A REPORT ON

DIOXIN CONTAMINATION AT THREE HOTSPOTS OF BIEN HOA, DA NANG AND PHU CAT AIRBASES

Da Nang, Dec. 2013

CONTENTS

- Overview on dioxin contaminated status at 3 hotspots
- Conclusions and recommendations

DATA SOURCES, IMPLEMENTING AGENCIES/ORGANISATIONS

1. DATA SOURCES

- MND projects: Projects Z1, Z2, Z3, etc…
- Researches and assignments under the 33 Program
- Researches and assignments under a number of local organisations and sectors
- Additional analysis and assessments sponsored by international organisations: GEF, USAID, UNDP, and FORD, etc.

2. PARTICIPATING PARTNERS

- MND agencies: VRTC; The Military Institute for Chemistry and Environment, The Chemistry Division, etc.
- Local research units/organisations: Office 33, Vietnam Academy of Science and Technology; The Monitoring Center Under VEA, Dong Nai DONRE, The 10-80 Committee, etc
- International organisations: USAID, UNDP, FORD, Hatfield, CDM, etc.

Quantity of herbicides and TCDD used in the South of Vietnam subject to different sources

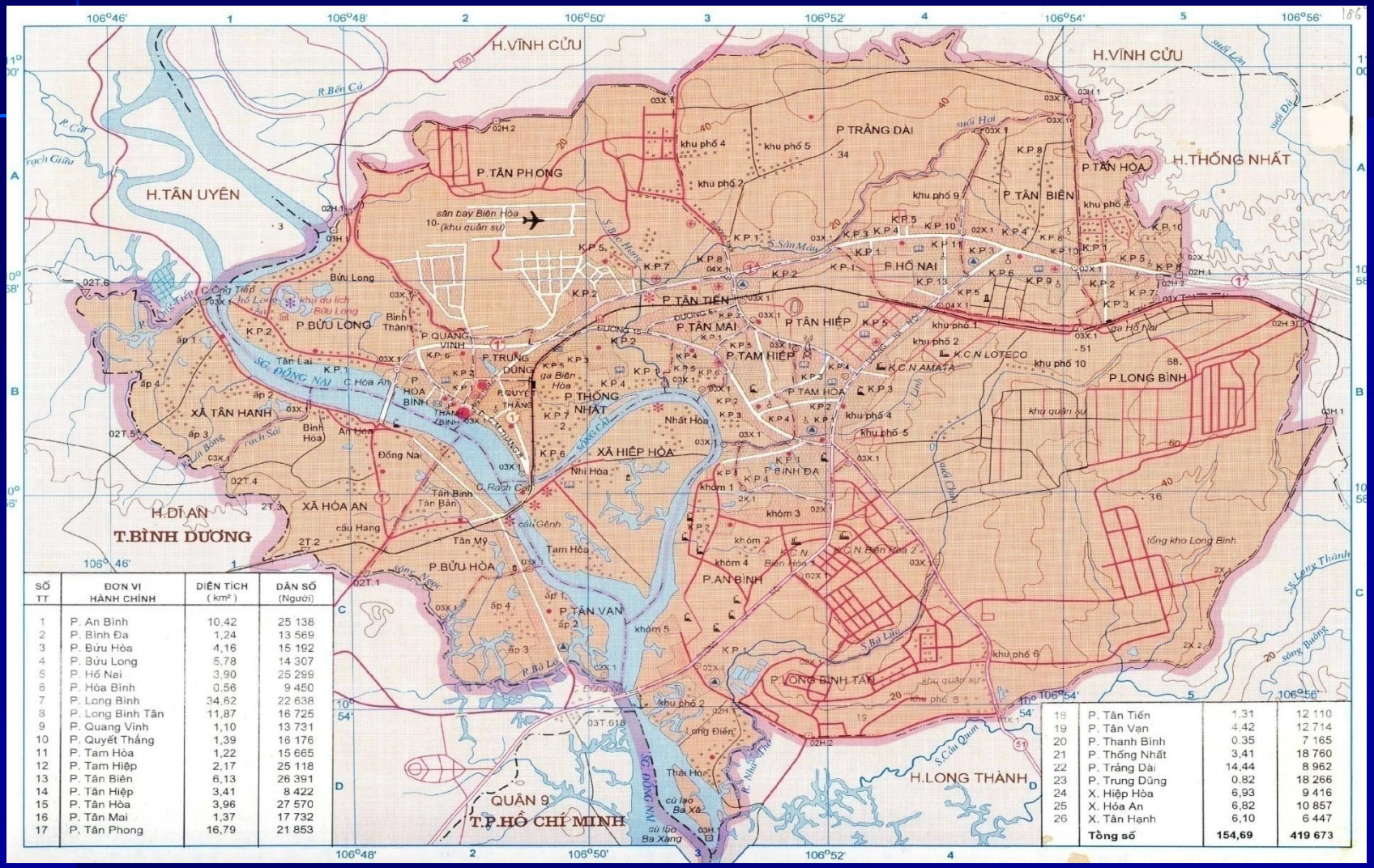
Sources	AO (lít)	Agent White (l)	Agent Blue (l)	Agent Purple, Pink, Green (l)	Total (l)	TCDD Qty (kg)
Westing (1976)	44,373,000	19,835,000	8,182,000	-	72,390,000	170
Stellman (2003)	49,268,937	20,556,525	4,741,381	2,387,963	**76,954,806**	**366**
Young (2009)	43,332,640	21,798,400	6,100,640	2,944,240	**74,175,920**	**130-144**

BIEN HOA AIRBASE

- Geographical location of Bien Hoa Airbase, Dong Nai Province

- Coordinate: 10°58‘30" North
  106°49‘10" East
- West: 700 m away from Dong Nai River

BIEN HOA AIRBASE



SỐ TT	ĐƠN VỊ HÀNH CHÍNH	DIỆN TÍCH (km²)	DÂN SỐ (Người)
1	P. An Bình	10,42	25 138
2	P. Bình Đa	1,24	13 569
3	P. Bửu Hòa	4,16	15 192
4	P. Bửu Long	5,78	14 307
5	P. Hố Nai	3,90	25 299
6	P. Hòa Bình	0,56	9 450
7	P. Long Bình	34,62	22 638
8	P. Long Bình Tân	11,87	16 725
9	P. Quang Vinh	1,10	13 731
10	P. Quyết Thắng	1,39	16 176
11	P. Tam Hòa	1,22	15 665
12	P. Tam Hiệp	2,17	25 118
13	P. Tân Biên	6,13	26 391
14	P. Tân Hiệp	3,41	8 422
15	P. Tân Hòa	3,96	27 570
16	P. Tân Mai	1,37	17 732
17	P. Tân Phong	16,79	21 853
18	P. Tân Tiến	1,31	12 110
19	P. Tân Vạn	4,42	12 714
20	P. Thanh Bình	0,35	7 165
21	P. Thống Nhất	3,41	18 760
22	P. Trảng Dài	14,44	8 962
23	P. Trung Dũng	0,82	18 266
24	X. Hiệp Hòa	6,93	9 416
25	X. Hóa An	6,82	10 857
26	X. Tân Hạnh	6,10	6 447
	Tổng số	154,69	419 673

BIEN HOA AIRBASE

- **During the Vietnam War:**
- **1. Main activities**

  - Head office of RANCH HAND Operation

  (From 1/12/1966 to 21/2/1970), was the main base for herbicide storage facilitating the toxic chemical spraying operation

  - One of the bases to serve PEACER IVY Operation (17/4/1970-31/3/1972)
- **2. Quantity of herbicides transferred, stored and used**

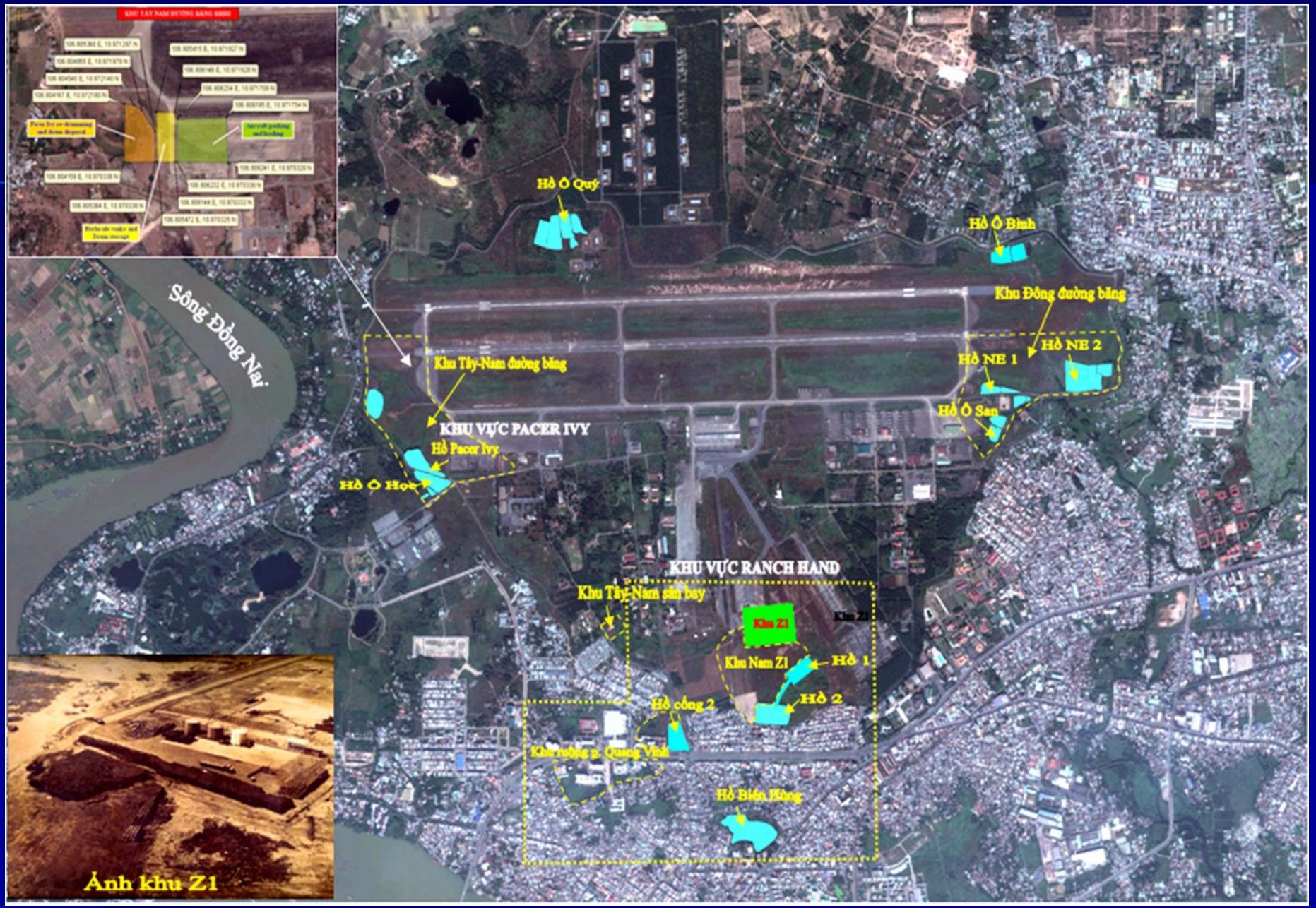
  - Agent Orange: 98,000 barrels
  - Agent White: 45,000 barrels
  - Agent Blue: 16,300 barrels


BÃI ĐỘC Z1

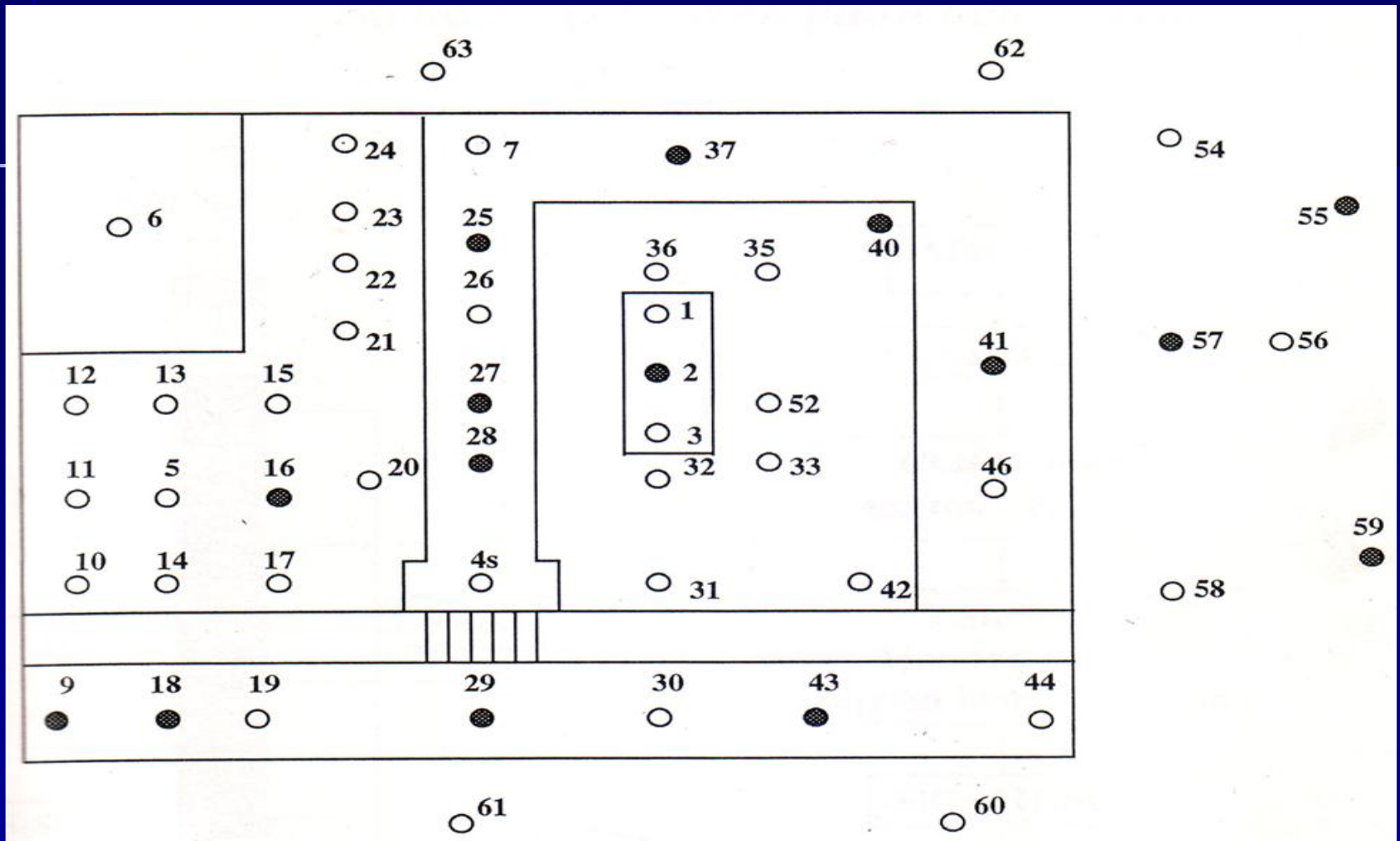
The herbicide spillage and overflow incident at Bien Hoa Airbase

