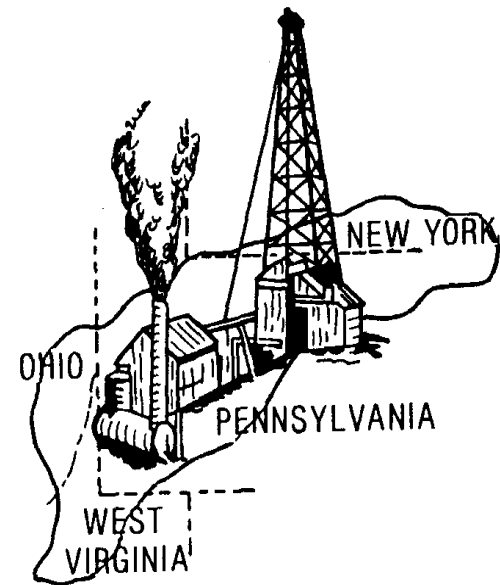

“BIOREMEDIATION”

AS A REMOVAL RESPONSE ACTION AT OPA SITES

Vincent E. Zenone, OSC
**U.S. Environmental
Protection Agency Region III**
Philadelphia, PA



“Bioremediation” as a Removal Alternative

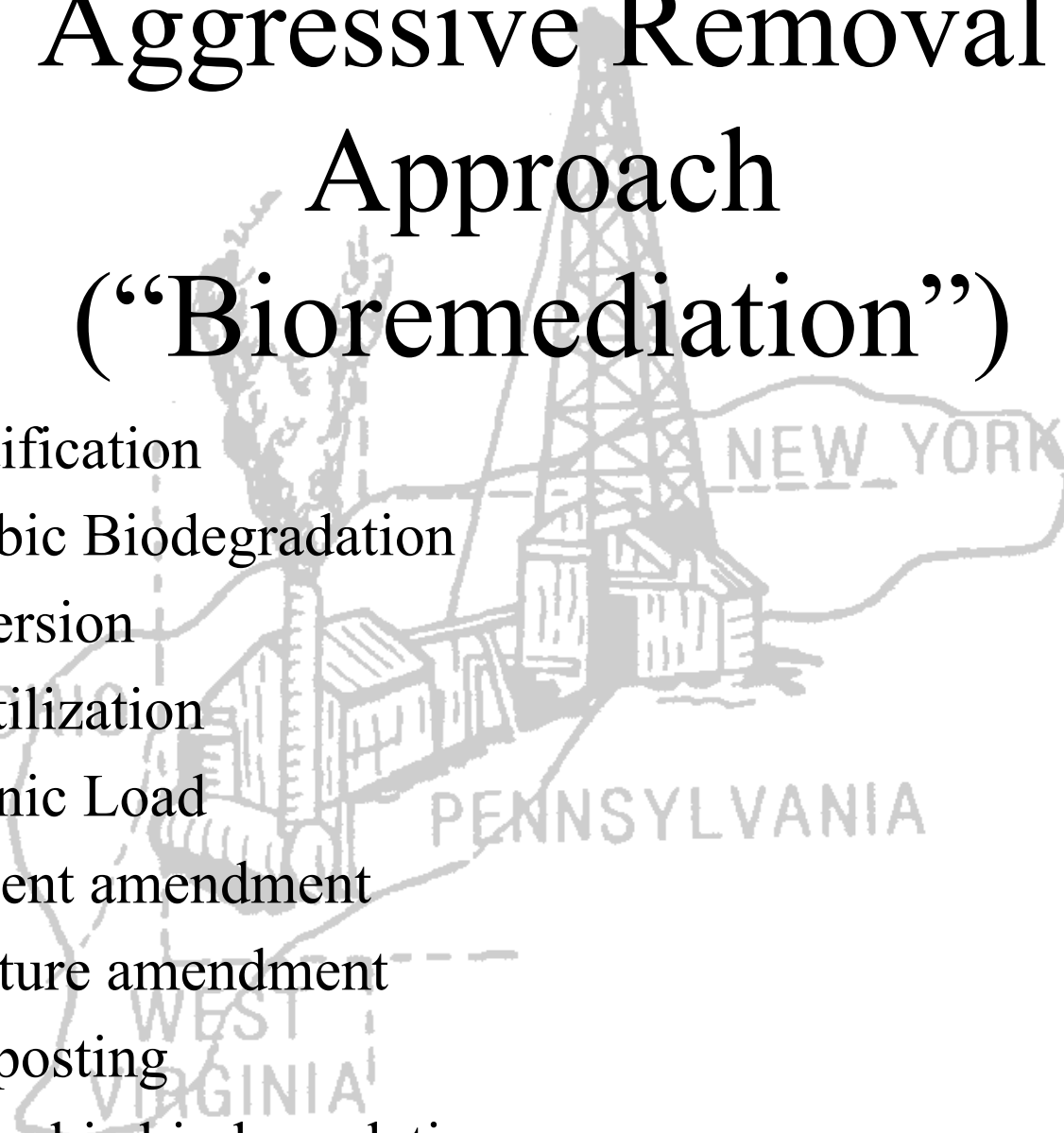
- EPA recommends the natural attenuation processes be evaluated when assembling an appropriate removal action plan for a site with petroleum contaminated soils. While natural attenuation processes include biodegradation, sorption, dispersion, and volatilization, numerous studies have indicated that the natural, in-situ biodegradation process, often called intrinsic bioremediation, is a primary mechanism for the attenuation of petroleum hydrocarbons. Biodegradation is the only natural attenuation mechanism that has the potential to destroy the contaminants in-situ with nontoxic inorganic end products.

The Passive Remedial Approach (Natural Attenuation)

- Aerobic Biodegradation
- Anaerobic Biodegradation
- Dispersion
- Volatilization
- Adsorption

Aggressive Removal Approach ("Bioremediation")

- Solidification
- Aerobic Biodegradation
- Dispersion
- Volatilization
- Organic Load
- Nutrient amendment
- Moisture amendment
- Composting
- Anaerobic biodegradation



Background

-NW PA Major Oil Spill
Project (1985-1987)

-Bar Room Brawls and
Back Alley Debates

Unknown Medium Oil Spill



Custer City, McKean County, PA

PIC #1-6-0006

PIC #1-6-0006





Practical Application of “Bioremediation” (Voodoo)

The Bryner Experiments
McKean County, PA

Mayburg Mountain
Forest County, PA



Practical Application of
“Bioremediation” (voodoo) at
Removal Response Actions

North Fork OPA Site

Allegheny National Forest

McKean County, Pennsylvania

North Fork Wellsite pre-removal



North Fork Wellsite pre-removal



North Fork Post plugging



North Fork Bio-ops

- Rototilling
- Organic load



North Fork Bio-ops Rototilling



North Fork Wellsite restoration

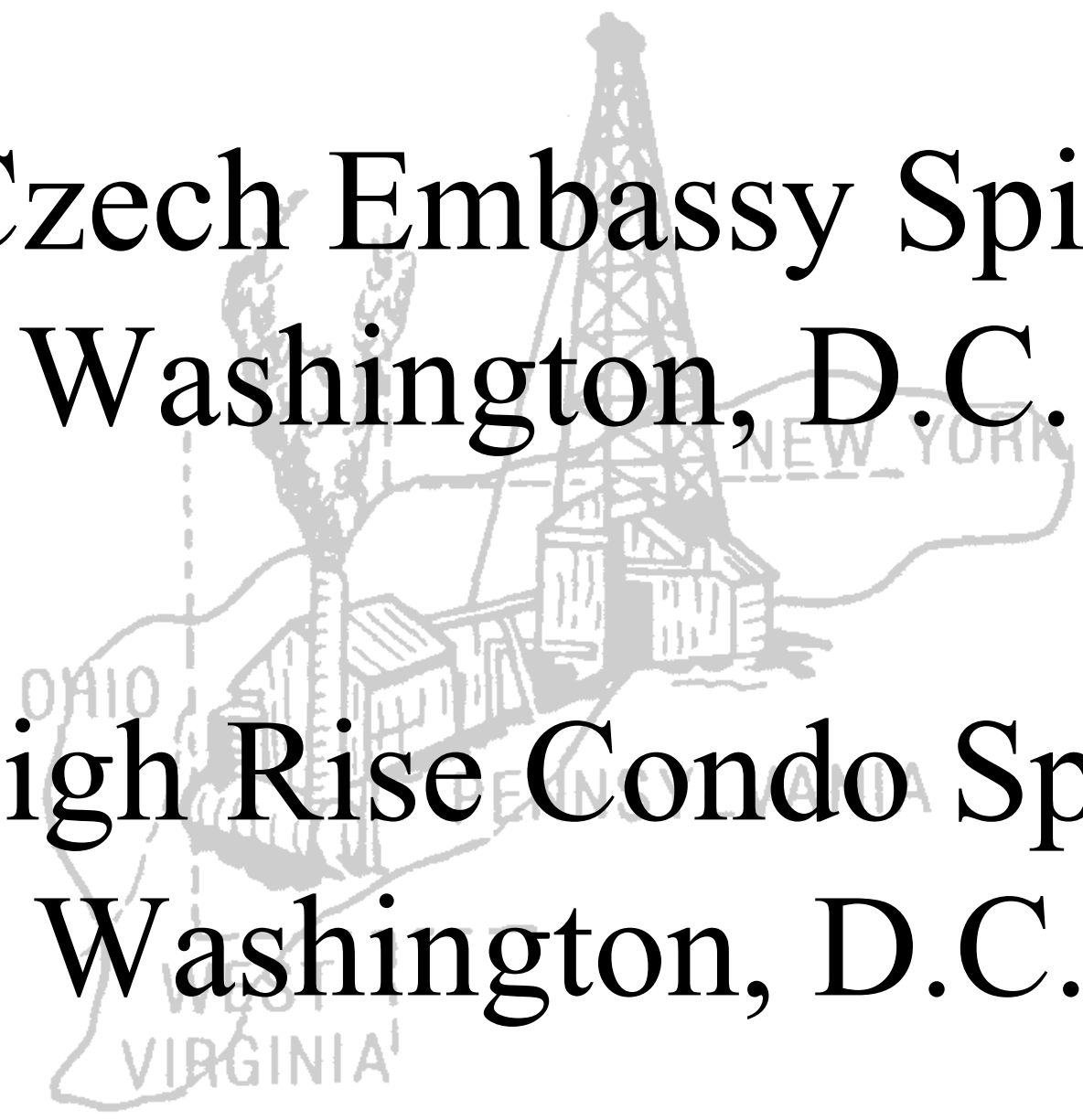


North Fork Post Bio-ops Wellsite Restoration



North Fork “Pre Bio-ops”





Czech Embassy Spill
Washington, D.C.

