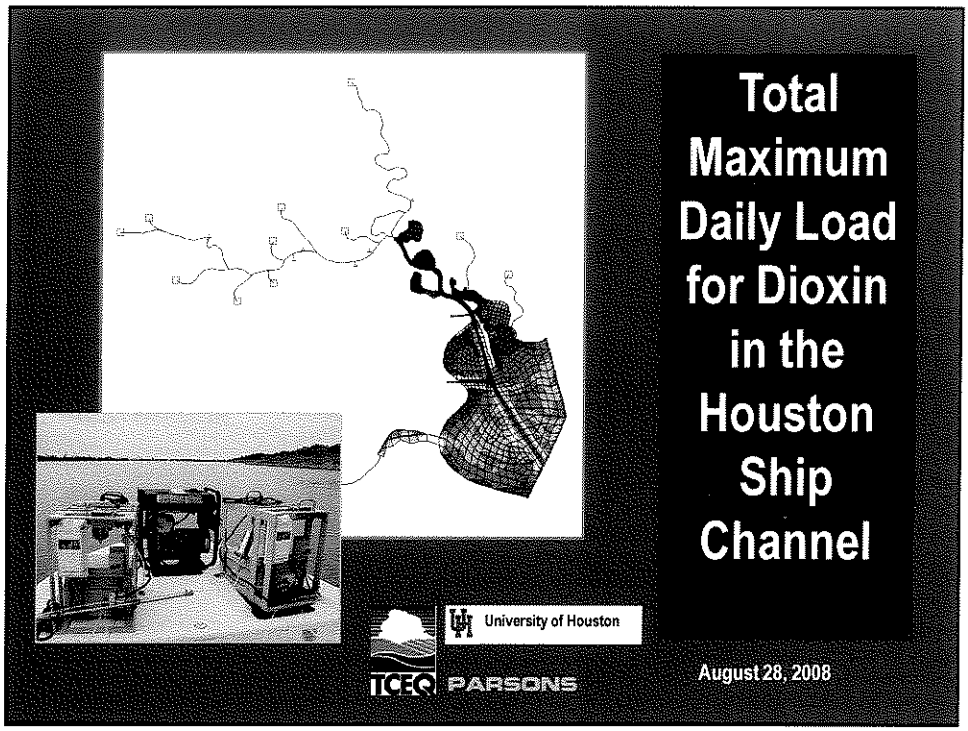
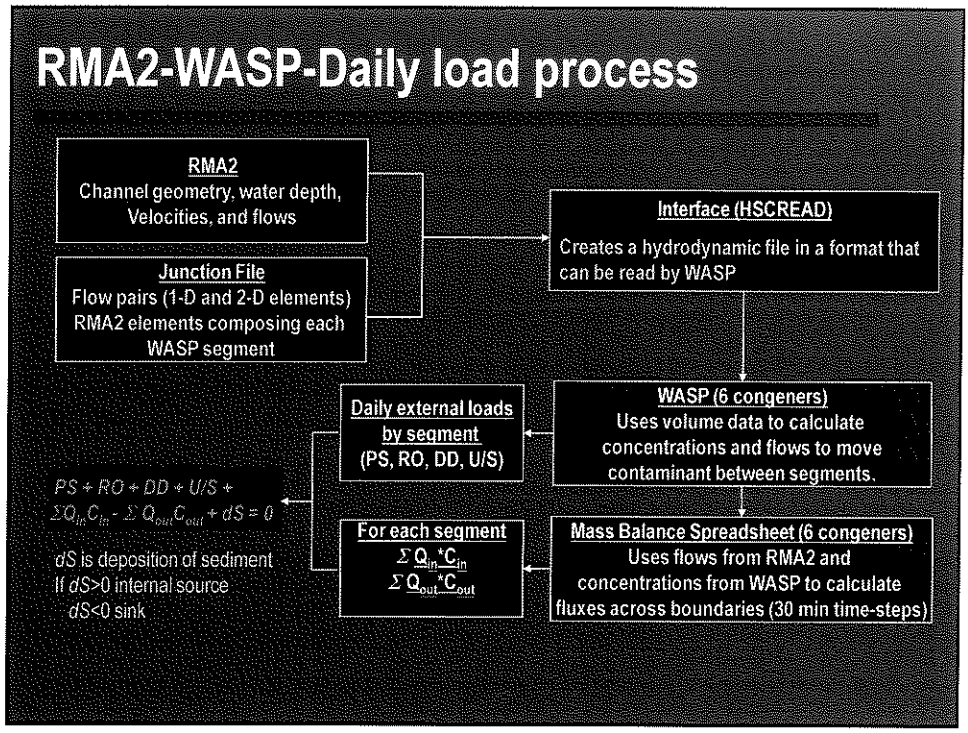


