DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH FIGHTER WING (ACC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO

03 OCT 1996

MEMORANDUM FOR US EPA Region VI (6PD-O)
Attn: Mr. Jeff Yurk
1445 Ross Avenue
Dallas TX 75202-2733

FROM: 49 CES/CD
550 Tabosa Avenue
Holloman AFB NM 88330-8458

SUBJECT: Sediment Benchmarks and DDT/DDE Egg Residues for Pond G

1. At Atch 1 is a letter detailing the results of a comparison of analytes in the organic sediments of Pond G to various sediment benchmarks. This comparison was conducted as a result of comments received from you during the 3 April 1996 Stakeholders Closure Meeting in Albuquerque.

2. This comparison was difficult for several reasons that are detailed in the letter at Atch 1. Pond G, which is an impoundment of an ephemeral lake in the geologically unique Tularosa Basin, differs in many important ways from both the marine and freshwater ecosystems for which the benchmarks were developed. The benchmarks chosen for this comparison have been published in the open literature or have received some other form of outside review. Benchmarks based only on internal unpublished reports were not used. We found that benchmarks developed for marine environments have received the most outside review. Only one freshwater sediment benchmark for a detected analyte, dieldrin, was found to have had sufficient outside review. However, the marine benchmark for dieldrin was similar and was used for consistency.

3. The only inorganic analyte significantly exceeding a benchmark was silver, which was above the Effects Range Low (ERL) benchmark but below the Effects Range Median (ERM) and the Washington Sediment Quality Standard for Puget Sound. There is reason to believe that the bioavailability of silver is low in Pond G because of the presence of sulfides, as detailed in the attached letter. This is supported by the levels of silver measured in waterfowl and fish, which are not of concern (Risk Assessment Addendum, Radian, March 1996).

4. Although levels of silver found are not expected to impact wildlife, the results indicate the release of excessive silver from past operations at HAFB. The suspected source is photography shops on base, all of which are equipped with silver recovery units. However, the hardness of the potable water on base often interferes with the operation of the silver recovery units. New monitoring procedures and other improvements, such as the use of reverse osmosis units to improve process water quality, have eliminated excessive silver discharges.

5. The organic analytes exceeding benchmarks were 4,4'-DDT and its breakdown product, 4,4'-DDE. 4,4'-DDE exceeded both the ERL and the ERM, but levels were lower when only the most recent samples (1994) were considered. The most recent 4,4'-DDT samples (1994) exceeded the ERL but not the ERM. However, the investigators who developed the ERL and ERM levels indicate low confidence for the DDT and DDE benchmarks because the concentration of DDT and DDE was not closely related to observed effects (see Atch 1). Additionally, these compounds are expected to have lower bioavailability in Pond G than in the marine systems used to develop the benchmarks, because of the significantly higher organic matter content of Pond G sediments, as detailed in Atch 1.

6. Another concern about DDT and its breakdown products was the potential impact on waterfowl eggs and reproductive success. Results from studies summarized in Atch 2 (Evaluation of Duck DDT/DDE Carcass Concentrations) indicate that levels of DDT and breakdown products in Pond G are unlikely to produce egg residues sufficient to impact reproductive success of waterfowl. Although the impacts of DDT and DDE on aquatic organisms, as indicated by sediment benchmarks, are not clear, the predicted egg residues and the results of the Ecological Risk Assessment (Radian, March 1996) suggest that DDT and breakdown products will not impact waterfowl populations.

6. The DDT and breakdown products present in Pond G are thought to result from past efforts to chemically control mosquitoes in the poorly-drained southwest corner of the base. Mosquito control is now accomplished through biological means (mosquitofish), improved wastewater treatment and by carefully selected drainage improvements. DDT has not been used since the 1970's and levels are expected to continue documented declines (Site Characterization Report, Radian, June 1995).

7. Overall, the comparisons reported here appear to support our previous conclusions that constituents present in Pond G are below levels expected to measurably impact the Pond G ecosystem. Please direct questions to Dr. Fred Fisher of the Civil Engineer Environmental Flight (49 CES/CEV) at (505) 475-3931.