High Rise Condo Spill
Washington, D.C.

Practical Application of “Bioremediation” at Removal Response Actions 1995- present

Park & Hungiville OPA Site, McKean County, PA

Allegro Oil and Gas Inc. OPA Site, Potter County, PA

Melvin Farm OPA Site, McKean County, PA

Avery Farm OPA Site, McKean County, PA

Hess Farm OPA Site, McKean County, PA

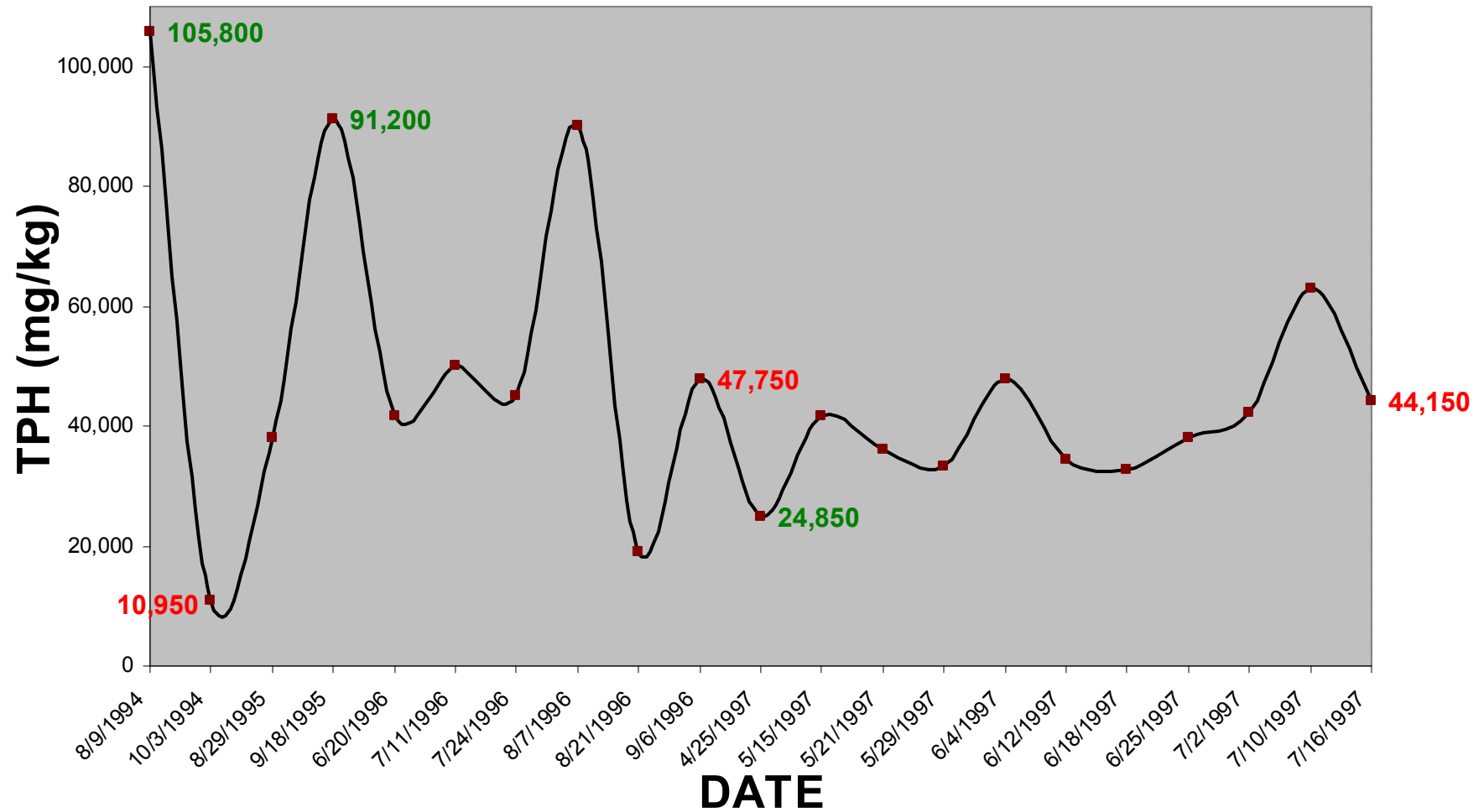
Onofrio Estate OPA Site, McKean County, PA

Barrett Wells OPA Site, McKean County, PA

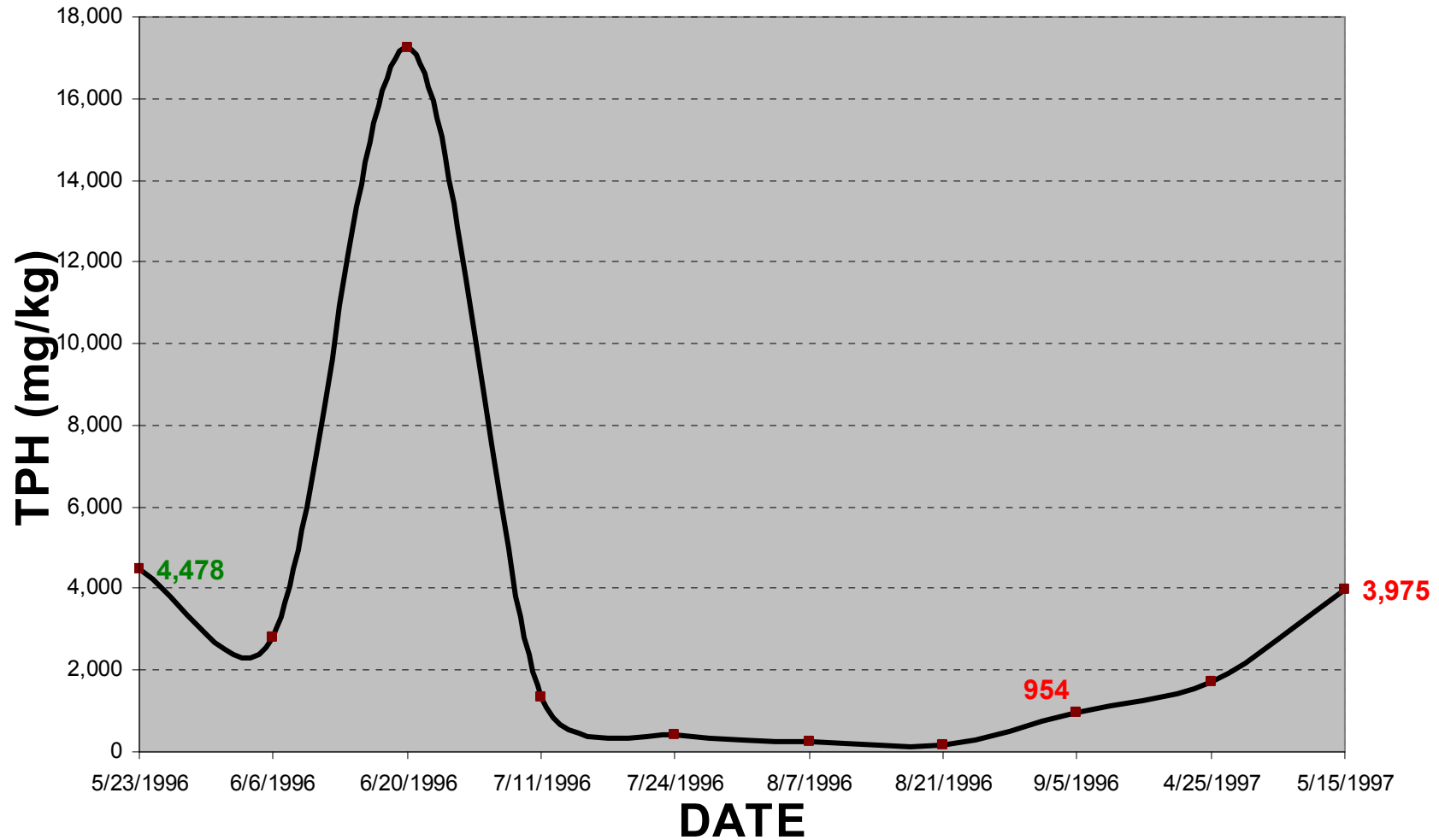
McCracken Farm OPA Site, McKean County, PA