- 12/ 1969 – 03/1970: There were 4 spillage incidents from the 28,000 litre capacity tanks
  - 2 spillage of Agent White: 2,500 litre
  - 2 spillage of Agent Orange: 25,000 litre

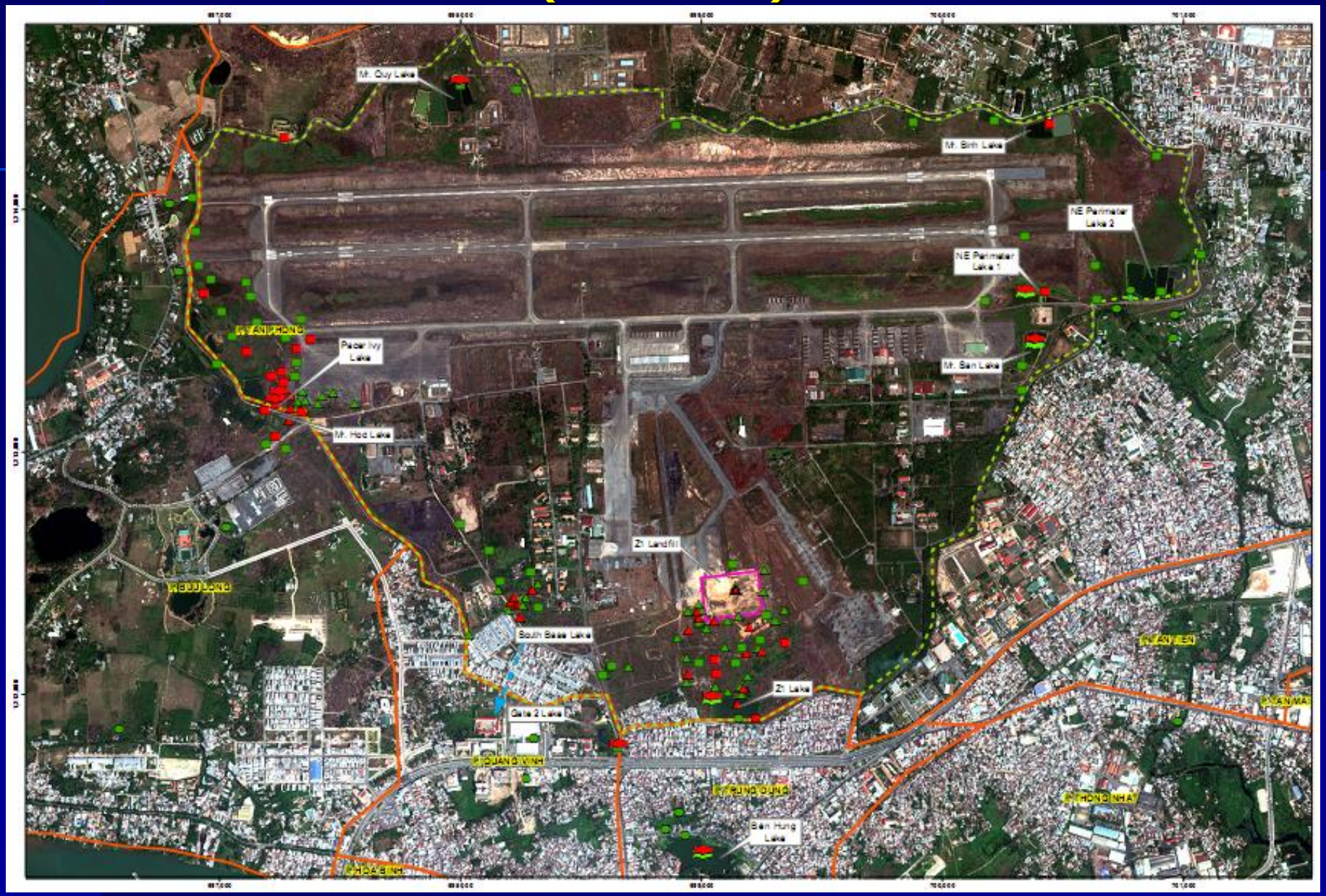
Overall layout of the study areas in Bien Hoa Airbase



The 1995-1996 sampling layout in Z1 area

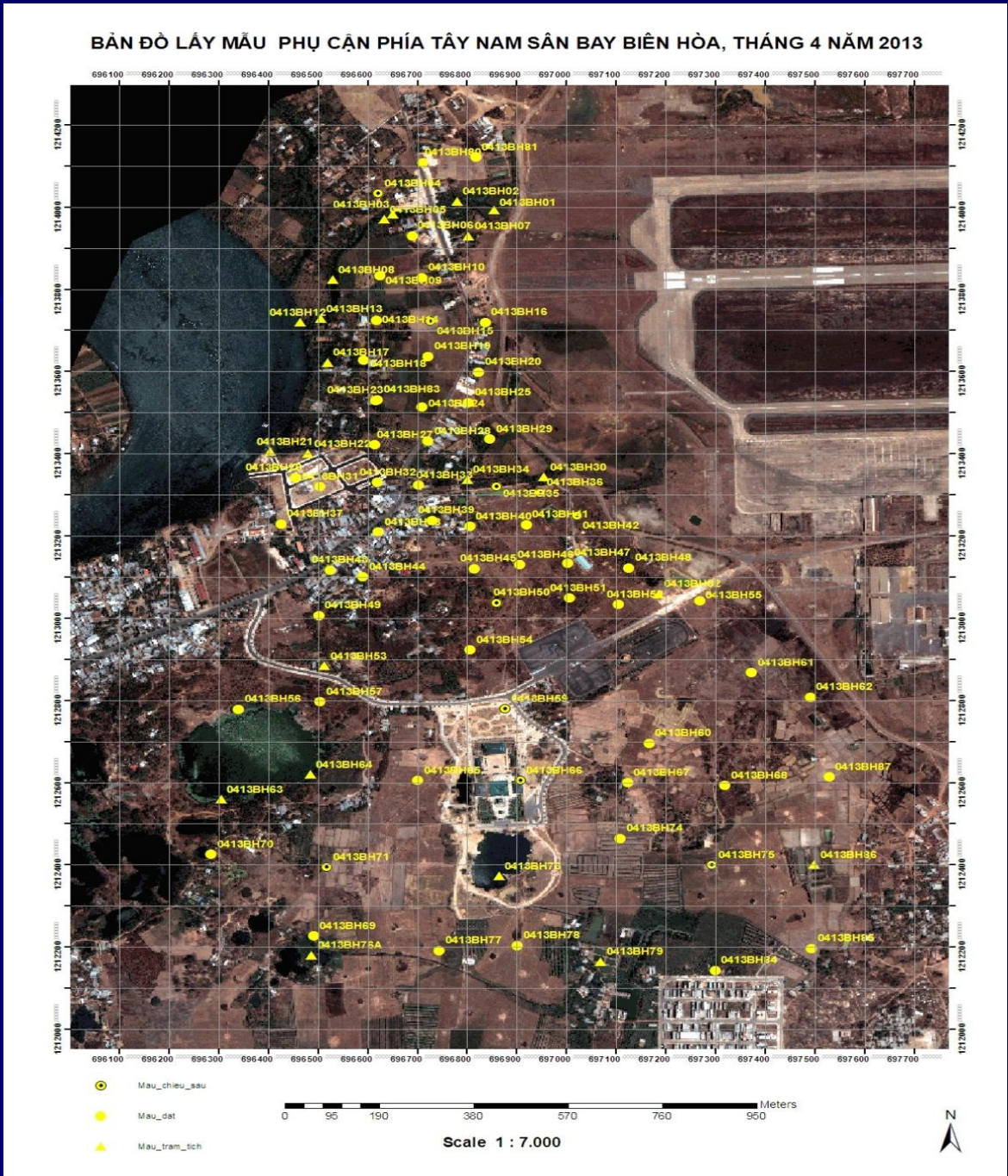


THE SAMPLING LOCATIONS BY HATFIELD/UB10-80/VRTC/OFFiCE33 (2004-2010)

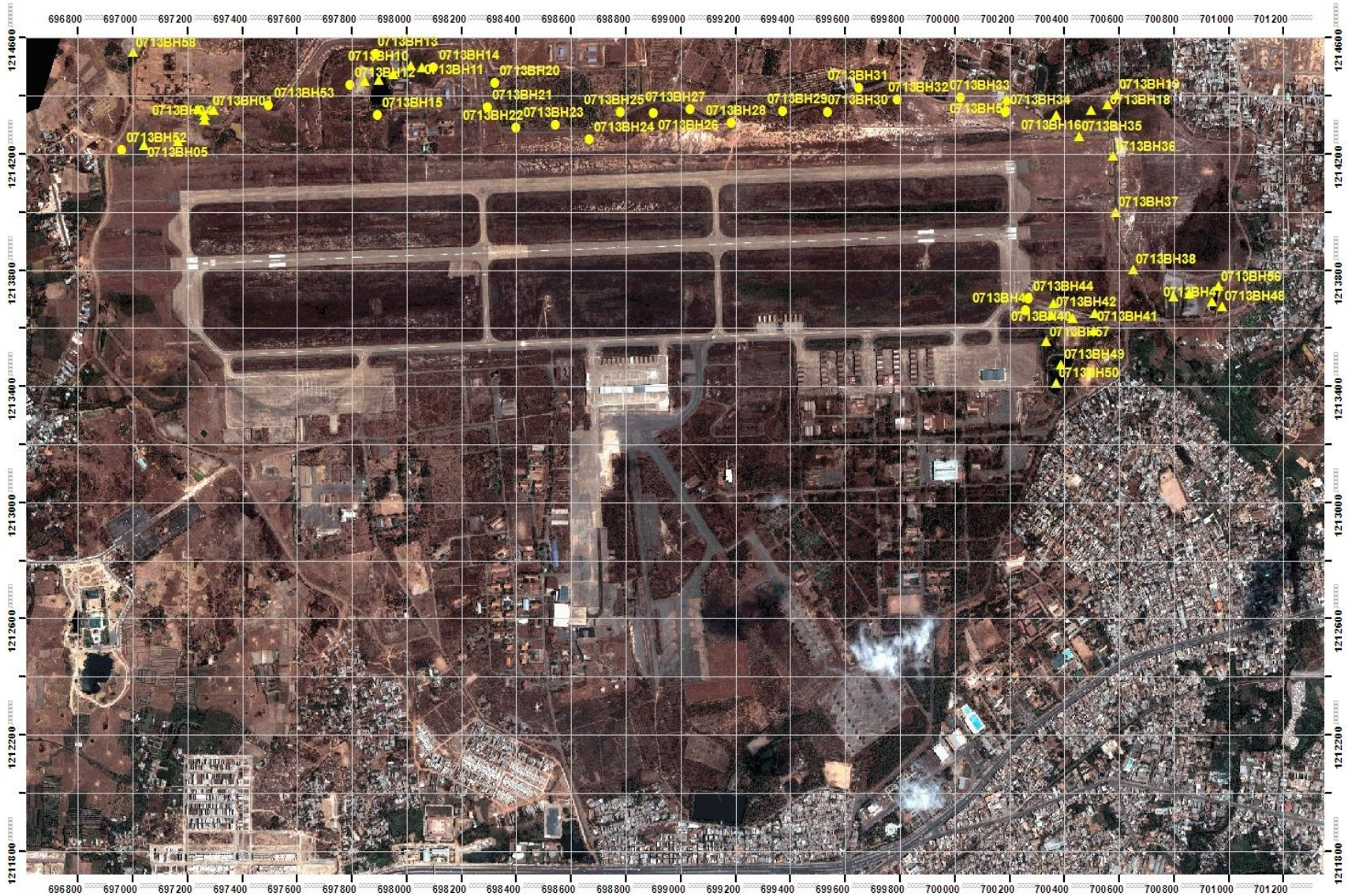


PACER IVY SAMPLING LOCATIONS (BY VEA, 2011)

The sampling map for the surrounding areas in the Southwestern part of Bien Hoa Airbase



SAMPLING MAP FOR BIEN HOA AIRBASE JUL 2013



Chú thích:

- Mau dat
- Mau tram tich

Scale 1:13.000

DIOXIN STANDARDS IN SOIL AND SEDIMENT

- Vietnamese standard TCVN 8183: 2009 providing dioxin threshold in soil and sediment in the heavily contaminated areas:
  - Soil: 1,000 ng/kg (ppt) TEQ
  - Sediment: 150 ng/kg (ppt) TEQ

- Vietnamese regulation QCVN 45:2012/BTNMT on the dioxin limit allowance in some soil types subject to usage purposes:

No.	Soil classification subject to land use purposes	The maximum concentration allowed
1	Crop land	40
2	Forest land or land for perennial trees	100
3	Rural residential land	120
4	Urban residential land	300
5	Land used for recreation purposes	600
6	Land used for commercial purposes	1,200
7	Land used for industrial purposes	1,200

CONTAMINATION ASSESSMENT FOR Z1 AREA AND QUANG VINH WARD'S PADDIES 1994-2001

Khu Z1
Average: 18,570 ppt I-TEQ (n=50)
Range: nd – 410,000 ppt

Section D: Paddies near Gate 2 Lake
Soil: 137 ppt (nd – 412 ppt), n=12
Sediment: 52 ppt (44-59 ppt), n=2