Focus

- Mass-balance spreadsheet
- TMDL endpoint
- Allocations



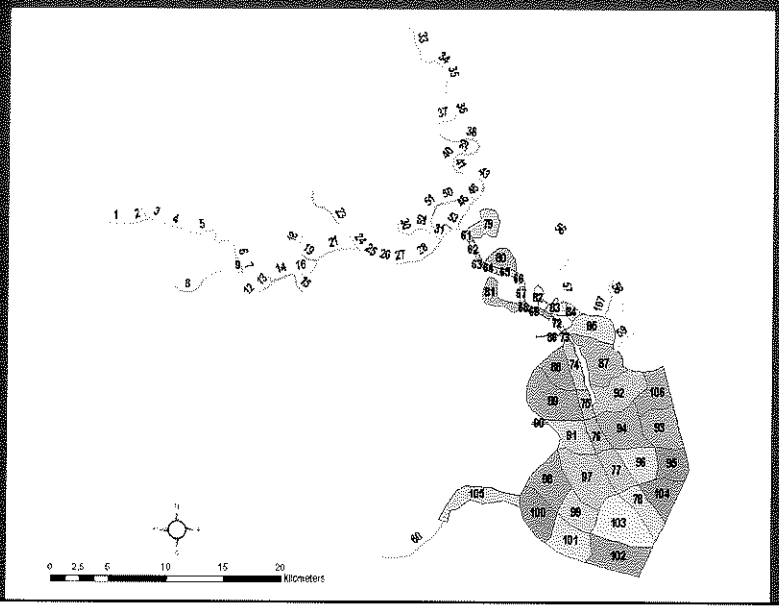
Modeled congeners

- TEQ is calculated as: $TEQ = \sum C_i \cdot TEF_i$
- where C_i and TEF_i are concentration and toxicity equivalent factor for congener *i*
- Texas TEFs:

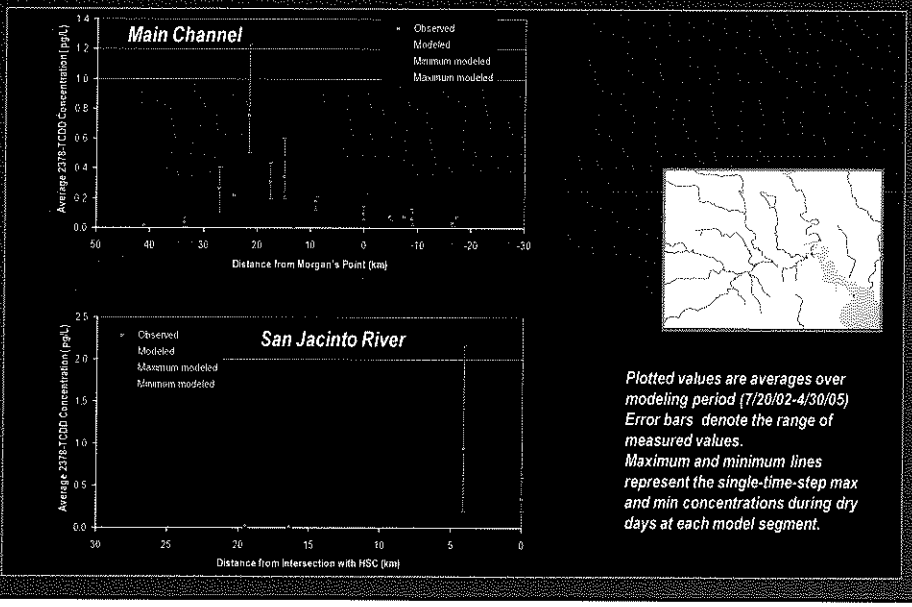
Congener	Texas TEF
2378-TCDD	1
12378-PeCDD	0.5
123478-HxCDD	0.1
123678-HxCDD	0.1
123789-HxCDD	0.1
2378-TCDF	0.1
12378-PeCDF	0.05
23478-PeCDF	0.5
123478-HxCDF	0.1
123678-HxCDF	0.1
123789-HxCDF	0.1

Congeners in orange contribute more than 96% of the TEQ in tissues from the HSC. Those six congeners were modeled in WASP.

WASP final model segmentation

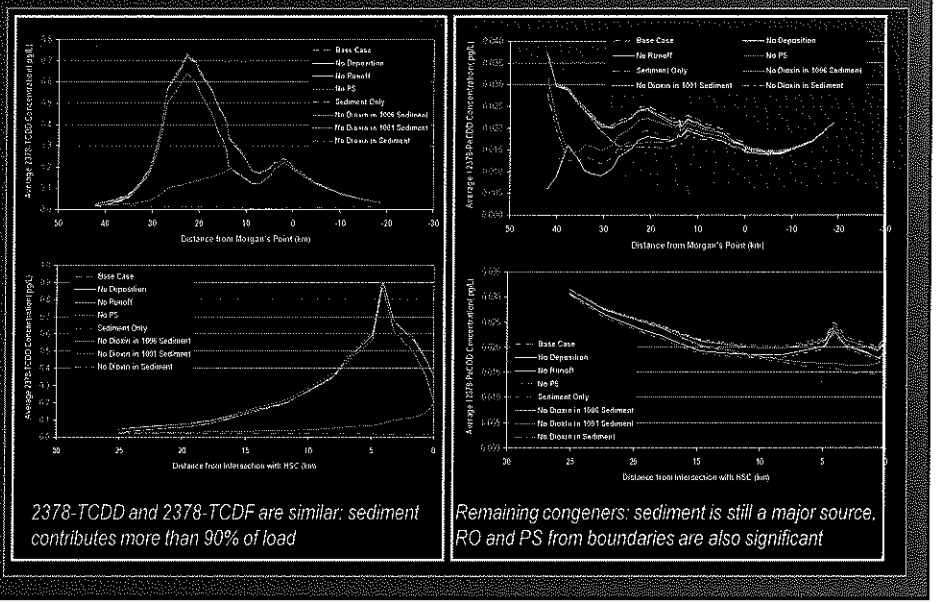


WASP 2378-TCDD calibration



Plotted values are averages over modeling period (7/20/02-4/30/05)
Error bars denote the range of measured values.
Maximum and minimum lines represent the single-time-step max and min concentrations during dry days at each model segment.