Howard E. Moffitt

HOWARD E. MOFFITT
Deputy Base Civil Engineer

Attachments:
1. Comparison of Pond G Organic Sediment Concentrations to Sediment Benchmarks
2. Evaluation of Duck DDT/DDE Carcass Concentrations Relative to Egg Residues

cc (with Atch):

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Rec'd CEV 5 Sep 96 JJ

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Dr. Fred Fisher
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Subject: **TERC Contract DACW45-91-D-0018**
Sewage Lagoons Closure Project
Comparison of Pond G Organic Sediment Concentrations to Sediment Benchmarks

Dear Dr. Fisher:

At the request of Mr. Jeff Yurk, U.S. Environmental Protection Agency (EPA) Region VI, analytes in the organic sediments of Pond G were compared to Federal and State sediment benchmarks as a means of assessing the potential adverse effects to benthic organisms. Pond G data were compared to EPA Sediment Quality Criteria (SQC), Effects Range Low (ERL) and Median (ERM) values, and the State of Washington Sediment Quality Standards (SQS) for marine environments. It should be noted that these benchmarks are intended either for general screening of estuarine and marine sediments (SQC, ERL, ERM) or are site-specific to an ecosystem much different than Pond G, Puget Sound (SQS). A number of site-specific factors affect the bioavailability of sediment contaminants, including pH, organic matter content, clay content/type, grain size, redox potential (EPA, 1996), and acid volatile sulfide (Di Toro, Mahony, Hansen, Scott, Hicks, Mayr, and Redmond, 1990). Many of these parameters are substantially different in Pond G compared to the estuarine and marine sediments used to develop the benchmarks.

Benchmarks Selected for Evaluation

EPA has derived SQCs for five organic chemicals (acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene) using methodology developed for the Clean Water Act (EPA, 1993). Of these five, dieldrin is the only analyte detected in the organic sediment in Pond G. EPA has reported the SQC values in terms of the central tendency estimate and the upper and lower 0.95 confidence limits (EPA, 1993). In this report, the central tendency values are designated SQCC and the lower confidence limit values are shown as SQCL (Table 1). The SQCL values were included in Table 1 to provide more conservative benchmarks.

All SQCs were estimated using the equilibrium partitioning method, which indirectly derives sediment criteria from the ambient water quality criteria based on the hydrophobic nature of a chemical and the sorption capacity of the sediment. The sorption capacity is, in turn, related to the mass fraction of organic carbon in the sediment. The SQCs are presented by EPA (1993) in units of μg/g organic carbon and are so reported here.

ATCH 1

The Washington SQSs are applicable to marine sediments (>25 parts per thousand salinity) located within Puget Sound (Washington State Department of Ecology, 1995). The Washington values are based on empirical data from Puget Sound rather than on indirect calculations from water quality criteria as used by EPA. These standards correspond to a sediment quality that will result in no adverse effects, including no acute or chronic adverse effects on biological resources and no significant health risk to humans. For nonionic organic analytes, the Washington SQSs account for the organic carbon within the medium of concern in a similar manner to the EPA SQCs, and are reported in Tables 1 and 2 as parts per million organic carbon (essentially equals μg/g organic carbon).

ERLs and ERMs were initially developed as internal guidelines for the National Oceanic And Atmospheric Administration's (NOAA's) National Status and Trends Program (Long and Morgan, 1990). These guideline values have subsequently been updated through the expansion and refinement of the sediment database and estimation methodology (Long, MacDonald, Smith, and Calder, 1995). ERL and ERM values were derived from studies of estuarine and marine sediments using laboratory, field, and modeling techniques. The organic carbon content of most of the sediments fell in a relatively narrow range (1-3%) and therefore Long et al. (1995) considered it unnecessary to adjust the benchmarks for organic carbon content.