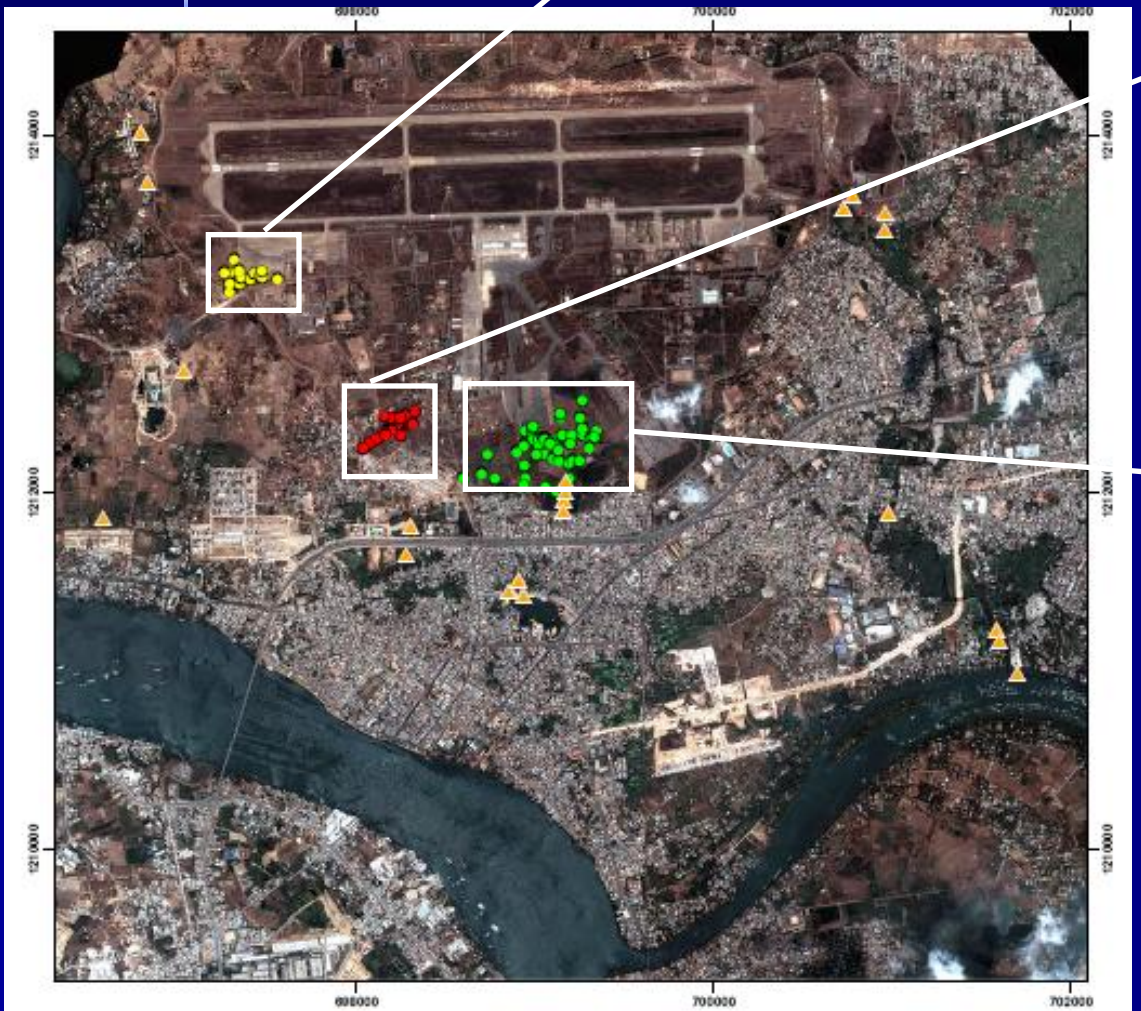
Gate 2 Lake
Average: 339 ppt I-TEQ (n=6)
Range: 236 – 508 ppt

Bien Hung Lake
Sediment: 107 ppt (59-210 ppt)
Soil: 83 ppt (5 – 256 ppt)

Section E: Paddies in Quang Vinh Ward
Soil: 59 ppt (26-108 ppt), n=7
Sediment: 88 ppt (17 – 149 ppt), n=7

Ofice 33, VRTC & Hatfield, 1/2008.
Dioxin in soil and sediment, ppt dry mass, total WHO-TEQ

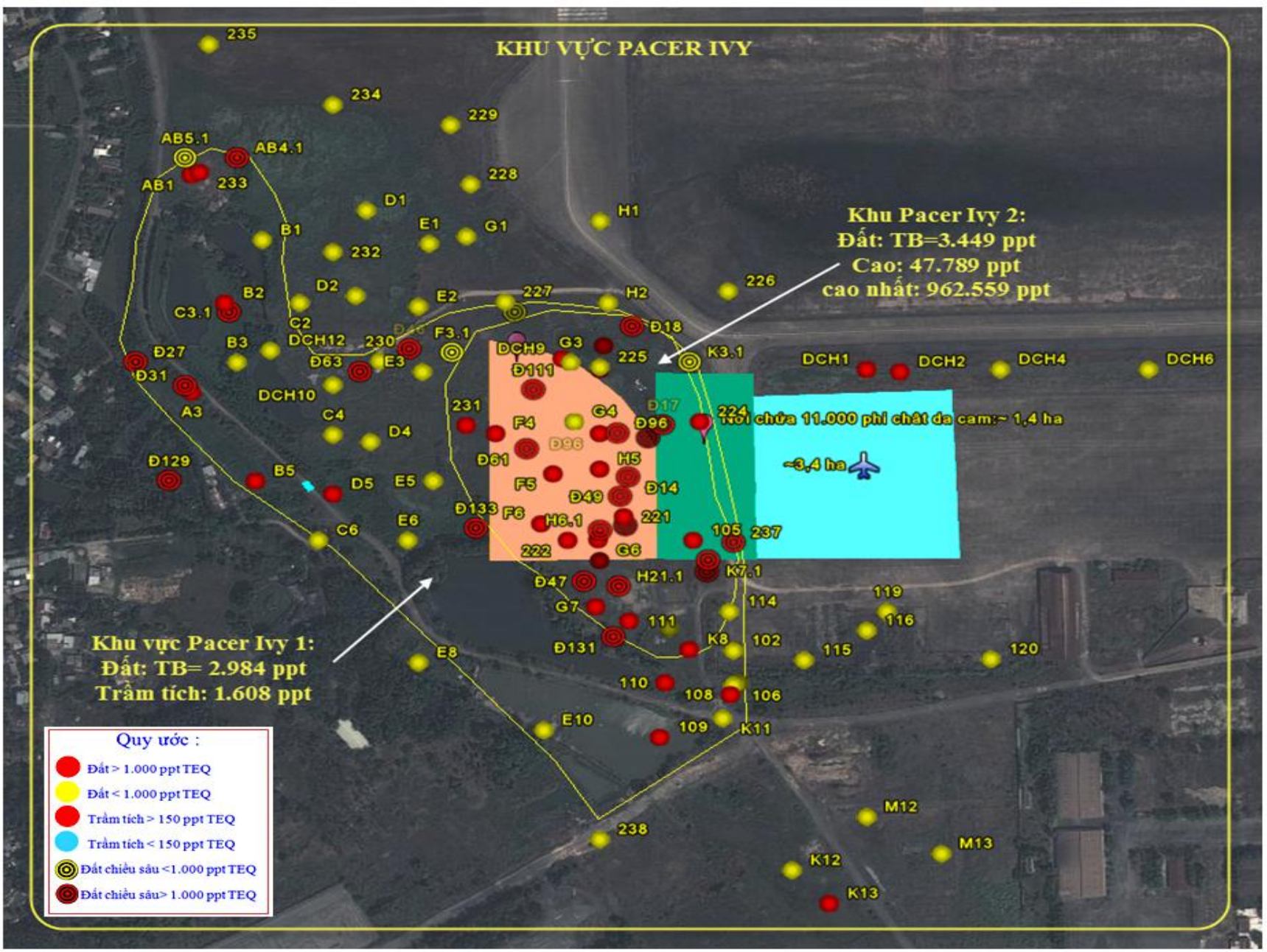
Pacer Ivy Area
Average in soil: 2582 ppt, n=11, Approx: 80-22,800 ppt
Average sediment: 2835 ppt, n=4, Approx 1,090-5,970 ppt



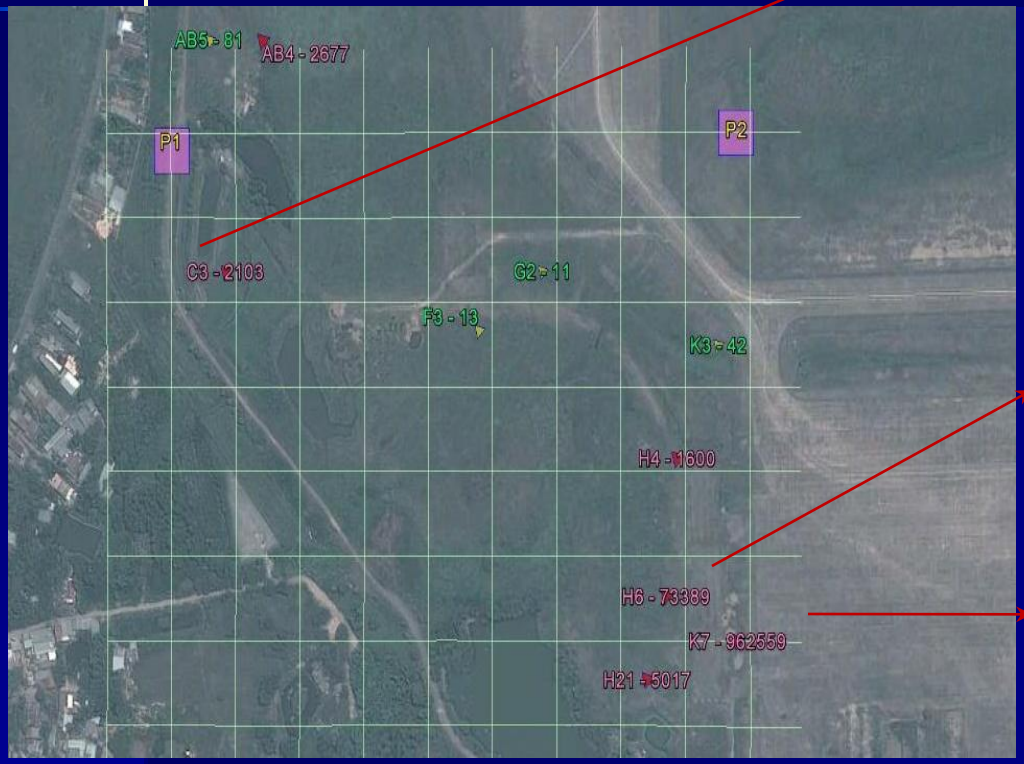
The Southwestern part:
Surface average: 5680 ppt (n=13)
Approx: 12.8 – 65,500 ppt

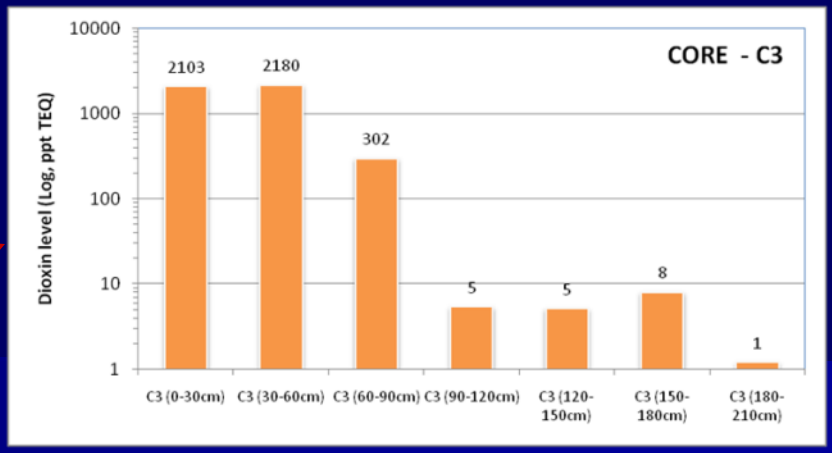
Z1 Area: 115,390 ppt
Approx: (109-262,000 ppt)
Around Z1: 936 ppt
Approx(6.15-13300 ppt)

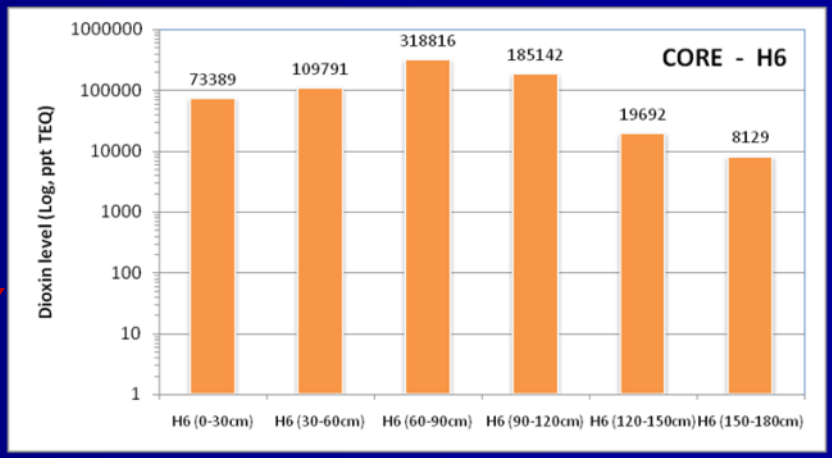
CONTAMINATION ASESSMENT FOR PACER IVY AREA (2008-2011)

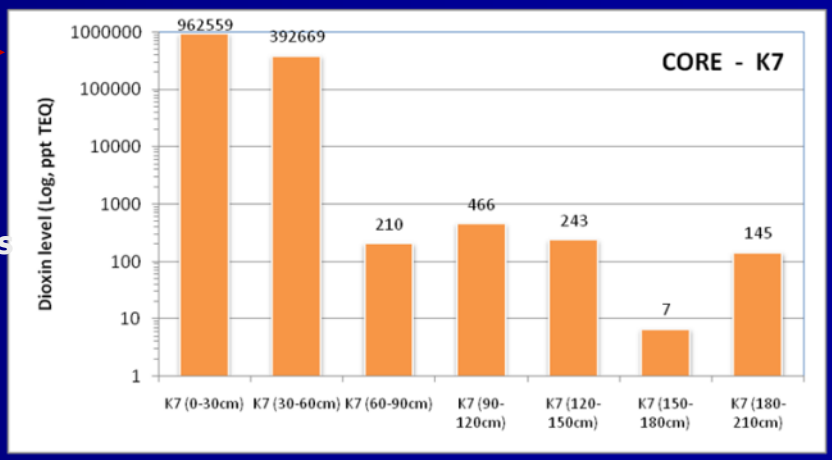


Indepth contamination of soil (Southwestern area – BHA)