WASP load scenarios

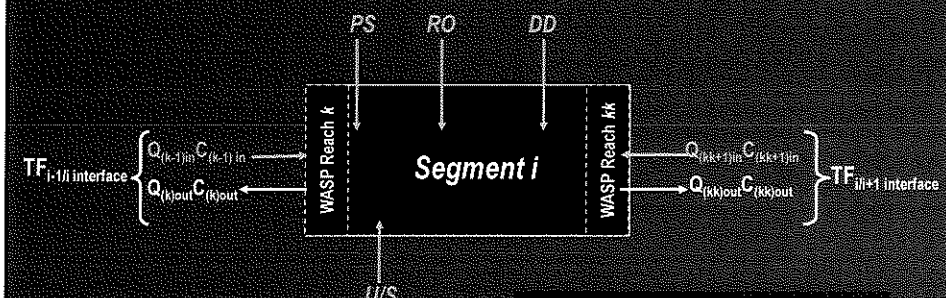


2378-TCDD and 2378-TCDF are similar: sediment contributes more than 90% of load

Remaining congeners: sediment is still a major source, RO and PS from boundaries are also significant

Sed. is majority of load

Spreadsheet conceptual model



PS = point sources
RO = runoff
DD = direct deposition
U/S = upstream load

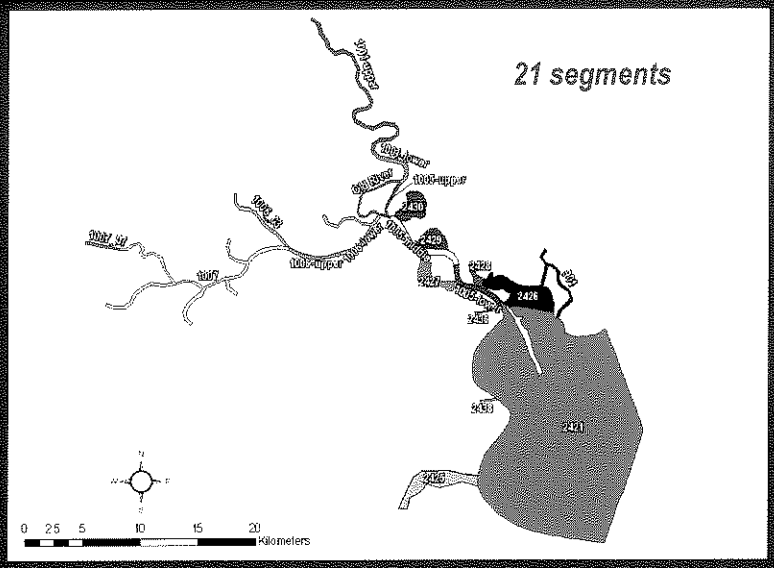
- blue arrows = Gross Load
- Yellow arrows = Net Load