Johnston and Matthews OPA Site, McKean County, PA

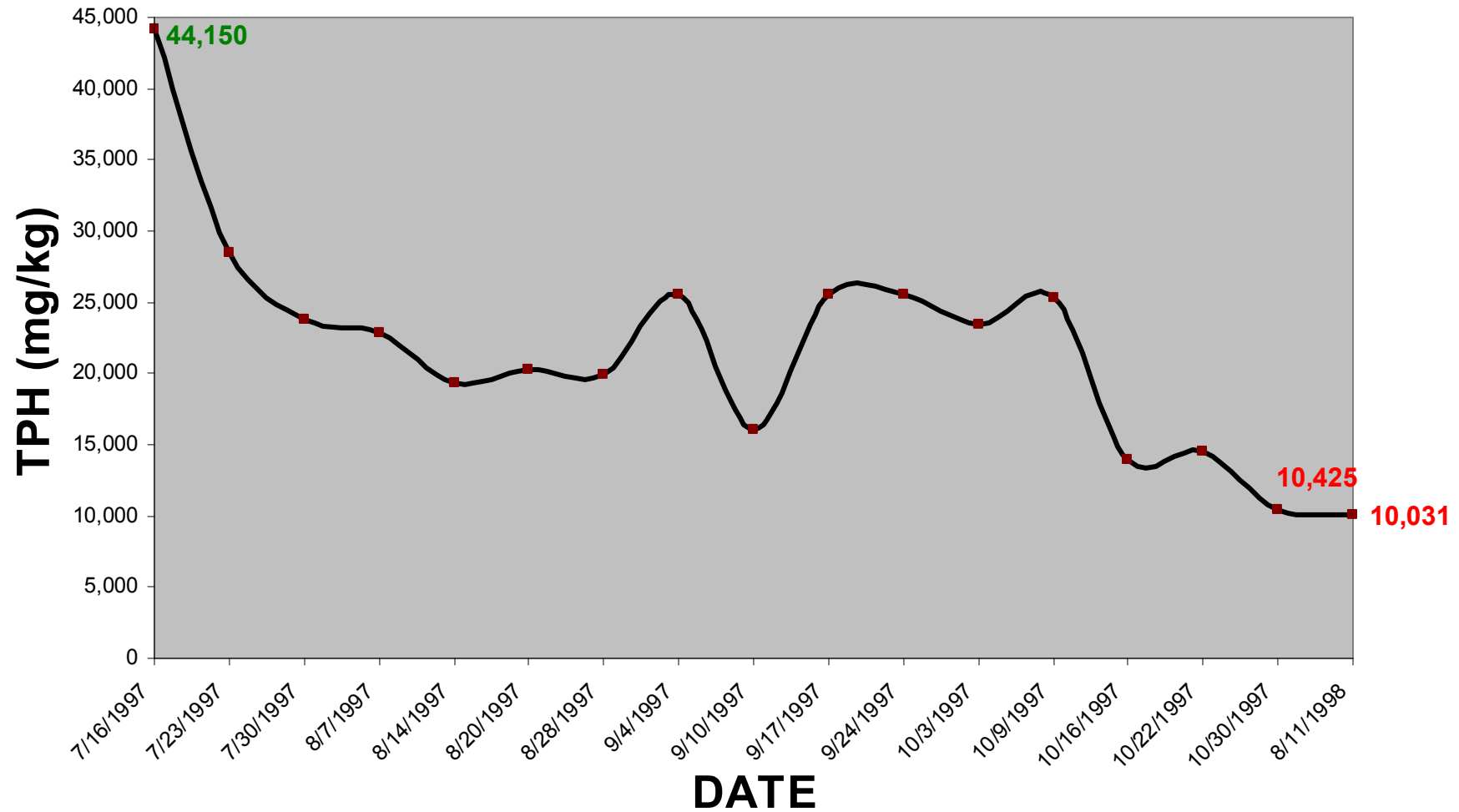
PARK & HUNGIVILLE BIOPOD #1



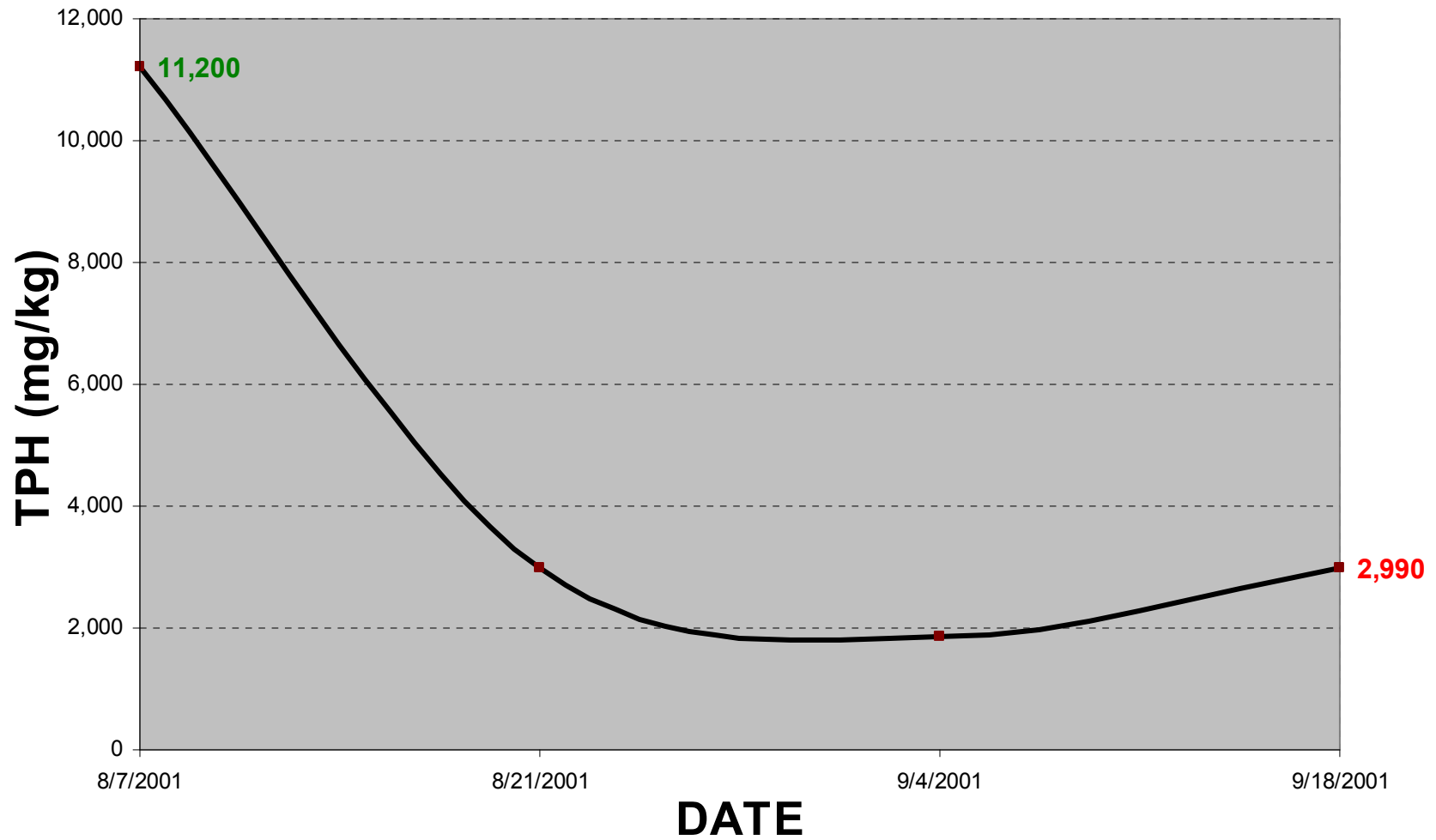
PARK & HUNGIVILLE BIOPOD #2



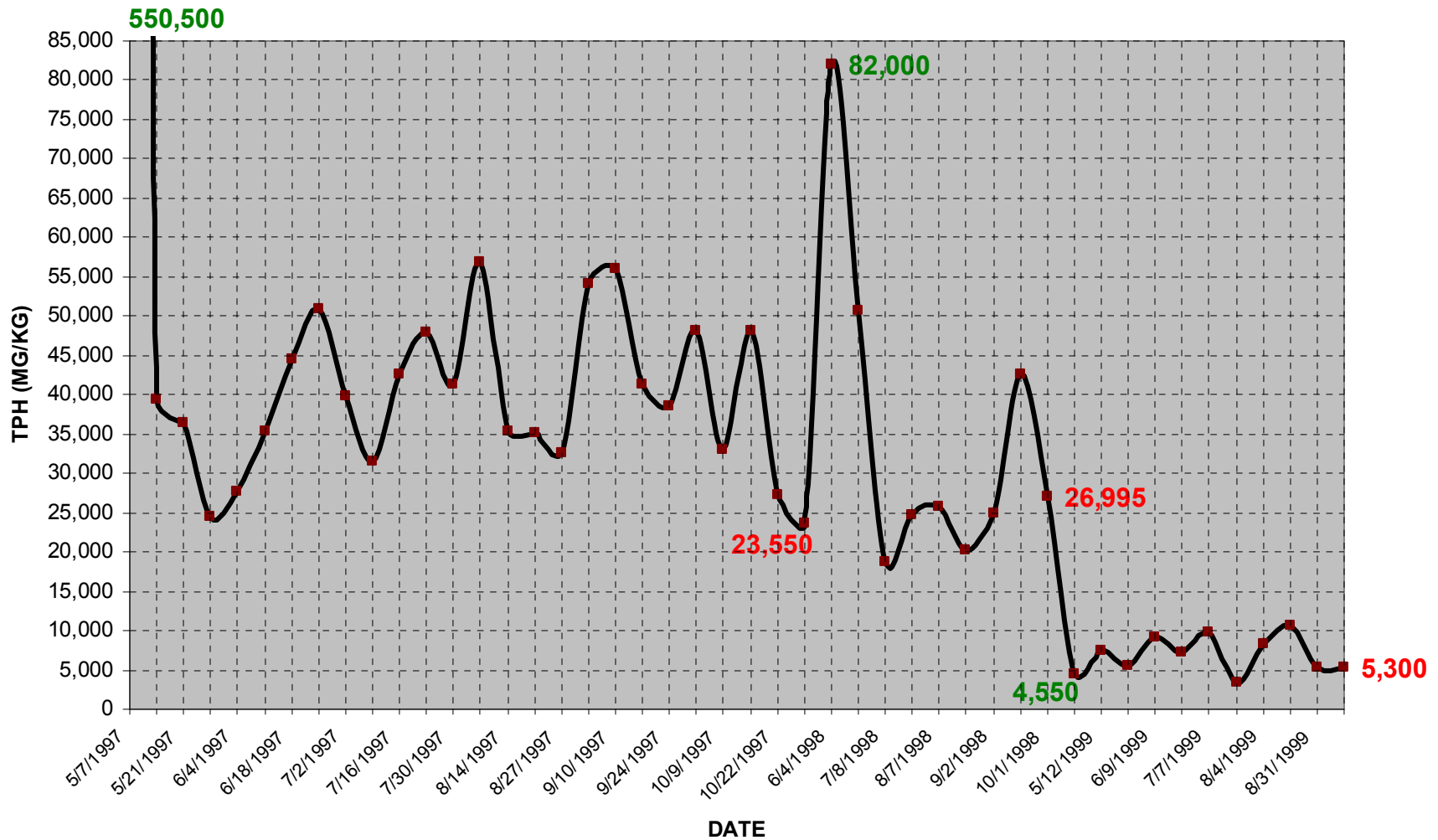
PARK & HUNGIVILLE BIOPOD #3



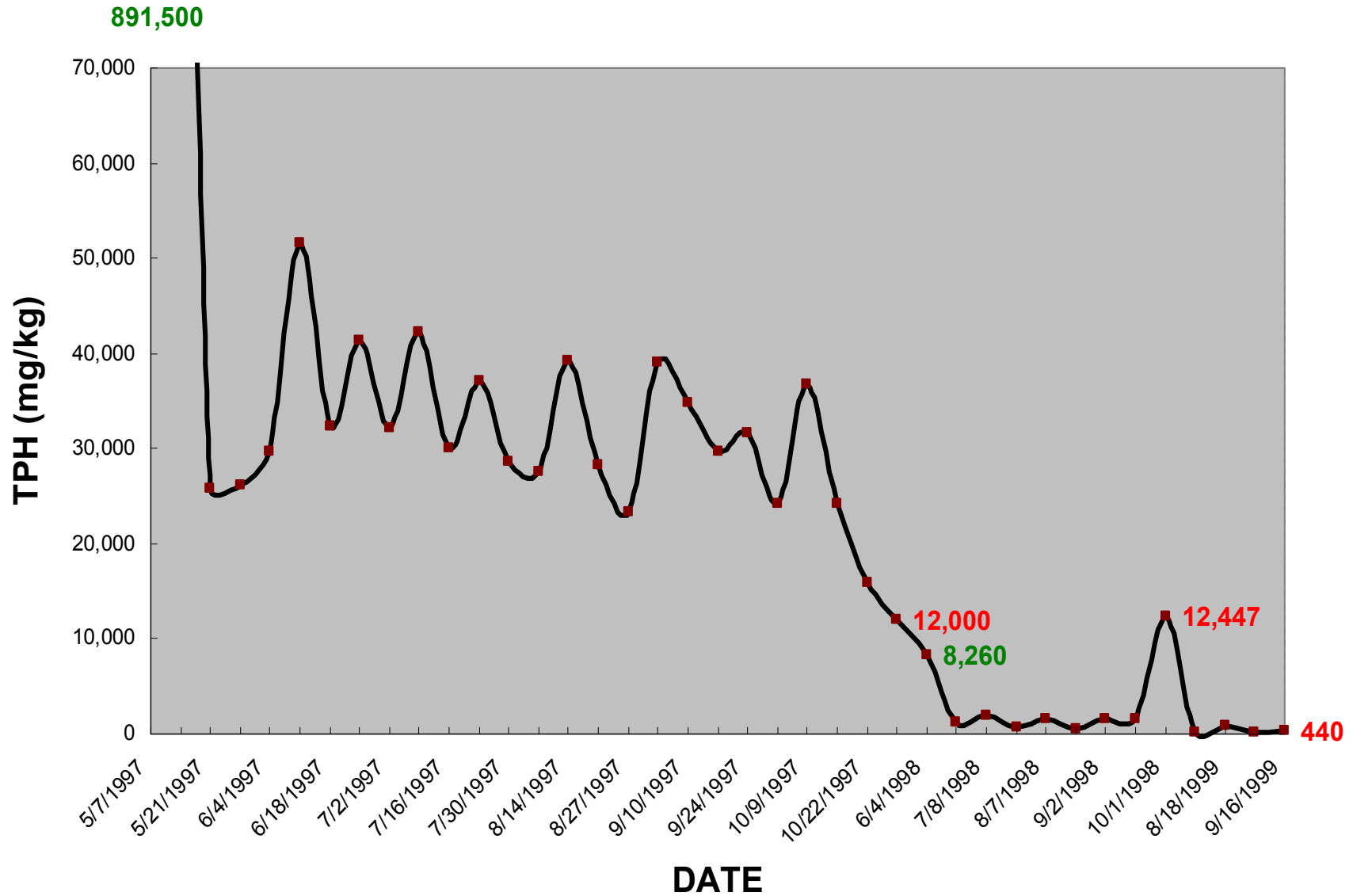
PARK & HUNGIVILLE BIOPOD #4



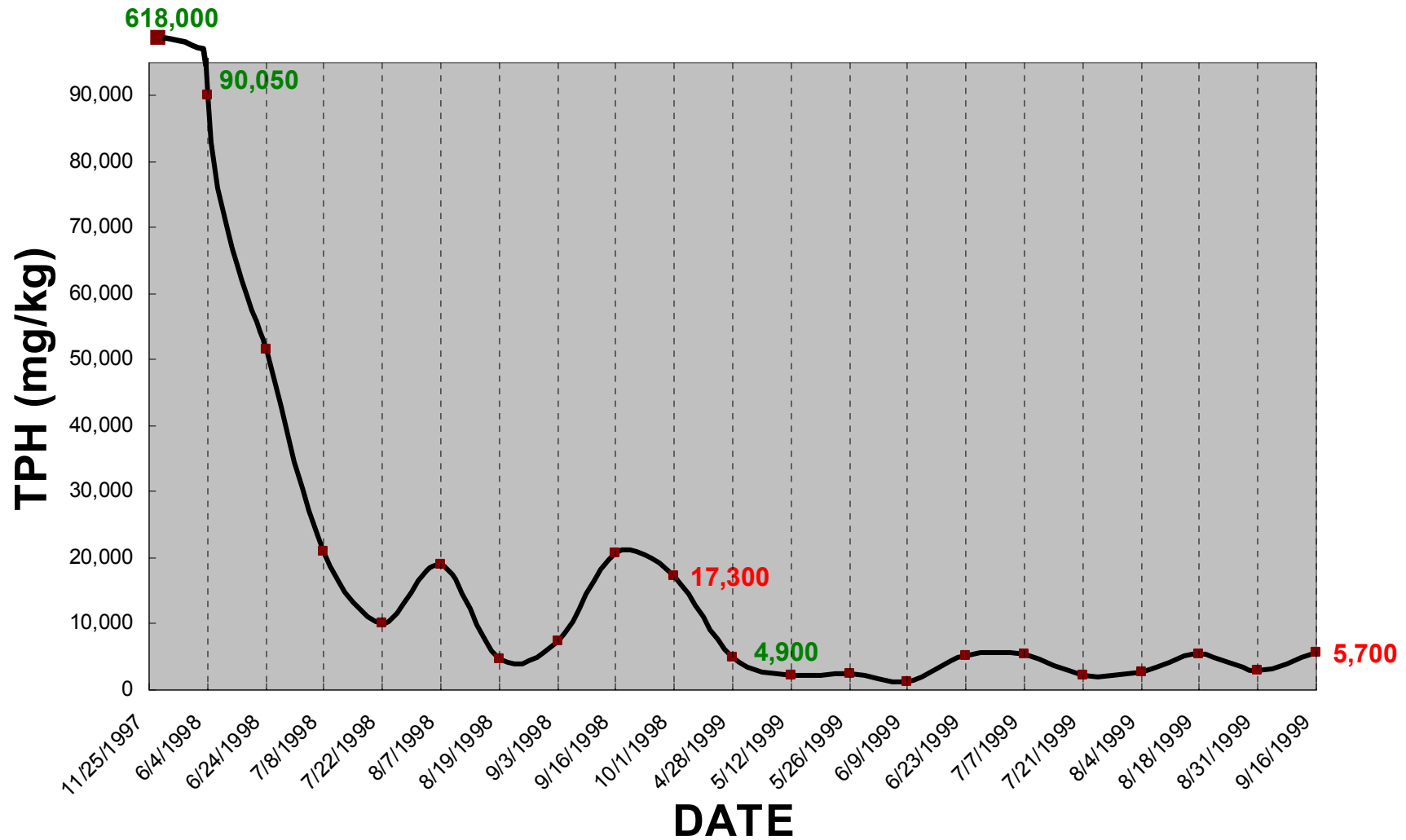
ALLEGRO BIPOD #1163



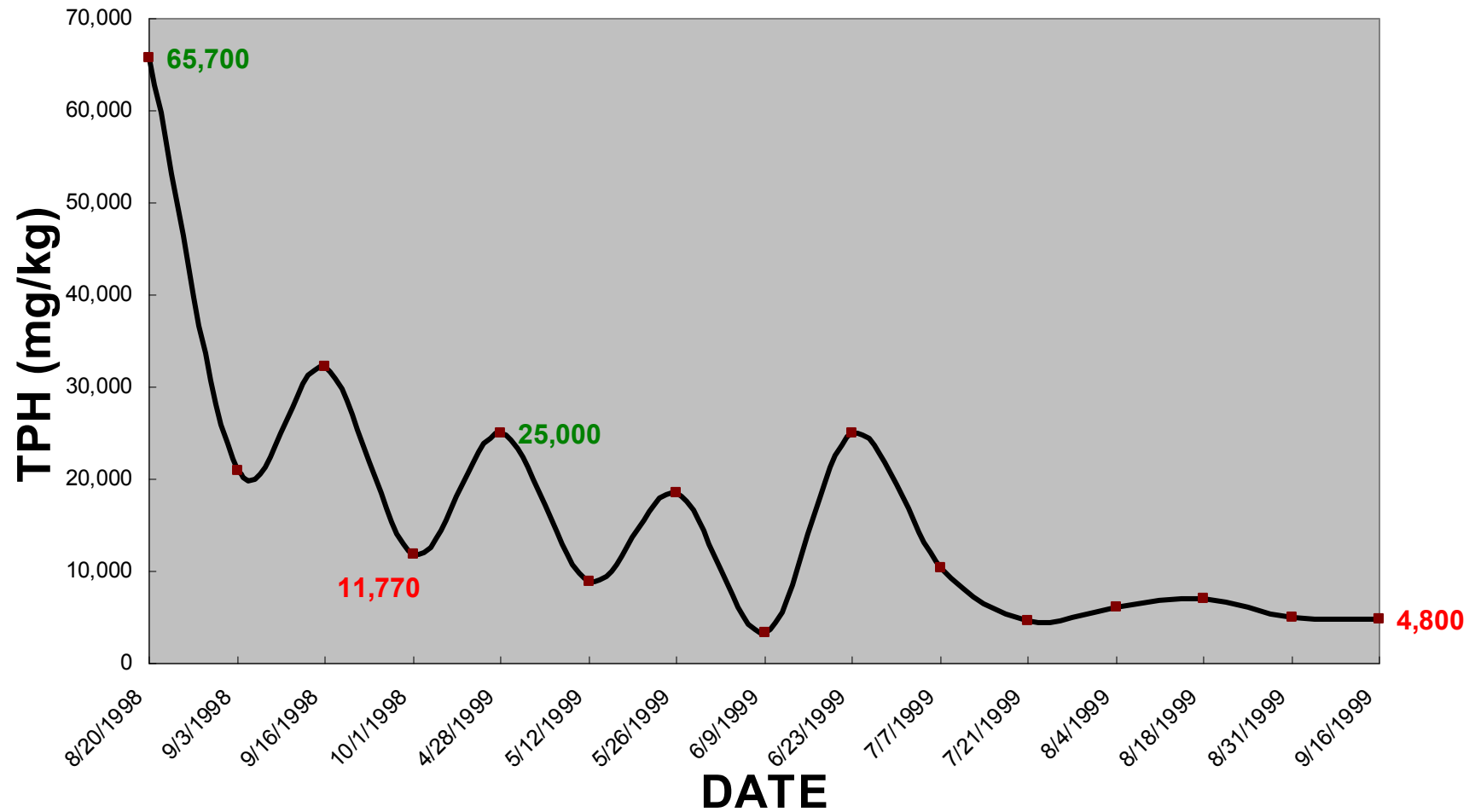
ALLEGRO BIPOD #1672



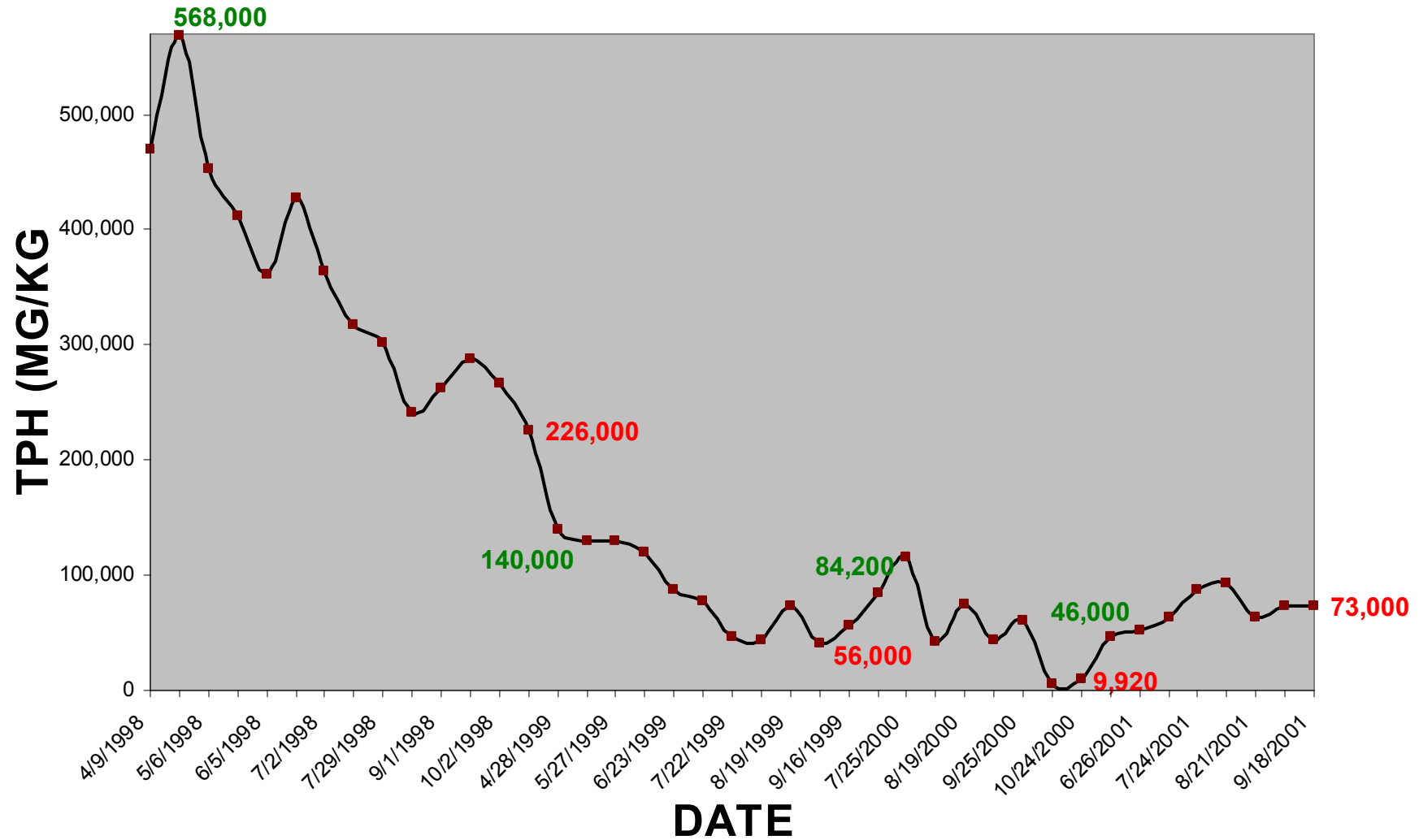
ALLEGRO BS BIOPOD



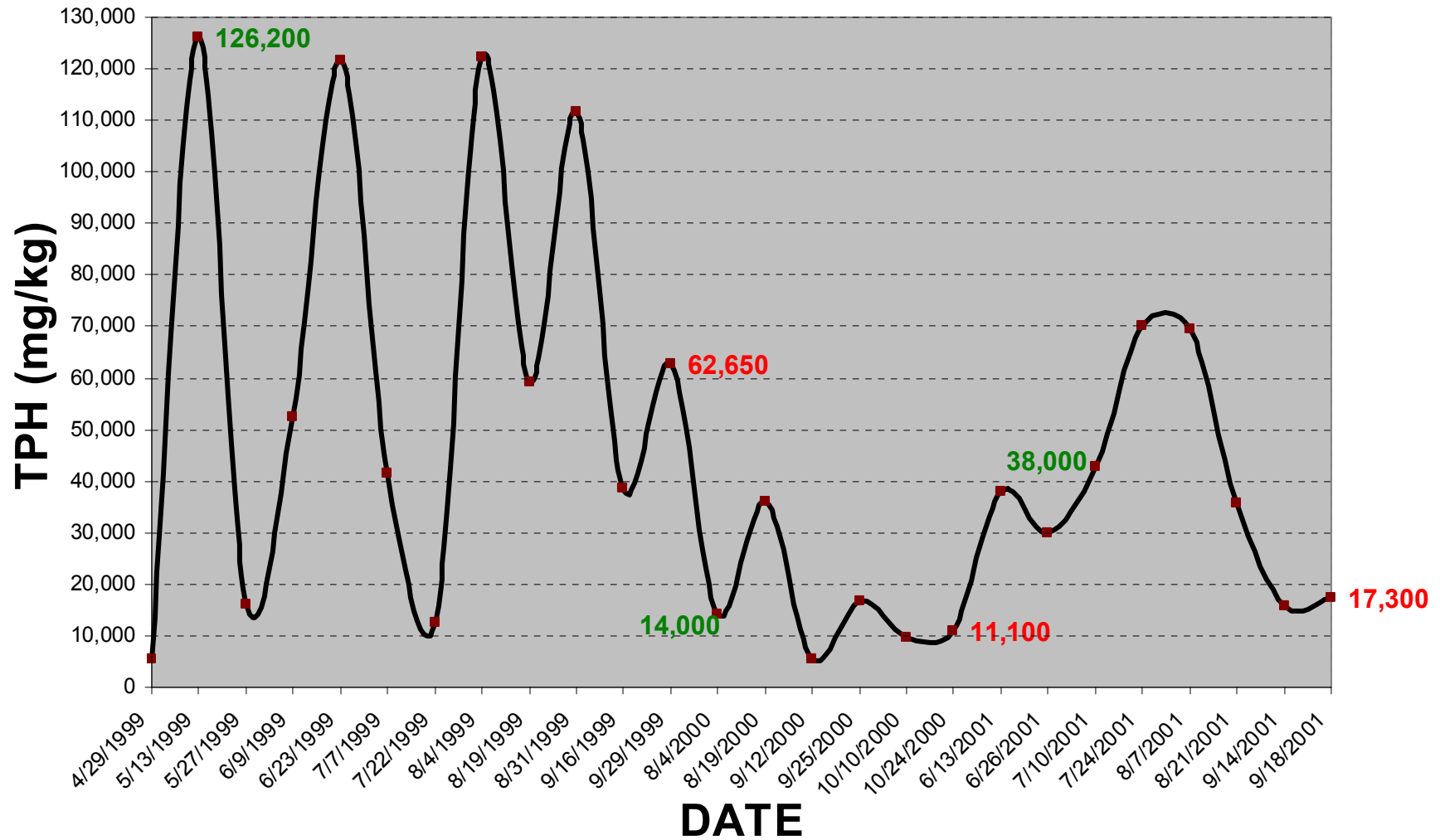
ALLEGRO BS II BIOPOD



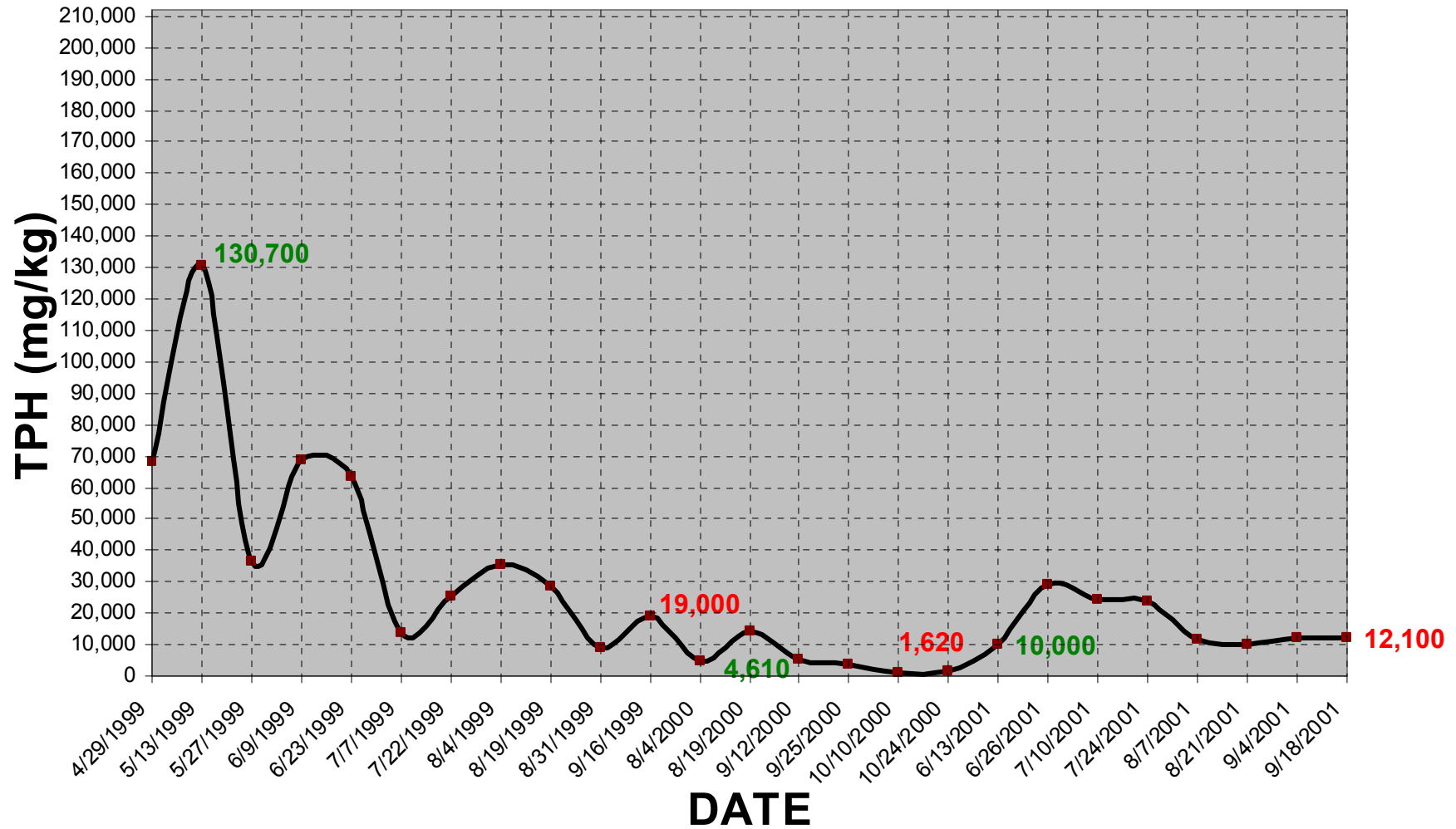