The ERL value represents the lower 10th percentile of contaminant concentrations associated with adverse effects and is intended to identify a chemical concentration range producing at most minimal effects. The ERM value is based on the 50th percentile contaminant concentrations associated with adverse effects. Chemical concentrations at or above the ERL, but below the ERM, are intended to represent a chemical concentration range where effects are possible. Chemical concentrations equal to or above the ERM are intended to represent a chemical concentration range where effects are probable. The technique was found to be generally effective at delineating chemical effects ranges. However, the incidence of effects was not closely related to chemical ranges for mercury, nickel, total PCB, total DDT and 4,4'-DDE (a degradation product of DDT). For example, the incidence of effects for total DDT was 20% for the minimal effects range, 75% for the possible effects range, and then declined to 53.6% for the probable effects range. The lack of correlation between chemical concentrations and observed effects for these five chemicals implies that site-specific factors may influence their bioavailability.

Benchmarks Excluded from Evaluation

Sediment benchmarks from the State of Florida sediment quality assessment guideline (SQAG) values, and Environment Canada threshold effect level (TEL) values, were also consulted. The benchmarks were both developed by MacDonald Environmental Sciences, Ltd. using the same methodology, and therefore the values are identical. These benchmarks were apparently developed using the same database (biological effects database for sediments, or BEDS) and the same techniques used by Long et al. (1995) to develop ERLs and ERMs. Although some of the Florida and Cañada benchmark values differed from those derived by Long et. al. (1995), the supporting documentation was not available to identify the source of the differences. We decided not to use the Florida and Canada benchmarks, because the same techniques apparently were used as for development of the ERLs and ERMs, and full documentation was not available. Also, Environment Canada considers their values "unapproved working values," and the guidelines document that includes the benchmarks is still in the interim draft stage.

Pond G Data

We selected the two most recent sampling events in 1992 and 1994 as being most representative of current conditions. Non-detect values were replaced with random values between 0.0 and the detection limit (with a mean of 0.5 times the detection limit). The 0.95 upper confidence limit (UCL) for the mean concentration was then calculated for each analyte. A normal distribution was assumed for the pooled 1992 and 1994 data for all analytes except 4,4'-DDT--the only analyte for which tests for normality indicated a lognormal distribution. Additionally, because of the significant decline of DDT and DDE concentrations from 1992 to 1994, the 0.95 UCL for these analytes was also calculated for the 1994 results alone. The resulting values were compared with the benchmarks.

One of the most important ways that Pond G differs from many of the sites used to develop the benchmarks is in the quantity of organic carbon. This parameter has not been measured directly for the organic sediments in Pond G but published values can be used to provide an estimate. The percent organic carbon in domestic sewage sludge is typically 20 to 40 percent as reported by Eckenfelder (1980). In the absence of site-specific organic carbon data for Pond G organic sediment, the organic carbon content was conservatively assumed to be 0.20 (20% percent). To compare the nonionic organic analytes from Pond G with EPA SQCs and Washington SQSs, the organic sediment data were converted from mg/kg dry weight to organic carbon-normalized concentrations (μg/g organic carbon).

Normalized Conc. (μg/g org. carbon) = (μg/g dry wt.) X (100 g dry wt./20 g org. carbon)

Results

Organic Carbon-Normalized Analytes. Analytes in this group were compared with the EPA SQCL, SQCC and Washington SQS sediment benchmarks. Only dieldrin and bis(2-ethylhexyl)phthalate were detected among this group of chemicals and neither exceeded any of the benchmarks (Table 1).

Dry Weight Based Analytes. This group included inorganic chemicals from the Washington SQSs and both inorganic and organic chemicals for which ERLs and ERMs were developed (Long and

Morgan, 1990; Long et al., 1995). None of the inorganic analytes in Pond G exceeded the Washington SQSs or the ERM values (Table 2). Mercury and silver are the only inorganic analytes in Pond G organic sediment that exceeded their respective ERL values. However, Long et al. (1995) reported that mercury effects had poor association with chemical concentration.