dS = load from sediment = Net –Gross

If dS>0 → sediment is a source

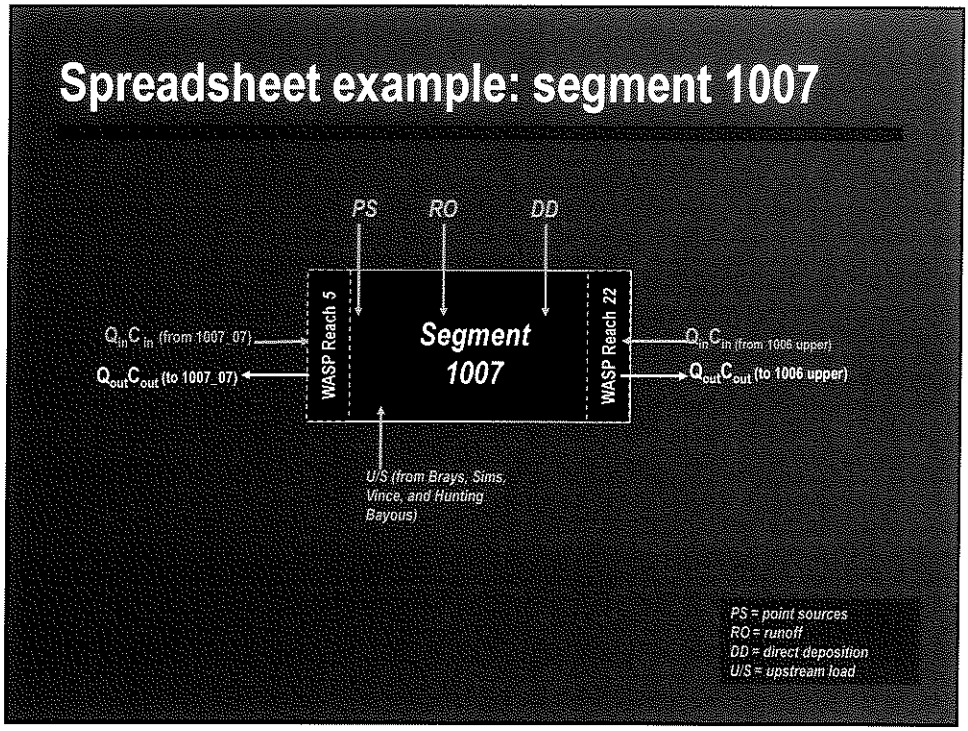
dS<0 → sediment is a sink

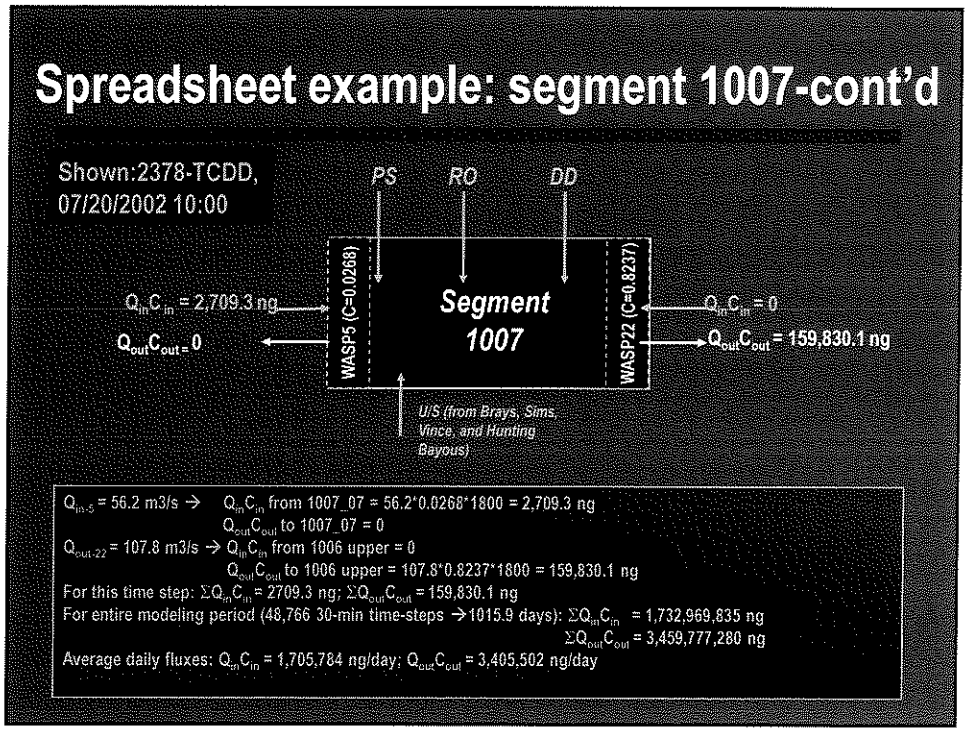
Mass balance spreadsheet segmentation



How does the spreadsheet work?

1. Find flows in and out of the WASP reaches at each end of the WQ segment.
2. Copy dioxin concentrations for the WASP reaches next to all interfaces of a WQ segment (includes WASP reaches within the WQ segment and their adjacent counterparts outside the WQ segment).
3. Calculate the time-step-based individual $(Qin*Cin)\Delta t$ and $(Qout*Cout)\Delta t$ terms appropriate for each WQ segment, based on how it is connected to others within the system.
4. Sum the $(Qin*Cin)\Delta t$ and $(Qout*Cout)\Delta t$ terms for each segment by time-step. These calculations correspond respectively to the mass in and out of the segment during a given time-step.
5. Add the sums obtained in the previous step for the entire simulation period and divide by the number of days in the simulation (1015.9 days). This results in average daily loads in and out of the WQ segment.


Spreadsheet example: segment 1007
PS
RO
DD
WASP Reach 5
Segment 1007
WASP Reach 22
$Q_{in}C_{in}$ (from 1007_07)
$Q_{out}C_{out}$ (to 1007_07)
$Q_{in}C_{in}$ (from 1006 upper)
$Q_{out}C_{out}$ (to 1006 upper)
U/S (from Brays, Sims, Vince, and Hunting Bayous)
PS = point sources
RO = runoff
DD = direct deposition
U/S = upstream load


Spreadsheet example: segment 1007-cont'd
Shown:2378-TCDD, 07/20/2002 10:00
PS
RO
DD
WASP5 (C=0.0268)
Segment 1007
WASP22 (C=0.8237)
$Q_{in}C_{in}$ = 2,709.3 ng
$Q_{out}C_{out}$ = 0
$Q_{in}C_{in}$ = 0
$Q_{out}C_{out}$ = 159,830.1 ng
U/S (from Brays, Sims, Vince, and Hunting Bayous)
Q_{in-5} = 56.2 m3/s → $Q_{in}C_{in}$ from 1007_07 = 56.2*0.0268*1800 = 2,709.3 ng
$Q_{out}C_{out}$ to 1007_07 = 0
Q_{out-22} = 107.8 m3/s → $Q_{in}C_{in}$ from 1006 upper = 0
$Q_{out}C_{out}$ to 1006 upper = 107.8*0.8237*1800 = 159,830.1 ng
For this time step: $\Sigma Q_{in}C_{in}$ = 2709.3 ng; $\Sigma Q_{out}C_{out}$ = 159,830.1 ng
For entire modeling period (48,766 30-min time-steps →1015.9 days): $\Sigma Q_{in}C_{in}$ = 1,732,969,835 ng
$\Sigma Q_{out}C_{out}$ = 3,459,777,280 ng
Average daily fluxes: $Q_{in}C_{in}$ = 1,705,784 ng/day; $Q_{out}C_{out}$ = 3,405,502 ng/day

Mass balance spreadsheet uses

Mass balance spreadsheet

Analysis Mode (with calibrated models)

$dS = \Sigma Q_{out}C_{out} - (PS + RO + DD + U/S + \Sigma Q_{in}C_{in})$

dS

Allocation Mode (with load scenario models)

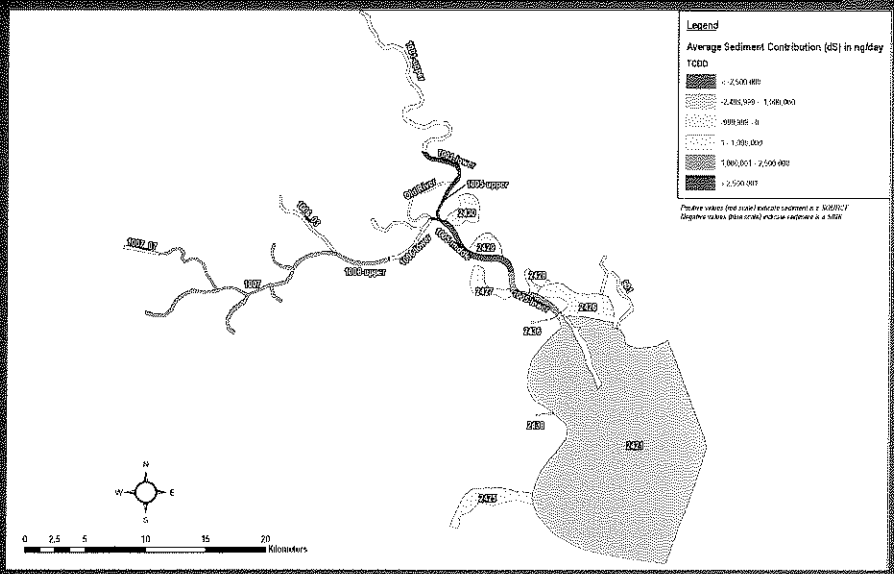
WQ target = f(gross load-internal loss/assimilation)
= f(TMDL- dS)