MELVIN FARMS BIOPOD



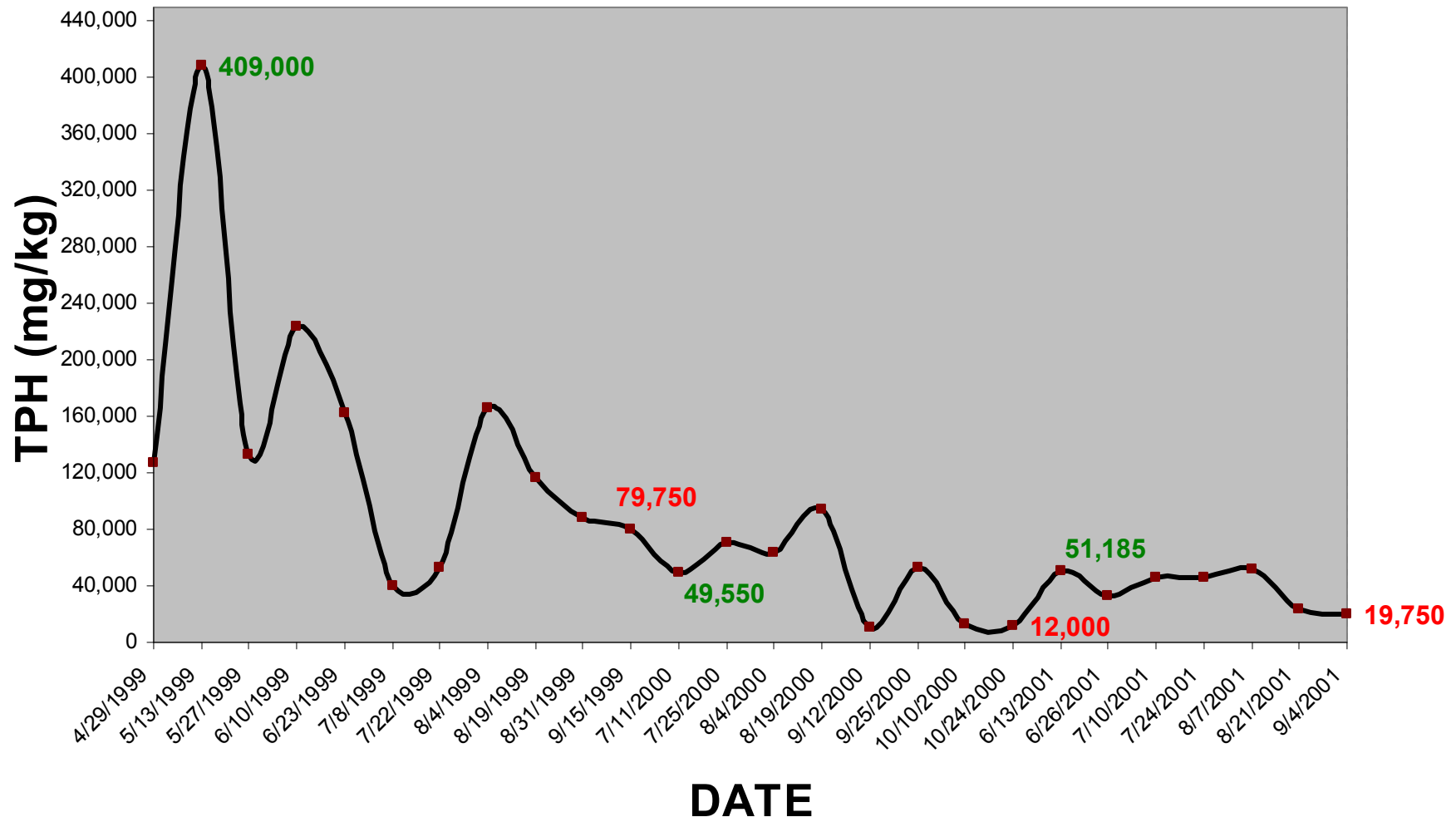
AVERY FARMS BIOPOD



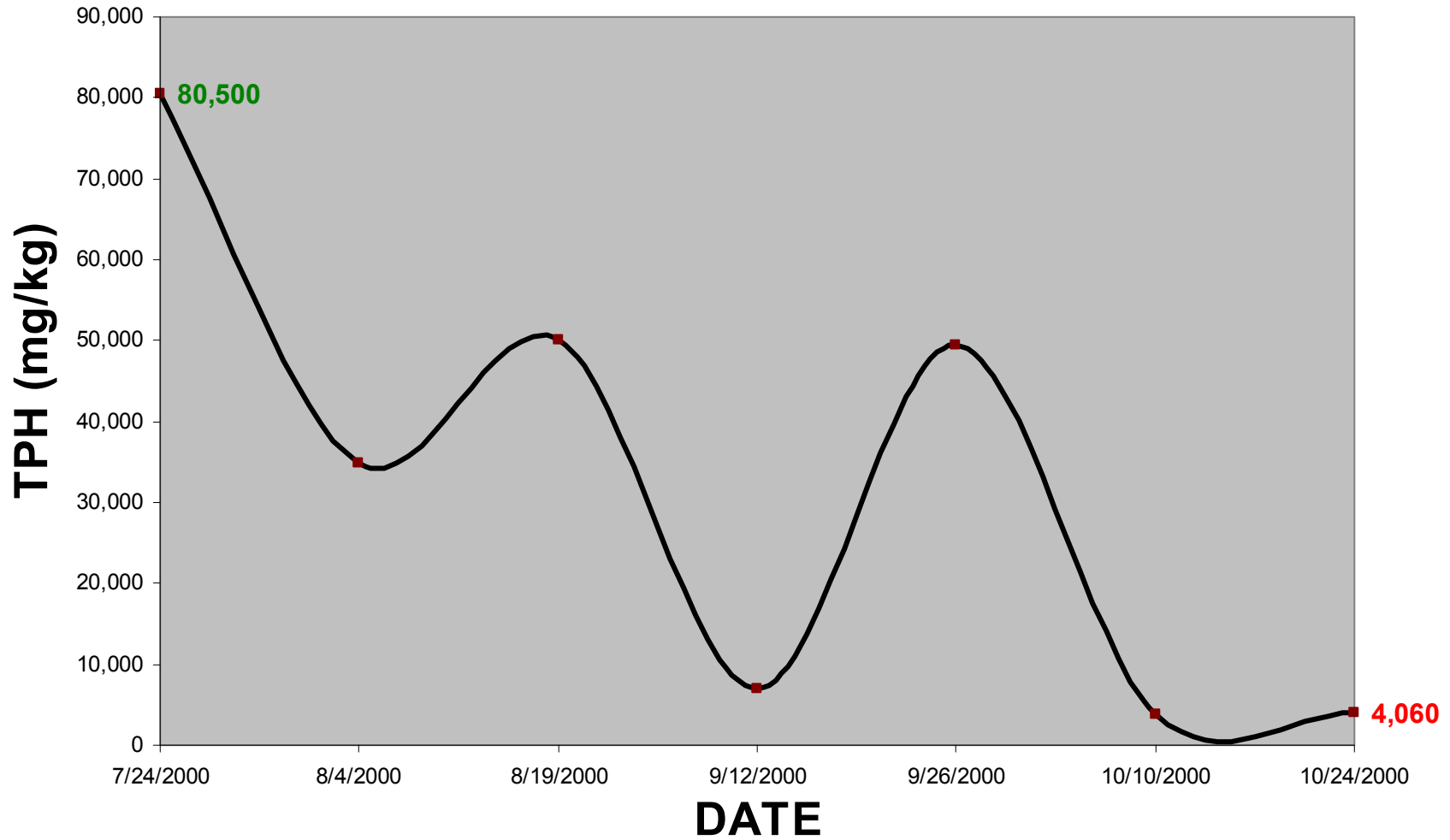
HESS BIOPOD



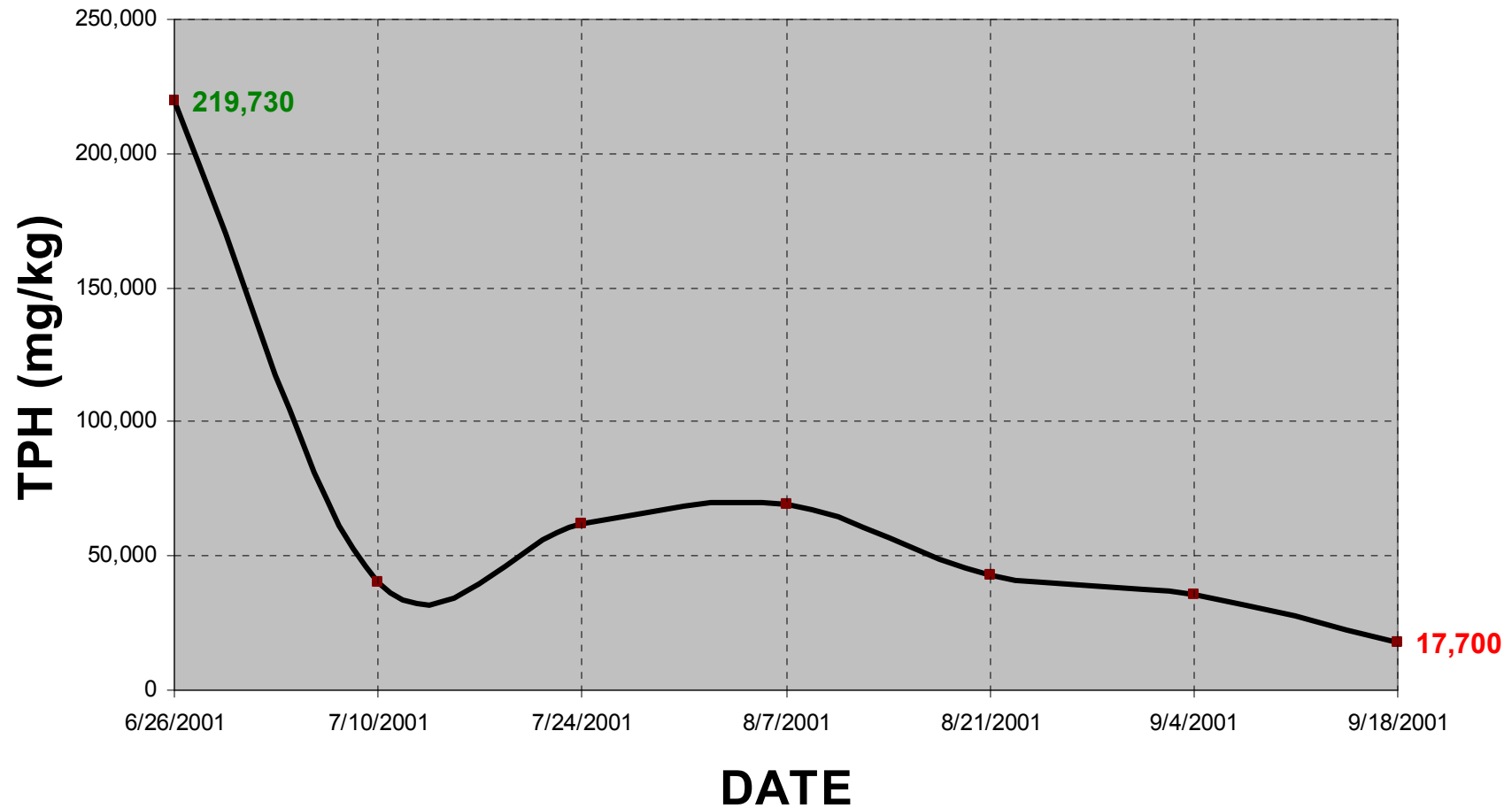
ONOFRIO BIPOD



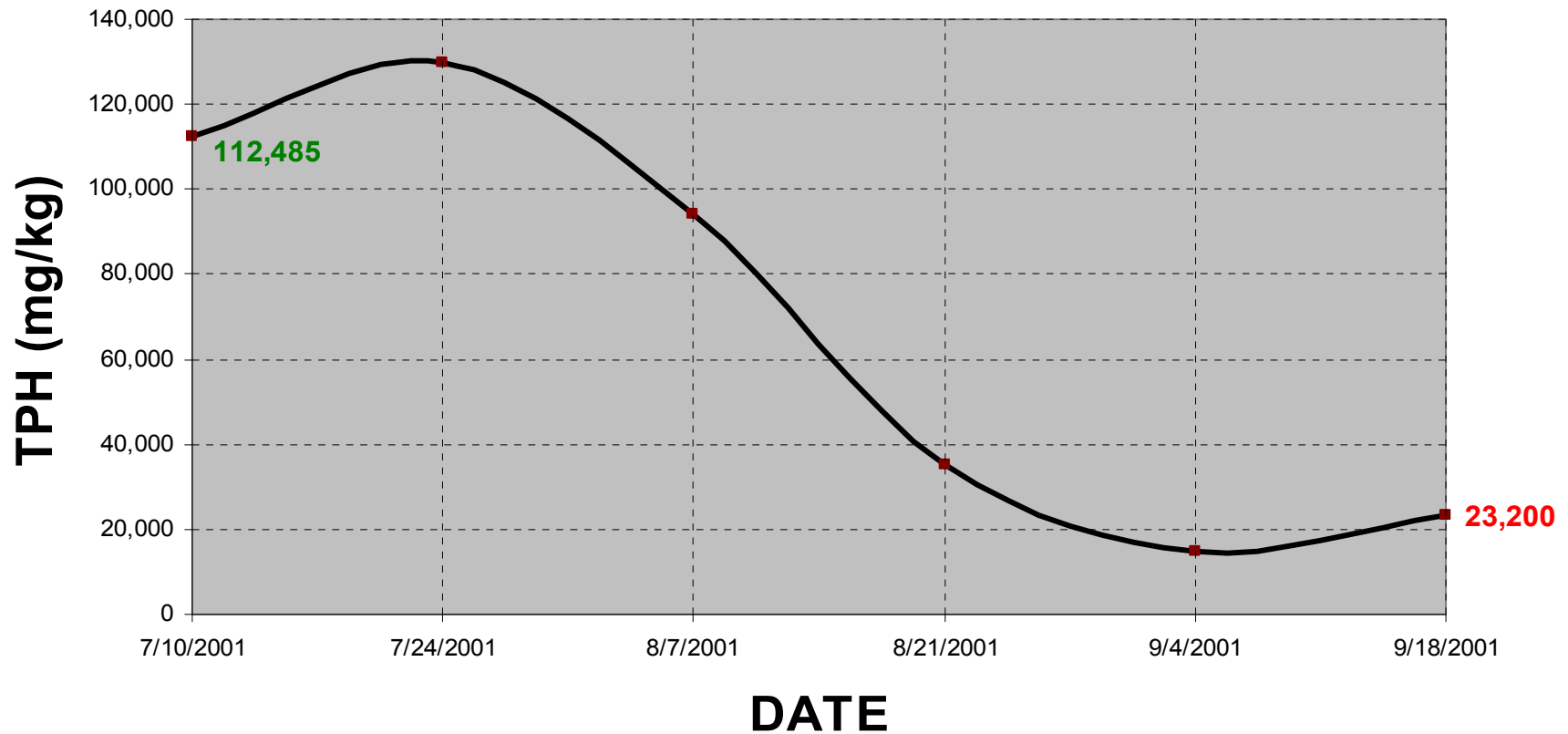
BARRETT BIOPOD



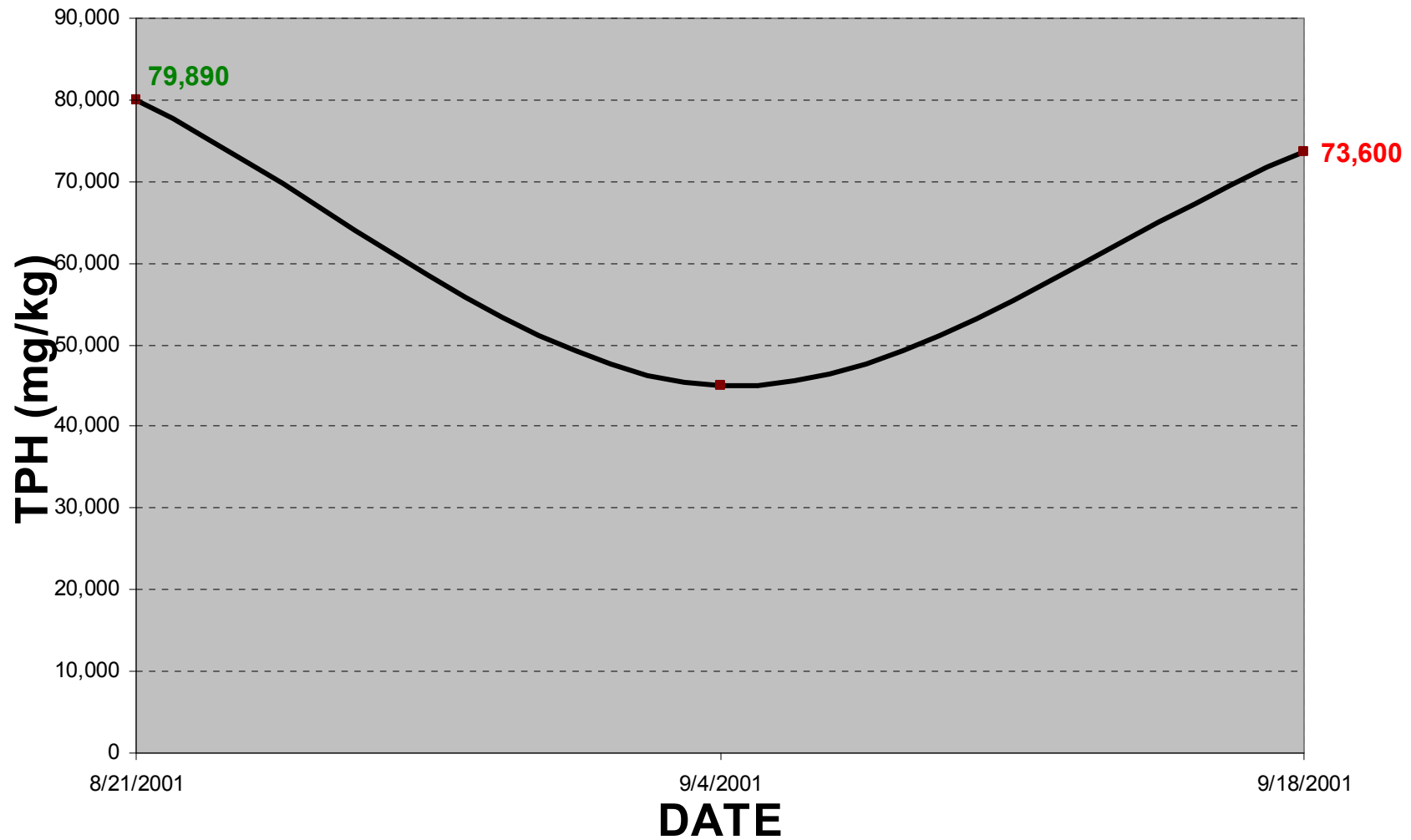
MCCRACKEN BIOPOD #1



MCCRACKEN BIOPOD #2



JOHNSTON & MATTHEWS BIOPOD



Summary:

Bioremediation of Oiled Sites in Northwestern PA and DC			Biopod Indicator	Petroleum Hydrocarbons (mg/kg)		Seasonal % removal	Est'd. Time "n"	Total % removal
				T-Zero	T-n			
"VooDoo"								
PIC# 1-6-0006	McKean County	PA						
