 | 42.6 | 18 | 17 | 42 | 41 | 28 | 23.4 | 10 | 12.5 |
| % TEQ from 2378 TCDD | 9.3 | 11.9 | 16.4 | 20.6 | 26.5 | 8.6 | 12.7 | 9.3 | 14.5 | 15.0 | 12.0 |
| Matrix | Serum | Plasma | Plasma | WB | WB | WB | Plasma | WB | NR | WB | WB |
| **Reference** | 1 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 9 | 10 | 10 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Unexposed participants

| | Spain, Male 50-69yrs | Spain, Female, 18-39 yrs | Spain, Female, 40-69 yrs | Adults from S. Germany | Urban Industrial Area, Group 1 | Urban Industrial Area, Group 2 | Rural Industrial Area, Group 1 | Rural Industrial Area, Group 2 | Rural area, group 1 | Rural area, group 2 | Control, 15-19 yrs | Control, >40 yrs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 Pools(12,15) | 2 Pools (26,21) | 2 Pools (28,24) | N = 15 | Pool (45) | Pool (79) | Pool (39) | Pool (44) | Pool (46) | Pool (33) | Pool (50) | Pool (50) |
| **Dioxin** | | | | | | | | | | | | |
| 2378-TCDD | 1.9 | 0.8 | 2.3 | 2.4 | 1.2 | 1.2 | 1.8 | 1.4 | 1.5 | 1.8 | <1.2 | ND |
| 12378-PnCDD | 5.8 | 4.7 | 6.1 | 6.1 | 2.5 | 2.7 | 3.8 | 3.2 | 3.1 | 3.6 | 1.6 | 3.1 |
| 123478-HxCDD[1] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | 1.8 | 3.8 |
| 123678-HxCDD | 43.3 [3] | 35.9 [3] | 51.5 [3] | 39.3 [3] | 14.3 [3] | 17.1 [3] | 18.9 [3] | 19 [3] | 17.8 [3] | 20.2 [3] | 4.3 | 4.9 |
| 123789-HxCDD | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | 1.7 | 2.6 |
| 1234678-HpCDD | 70.1 | 72.6 | 99.1 | 46.4 | 28.8 | 31.5 | 29.3 | 26.3 | 26 | 30.2 | 11.6 | 17.5 |
| OCDD | 452.3 | 516.6 | 688.4 | 416.9 | 255.9 | 237.6 | 219.5 | 180.5 | 197.9 | 247.2 | 104.1 | 117 |
| **Dibenzofurans** | | | | | | | | | | | | |
| 2378-TCDF | 1.3 | 1.2 | 1.4 | 1.7 | <1.9 | <2.2 | <2.2 | <1.9 | <2.3 | <1.9 | <4.2 | 2.7 |
| 12378-PnCDF | 6.8 [3] | 5 [3] | 8.3 [3] | 12.4 [3] | 3.9 [3] | 4.8 [3] | 5.4 [3] | 4.9 [3] | 6.3 [3] | 5.5 [3] | <1.6 | ND |
| 23478-PnCDF | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | 2.7 | 2.7 |
| 123478-HxCDF | 11.2 [3] | 10 [3] | 13 [3] | 16.5 [3] | 7 [3] | 8 [3] | 9.7 [3] | 9.4 [3] | 7.7 [3] | 9.2 [3] | 3.4 | 4.7 |
| 123678-HxCDF[2] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | 2.1 | 3 |
| 123789-HxCDF | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | ND | ND |
| 234678-HxCDF | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | 1.9 | 2.7 |
| 1234678-HpCDF | 6.8 [3] | 6.2 [3] | 7.8 [3] | 13 [3] | 10.6 [3] | 11.7 [3] | 11.3 [3] | 12.3 [3] | 26.3 [3] | 13.2 [3] | 5.1 | 7.7 |
| 1234789-HpCDF | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | [3] | ND | <2.3 |
| OCDF | 2.5 | 2.5 | 2.2 | <5.0 | 1.5 | <4.8 | <5.0 | <5.0 | 1.2 | 1.8 | <5.0 | <5.0 |
| PCDD & PCDF TEQ | 15 | 11.7 | 17.6 | 18.4 | 7.3 | 8.2 | 10 | 9 | 9.3 | 10.1 | 4.8 | 5.7 |
| % TEQ from 2378 TCDD | 12.7 | 6.8 | 13.1 | 13.0 | 16.4 | 14.6 | 18.0 | 15.6 | 16.1 | 17.8 | 25.0 | 0.0 |
| Matrix | WB | WB | WB | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| **Reference** | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 14 | 14 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Unexposed participants