$TMDL = \Sigma Q_{out}C_{out} - dS$

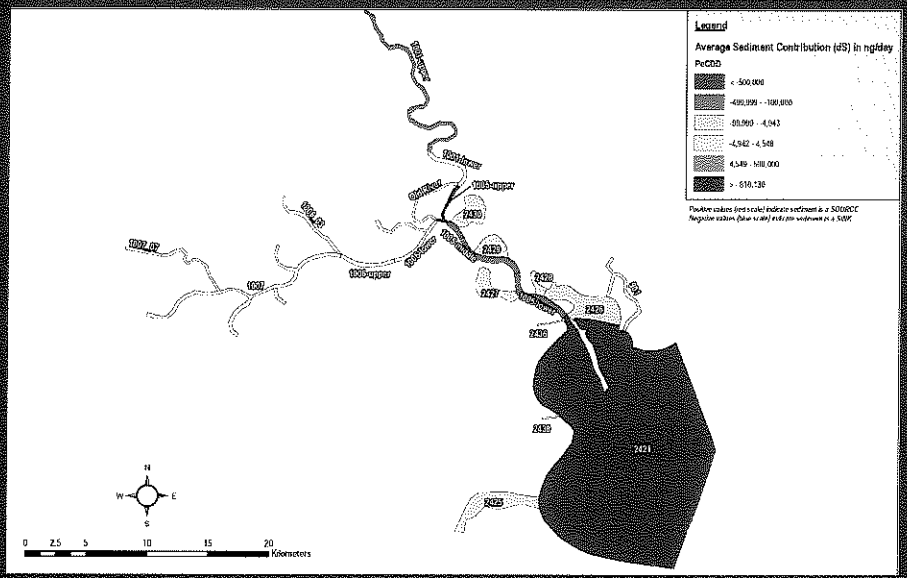
TMDL, load reductions

dS is deposition of sediment
If *dS*>0 internal source
dS<0 sink

Analysis mode : dS in 2378-TCDD



Analysis mode : dS in 12378-PeCDD



Analysis mode : average daily TEQ loads

Segment	Loads (ng/day)							dS action	% load from sediment[c]
	PS	RO	DD	U/S[a]	Σ CinQin	Σ CoutQout	dS[b]		
1007	107,300	71,713	6,906	210,005	2,470,800	5,158,288	2,291,563	Source	85.3%
1006-upper	35,389	10,872	2,442		7,603,710	8,890,673	1,238,259	Source	96.2%
1006-lower	20,129	10,760	3,053	12,273	9,027,631	8,217,018	-856,828	Sink	
1001-lower	1,608	2,174	1,307		7,262,791	12,362,025	5,094,145	Source	99.9%
1005-upper	1,815	547	1,655		18,938,278	26,208,253	7,265,959	Source	99.9%
1005-middle	2,147	2,916	6,065		24,912,227	17,595,047	-7,328,308	Sink	
2427	1,653	7,804	6,694		547,510	579,827	16,165	Source	50.0%
2421	2,042	17,476	378,409		22,264,736	19,083,390	-3,599,272	Sink	
OVERALL	**189,588**	**299,117**	**452,453**	**1,819,134**	**118,621,654**	**128,396,416**	**7,014,469**	**SOURCE**	**71.8%[d]**

Note: only a few segments are shown
[a] Loads from freshwater reaches outside HSC
[b] dS= Σ QoutCout – (PS+RO+DD+U/S)
[c] dS/(PS+RO+DD+U/S+dS)
[d] average daily dioxin flux transported by sediment

For an average day
Total gross load = 22M ng/day
Gross load from sediment = Σ dS⁺ = 19M = 87.5% total gross
Gross load to sediment = Σ dS⁻ = 12M = 55.8% total gross
Sediment-source load in water column = 7M = 32% total gross
Gross load from non-sediment sources = 2.7M = 12% total gross