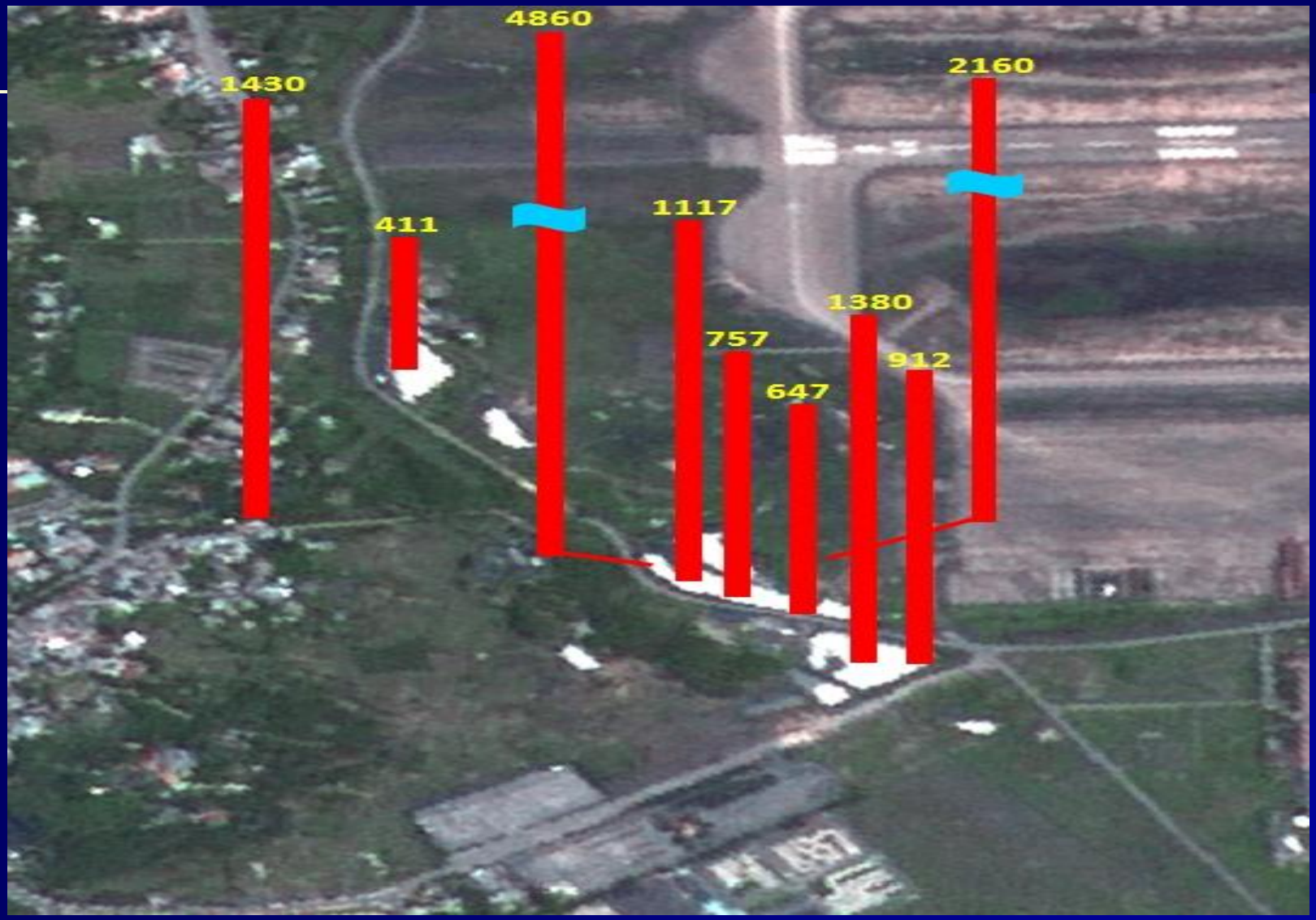


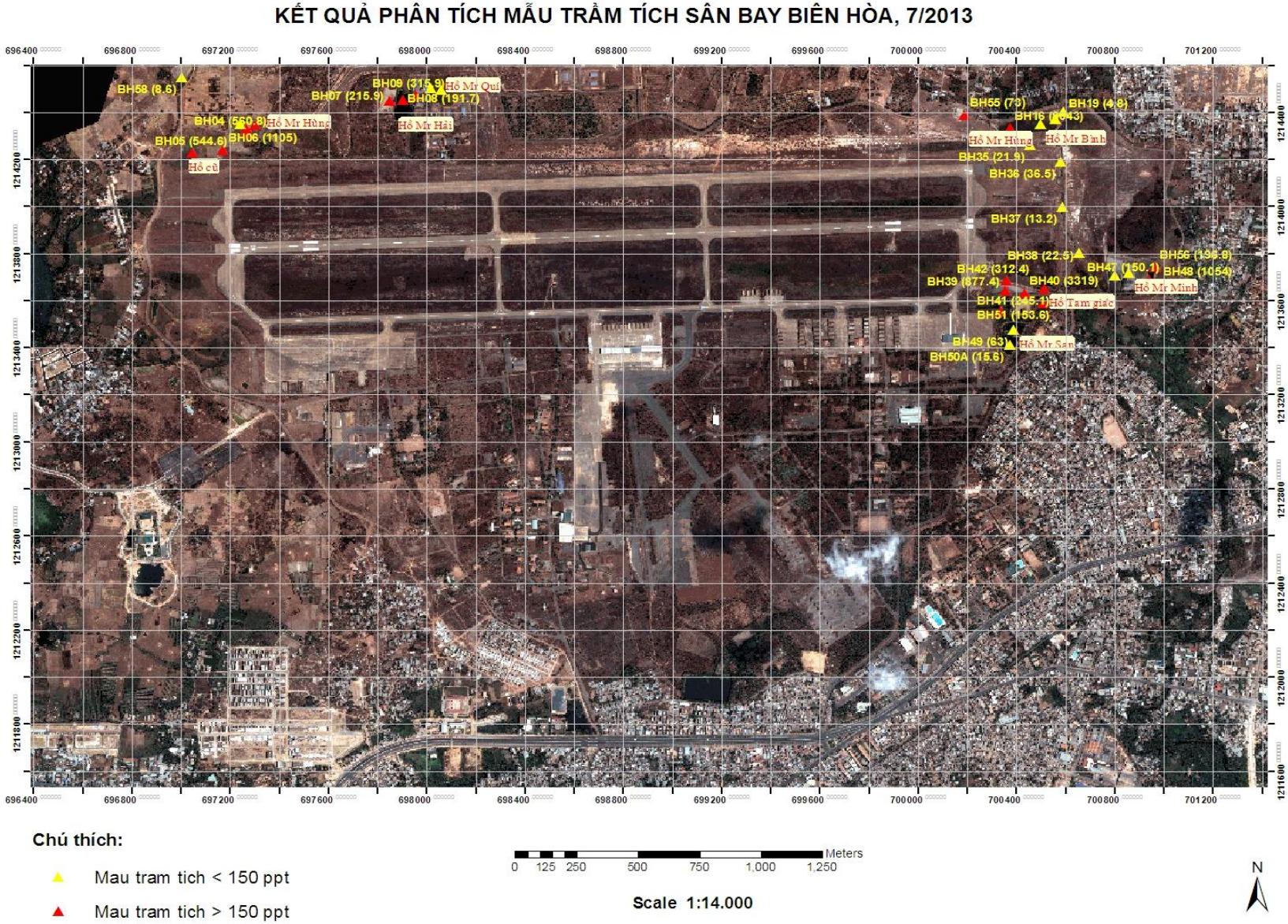




Contamination deep: 60 – 180 cm or even more in certain points

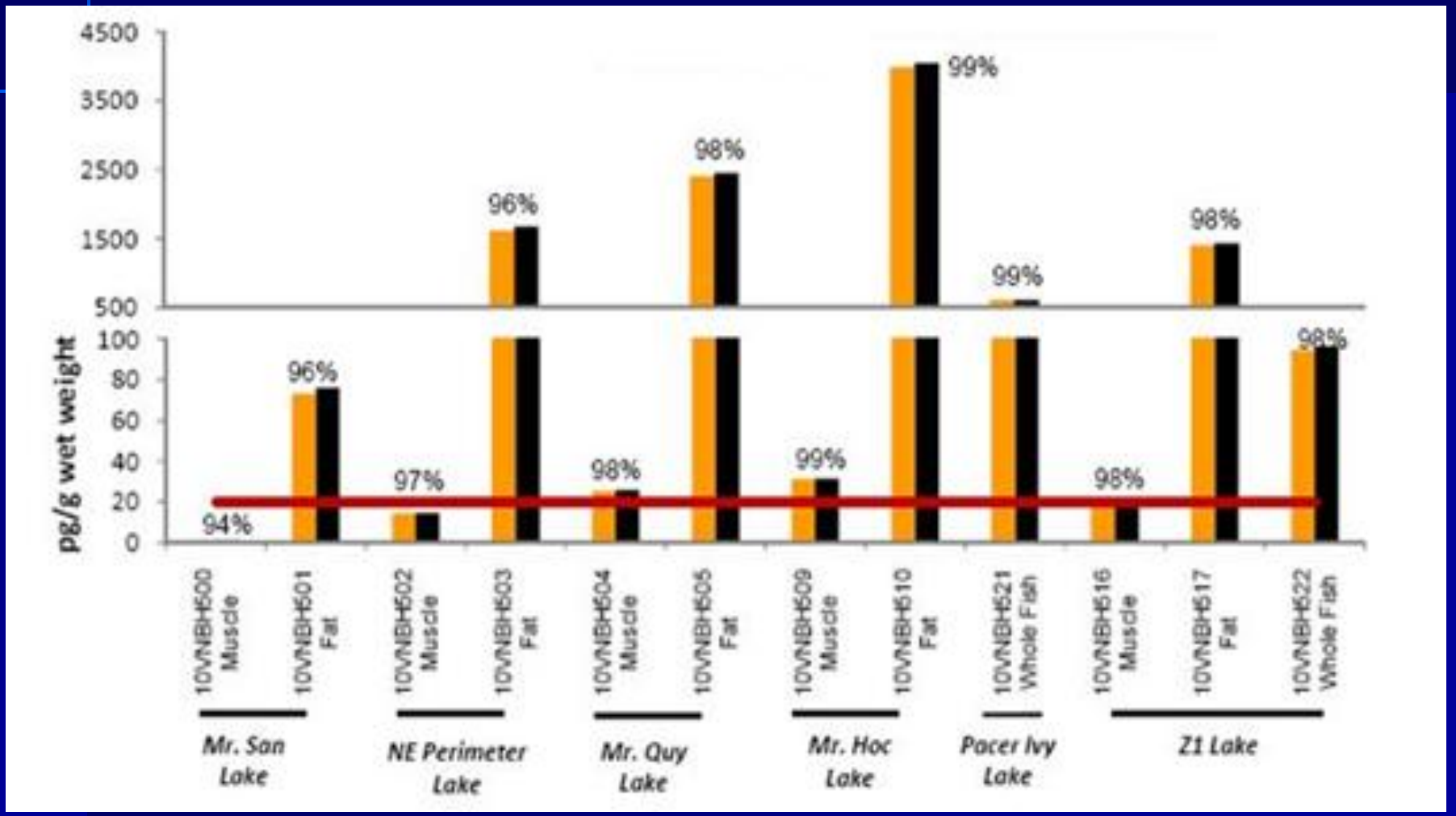
CONTAMINATION ASESSMENT FOR PACER IVY AREA (2008-2011)



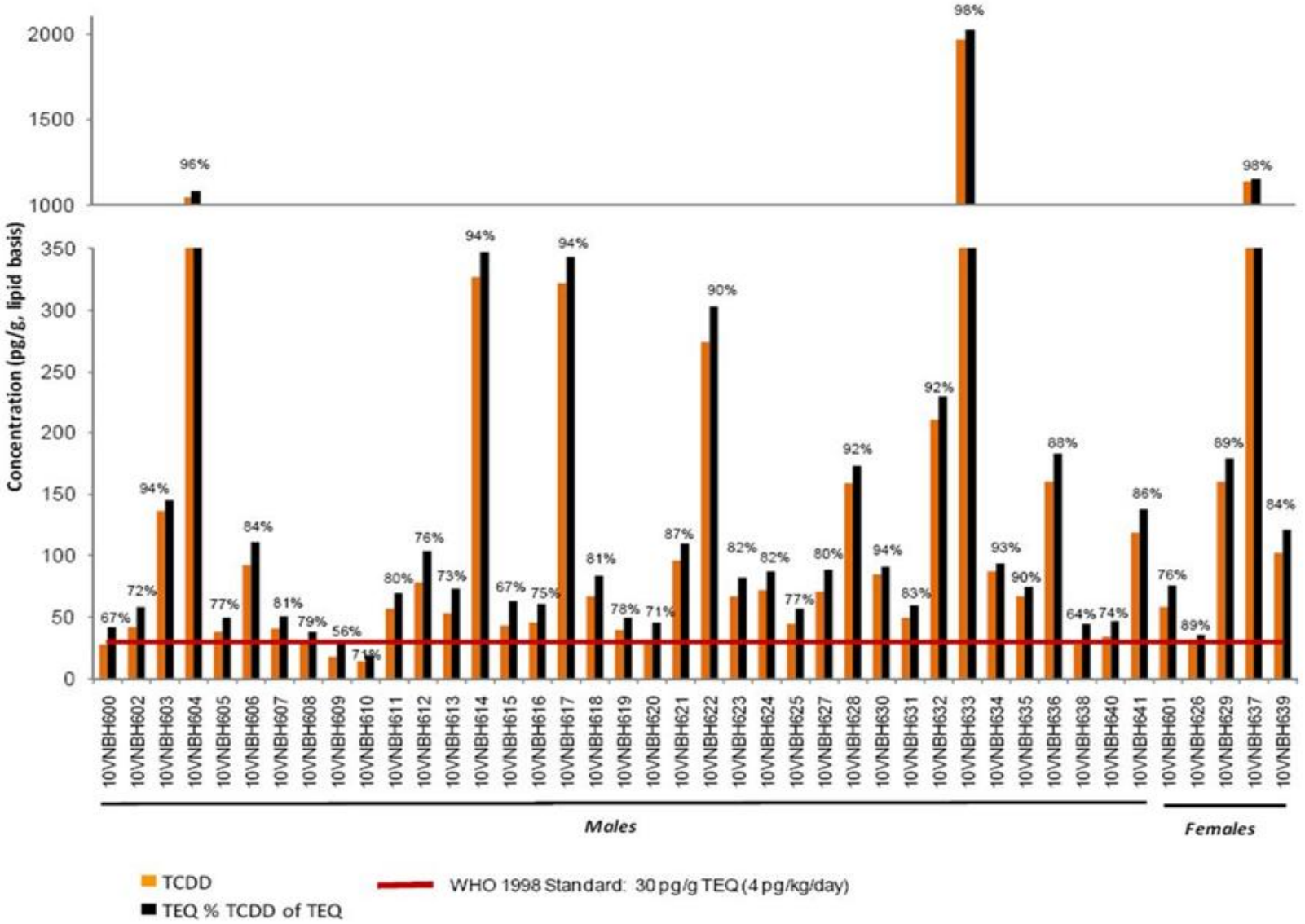


The analysis result of 35 sediment samples from 28 lakes shows that: 20/35 samples exceeding national threshold, ranging from 4.7- 8,043 ppt

Dioxin in meat and fish tissues



Dioxin in human's blood



Comments:

- AO/dioxin contaminated areas in Bien Hoa Airbase include:

  + Z1 area: 94,000 m3 of contaminated soil has been contained 2009

  Southern part of Z1 covering a contaminated area of ~ 5 - 6 ha

  + Pace Ivy Area (Western airbase) ~ 6 -7 ha

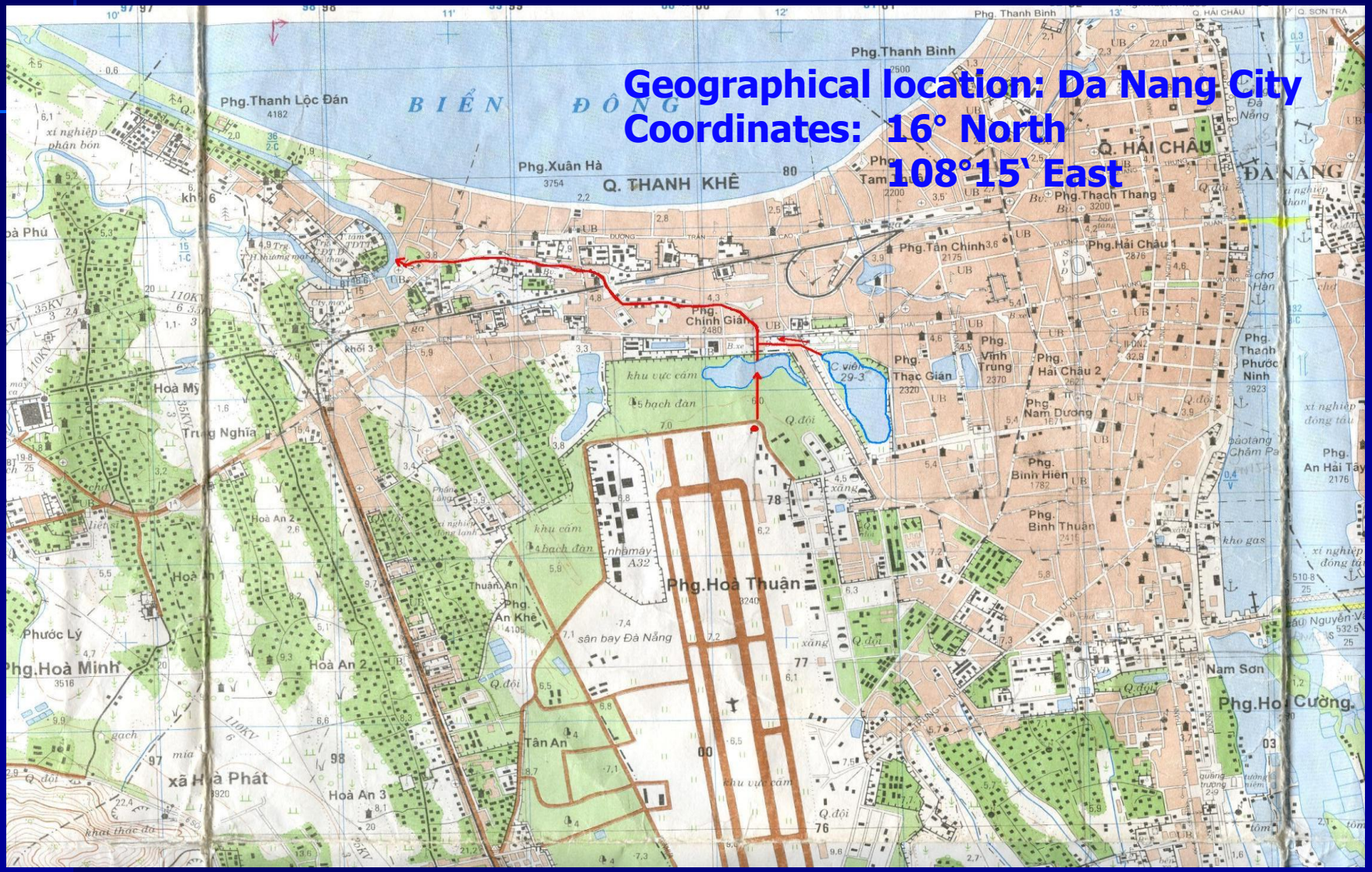
  + Lakes and ponds in the airbase ~ **10 - 15** ha
- Contamination situation is complicated
- Dioxin continues contaminating aquatic organisms and the food chain;
- Raised and harvested fish from the airbase is heavily contaminated with dioxin;
- Those who eat fish and other animals from the airbase are discovered having high dioxin concentration in their bodies

Da Nang Airport

Projects and research programs on the contamination status in Da Nang Airport

- Z2 Project, by MND (1997-98)
- The 33 program (2002-04)
- Cooperation programs between Office 33, VRTC, Hatfield Consultant & CDM in 2005, 2006, 2009 & 2010

DA NANG AIRPORT



DA NANG AIRPORT

- **During the Vietnam War:**
- **1. Main activities**

  - Used to serve RANCH HAND Operation

  (from 5/1964 to 7/1/1971), used as a base for spraying activities from Latitude 17 southward to Quy Nhon and Kontum.

  - Used for PEACER IVY (17/4/1970-31/3/1972) Operation
- **2. Quantity of herbicides transferred, stored and used**

  - Agent Orange: 52,700 barrels
  - Agent White: 29,000 barrels
  - Agent Blue: 5,000 barrels

Main contamination areas in Da Nang Airport

SURFACE SOIL LAYER AT SUB-SECTION A

DIOXIN CONTAMINATION IF SOIL AT DA NANG AIRPORT DATA IN 1997 – 1998 (SOURCES Z2 PROJECT)

TEQ TRONG MẪU ĐẤT

LỚP BỀ MẶT

Đất (n=78)

TEQtb = 26.603ppt

51ppt < TEQ < 200.400 ppt

Bùn (n=3)

TEQtb = 29.435ppt

64ppt < TEQ < 54.200 ppt

● : mẫu đất

▲ : mẫu bùn

TEQ CONCENTRATION IN SOIL SAMPLES COLLECTED AT DA NANG AIRPORT IN 1997-1998

TEQ TRONG ĐẤT
THEO CHIỀU SÂU
BÃI ĐỘC SÂN BAY

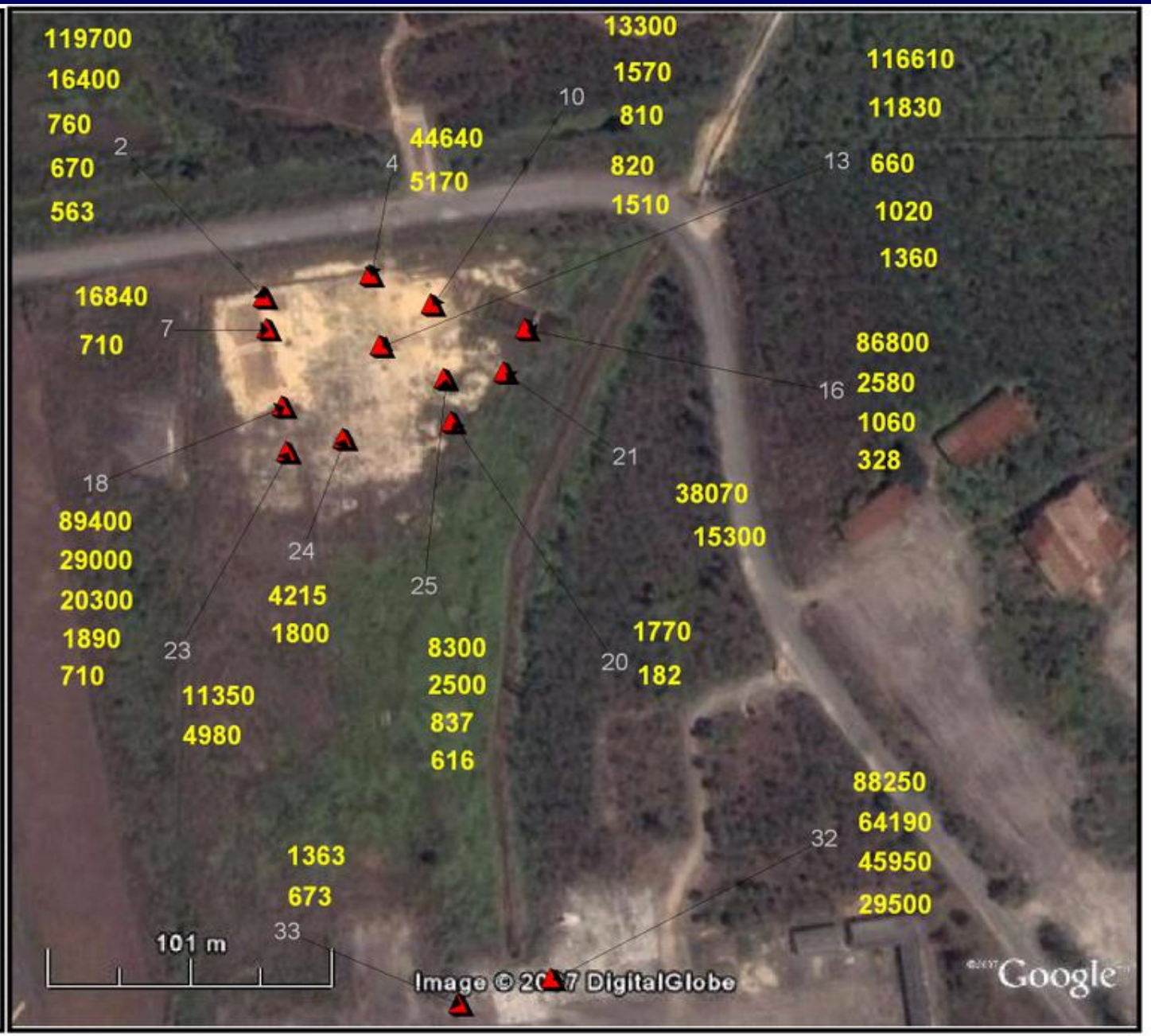
Lớp 0-30cm (n= 14)
TEQtb= 45.330ppt
1.363ppt < TEQ < 119.700ppt

Lớp 30-60cm (n= 13)
TEQtb= 12.460ppt
182ppt < TEQ < 64.190ppt

Lớp 60-90cm (n= 8)
TEQtb= 8.970ppt
660ppt < TEQ < 45.950ppt

Lớp 90-120cm (n= 7)
TEQtb= 4.2780ppt
563ppt < TEQ < 24.400ppt

Lớp 120-150cm (n= 5)
TEQtb= 952ppt
563ppt < TEQ < 1.510ppt



TEQ CONCENTRATION IN SOIL AND SEDIMENT IN DA NANG AIRPORT IN 2002-2004

TEQ TRONG ĐẤT, BÙN

SÂN BAY ĐÀ NẴNG

Đất (n=25)

TEQtb= 3.516ppt

2ppt < TEQ < 41.900ppt

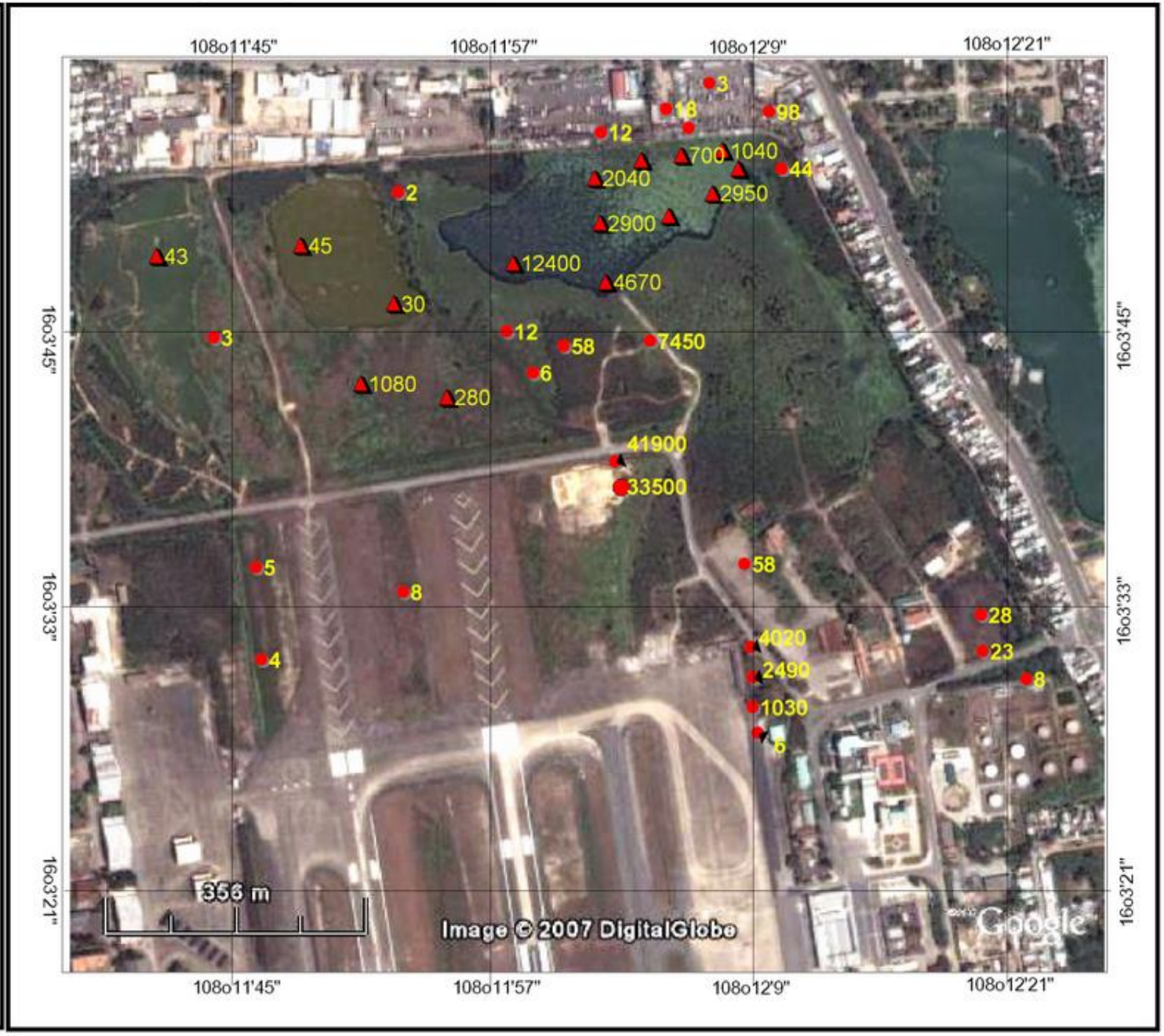
Bùn (n=15)