The UCL for mercury (0.18 mg/kg) slightly exceeded its ERL value (0.15 mg/kg), but was well below the ERM (0.71 mg/kg). By definition of the ERL, ecological effects are possible. However, mercury concentrations had poor correlation with the incidence of effects (Long et al., 1995). The observed incidence of effects in the probable effects range (concentration>ERM) was only 42%, compared to greater than 60% for all other inorganic chemicals except nickel. Further, it should be noted that the mean of the proxy values (0.14 mg/kg) for the samples in which mercury was either not detected or detected below the reporting limit is very near the ERL. Also, Di Toro et al. (1990) have shown that acid volatile sulfide is known to influence the bioavailability of some metals that form insoluble sulfides (mercuric sulfide is extremely insoluble). Acid volatile sulfide levels are potentially quite high in Pond G because of the biologically active organic sediments combined with the high sulfur availability associated with the gypsiferous soils. Because the accuracy of the ERL is low, the UCL is only slightly greater than the ERL, and high acid volatile sulfide levels are likely to mitigate the ecological effects, current mercury levels are not likely to adversely affect aquatic receptors at Pond G.

The UCL for silver (3.21 mg/kg) also exceeded its ERL value (1.0 mg/kg), but was below the ERM (3.7 mg/kg). By definition of the ERL, ecological effects are possible. However, as discussed above, acid volatile sulfide is known to influence the bioavailability of metals that form insoluble sulfides. Although Di Toro et al. (1990) consider only divalent metals in their analysis of sulfide effects on metal bioavailability, note that silver sulfide (Ag_2S) is less soluble than all divalent metal sulfides except mercuric sulfide (HgS) (CRC Press, 1995). Therefore, silver should be affected by acid volatile sulfide in the same manner as the divalent metals. Although there is some indication of possible ecological effects of silver, the high acid volatile sulfides level in Pond G would mitigate these effects to some extent.

Organic analytes in Pond G sediment were also compared to EPA's ERL and ERM values. The UCLs for 4,4'-DDE (0.0988 mg/kg) and 4,4'-DDT (0.055 mg/kg) exceeded their ERMs (0.027 mg/kg and 0.046 mg/kg, respectively). However, concentrations of 4,4'-DDE and total DDT have shown a relatively low correlation with the incidence of effects. It should be noted that even the means of the proxy values for the samples in which 4,4'-DDE and 4,4'-DDT were either not detected or detected below the reporting limits are above the ERL (the means are 0.012 mg/kg and 0.022 mg/kg, respectively). It should also be noted that DDT is no longer used at the Base, and it was detected in only 1 out of 19 Pond G organic sediment samples collected in 1994. Further, the concentrations of 4,4'-DDE (a degradation product of DDT) in Pond G organic sediment decreased by approximately one order of magnitude from 1992 to 1994, and are anticipated to continue to decline.

Conclusion

On the basis of these comparisons, the constituents detected in Pond G organic sediment are not likely to have major adverse effects on the resident aquatic species. All constituents in Pond G organic sediment, except 4,4'-DDE and 4,4'-DDT, are below EPA SQCs, EPA ERMs, and the State of Washington SQSs. Only the concentrations of silver, 4,4'-DDE, and 4,4'-DDT significantly exceeded their respective ERL values, while mercury concentrations slightly exceeded its ERL. Only the UCLs for 4,4'-DDE and 4,4'-DDT exceeded their ERM values. It should be noted that there is a relatively low correlation between the incidence of effects and the concentrations evaluated in deriving the ERLs and ERMs for mercury, 4,4'-DDE and total DDT. It is difficult to evaluate the potential ecological effects for mercury because the 3 (out of 25) detections are at or near the reporting limits and Long et al. (1995) have shown there is poor correlation between mercury concentrations and ecological effects. However, the tendency to form insoluble mercuric sulfides leads to the tentative conclusion that mercury is unlikely to be a problem.

Sincerely,

Robert Michna

Robert Michna
Task Leader, Sewage Lagoons Closure Project

Attachment

cc: Mr. Warren Neff, Holloman AFB
Mr. Mark Mercier, USACE
Ms. Judy Strawhecker, USACE
Mr. Ron Versaw, Foster Wheeler
Dr. Fred Applehans, Foster Wheeler
Mr. Tom Holcomb, Radian

References

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Washington State Department of Ecology, 1995. *Sediment Management Standards,* December, 1995, pp. 173-204.