| | control | US controls | German controls | Control pool | Controls | Vegetarians | Non-vegetarians | Reference blood | Cornwall Fish Eater <38 yrs | Cornwall Fish Eater 38-50 yrs | Cornwall Fish Eater >50 yrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N = 3 | Pool (14) | Pool (25) | Pool (100) | N = 14 | N < 25 | N < 25 | N = 10 | Pool | Pool | Pool |
| **Dioxin** | | | | | | | | | | | |
| 2378-TCDD | 0.9 | NR | NR | 12 | 4.1 | 3.39 | 3.58 | 4 | 3 | 4.6 | 5.9 |
| 12378-PnCDD | 5.1 | 5.2 | 14.1 | 9.5 | 17 | 14.1 | 15.5 | 16.5 | 8.7 | 6.8 | 15.1 |
| 123478-HxCDD[1] | 2.5 | [3] | [3] | [1] | 4 | 12.3 | 14.7 | [3] | [1] | [1] | [1] |
| 123678-HxCDD | 43 | 65.1 [3] | 93.7 [3] | 6 | 150 | 36 | 39.9 | 75.7 [3] | 55.5 | 88.1 | 85.5 |
| 123789-HxCDD | 7.6 | [3] | [3] | ND | 12 | 6.84 | 8.33 | [3] | 14.5 | 11.3 | 9.3 |
| 1234678-HpCDD | 147 | NR | NR | 9.7 | 132 | 70.2 | 80 | 88.2 | 98.4 | 127.2 | 126.7 |
| OCDD | 1227 | 531 | 601 | 73 | 804 | 447 | 456 | 610.8 | 417.2 | 673.1 | 709.8 |
| **Dibenzofurans** | | | | | | | | | | | |
| 2378-TCDF | 1 | 3.5 | 3.3 | ND | 1.9 | 0.94 | 1.25 | NR | ND | ND | ND |
| 12378-PnCDF | 0.6 | NR | NR | NR | 1.2 | 0.64 | 0.66 | 46.3 [3] | NR | NR | NR |
| 23478-PnCDF | 14 | NR | NR | 8 | 29 | 25.8 | 25.5 | [3] | 13 | 14.9 | 17.3 |
| 123478-HxCDF | 5.1 | 20.3 [3] | 30.2 [3] | 7 | 10 | 8.09 | 9.05 | 32.1 [3] | 13.7 | 16.9 | 19.8 |
| 123678-HxCDF[2] | NR | [3] | [3] | [2] | 9.5 | 11.8 | 12.9 | [3] | [2] | [2] | [2] |
| 123789-HxCDF | NR | [3] | [3] | NR | 1.6 | NR | NR | [3] | NR | NR | NR |
| 234678-HxCDF | ND | [3] | [3] | ND | 4.8 | 3.16 | 3.16 | [3] | 6.2 | 4.6 | 6.5 |
| 1234678-HpCDF | ND | 18 [3] | 22.9 [3] | 8.4 | 64 | 14.2 | 14.6 | 24.1 [3] | 19.2 | 14.2 | 19.4 |
| 1234789-HpCDF | NR | [3] | [3] | NR | ND | 0.4 | 0.58 | [3] | NR | NR | NR |
| OCDF | ND | NR | NR | NR | NR | 2.02 | 1.36 | NR | NR | NR | NR |
| PCDD & PCDF TEQ | 19.1 | 3.5 | 8 | 22.3 | 49 | 32.6 | 34.32 | 12.9 | 24.7 | 29.8 | 36.8 |
| % TEQ from 2378 TCDD | 4.7 | NR | NR | 53.8 | 8.4 | 10.4 | 10.4 | 31.0 | 12.1 | 15.4 | 16.0 |
| Matrix | Plasma | WB | WB | WB | Plasma | WB | WB | WB | Plasma | Plasma | Plasma |
| **Reference** | 15 | 16 | 16 | 17 | 18 | 19 | 19 | 22 | 23 | 23 | 23 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

# DIOXIN REVIEW
## Concentrations of Dioxins/Furans (pg/g lipid) in Blood
## Unexposed participants

| | Mississauga Fish Eater, <38 yrs | Mississauga Fish Eater, 38-50 yrs | Mississauga Fish Eater, >50 yrs | Adults from Madrid | Adults from Germany | General Russian Population | German controls | Referent | General Ufa Population | Factory Worker Offspring (no chloracne) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pool | Pool | Pool | N = 11 | N = 134 | Pool (68) | N = 85 | 29<N<80 | Pool (100) | N = 8 |
| **Dioxin** | | | | | | | | | | |
| 2378-TCDD | 2.8 | 3.6 | ND | 1.52 | 2.9 | 4.4 | 3.6 | 7 | 12 | 40 |
| 12378-PnCDD | ND | 11 | 11 | 4.09 | 6.3 | 8.8 | NR | 12 | 9.5 | 20 |
| 123478-HxCDD[1] | [1] | [1] | [1] | 2.75 | 6.9 | [1] | [3] | 13 | [1] | [1] |
| 123678-HxCDD | 44.5 | 68.1 | 99 | 32.63 | 26.7 | 10.6 | 81.1 [3] | 84 | 6 | 11 |
| 123789-HxCDD | 11 | 11 | 16 | 5.81 | 4.9 | 2.3 | [3] | 13 | ND | ND |
| 1234678-HpCDD | 114 | 81 | 115 | 71.46 | 45.3 | 13.5 | 93.8 | 160 | 9.7 | 30 |
| OCDD | 530.8 | 545.7 | 586.3 | 397.03 | 370 | 85.2 | 596 | 1010 | 73 | 217 |
| **Dibenzofurans** | | | | | | | | | | |
| 2378-TCDF | ND | ND | ND | 4.66 | 1.9 | 2.3 | 2.5 | NR | ND | ND |
| 12378-PnCDF | NR | NR | NR | 1.44 | 0.5 | ND | NR | NR | NR | NR |
| 23478-PnCDF | 15.9 | 17.4 | 21 | 6.98 | 12.8 | 9.9 | 36.8 | 11 | 8 | 10 |
| 123478-HxCDF | 57.7 | 13.7 | 23 | 5.8 | 7.9 | 13 | 31.6 [3] | 11 | 7 | 13 |
| 123678-HxCDF[2] | [2] | [2] | [2] | 5.06 | 5.8 | [2] | [3] | 8.5 | [2] | [2] |
| 123789-HxCDF | NR | NR | NR | 1.83 | ND | NR | [3] | NR | NR | NR |
| 234678-HxCDF | 66 | ND | 8.2 | 2.6 | 2.6 | 1.3 | [3] | - | ND | ND |
| 1234678-HpCDF | 81.3 | 15.8 | 18 | 12.79 | 11.4 | 6.1 | 21.8 | 20 | 8.4 | 31 |
| 1234789-HpCDF | NR | NR | NR | 5 | 0.6 | NR | NR | NR | NR | NR |
| OCDF | NR | NR | NR | 20.57 | 2.6 | ND | 5.5 | NR | NR | NR |
| PCDD & PCDF TEQ | 34 | 29.1 | 34.3 | 14.3 | 19.1 | 17 | 42 | 34.3 | 22.7 | 58.6 |
| % TEQ from 2378 TCDD | 8.2 | 12.4 | 0.0 | 10.6 | 15.2 | 25.9 | 8.6 | 20.4 | 52.9 | 68.3 |
| Matrix | Plasma | Plasma | Plasma | Serum | WB | WB | WB | Serum | WB | WB |
| **Reference** | 23 | 23 | 23 | 24 | 25 | 26,33 | 28 | 32 | 33 | 33 |