TEQtb= 2.520ppt

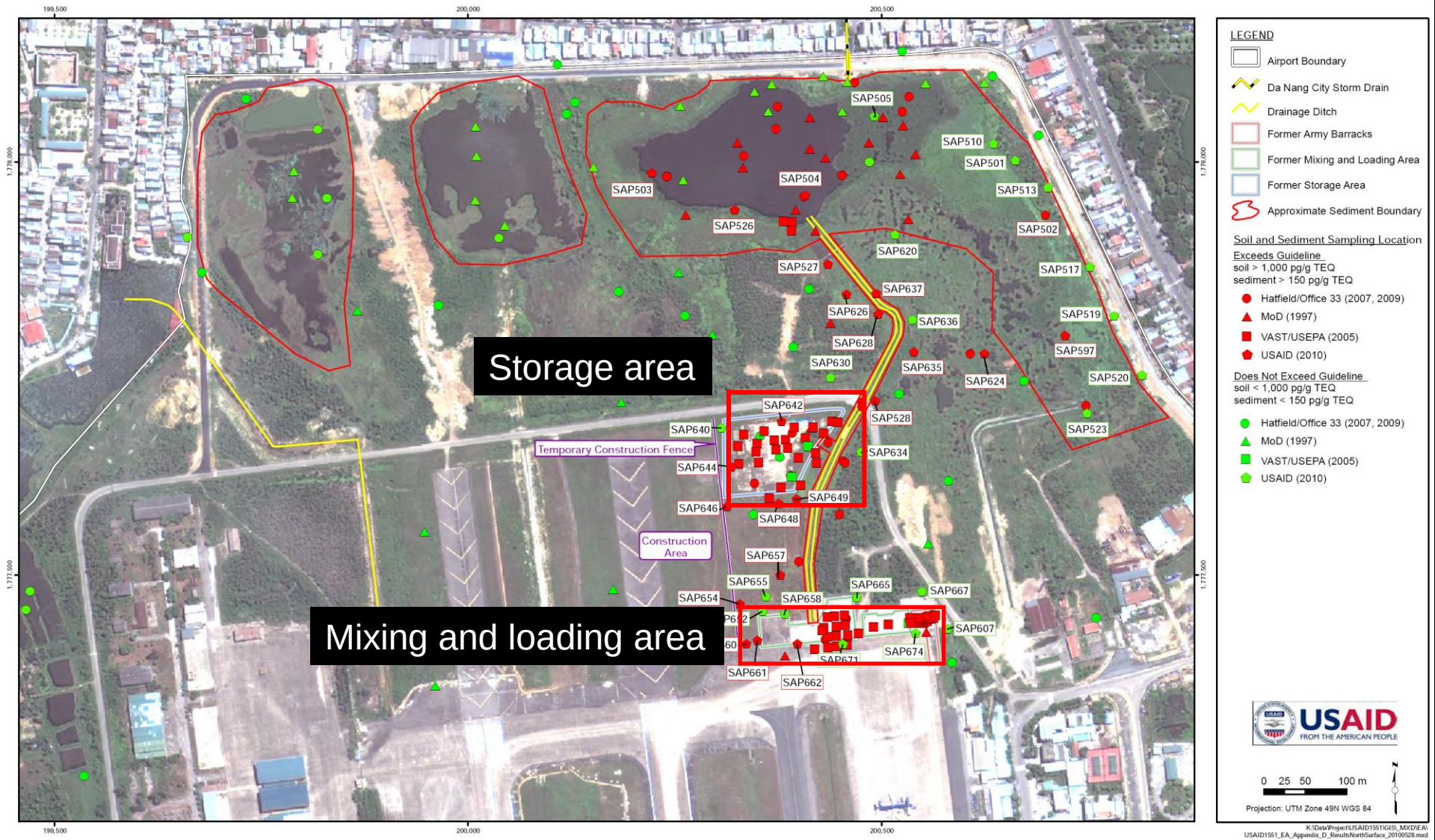
30ppt < TEQ < 12.400ppt

● : mẫu đất

▲ : mẫu bùn



Compilation of results on dioxin contamination at Da Nang Airport



Da Nang Airport

Project	Area	Type, No. of samples	Dioxin concentration, total TEQ Average (Range of concentration)
Z2 1997-98, MND	Within Da Nang Airbase	Soil, n = 78 Sediment, n = 3	26,603 ppt I-TEQs (51-200,400ppt) 29,435 ppt (64 – 54,200 ppt)
The 33 Program 2002-04	Sen (Lotus) Lake	Sediment, n = 11	(280 – 12,390 ppt)
	B Lake	Sediment, n = 2	(39.4 – 70.5 ppt)
	C Lake	Sediment, n = 3	(16 – 20.1 ppt)
	Thạc Gián Lake	Soil, n=6 Sediment, n = 9	7.8 ppt (2-17 ppt) 62 ppt (2-111 ppt)
	Xuân Hà Lake	Soil, n=7 Sediment, n = 9	5.9 ppt (1 – 13 ppt) 44.1 ppt (1 – 79 ppt)
	Hàn River	Sediment, n = 3	5.3 ppt (1 – 9 ppt)
	Cẩm Lệ River	Sediment, n = 4	1 ppt
	Phú Lộc River	Soil, n = 2 Sediment, n = 2	2 ppt 2 ppt
	Sen (Lotus) Lake	Thực vật, n = 12	97.5 ppt (1.7 – 498 ppt)

Da Nang Airport

Project	Area	Type, No. of samples	Dioxin concentration, total TEQ Average (Range of concentration)
The 33 Program	Drainage canal to Sen (Lotus) Lake	Flora, n = 2	519 ppt (519 – 2,803 ppt)
	A Lake	Aquatic organism, n = 14	44.9 ppt (1.3 – 158 ppt) wet weight
	B Lake	Aquatic organism, n = 5	2 ppt (0.43 – 2.9 ppt) wet weight
	C Lake	Aquatic organism, n = 4	100.6 ppt (28.7 – 155 ppt) wet weight
	Outside the Airport	Aquatic organism, n = 5	0.15 ppt (0.05 – 0.49 ppt) wet weight
	Inside the Airport	Terrestrial animals, n = 5	1.57 ppt (0.06 – 5.7 ppt), wet weight
Office 33, VRTC & Hatfield 2005, 06	Outside the Airport	Soil , n = 21	42.7 ppt (0.42 – 269 ppt)
Office 33 & Hatfield 2007	The mixing & loading area	Soil, n = 9	105,080 ppt (899 – 365,000 ppt)
	Storage area	Soil, n = 9	26,980 ppt (24.5 – 106,000 ppt)
	Buffer area	Soil, n = 3	3,610 ppt (170 – 6,520 ppt)
	Surrounding area	Soil, n = 19	496 ppt (0.643 – 5,690 ppt)

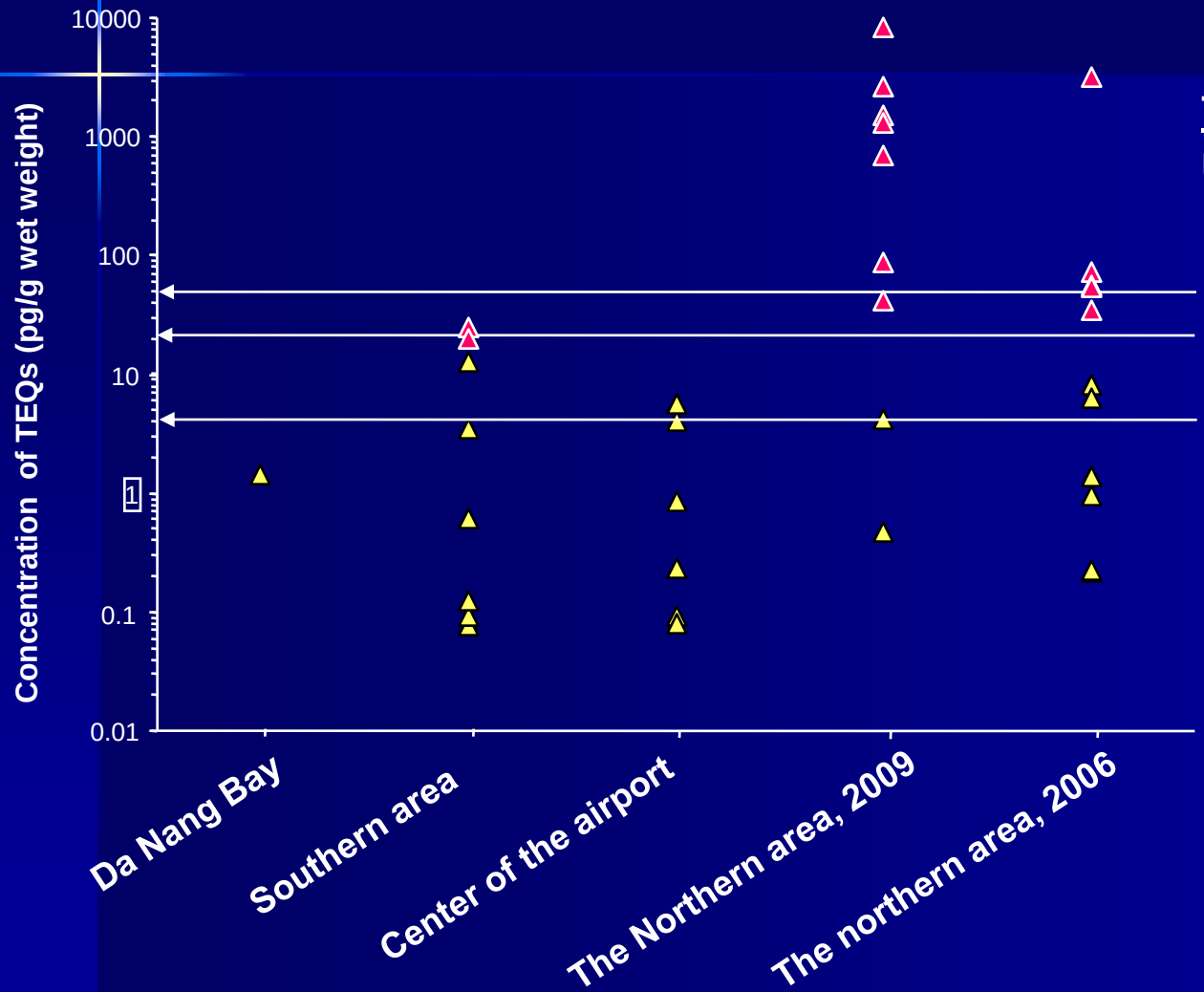
Da Nang Airport

Project	Area	Type, No. of samples	Dioxin concentration, total TEQ Average (Range of concentration)
Office 33, VRTC & Hatfield 2005, 2006	Drainage canal	Sediment, n = 2	18,100 ppt (8,580 – 27,700 ppt)
	Sen (Lotus) lake	Sediment, n = 12	1,904 ppt (68.6 – 6,820 ppt)
	Sen (Lotus) lake	Sediment subject to the depth, n = 7	703 ppt (18.9 – 4,050 ppt)
	B Lake	Sediment, n = 2	54.9 ppt (39.4 – 70.5 ppt)
	C Lake	Sediment, n = 3	14.7 ppt (7.99 – 20.1 ppt)
	Western Lake	Sediment, n = 1	7.14 ppt
	Da Nang City	Soil & Sediment, n = 10	12.9 ppt (3.14 – 36.1 ppt)
	Sen (Lotus) lake	Fish, n = 2, wet weight	1570 ppt (34.5 – 3120 ppt)
	B Lake	Fish, n = 2, wet weight	36.8 ppt (0.967 – 72.6 ppt)
	C Lake	Fish, n = 2, wet weight	4.22 ppt (0.22 – 8.22 ppt)
	Western Lake	Fish, n = 4, wet weight	27.9 ppt (1.38 – 56.1 ppt)
	Xuân Hà Lake	Fish, n = 2, wet weight	3.29 ppt (0.223 – 6.37 ppt)
	Sen (Lotus) lake	Fish, n = 1, wet weight	7.25 ppt

Da Nang Airport – Office 33, VRTC & Hatfield 2009

Area		Type, No. of samples	Dioxin concentration, total TEQ Average (Range of concentration)
	Packing area of Pacer Ivy	Soil, n = 11	30.75 ppt (1.21 – 99.7 ppt)
	Storage area of Pacer Ivy	Soil, n = 15	1,495 ppt (1.72 – 20,600 ppt)
Southern border		Soil, n = 15 Sediment, n = 6	30.04 ppt (1.14 – 161 ppt) 12.24 ppt (0.54 – 30.8 ppt)
Center of the Airport	Western part	Soil, n = 19	21.91 ppt (1.67 – 115 ppt)
	Western lake	Sediment, n = 2	10.45 ppt (9 – 11.9 ppt)
	Eastern lake	Sediment & Soil, n = 7	20.32 ppt (7.6 – 38.5 ppt)
	Eastern lake	Sediment, n = 2	74.14 ppt (2.28 – 146 ppt)
	Center of the airport	Sediment, n = 1	191 ppt

Dioxin in fish collected from Da Nang Airport Office 33, VRTC & Hatfield, 2006 & 2009



The allowable threshold:

US FDA, Health Canada, EU

50 pg/g TEQs wet weight

20 pg/g TEQs wet weight

4 pg/g TEQs wet weight

3. PHU CAT AIRBASE

Projects and research programs on the contamination status in Phu Cat Airbase

- Z3 Project, MND (1999-2002)
- Hatfield and 10-80 Committee (2004-05)
- Cooperation program between Office 33, VRTC, and Hatfield, 2008

PHU CAT AIRBASE

Geographic location of Phu Cat Airbase, Binh Dinh Province

Coordinates: 13°57'48" North

109°03'57" East

To the East: border to National Highway No. 1, and around 30 km to Qui Nhon City in the Northwestern direction

PHU CAT AIRBASE

During the Vietnam war:

1. Main activities

Was a storage, loading and washing of aircraft after spraying herbicides under RANCH HAND Operation *(from 6/1968 to 5/1970)*