Table 1
Comparison of Organic Carbon-Normalized Analyte Concentrations in Pond G Organic Sediment to Federal and State Sediment Benchmarks

Analyte	Detections	UCL [a] Normalized (µg/g oc)	EPA				Washington	
			SQCC [b] (µg/g oc)	UCL > SQCC?	SQCL [c] (µg/g oc)	UCL > SQCL?	SQS [d] (µg/g oc)	UCL > SQS?
Dieldrin	1/25	0.00187	20	NO	9.5	NO	--	--
bis(2-Ethylhexyl)phthalate	6/6	16.12	--	--	--	--	47	NO

Table 2
Comparison of Analyte Concentrations in Pond G Organic Sediments to Dry-Weight Based Federal and State Sediment Benchmarks

Analyte	Detections	UCL Dry Wt. (mg/kg)	Long and others 1995				Washington	
			ERL [e] (mg/kg)	UCL > ERL?	ERM [e] (mg/kg)	UCL > ERM?	SQS [d] (mg/kg)	UCL > SQS?
Arsenic	25/25	3.023	8.2	NO	70	NO	57	NO
Cadmium	0/25	ND	1.2	NA	9.6	NA	5.1	NA
Chromium	23/25	11.77	81	NO	370	NO	260	NO
Copper	24/25	19.36	34	NO	270	NO	390	NO
Lead	25/25	20.37	47	NO	218	NO	450	NO
Mercury [f,g]	3/25	0.1806	0.15	YES [f]	0.71	NO	0.41	NO
Nickel [f]	20/25	8.331	21	NO	52	NO	--	--
Silver	11/25	3.214	1.0	YES	3.7	NO	6.1	NO
Zinc	25/25	48.28	150	NO	410	NO	410	NO
4,4'-DDE [f,h]	19/25	0.0988	0.0022	YES [f]	0.027	YES [f]	--	--
4,4'-DDE (1994) [f]	14/19	0.0408	0.0022	YES [f]	0.027	YES [f]	--	--
4,4'-DDT [f,h]	3/25	0.0550	0.0016	YES [f]	0.046	YES [f]	--	--
4,4'-DDT (1994) [f]	1/19	0.01386	0.0016	YES [f]	0.046	NO	--	--

ERL = Effects range, low.
ERM = Effects range, median.
NA = Not applicable.
ND = Not detected.
oc = Organic carbon.
SQCL = Sediment quality criteria (marine), lower limit.
SQCC = Sediment quality criteria (marine), central tendency value.
SQS = Sediment quality standards.
UCL = Upper confidence limit.
-- = Data not available.

a Sludge and soil data were normalized from dry weight measure to organic carbon-normalized concentrations using the following equation:

Normalized Concentration (μg analyte/g organic carbon) = (μg analyte/g dry wt.) x (100 g dry wt./20 g organic carbon),

where a TOC value of 20% (20 g organic carbon/100 g dry wt.) from Eckenfelder (1980) was used for sludge in the absence of site-specific data.

b SQCCs are the central tendency values derived using the equilibrium partitioning method (EPA, 1993).

c SQCLs are the lower limits of the 95 percent confidence interval derived using the equilibrium partitioning method (EPA, 1993).

d These SQSs are from the Washington State Department of Ecology (1995) and apply only to marine sediments located within Puget sound.

e ERL and ERM values are from Long et al. (1995). Chemical concentrations at or above the ERL but below the ERM represent a range where effects are possible, while concentrations equal to or above the ERM represent a range where effects are probable.

f The ERL and ERM for this analyte should be used cautiously since there is a relatively low correlation, and consequently low accuracy, between the incidence of effects and the concentrations evaluated.

g Mercury was detected in 3 of the 25 samples analyzed and all three results were very near or below the reporting limit. Note that the mean of the proxy values (0.14 mg/kg) for the samples in which mercury was either not detected or detected below the reporting limit is very near the ERL.

h Note that the means of the proxy values for the samples in which 4,4'-DDE and 4,4'-DDT were either not detected or detected below the reporting limit are above the respective ERLs. The mean proxy values were 0.012 mg/kg for 4,4'-DDE and 0.022 mg/kg for 4,4'-DDT.