[1] Where 123478-HxCDD and 123678-HxCDD coeluted, the value was recorded as 123678-HxCDD

[2] Where 123478-HxCDF and 123678-HxCDF coeluted, the value was recorded as 123478-HxCDD

[3] Individual values of 2378 CDD/Fcongeners were not reported; Total values are reported

x pools(y)(z) = x replicates of pooled blood from y and z donors were analysed and averaged

N = x, x samples were analysed seperately and the average reported

ND = not detected( and not included in averages), NR = Not Reported, WB = Whole Blood

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# Appendix A3

# Dioxins and Furans in the Environment: Sources, Levels, Fate and Toxicity

## TABLE OF CONTENTS

## LIST OF TABLES

## SOURCES OF DIOXINS AND FURANS IN THE ENVIRONMENT

This is not an exhaustive review, but rather a selective overview highlighting progress in the field with reference to topics relevant to this project.

Since the advent and widespread use of synthetic organochlorines, there has been an increasing global awareness of potential ecological effects arising from exposure to some of these chemicals (CADAS 1994; IOM 1994; ISCDRC 1995). Increasing public concern has largely paralleled improvements in analytical detection limits for many xenobiotics. Detection limits have improved from the ppm (1 part in $10^6$) in the 1950s to parts per quadrillion (1 part in $10^{15}$) in the 1980s resulting in the ability to detect trace levels of synthetic compounds, even in apparently unpolluted environments. Attaching significance to the levels that analytical chemists can detect is a major challenge facing regulatory agencies.

Dioxins were claimed to be detected in ancient sediments (8,000 years old), which suggests that dioxins existed before industries were developed (Hashimoto *et al.*1990). For example, forest fires have been cited as one possible natural source of dioxins (Tashiro *et al.* 1990; Zook and Rappe 1994). However, data on this point are inconclusive as other sediment studies in the Great Lakes in Canada and three high altitude lakes in Switzerland have failed to detect dioxins in pre-industrial age sediments (Hites 1990).

Four primary routes have been identified by which dioxins and furans enter the environment:

- combustion sources;
- chemical products;
- industrial processes; and
- natural sources.

Each of these sources is discussed below. Major contributors in the USA are listed in Table A3.1. The contributors on the list would likely be similar in Canada, although the order may be different (e.g., historically, in British Columbia the pulp and paper industry and forest fires would probably contribute more to the total).

**Table A3.1 Estimated dioxin releases to the U.S. environment (adapted from Stillman 1990).**

| Source | Dioxin TEQ kg/y | Source | Dioxin TEQ kg/y |
|---|---|---|---|
| Municipal Waste Incinerators | 21.1 | Secondary Copper Smelters | 4.4 |
| Coal Combustion | 4.0 | Wood Combustion | 1.9 |
| Forest Fires | 1.8 | Magnesium Production | 0.9 |
| Magnesium Production | 0.9 | Municipal Waste Treatment Sludge | 0.7 |
| Bleached Pulp Manufacturing | 0.55 | Hospital Incinerator | 0.5 |
| Hazardous Waste Incineration | 0.3 | Municipal Sludge Incineration | 0.2 |
| Municipal Waste Treatment Effluent | 0.1 | Petroleum Refining | 0.1 |
| Other | 0.2 | | |

## Combustion Sources

Inputs of dioxins and furans into the environment by combustion processes originate from many sources. For example, incomplete combustion of organic material in the presence of chlorine, such as during waste incineration, is an important source of dioxin (Zook and Rappe 1994). In the absence of a more extensive database, the relative contributions from the different sources are difficult to assess. The following section describes those combustion sources that have been studied in greatest detail.

### *Municipal Incineration*

Approximately 0.6 tonnes of garbage per person per year are incinerated in Canada. In 1984, Environment Canada established the National Incinerator Testing and Evaluation Program (NITEP) to address a wide range of environmental issues related to incineration. The study determined, among other things, that incineration resulted in the release of many pollutants (including dioxins) directly into the atmosphere. It was also determined that fly ash precipitated from municipal incinerators contained dioxins in the range of ten to 170 parts per billion (ppb). Plastics such as polyvinyl chloride are a major source of organochlorine compounds in municipal waste, and may provide precursors for PCDD and PCDF (Environment Canada 1990; Rottluff *et al.* 1990; Christmann *et al.* 1989a), although the data are not conclusive (NATO 1988 a,b,c; Giugliano *et al.* 1989). Several studies have suggested that there is considerable potential for reducing levels of emitted dioxins through the proper design and operation of incinerator facilities (Hiroaka *et al.* 1989; Naikwadi and Karasek 1989; Manscher *et al.* 1990).