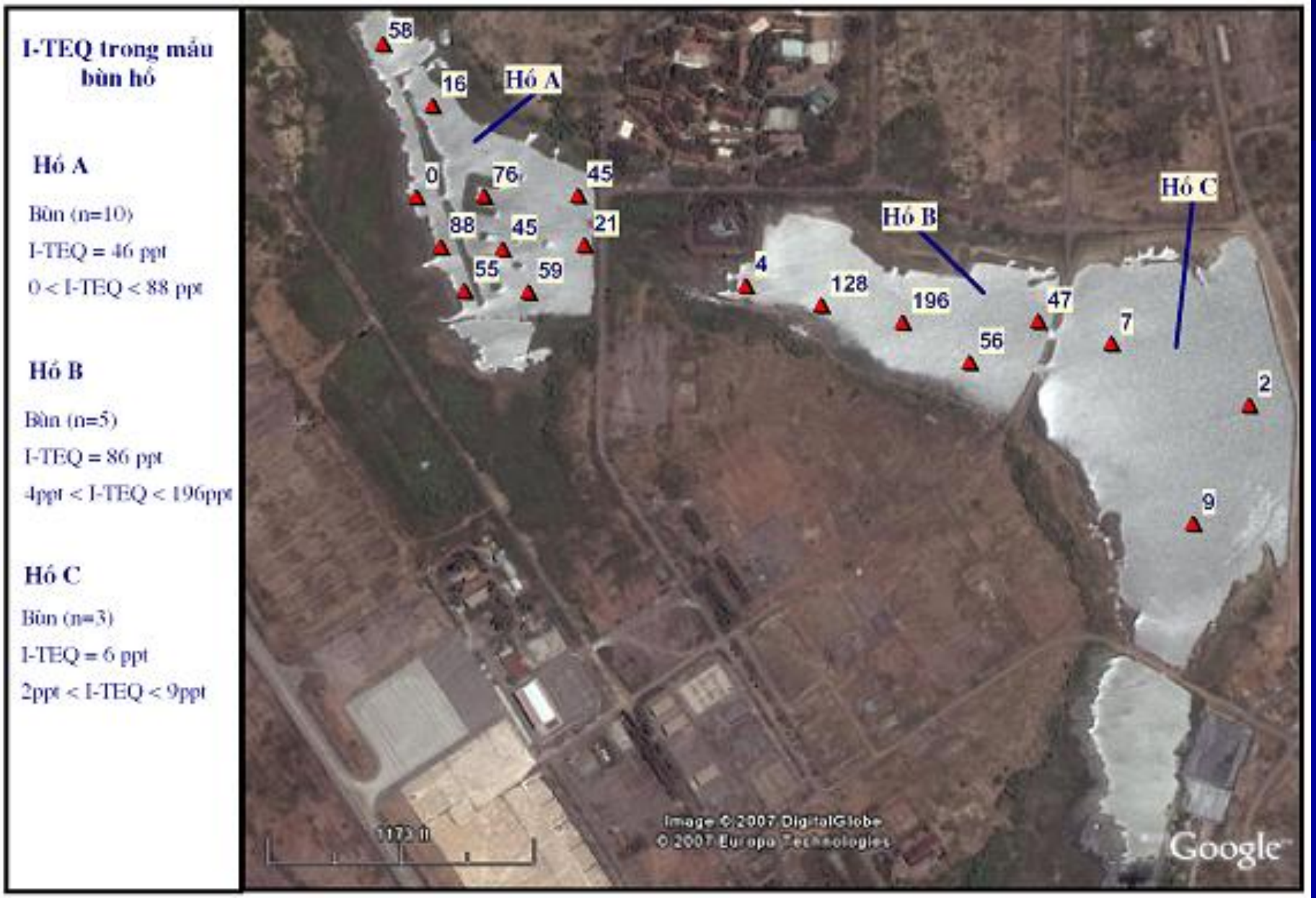
2. The herbicides quantity in the Airbase

- Agent Orange: 17,000 barrels
- Agent White: 9,000 barrels
- Agent Blue: 2,900 barrels

Sân bay Phù Cát (PCA)

Dioxin concentration in soil and sediment samples in different sub-areas in Phu Cat Airbase

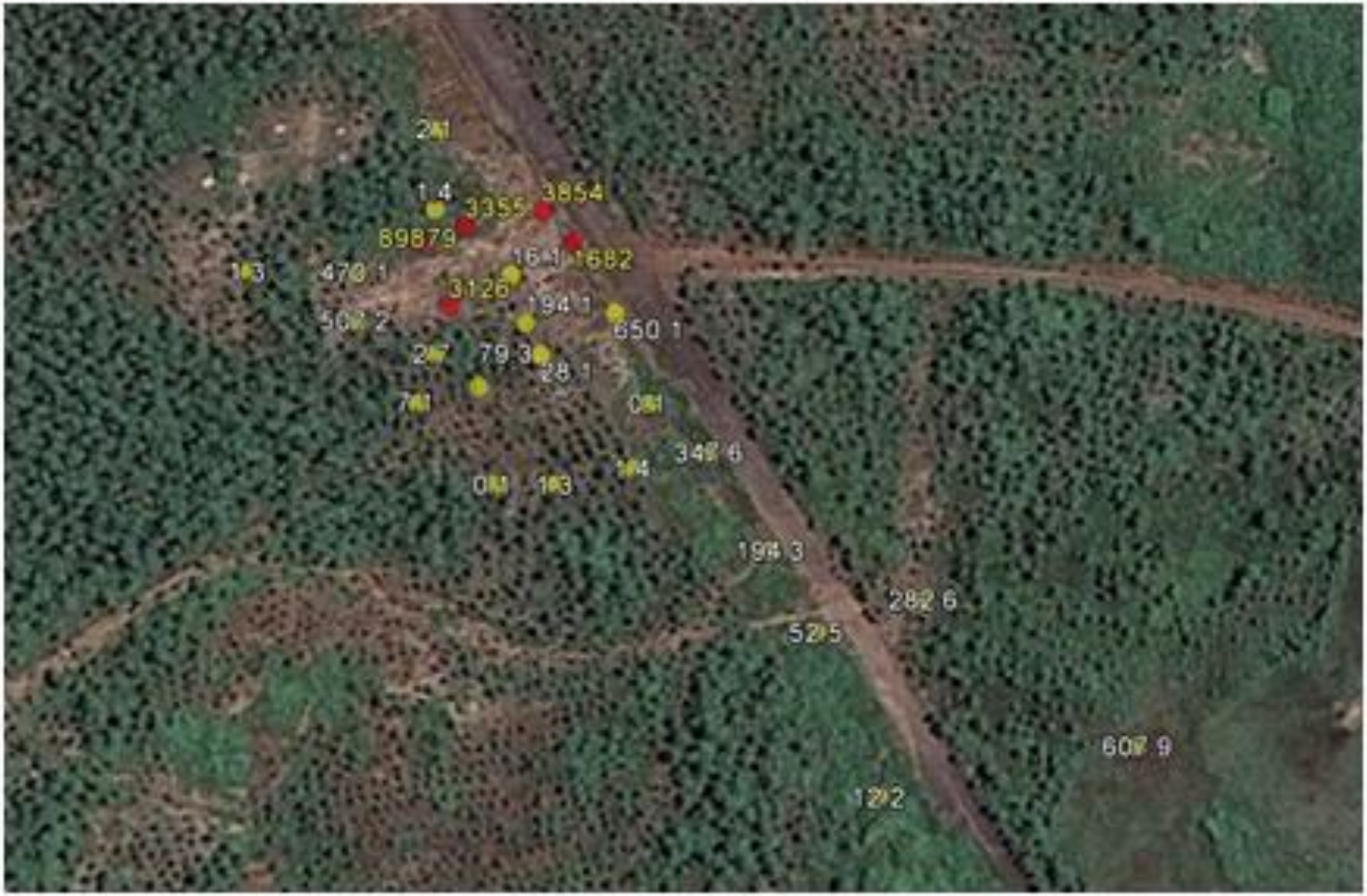
Dioxin concentration in sediment samples in the lakes in Phu Cat Airbase



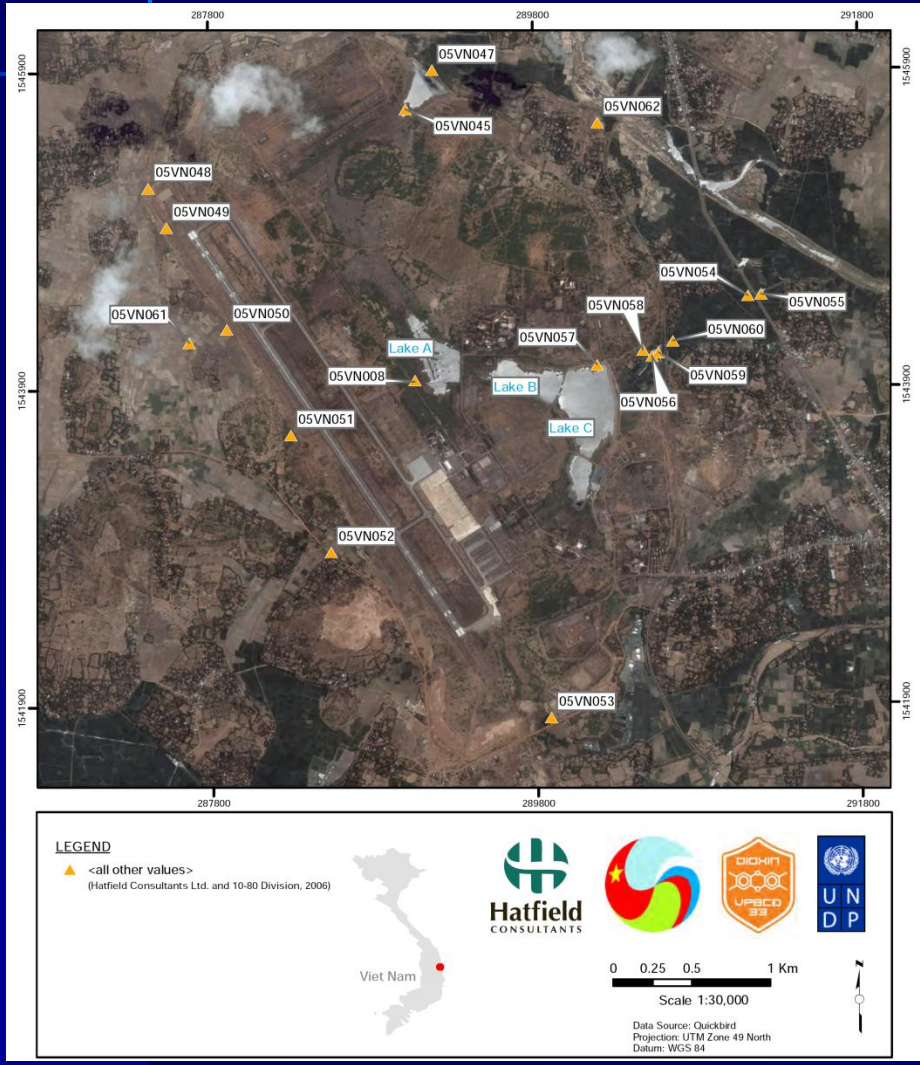
Dioxin concentration in soil and sediment samples in Phu Cat Airbase – Office 33, Hatfield Consultant & the 10-80 Committee, 2008

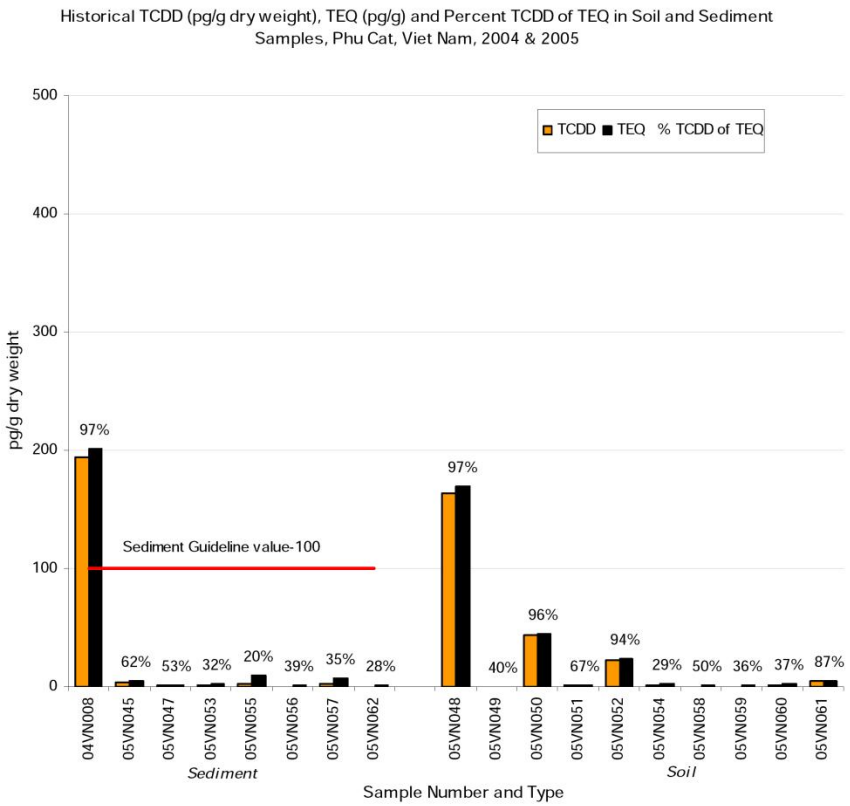
Area	Type and No. of samples	Dioxin concentration (total TEQ) Average concentration (in range)
Storage area	Soil, n = 11	37,710 ppt (352-238,000 ppt)
Loading area	Soil, n = 7	261 ppt (2.6-866 ppt)
Buffer area	Soil, n = 5	801 ppt (1.5-2,950 ppt)
Washing area	Soil, n = 10	3.83 ppt (1.85-6.23 ppt)
The Southeastern part	Soil, n = 11	41.7 (7.07-236 ppt)
Sediment tank	Sediment, n = 5	67.6 ppt (3.6-127 ppt)
Lakes A, B, and C	Sediment, n = 2 Sediment, n = 2 Sediment, n = 1	Lake A: 24.8 ppt (16-33.7 ppt) Lake B: 10.55 ppt (9.81-11.3 ppt) Lake C: 4.5 ppt

AO/Dioxin discovered at new location of Phu Cat Airbase

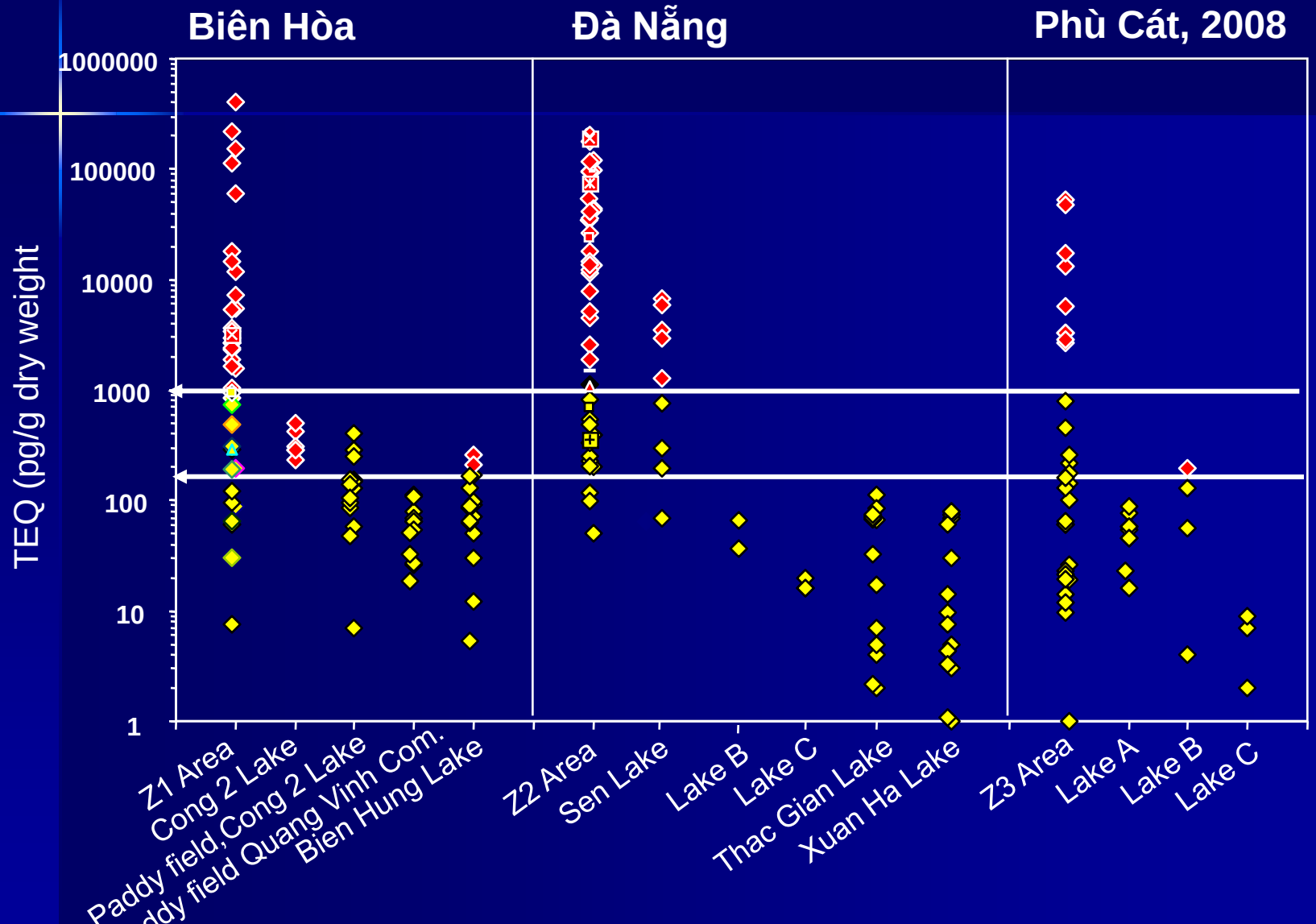


Dioxin in soil and sediment at Phu Cat Airbase – Data by Hatfield & the 10-80 Committee, 2004 – 05