The "Bryner Experiments"	McKean County	PA						
Mayburg Mountain	Forest County	PA						
North Fork Minor Oil Spill, Allegheny Nat'l Forest	McKean County	PA		For these 6 sites sensory observations and plant growth were used to judge treatment effectiveness.				
Czech Embassy Spill	Washington	DC						
High Rise Condo Spill	Washington	DC						
"Science"								
Park & Hungiville OPA Site, Rixford	McKean County	PA	#1	105,080	10,950	90%	8/94-10/94	90%
			#1	91,200	47,750	48%	9/96-7/97	
			#1	47,750	44,150	8%	4/97-7/97	58%
			#2	6,000	1,200	80%	5/96-9/96	
			#2	1,200	1,200	0%	4/97-5/97	80%
			#3	44,150	10,000	77%	7/97-10/97	89%
			#4	11,200	1,070	91%	8/01-10/01	91%
Allegro Oil & Gas OPA Site, Shinglehouse	Potter County	PA	#1672	891,500	12,000	99%	Summer '97	
			#1672	8,260	1,535	81%	6/98-9/98	
			#1672	12,447	440	96%	10/98-9/99	99%
			#1163	550,000	23,550	96%	Summer '97	
			#1163	82,000	42,600	48%	6/98-9/98	
			#1163	26,995	5,300	80%	10/98-9/99	99%
			BS	90,050	17,300	81%	6/98-9/98	
			BS	17,300	5,700	67%	7/99-9/99	94%
			BS-II	65,700	11,770	82%	8/98-10/98	
			BS-II	11,770	4,800	59%	7/99-9/99	93%
Melvin Farm OPA Site, Bradford	McKean County	PA	#1	568,000	226,000	60%	4/98-10/98	
			#1	140,000	56,000	60%	4/99-9/99	
			#1	84,200	9,920	88%	7/00-10/00	