Several different mechanisms have been proposed to account for the formation of dioxins and furans during incineration of municipal waste (Dickson *et al.* 1989; Stieglitz *et al.* 1989; Barton

*et al.* 1990; Rottluff *et al.* 1990; and Ward 1989). The following represent four different hypotheses:

- Dioxins and furans are present in the incinerator feed and pass through the combustor undestroyed. This is unlikely to be a significant pathway as there is often a poor correlation between the levels of dioxins emitted from a plant and the nature of the feed;
- Precursors, formed from radicals generated during combustion, react on the surface of fly ash at lower temperatures to form dioxins and furans;
- Organochlorine compounds are synthesized *de novo* from particulate carbon present on fly ash which reacts with oxygen and chlorides, possibly in the presence of a metal catalyst (e.g., Cu(II)) to form dioxins and other compounds; and
- Dioxins and furans may be formed when long-chain hydrocarbons (like PVC or cellulose) are not completely oxidized during combustion. A correlation between total organic halogen (TOX) levels in feed and the total level of PCDDs and PCDFs emitted has been observed (NATO 1988c).

It is possible that more than one of the above mechanisms may be operative at the same time. Total and relative amounts of PCDD/PCDF and other compounds in incinerator emissions vary daily and somehow depend on the incinerator operation conditions (NATO 1988c). Studies in the United Kingdom indicate that dioxin levels found in ash residues from facilities incinerating clinical wastes (which traditionally have a high level of PVC, plastics, etc.) are often much higher than incinerators receiving non-clinical wastes (Brown *et al.* 1990). The dominant dioxin associated with incinerator fly ash is usually O8CDD, one of the least toxic forms of dioxin (Harris 1990), although all other congeners have been detected.

### *Automobile Exhaust*

A Swedish study found that automobiles burning leaded gas produced between 0.05 and 0.3 nanograms of 2,3,7,8-T4CDD/km. Dibromomethane (DBE) and dichloroethane (DCE), which are added as scavengers to leaded gasoline to prevent lead deposits in engines, may be involved in combustion mechanisms leading to dioxin formation. A 1989 New Zealand study also detected low levels of some dioxin and furan congeners in car exhaust (Bingham *et al.* 1989). Studies have produced conflicting results regarding detection of dioxins and furans in exhausts of cars burning unleaded gas (Rottluff *et al.* 1990; NATO 1988c).

## Industrial Sources

There is no known commercial use for dioxins or furans; these compounds are not deliberately synthesized, but are produced as unwanted contaminants during various manufacturing processes.

*Pulp and Paper Industry*

The pulp and paper industry is a source of chlorinated organic release into the environment, primarily as a result of effluent discharges from bleached kraft mills. In the late 1980's there was increasing public concern regarding impacts of these compounds on the aquatic environment, specifically on the fishing industry, with its indirect implications on human health. According to Swedish and Canadian studies, dioxins were formed in pulp bleaching stages using chlorine. Quantities of dioxins and furans formed are strongly dependent on the amount of chlorine used per tonne of pulp produced. Very low concentrations (picograms per gram of product, or parts per trillion) of PCDD and PCDF have been detected in some bleached paper products. In general, bleached softwood kraft pulps had higher concentrations of 2,3,7,8-T4CDD/F than bleached hardwood pulps. Bleached kraft mills also had higher concentrations of 2,3,7,8-T4CDD/F in wastewater effluents and sludges than sulphite mills (Whittemore *et al.* 1990).

A recent study claimed that dioxin congeners were detected in unbleached pulp and concluded that chlorine bleaching is not necessarily the only source of dioxins and furans in pulping of wood. It was hypothesized that dioxins found in unbleached pulp were most likely formed from chlorophenols during cooking. One of the sources of chlorophenols may have been the use of chlorine for disinfection and decolourizing of freshwater (Kitunen and Salkinoja-Salonen 1990).

Although effluent concentrations of dioxins and furans were low, because of the large volume of effluent released into the environment each year, the pulp and paper industry was estimated to release between 100 and 150 grams/year of dioxins and 2,000 to 3,000 grams/year of furans into the Canadian environment (Environment Canada 1990). Through changes in the bleaching process and elimination of elemental chlorine during this process, dioxins have become virtually undectectable.

*Municipal Waste Water Treatment*

The sources responsible for the PCDD and PCDF detected in digested sludge produced by wastewater treatment plants is dependent on the contaminant profiles of the input water. Main contributors are probably stormwater run-offs from the same or similar sites/sources discussed in this section, namely municipal and hospital incinerators, automobile exhausts, etc. (Naf 1990). Studies in Sweden found that storm sewer water (urban runoff) contained up to 2,500 $pg/m^3$ (2,3,7,8-T4CDD-TEQ) dioxins (Naf 1990; Rappe *et al.* 1989). A study performed by the Ontario Ministry of Environment of 37 Ontario municipal water pollution control plants indicated that O8CDD is the principal dioxin/furan congener detected in raw and treated sludge samples (Ho and Clement 1990).

