Environmental Standards for Beneficial Use of Dredged Materials in Korea

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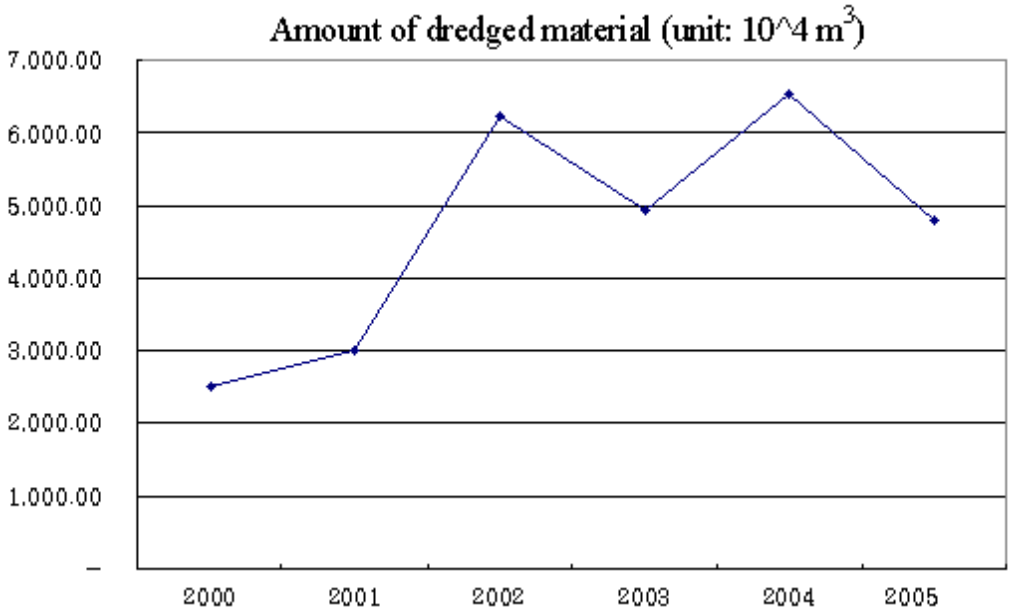
Background



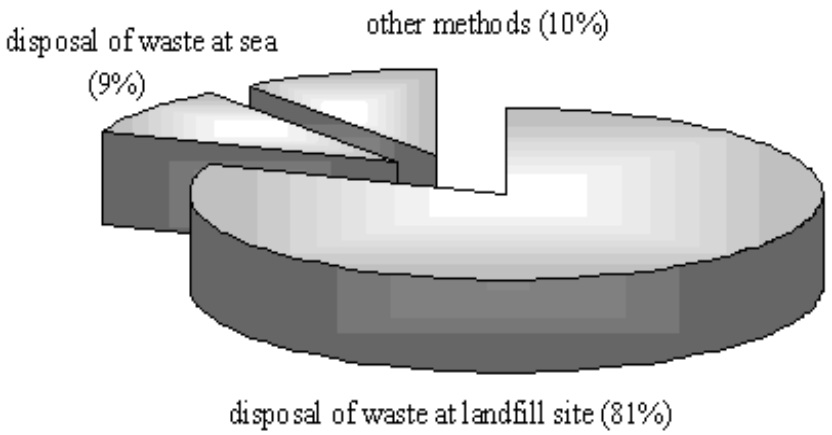


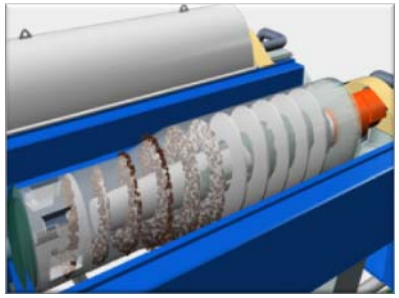
Fig. Annual dredged material and treatment for contaminated sediments (Ministry of Maritime Affairs and Fisheries, 2005)

- In Korea, the amount of dredged material has annually increased.
- Dredged material from most harbors is disposed of as waste materials

Environmental standards for beneficial use of dredged materials in Korea was important to develop