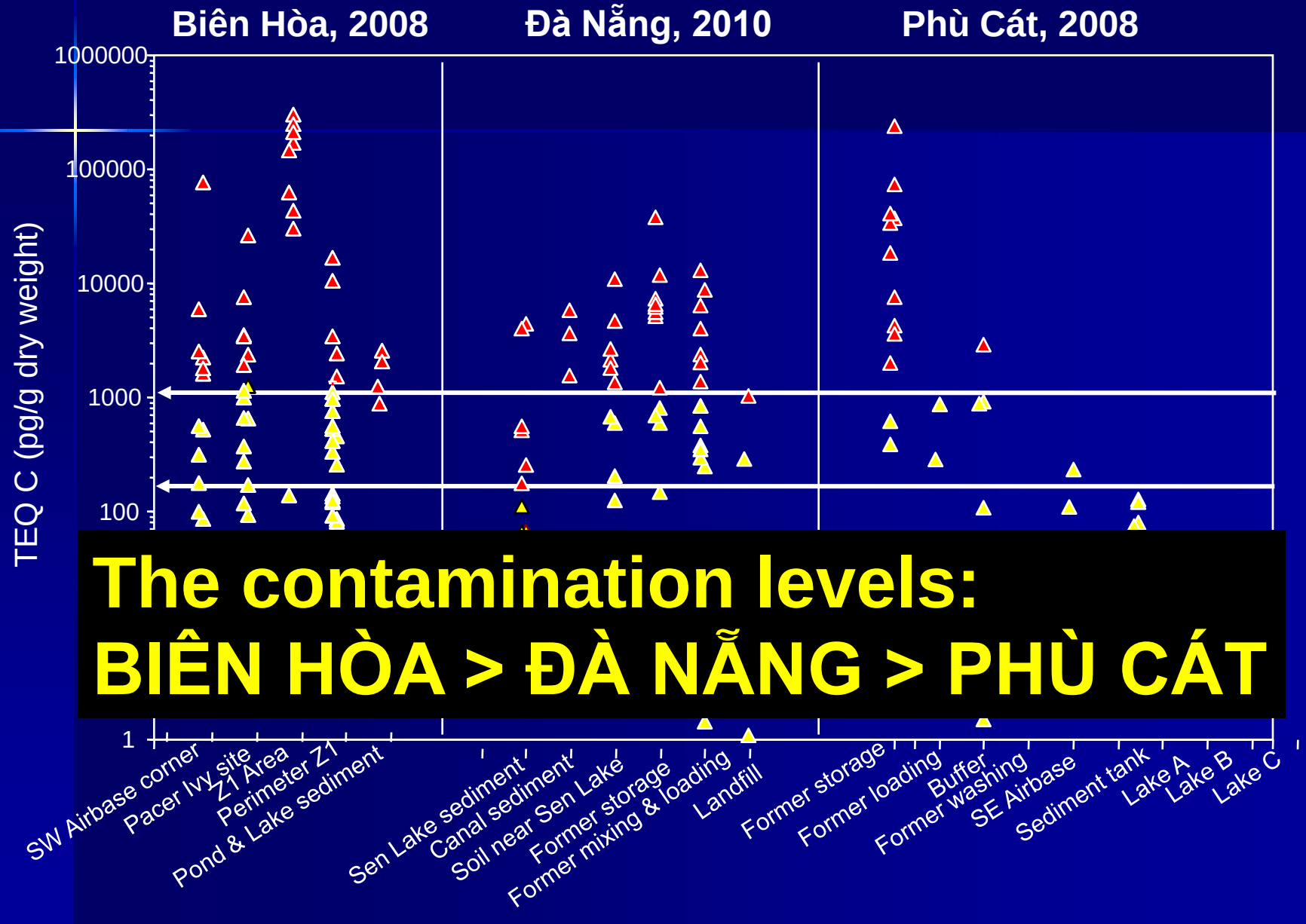




Comparison of dioxin residue in Soil & Sediment at 3 hotspots – the Z1, Z2, Z3 projects; MND, 1992-2002

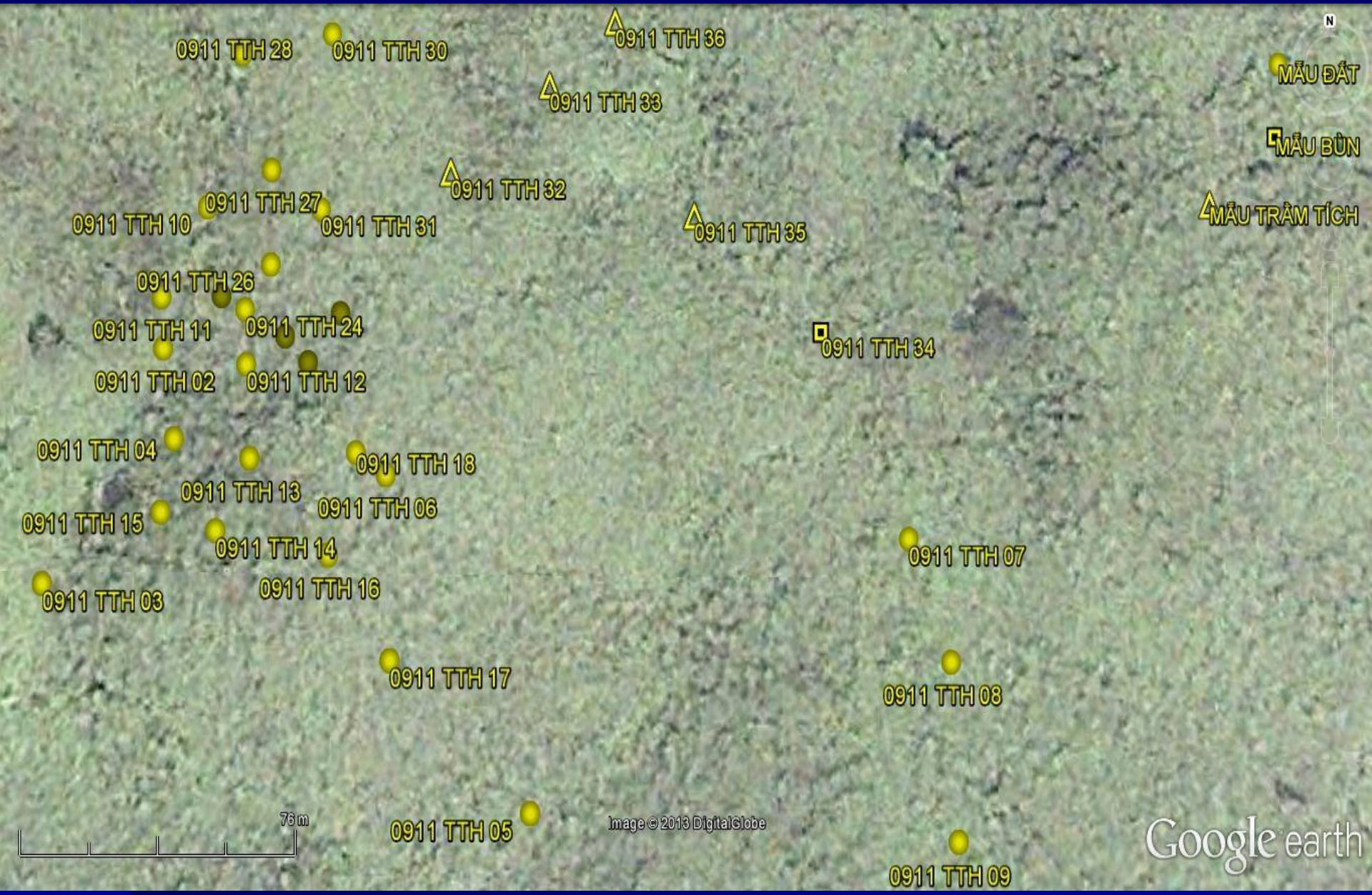


Comparison of dioxin residue in Soil & Sediment at 3 hotspots – Office 33, VRTC & Hatfield

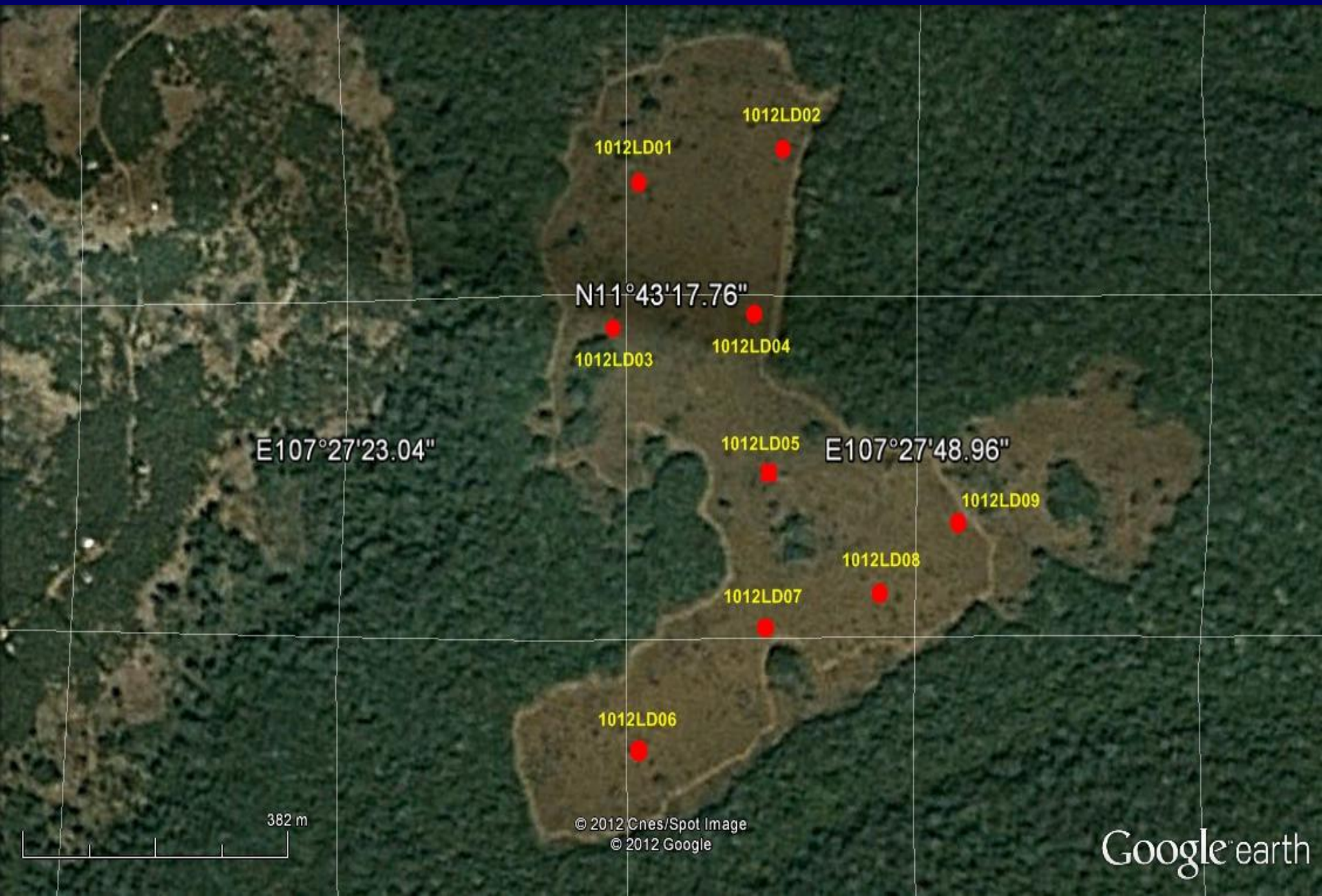


The contamination levels:
BIÊN HÒA > ĐÀ NẴNG > PHÙ CÁT

SAMLPING MAP AT HUONG TRA DISTRICT, THUA THIEN HUE, 2011



SAMPLING MAP AT DONG NAI THUONG COMMUNE, LAM DONG PROVINCE, 2012



Conclusions

1. **Classification of dioxin contaminated areas**

- Sprayed areas: low contamination, and lower than the national threshold
- Storage, loading and mixing areas: concentration remains significant in Soil, Sediment and organism, and are hotspots. These are areas to be remediated.

Conclusions

2. Sources of dioxin

- The main source is from herbicides used in the war, has demonstrated using high value of T% (% TCDD per total TEQ)

Recommendations

- Do not raise fish, poultry and aquatic animals and harvesting fish in AO/dioxin contaminated lakes within the airbase
- Continuously carry out measures to minimise and provide remediation for dioxin contaminated soil and sediment in storage, loading and washing areas in the 3 airbases: Z1 area, The Southwestern area (Pacer Ivy), The Southern area of the runway, and ponds and lakes in the Northern part of Bien Hoa Airbase.
- Promptly select and implement the suitable remediation methods for each contaminated area: containment, active landfill (containment + bio-treatment), thermal desorption destruction, thermal desorption destruction using Cu as an additive, ball milling.
- Carry out monitoring at contaminated areas to provide timely warnings and select suitable prevention measures to mitigate the risks for local people who live by the hotspots.
- Promote close cooperation between GOV and Government of the USA as well as the international community.

Thank you for your attention!