*Pharmaceuticals*

Some medical, dental, and cosmetic products contained the bactericide hexachlorophene. Hexachlorophene is a derivative of trichlorophenol and was shown to be contaminated with

dioxins and furans. Subsequently, its use has virtually been eliminated in products used by humans. Soft soaps, tall oil and tall oil resins (all by-products of the pulping processes) were found to be contaminated with dioxins at levels comparable to levels that were recorded in effluents of bleached pulp mills (Rappe *et al.* 1990).

### *Pesticides*

Other potential chemical sources of dioxins are from phenoxy herbicides like 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and mixtures like Agent Orange. Agent Orange, a defoliant widely used in Viet Nam, was a one-to-one mix of 2,4-D and 2,4,5-T. Use of 2,4,5-T was banned in the United States in 1985, and is no longer used in Canada. However, 2,4-D is now the third most widely used pesticide in the United States, with an estimated 52 to 67 million pounds being used in 1987 (Holloway 1990). Levels of 2,3,7,8-T4CDD/F in 2,4-D are generally below detection limit or at very low levels. The application of these substances to public land is now strictly controlled in Canada, resulting in reduced losses to the environment.

### *Metal Production*

Dioxins are released during the manufacture of iron and steel, in particular the melting of scrap metal which may be coated with paints or other polymers (Antonssen *et al.* 1989; Tysklind *et al.* 1989; NSEPB 1988; Zook and Rappe 1994). Some investigations have also reported high local concentrations of dioxins and furans in the vicinity of copper reclamation plants. In these facilities, scrap copper containing varying quantities of PVC-coated cables, is pre-cleaned by combustion or pyrolysis and then recycled in a copper smelter (cited in Christman *et al.* 1989 b).

Factors that influence dioxin emissions from metallurgical processes are the chlorine load and oxygen level. Efficient final oxidation of the process gas is likely to reduce emissions to a greater extent than melting less contaminated scrap metals. A reduction of dioxin emissions to the air can also be achieved through removal of particulate material by filtering stack emissions (Öberg and Allhammer 1989).

### *Petroleum Industry*

Catalyst regeneration from reforming operations in the petroleum refining industry was recently recognized as another potential source of dioxins and furans. The internal aqueous streams contained parts per quadrillion (ppq) levels of dioxins and furans, while stack emissions contained ng/m$^3$ concentrations (Thompson *et al.* 1990).

## Chemical Sources

Dioxins are not deliberately synthesized, but are produced as contaminants in a variety of chemical processes. For chemical manufacturing, the following processes have been ranked in

order of decreasing priority regarding levels of dioxins/furan contamination levels (NATO 1988a):

- processes to manufacture chlorophenols and their derivatives;
- processes to manufacture chlorobenzenes and substituted chlorobenzenes;
- synthesis of aliphatic chlorine compounds;
- methods involving chlorine-containing intermediates;
- inorganic chlorochemical processes; and
- processes applying chlorinated catalysts and solvents.

### *Chlorophenols*

Chlorophenols have been widely used since the 1930s as fungicides, slimicides, insecticides, and bactericides. Concentrations of dioxins in commercially produced chlorophenols were found to range between 0.2 ppm and 690 ppm (Rottluff *et al.* 1990). The wood preservative pentachlorophenol (PCP) was identified in the early 1980s as a significant source of dioxins in the environment (NRCC 1981). Since the problem was identified, the dioxin content has been steadily reduced to approximately one tenth of what it was originally. However, due to lack of detailed inventory of chemical waste sites in Canada, contribution of these sources to the dioxin/furan load to the environment is difficult to estimate. For example, although sawmills have largely stopped using PCP-based preservatives, old diptank areas, lumber storage areas, etc., which have not been cleaned up, may still be a source of dioxins.

### *Polychlorinated Biphenyls (PCBs)*

PCBs were originally thought to be relatively inert and nontoxic compounds. Mixtures known to contain PCBs are: transformer and capacitor fluids, heat transfer fluids, hydraulic oils, etc. PCB mixtures have been found to contain PCDF substituted with between four and seven chlorine atoms, primarily the tetra- and penta-substituted derivatives, but not dioxin congeners. Furans are known to form when PCBs are heated or burned (Rottluff 1990; Erickson 1989). The mechanism of formation of PCDFs from PCBs is straightforward requiring heat to provide energy for chemical reaction and oxygen. As a result of public concern, use of PCB-containing compounds has been curtailed or eliminated, and storage of contaminated compounds is now also strictly controlled. This has resulted in reduced losses to the environment.

*Chemical Wastes*

Sites containing chemical wastes (e.g., landfills, waste dumps, and contaminated industrial sites), may serve as point sources for dioxins/furans in the environment. Lack of detailed inventory of chemical waste disposal sites, and lack of knowledge of composition of much of the waste that is disposed of at dump sites, makes it difficult, if not impossible, to accurately assess the magnitude of the problem.

### Natural Sources

Pre-industrial age sediments (8,000 years old) have been found to contain detectable levels of dioxins and furans, suggesting natural events (e.g., volcanoes or forest fires) are potential sources of dioxins/furans (Hashimoto *et al.* 1990).

It has been suggested that trace amounts of chlorine found naturally in wood may be sufficient to allow dioxin and furan formation to occur when wood is burned under appropriate conditions. Forest fires represent large-scale combustion of wood under uncontrolled, inefficient conditions, and may be a significant source of dioxins in the environment. A joint Canadian/US program, which monitored the behaviour and environmental impact of prescribed (forest) burns, resulted in detection of varying levels of dioxins and furans in collected air samples. Soil samples indicated that there was a small increase in levels of higher chlorinated dioxins and furans caused by the fire, however data were not conclusive (Tashiro *et al.* 1990; Rottluff *et al.* 1990). There is insufficient data to assess the relative importance of these sources, compared with other sources discussed (Environment Canada 1990).