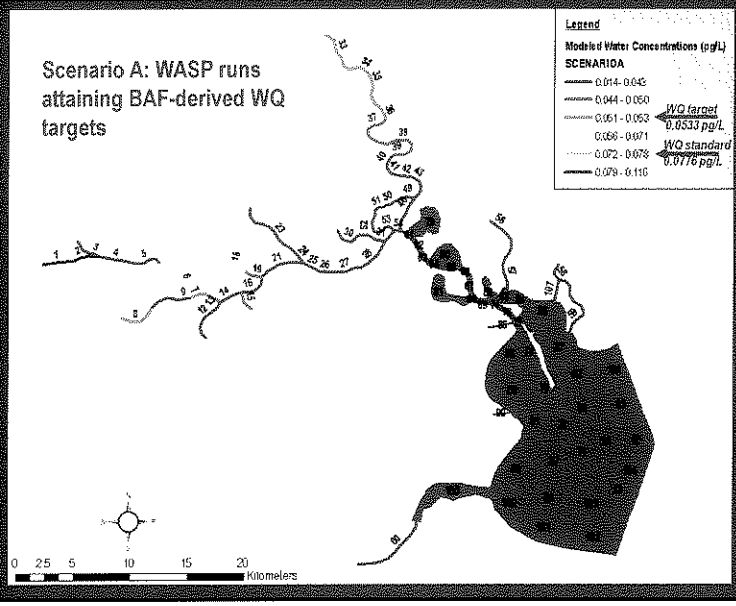
Allocation mode : water quality targets

- Model and analyze by congener, but write TMDL in terms of TEQ
- Alternatives:
  - WQ targets for six major congeners using site-specific BAFs (0.0553 pg/L for 6 congeners). BAFs between 4,000 and 120,000 L/kg. Target for a given congener is:
  - Existing WQ standard (0.0933 pg/L (total) → 0.0776 for six major congeners). Assumed BAF is 5,000 L/kg

Allocation mode : two scenarios

- Scenario A: remove sources so that attainment of the WQ target for each congener is reached everywhere. Attainment is defined as having average concentration for each WASP reach at or below the WQ target.
  - TCDD and TCDF → set initial concentrations in sediment to zero
  - PeCDD → boundary loads (RO&PS) set to zero, concentrations in sediment at hot spots set to zero
  - PeCDF → RO and PS loads and initial sediment concentrations set to zero
  - HxCDD and HxCDF → Boundary loads, PS, RO, and initial sediment concentrations set to zero
- Scenario B: set initial concentrations of sediment to zero everywhere for every congener

Allocation mode : TEQ scenario A



Allocation mode : TEQ average daily loads scenario A

Segment	Loads (ng/day)[a]							Allowable load Option A[c] (ng/day)	Required reduction[d]
	PS	RO	DD	U/S	Σ CinQin	ΣCoutQout	dS[b]		
1007	61,260	32,131	6,906	103,767	128,270	297,004	-35,331	332,335	88%
1006-upper	12,561	4,868	2,442		267,744	261,972	-25,643	287,615	96%
1006-lower	9,854	4,821	3,053	5,029	301,508	296,771	-27,496	324,267	96%
1001-lower	1,017	974	1,307		614,924	600,411	-17,812	618,223	91%
1005-upper	327	245	1,655		827,997	1,453,414	623,190	830,224	96%
1005-middle	622	1,307	6,065		1,581,314	1,068,519	-520,788	1,589,307	94%
2427	1,075	3,499	6,694		32,582	31,723	-12,128	43,850	92%
2421	1,545	7,831	378,409		11,110,547	6,242,893	-5,255,440	11,498,333	49%
OVERALL	99,896	134,050	452,453	852,338	16,923,440	12,688,034	-5,774,144	18,462,178	85%

Note: only a few segments are shown

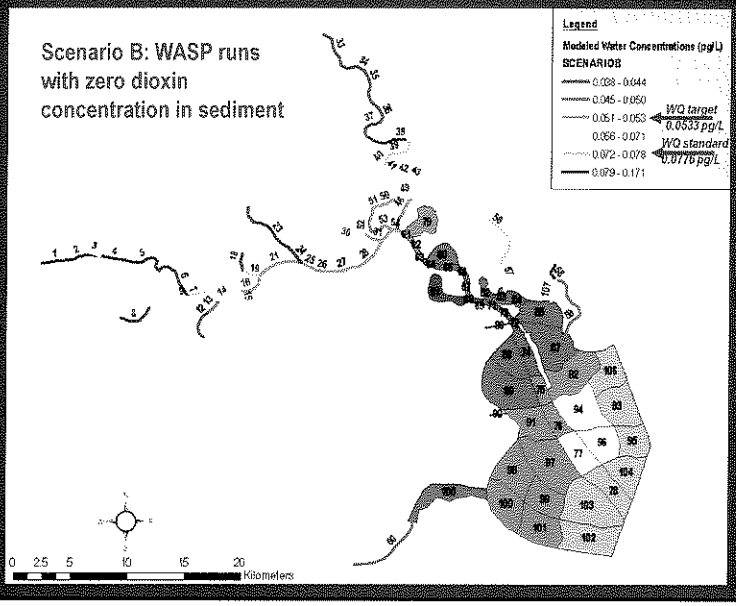
[a] Loads into WASP models that meet WQ targets

[b] dS= Σ QoutCout – (PS+RO+DD+U/S)

[c] TMDL= Σ QoutCout – dS

[d] (Calibration gross-TMDL)/Calibration gross

Allocation mode : TEQ scenario B



Allocation mode : TEQ average daily loads scenario B

Segment	Loads (ng/day)							Allowable load Option B[c] (ng/day)	Required reduction[d]
	PS	RO	DD	U/S[a]	Σ CinQin	ΣCoutQout	dS[b]		
1007	107,300	71,713	6,906	210,005	361,635	635,775	-121,785	757,560	74%
1006-upper	35,389	10,872	2,442		621,829	594,064	-76,468	670,532	91%
1006-lower	20,129	10,760	3,053	12,273	692,687	696,364	-42,377	738,741	92%
1001-lower	1,608	2,174	1,307		1,445,061	1,389,511	-60,639	1,450,150	80%
1005-upper	1,815	547	1,655		1,962,978	3,760,947	1,793,953	1,966,994	90%
1005-middle	2,147	2,916	6,065		4,067,229	3,158,682	-919,674	4,078,356	84%
2427	1,653	7,804	6,694		76,540	73,087	-19,605	92,691	84%
2421	2,042	17,476	378,409		12,507,960	10,337,738	-2,568,148	12,905,886	43%
OVERALL	**189,588**	**299,117**	**452,453**	**1,819,134**	**26,623,065**	**26,320,046**	**-3,063,312**	**29,383,358**	**76%**