Treatment technique of contaminated sediment (Korea)

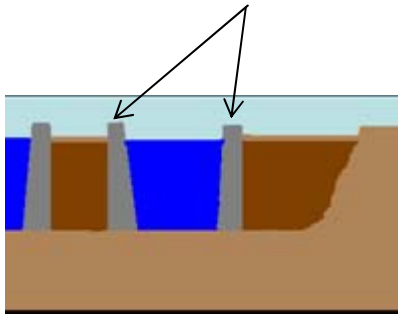
- The new technology of transport and treatment is recently developed.
- Segregated sand, heavy metal segregation, dehydrated cake ⇒ Reuse



Standard for reuse and treatment of dredged material- beneficial use for shore protection (United States)

- There is no standard for building shore protection except for isolated treatment facility
- According to the purpose of usage, decision is made

(USACE, CEFAS, ICRAM, WODA, etc.)



Design Guidance for Confined Disposal Facility Lateral Seepage Control

Examples of foreign environmental standard (United States)

Exhibit A-8. Beach nourishment.

Contaminant	IL[a]	IN[b]	MI	MN[c]	NY[d]	OH	PA	WI[e]
Arsenic	0.05*	3.9	Must be >95% sand	12	7.5			Grain size and color requirements
Lead	0.0075*	81		400	Background			
Zinc	7,500	10,000		1,242**	20			
PCBs	1	1.8		1.2**	1			
Benzo(a)pyrene	0.09	0.5		1.0**	0.061			
Benzene	0.03	0.034		0.034**	0.06			
Criteria Source	Cleanup - Residential	Cleanup - Residential	Use-specific regulation	Cleanup - Recreational	Cleanup - General			Use-specific regulation

All units are in milligrams per kilogram (mg/kg) of material except * in milligrams per liter (mg/L) of leachate.

a. Illinois values are based on the most restrictive exposure route for that contaminant from the TACO Tier 1 residential tables.[73] For ionizable contaminants, a soil pH of 7.0 is assumed for the groundwater ingestion route.

b. Indiana values are based on the RISC tables for a residential soil.[74]

c. Minnesota criteria are based on SRV Tier 2 chronic recreational standards,[96] except for **, which are from SLV Tier 1 standards (Minnesota Pollution Control Agency 1996).[194]

d. New York criteria are based on Department of Environmental Remediation Technical and Administrative Guidance Memorandum 4046: Determination of Soil Cleanup Objectives and Cleanup Levels.[98]

e. The Wisconsin code lists only two explicit criteria, grain size and color. Risk to beach users is addressed qualitatively by limits placed on the source of beach nourishment material. Grain size is limited by requiring the P200 fraction to be no more than 15% of the average fines content (silt and clay, or P200 fraction) of the native beach material. Color is required to be a close match to existing beach soil color.

In federal government, there is no standard for beachfill project established

Examples of foreign environmental standard (Italy)

Action levels

Parameter	BCL (pelite < 10%)	BCL
Trace Elements	[mg kg^{-1}] p.s.	[mg kg^{-1}] p.s.
As	17	25
Cd	0.20	0.35
Cr	50	100
Cu	15	40
Hg	0.20	0.40
Ni	40	70
Pb	25	40
Zn	50	100
Organic Contaminants	[ug kg^{-1}] p.s.	
Organotin* (1)	4.5	
Σ PCB(2)	5	
Σ DDD(3)	1.2	
Σ DDE(3)	2.1	
Σ DDT(3)	1.2	
Chlordane	2.3	
Dieldrin	0.7	
Endrin	2.7	
γ-HCH*	0.3	
Heptachlor-epoxide	0.6	
Σ PAH*(4)	900	
Acenaphthene	7	
Anthracene	47	
Benzo[a]anthracene	75	
Benzo[a]pyrene*	80	
Chrysene	108	
Dibenz[a,h]anthracene	6	
Phenanthrene	87	
Fluorene	21	
Fluoranthene	113	
Naphthalene	35	
Pyrene	153	

Examples of foreign standard (United States-San Francisco)