## ENVIRONMENTAL LEVELS OF DIOXINS AND FURANS

Analytical methodologies capable of measuring environmental contaminants in parts per trillion range (nanograms/kilogram) revealed that dioxins and furans are ubiquitous environmental contaminants. The ability to detect dioxins in samples collected from areas remote from industrial activity and in a wide range of biological species, has prompted considerable research into mechanisms of transportation and persistence of these compounds throughout the environment, such as in Canada (Table A3.2).

**Table A3.2 Dioxin/furan levels in the Canadian environment (Environment Canada 1990).**

| Medium | Range in Concentration | Medium | Range in Concentration |
|---|---|---|---|
| Ambient Air | 0.4 to 36.7 pg total dioxins and furans per cubic metre | Ontario drinking water | Not detectable (ND) to 46 pg/L O8CDD |
| Soil: urban backyards, public areas, parkland | 50 to 14,100 pg/g total dioxins and furans | Mammals | ND to 37 ng/kg 2,3,7,8-T4CDD |
| Birds | ND to 1,996 ng/kg 2,3,7,8-T4CDD | Reptiles | ND to 474 ng/kg 2,3,7,8-T4CDD |
| Amphibians | ND to 35 ng/kg 2,3,7,8-T4CDD | Crabs | ND to 662 ng/kg 2,3,7,8-T4CDD |
| Shellfish | ND to 31 ng/kg 2,3,7,8-T4CDD | Fish | ND to 137 ng/kg 2,3,7,8-T4CDD |
| Human fat tissues | 3-10 ng/kg 2,3,7,8-T4CDD | | |

ND=Not detected.

## Transport and Persistence

Due to their refractile nature, chlorinated organic compounds (particularly dioxins and furans), tend to be very persistent in the environment. Data on the relative (environmental) persistence of different dioxin congeners are not conclusive. Some reports claim that 2,3,7,8-T4CDD has a degradation half-life of ten years or longer (in absence of UV-light), while another report claims that only the most chlorinated dioxins (i.e., least toxic) are environmentally persistent (Eitzer and Hites 1989; Hites 1990; ISCDRC 1995).

### *Air*

New sampling technologies have allowed for the detection of low levels of dioxins and furans adsorbed onto suspended particulate matter (Hunt 1989; Tashiro *et al.* 1989; Christmann *et al.* 1989b). These compounds can be transported to remote parts of the country by prevailing winds and are deposited on sediments and soils (Maisel and Hunt 1990). Air quality surveys performed in Ontario determined that the average ambient air concentrations of dioxins were well below the provincial ambient air guideline of 30 pg/m$^3$ for concentration of total PCDD (Bobet *el al.* 1990; Steer *et al.* 1990). A similar study in a northeastern American urban coastal environment (Hunt and Maisel 1990) found that the ambient concentration range never exceeded 2.5 pg/m$^3$ and was usually well below 1.0 pg/m$^3$. The isomer profile in airborne samples is generally consistent with that for emissions from combustion sources (NSEPB 1988), however combustion sources can show a substantial range in concentrations and PCDD/F profile (the relative amounts of compounds grouped by level of chlorination). Conversely, sediment samples (the ultimate environmental sink) have a more consistent isomer profile. This strongly suggests that transformations occur during aerial transport and deposition (Eitzer and Hites 1989).

*Soils and Sediments*

Soils, and ultimately sediments, are the final sink for most xenobiotics including dioxins and furans. Although dioxins tend to accumulate on particulate surfaces, evidence suggests that in many cases they become immobilized resulting in reduced bioavailability (Umbreit 1986; Servos 1988; Servos and Muir 1989). An Ontario Ministry of Environment study determined that PCDDs and PCDFs appear to be relatively ubiquitous at very low levels in rural soils and slightly higher levels in urban soils (Pearson *et al.* 1990). A similar study performed in the United Kingdom also determined that mean levels for urban samples are significantly higher than rural and semi-rural areas (Creaser *et al.* 1990). Composition of sediment or soil affects the degree of binding; soils rich in humic material tend to immobilize organic contaminants better than sandy soils. Another study involving PCB distribution in sediments found that distribution of PCBs within an impoundment (e.g., dam or lake) was controlled by distribution of fine-grained sediments (Frink *et al.* 1989). Because dioxins partition rapidly into sediments, where they tend to accumulate due to low degradation rates, sediments may act as a source of dioxins and furans to biota long after inputs have been reduced or eliminated.

## ENVIRONMENTAL FATE OF DIOXINS AND FURANS

Relative distribution of dioxins and furans from combustion sources do not resemble the pattern observed in sediments. A combustion profile shows a relatively even distribution of congeners, whereas in a profile of sediment, the octachlorodioxin dominates, the heptachlorofurans and dioxins are significant, and other homologues are much less abundant. Several different mechanisms have been proposed to explain differences (Hites 1990):

- The less chlorinated dioxins and furans could degrade, perhaps biologically, after deposition in the sediments. This is unlikely since the relative composition of dioxins and furans is constant down through sediment core and is unlikely that all these compounds would be degrading at the same rate;
- Perhaps the less chlorinated dioxins and furans are lost preferentially from the atmosphere by photochemical processes. Dioxins absorb strongly in the UV at 310-320 nm and may thus be degraded by photolysis when exposed to UV-irradiation; and
- Only the more highly chlorinated dioxins and furans are deposited from the atmosphere. For example, precipitation scavenging processes could favour removal of only the more highly chlorinated (i.e., less volatile) compounds.