Note: only a few segments are shown

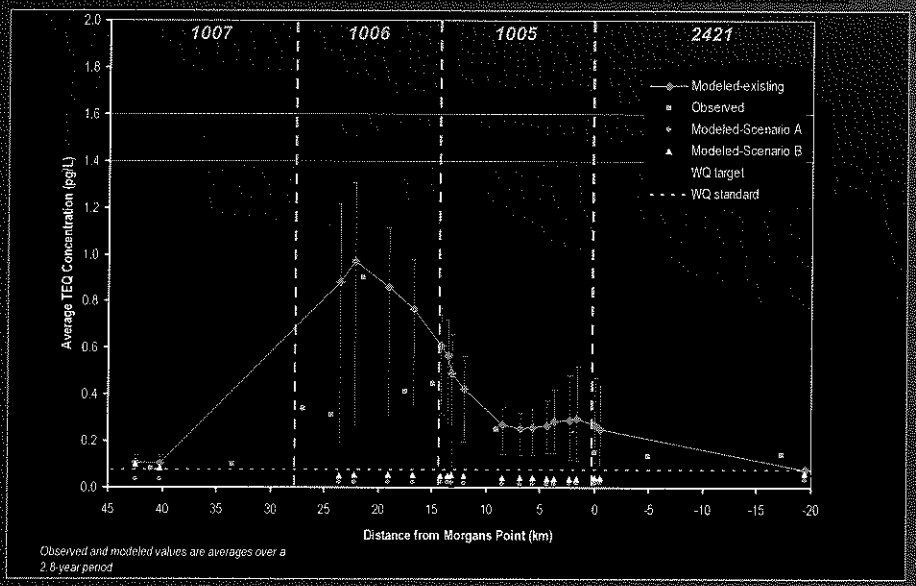
[a] Loads into WASP models that meet WQ targets

[b] dS= Σ QoutCout – (PS+RO+DD+U/S)

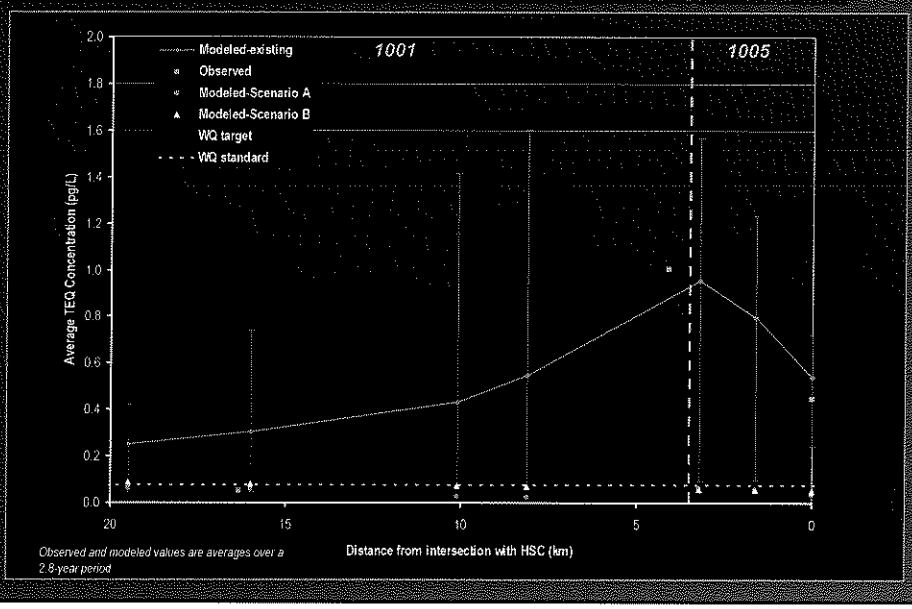
[c] TMDL= Σ QoutCout – dS

[d] (Calibration gross-TMDL)/Calibration gross

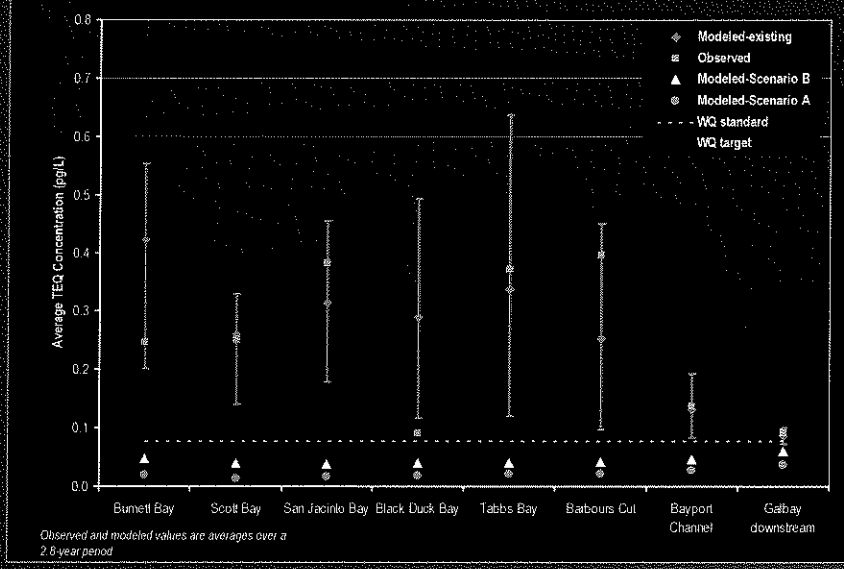
Summary allocation scenarios-main channel