17-B-49

FOSTER WHEELER ENVIRONMENTAL CORPORATION

April 22, 1996
TERC-002.005-96-008

Dr. Fred M. Fisher, Ph.D.
Water Resources Manager
49 CES/CEV
550 Tabosa Avenue
Holloman AFB, NM 88330-8458

Subject: TERC Contract DACW45-D-0003, Delivery Order 02, WAD 05
Evaluation of Duck DDT/DDE Carcass Concentrations Relative to Egg Residues

Dear Dr. Fisher:

Foster Wheeler Environmental Corporation has completed its evaluation of the significance of duck DDT/DDE carcass concentrations relative to potential egg concentrations to address concerns raised by the U.S. Fish and Wildlife Service during the Holloman Air Force Base Sewage Lagoons Stakeholder Closure Meeting on April 3, 1996.

Our files contained a study by Longcore and Stendell (1977) that related egg residues to carcass residues based on a study of DDE transfer and toxicity in black ducks. They found that DDE residues in the eggs were correlated with carcass residues of hens on a wet-weight basis ($r = 0.917$, $n = 8$, $P < 0.01$) and the relationship approached significance on a lipid-weight basis ($r = 0.693$, $n = 8$: at $P < 0.05$, $r > 0.707$). They estimated that the average egg concentration (wet weight) was about 1.8 times the average carcass concentration (wet weight). They derived the following regression equation to correlate carcass concentrations to egg concentrations:

$$\text{egg concentration (EC)} = 0.428 + (1.699 * \text{carcass})$$

Applying this equation to the waterfowl carcass data from Holloman AFB (Table F-42, Draft Final Risk Assessment Addendum) results in the following egg concentration of total DDT residues (represented as DDx):

2,4'-DDE: 0.012 mg/kg
4,4'-DDD: 0.014 mg/kg
4,4'-DDE: 0.087 mg/kg
4,4'-DDT: 0.00028 mg/kg

DDx: 0.113 mg/kg (or ppm)

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$$EC = 0.428 + (1.699 * 0.620 \text{ mg/kg})$$
$$EC = 0.620 \text{ mg/kg}$$

This estimated egg concentration is not likely to impact reproductive success in ducks at Holloman based on the results of published DDT/DDE toxicity studies. Black duck eggs (n = 36) collected in 1978 with DDE concentrations in the range 0.09 – 3.4 ppm (mean = 0.65 ppm wet weight, similar to the estimated concentration for Holloman duck egg) and mean eggshell thickness was the same as in samples collected before DDT was first produced (Haseltine *et al.* 1980). In the Longcore and Stendell study (1977), the black duck hens in the control group laid eggs (n = 4) that contained an average of 0.39 ppm DDE; the mean hatchability was 95 percent.

Additional toxicity studies have shown that for the brown pelican, considered the most sensitive avian species to the effects of DDT and its metabolites on reproduction, 3 ppm in eggs can cause near total reproductive failure in a population (Blus 1982). However, the bald eagle is considered a moderately sensitive avian species to DDT; ≤ 3 ppm in eggs led to normal reproductive success, while ≥ 16 ppm caused near complete reproductive failure (Wiemeyer *et al.* 1984).

It appears, therefore, that waterfowl carcass concentrations similar to those reported above for Holloman AFB would not be expected to be related to, nor cause, concentrations in eggs that could be considered detrimental to reproductive success.

A list containing the references cited above is attached. Please feel free to call me at (303) 980-3542 if you have any questions.

Sincerely,
Foster Wheeler Environmental Corporation

Fred M. Applehans, D.V.M.
Manager of Risk Services

FMA/lrw
Attachment

cc: M. Mercier - USACE (CEMRO-ED-EA), Omaha, NE
W. Neff - USAF, Holloman AFB
R. Michna - Radian Corp.
R. Versaw
TERC File

ATTACHMENT

REFERENCES:

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