## TOXICITY OF DIOXINS AND FURANS

As dioxin has been called the most toxic chemical known, numerous studies on toxicology of dioxins and related compounds have yielded a large body of literature. A major problem facing regulatory agencies is the wide range in sensitivities that different species exhibit towards dioxin.

## Uptake and Bioaccumulation

The low water solubility of dioxins and furans contributes to their propensity for accumulating in biological tissues. In addition, many of these compounds are degraded very slowly, and therefore persist in body tissues for extended periods. Dioxins and furans move through the food chain and are found in food consumed by humans. Accumulation is determined by both uptake and elimination rates.

### *Plants*

The nature of the soil in which the plant grows would undoubtedly have a strong influence on the absorption behavior of dioxins/furans by root systems. In general, however, absorption through the root system of plants does not appear to be a significant pathway. Samples of vegetation taken in the UK contained detectable levels of most congener groups indicating widespread contamination (Startin *et al.* 1989). Data suggest that accumulation of dioxins and furans in above ground plants mainly results from atmospheric deposition of gaseous and particulate phase TCDD/F (Reischl *et al.* 1989).

### *Foraging Animals*

A study which examined bioaccumulation of dioxins and furans in chickens and cows foraging in a contaminated area concluded that (Chang *et al.* 1989):

- foraging animals assimilate PCDD/Fs from soil containing low concentrations of these compounds; the toxins accumulated primarily in liver, adipose tissue and eggs;
- the congener profiles seen in chicken and bovine liver tissue and chicken eggs more nearly approximate the congener profile of the contaminated soil than the profile seen in adipose tissue; and
- concentrations detected in eggs, poultry and bovine tissues are of public health concern; moderate consumption by humans (e.g., one egg per day), could result in exposure in the range of 10 to 30 pg/kg per day, which would exceed most Acceptable Daily Intake levels (ADIs); The data suggested that unacceptable food animal contamination could result from exposure to soils with TCDD toxic equivalent (TEQ) concentrations in the 10-50 ppt (or pg/g) range, which is 20-100 times lower than the commonly used 1 ppb action level for contaminated soils (Chang *et al.* 1989).

### *Fish*

A long-term laboratory experiment in which year-old lake trout (*Salvelinus namaycush*) were exposed to Lake Ontario sediment, showed that bioaccumulation of 2,3,7,8-T4CDD occurred primarily through the food chain and secondarily through contact with contaminated sediment. The water exposure route, even under simulated equilibrium conditions and low suspended solids

concentrations, did not appear to make a significant contribution to 2,3,7,8-T4CDD accumulation (Batterman *et al.* 1989).

Studies in Sweden (Bergqvist *et al.* 1989) and in British Columbia (Dwernychuk 1989, a,b, 1990, a,b,c,d,e,f,g; Dwernychuk *et al.* 1991 to 1998) have resulted in detection of dioxins and furans in a range of freshwater and marine species. In contrast to mammals, liver in fish is quantitatively not the most important organ for deposition of 2,3,7,8-substituted dioxins and furans. In one experiment, only one to four percent of the total oral-dosed TCDFs were retained in liver of exposed carp. In rainbow trout, 90 percent of an administered dose of 2,3,7,8-T4CDD was stored in the skin and visceral tissue. In the carp, the majority of 2,3,7,8-T4CDD was found in the fat above the brains and the visceral fat, after exposure to contaminated sediment (cited in van der Weiden *et al.* 1989).

In addition to fish, dioxins and furans have also been detected in crabs, mussels and oysters, indicating widespread contamination in both marine and freshwater ecosystems (Dwernychuk 1989, a,b, 1990, a,b,c,d,e,f,g; Dwernychuk *et al.* 1991 to 1998; Miyata *et al.* 1989).

### *Humans*

PCDD and PCDF have been detected in human tissues in many industrialized countries. Concentrations of PCDD in human tissue varied from 1 to 1,000 parts per trillion depending on the degree of chlorination. Isomer specific analysis of food, air, water and soil indicates food is the major source of human exposure to PCDD/Fs (Vainio *et al.* 1989; Birmingham 1990). Ingestion of dioxin/furan contaminated food likely represent the most significant exposure source.

Canadian estimates suggest a daily average intake of 1.52 pg of 2,3,7,8-T4CDD equivalents per kg of body weight (Birmingham *et al.* 1989a). CADAS (1994) stated that the World Health Organization ADI for a TEQ of 10 pg per kg body weight per day of PCDD/F was reasonable.

Daily intake may be significantly higher for certain groups of people. For example, persons with an unusually high consumption of fish may have higher exposure. Detectable levels of dioxins and furans have been found in fish, beef, pork, poultry, eggs, and milk. Near-detection limit concentrations were also detected in fruits, vegetables and wheat-based products (Environment Canada 1990; de Wit *et al.* 1990; NSEPD 1988). Plants do not appear to take up dioxins through their root systems; contaminated food is probably a result of external contamination from growing in contaminated soils, and/or contamination of leaves/fruit by pesticide spraying, contaminated particulate deposition, etc.