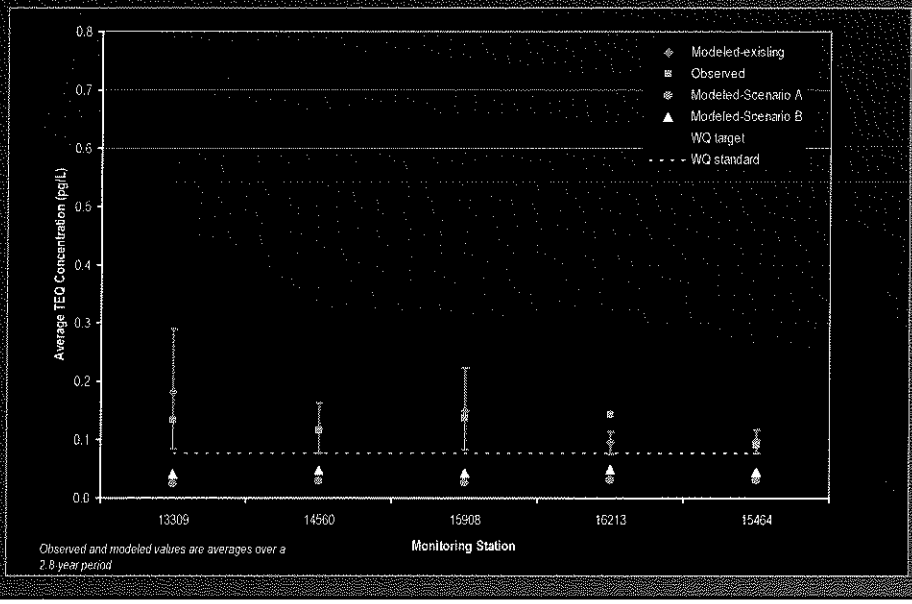
Summary allocation scenarios-San Jacinto



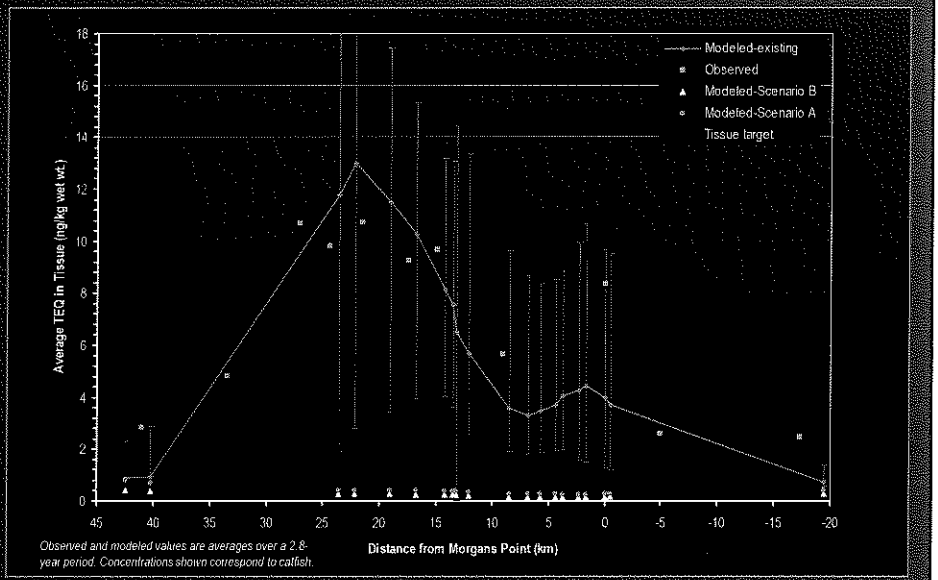
Summary allocation scenarios-side bays



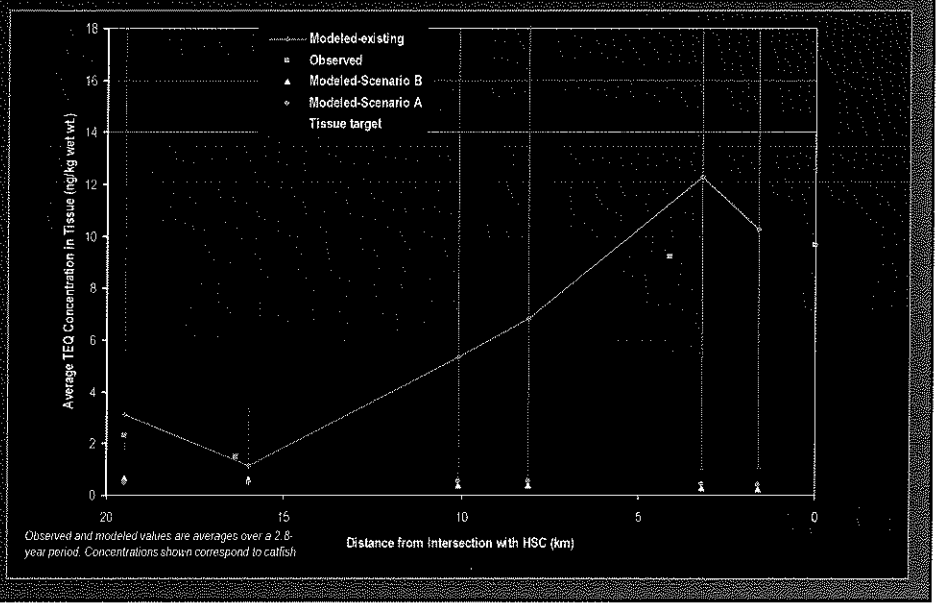
Summary allocation scenarios-Galbay



Tissue concentration verification-main channel



Tissue concentration verification-San Jacinto



Next steps

- Define TMDL (WQ target vs. WQ standard; scenario A or B)
- Develop allocations (LA, WLA, MOS)
- Write TMDL report