			#1	46,000	32,600	29%	6/01-10/01	94%
Avery Farm OPA Site, Custer City	McKean County	PA	#1	126,200	62,650	50%	5/99-9/99	
			#1	14,000	11,100	21%	8/00-10/00	
			#1	38,000	23,100	39%	6/01-10/01	82%
Hess Farm OPA Site, Custer City	McKean County	PA	#1	130,700	19,000	85%	5/99-9/99	
			#1	14,300	1,620	89%	8/00-10/00	
			#1	10,000	9,400	10%	6/01-10/01	93%
Onofrio Estate OPA Site, Bradford	McKean County	PA	#1	409,000	79,750	81%	5/99-9/99	
			#1	70,950	12,000	83%	7/00-10/00	
			#1	51,185	20,600	60%	6/01-10/01	95%
Barrett Farm OPA Site, Bradford	McKean County	PA	#1	80,500	4,060	95%	7/00-10/00	
McCracken Farm OPA Site, Foster Twp.	McKean County	PA	#1	219,730	16,300	93%	6/01-10/01	93%
			#2	112,485	10,400	91%	7/01-10/01	91%
Johnston & Matthews Farm OPA Site, Bradford	McKean County	PA	#1	78,890	32,800	59%	7/01-10/01	59%

Bio-pod Soup to Nuts

Site Specific “Bio-pod”
Characterization

Pre-removal



Solidification



Solidification



Solidification



Configuring Bio-pod



Addition of BS



Solidification of BS



Solidification/Organic Load



Rototilling



Current Conditions



Current Conditions



Current/Future Removal Response Bioremediation Plan of Action

- Identification of Hydrocarbon-Degrading Microbes
- Removal Response Application of Plant System Technologies