A study of the risks associated with human exposure to dioxin from municipal solid waste incineration, indicate that despite slightly elevated air concentrations of dioxins in the vicinity of incinerators, background intake accounted for 99.3 % of total exposure to PCDD/Fs (Travis and Hattemer-Frey 1989; Greim 1990). Cigarette smoking is another source of exposure to dioxins. Total concentration of dioxins in cigarette smoke was determined to be 5 micrograms per cubic meter. In general, concentrations of furans are usually lower than concentrations of dioxins.

## Kinetics, Metabolism and Toxicity

In animal studies, absorption efficiency of dioxins and furans was dependent on the medium in which they were administered, the specific compound involved, and whether exposure took place through the mouth, skin, or lungs. In general, absorption is greater when dioxins and furans are ingested than when applied to the skin. Absorbed dioxins and furans tend to be found in different concentrations in various tissues within the body in proportion to the fat content of the tissue (Environment Canada 1990). The ability to metabolize dioxins and furans appears to be highly species specific (e.g., rats appear to be highly efficient at eliminating dioxins, while guinea pigs have a limited ability (NCASI Technical Bulletin 1987)). In humans, the half-life of 2,3,7,8-T4CDD has been estimated to be between five and eight years (NCASI Technical Bulletin 1987).

### *Animals*

As discussed above, there are large differences in toxicity among various dioxins. 2,3,7,8-T4CDD is the most toxic, and O8CDD the least toxic congener in the dioxin family. There are also large differences in susceptibility of different animal species to dioxins. For example, the guinea pig is approximately 1,000 times more susceptible to 2,3,7,8-T4CDD than hamsters. PCDD is extremely toxic to guinea pigs ($LD_{50}$ 0.8 µg/kg body weight), and less toxic towards mice (280 µg/kg) and hamsters (5,000 µg/kg). These figures highlight a very strong species dependence towards toxicity. Animal studies have demonstrated 2,3,7,8-T4CDD is teratogenic and fetotoxic in rats, mice, rabbits and ferrets; and fetotoxic in monkeys (US EPA 1988; Silkworth 1989; Abbott and Birnbaum 1990; Chahoud *et al.* 1989). 2,3,7,8-T4CDD produced hydronephrosis and cleft palate in mice. The central nervous system has also been implicated in 2,3,7,8-T4CDD toxicity in rats (Pohjanvirta *et al.* 1989).

### *Humans*

There have been several industrial accidents or incidents in which people were exposed to high concentrations of 2,3,7,8-T4CDD. Events in Times Beach, Missouri, and Seveso, Italy, where as many as 40,000 people were exposed, are probably the best known and most researched (Schecter 1994).

Studies of these and other exposed populations indicate that humans are not particularly sensitive to 2,3,7,8-T4CDD. Initial high exposures result in chloracne. Studies of workers who suffered from chronic exposure have not yet produced convincing evidence of elevated levels of cancer, heart disease or overall mortality (Harris 1990) among the exposed group, compared to controls. However, chronic exposure has been implicated in aryl hydrocarbon hydroxylase (AHH) induction, thymic atrophy, hyperkeratosis, and chloracne in man (Paasivirta 1988). A half-life of 4.95 years was reported for humans after ingestion of a single dose of radiolabeled TCDD. Exposure of humans to dioxins is believed to increase the risk of soft tissue sarcoma (STS) (Eriksson *et al.* 1990; IOM 1994), although much of the cancer epidemiology relating to TCDD and TCDF is inconclusive (Vainio *et al.* 1989; Skene *et al.* 1989; CADAS 1994).

Despite lack of direct evidence that levels of dioxins and furans commonly found in the environment pose a significant health threat to humans, regulatory agencies agree that these compounds are undesirable environmental contaminants, and that their unintentional production and release should be reduced as much as possible. In Canada, decision was made that 10 pg 2,3,7,8-T4CDD (2,3,7,8-T4CDD-TEQ) per kilogram body weight per day is an appropriate value to protect humans exposed to all sources of PCDD and PCDF mixtures (Birmingham *et al.* 1989b), and this matches the current World Health Organization ADI (CADAS 1994). In Canada, 30 ppt TEQ for liver, hepatopancreas and fat, and 15 ppt TEQ for muscle tissue has been set by Health Canada as an upper limit which would trigger consumption advisories.

### *Mechanism of Toxicity*

An explanation of toxicity of dioxin has been developed from the "cytosolic receptor" theory. This theory proposed that many dioxin congeners have the ability to bind to a class of intra-cellular receptors. These receptors are soluble (i.e., not bound to the cell membrane), which allows for the receptor/TCDD complex to migrate and bind directly with DNA (Holloway 1990). This binding leads to induction of aryl hydrocarbon hydroxylase (AHH), a key enzyme in steroid metabolism. AHH activity is normally turned on when natural xenobiotics such as polycyclic aromatic hydrocarbons (PAHs) bind to a receptor protein. The process is self-regulating because the enzyme degrades the PAH. As levels of PAH fall, the stimulus abates and AHH activity drops back to normal.

However, due to the refractile nature of dioxin congeners, the AHH enzyme is unable to degrade them, resulting in the enzyme system being stuck in the "on" position. The toxic action of dioxins is therefore believed to be a manifestation of AHH induction, and includes thymic atrophy, hyperkeratosis, and chloracne (Paasivirta 1988; Webster 1990; IOM 1994; Schecter 1994).

There is general agreement in the research community the more work is required on the fate and effects of dioxins in the environment and impacts to human health. Annual conferences focussing on these compounds are testament to the significant research underway in this field (e.g., International Symposium on Chlorinated Dioxins and Related Compounds).

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