Recommended sediment guidelines for beneficial use of dredged material

ANALYTE	Wetland Surface Material		Wetland Foundation Material	
	Concentration	Decision Basis	Concentration	Decision Basis
METALS (mg/kg)				
Arsenic	15.3	Ambient Values	70	ER-M
Cadmium	0.33	Ambient Values	9.6	ER-M
Chromium	112	Ambient Values	370	ER-M
Copper	68.1	Ambient Values	270	ER-M
Lead	43.2	Ambient Values	218	ER-M
Mercury	0.43	Ambient Values	0.7	ER-M
Nickel	112	Ambient Values	120	ER-M
Selenium	0.64	Ambient Values		
Silver	0.58	Ambient Values	3.7	ER-M
Zinc	158	Ambient Values	410	ER-M
ORGANOCHLORINE PESTICIDES/PCBS (µg/kg)				
DDTS, sum	7.0	Ambient Values	46.1	ER-M
Chlordanes, sum	2.3	TEL	4.8	PEL
Dieldrin	0.72	TEL	4.3	PEL
Hexachlorocyclohexane, sum	0.78	Ambient Values		
Hexachlorobenzene	0.485	Ambient Values		
PCBs, sum	22.7	ER-L	180	ER-M
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)				
PAHs, total	3,390	Ambient Values	44,792	ER-M
Low molecular weight PAHs, sum	434	Ambient Values	3,160	ER-M
High molecular weight PAHs, sum	3,060	Ambient Values	9,600	ER-M
1-Methylnaphthalene	12.1	Ambient Values		
1-Methylphenanthrene	31.7	Ambient Values		
2,3,5-Trimethylnaphthalene	9.8	Ambient Values		
2,6-Dimethylnaphthalene	12.1	Ambient Values		
2-Methylnaphthalene	19.4	Ambient Values	670	ER-M
2-Methylphenanthrene		Ambient Values		
3-Methylphenanthrene		Ambient Values		
Acenaphthene	26.0	Ambient Values	500	ER-M
Acenaphthylene	88.0	Ambient Values	640	ER-M
Anthracene	88.0	Ambient Values	1,100	ER-M
Benz(a)anthracene	412	Ambient Values	1,600	ER-M
Benzo(a)pyrene	371	Ambient Values	1,600	ER-M
Benzo(e)pyrene	294	Ambient Values		
Benzo(b)fluoranthene	371	Ambient Values		
Benzo(g,h,i)perylene	310	Ambient Values		
Benzo(k)fluoranthene	258	Ambient Values		
Biphenyl	12.9	Ambient Values		
Chrysene	289	Ambient Values	2,800	ER-M
Dibenz(a,h)anthracene	32.7	Ambient Values	260	ER-M
Fluoranthene	514	Ambient Values	5,100	ER-M
Fluorene	25.3	Ambient Values	540	ER-M
Indeno(1,2,3-c,d)pyrene	382	Ambient Values		
Naphthalene	35.8	Ambient Values	2,100	ER-M
Perylene	145	Ambient Values		
Phenanthrene	237	Ambient Values	1,500	ER-M
Pyrene	665	Ambient Values	2,600	ER-M

Source: Table 4, San Francisco Bay Regional Water Quality Control Board (2000).

Examples of domestic environmental standard (Korea)

	Remediation standard of contaminated sediments	
	Lower level	Higher level
Parameter	mg/kg dry weight	
Ag	1	3.7
As	9	41.6
Cd	0.68	4.21
Cr	80	370
Cu	24	108
Hg	0.15	1
Ni	23	52
Pb	50	220
Zn	200	410
Parameter	μg/kg dry weight	
Chlordane	0.5	6
Dieldrin	0.02	8
DDT	1.6	46
tPCB	21.6	189
Parameter	μg/kg dry weight	
Acenaphthene	16	500
Acenaphthylene	44	640
Dibenzo(a,h)anthracene	63	260
Anthracene	85	1,100
Benzo(a)anthracene	261	1,600
Benzo(a)pyrene	430	1,600
Chrysene	384	2,800
Fluoranthene	600	5,100
Fluorene	19	540
2-Methylnaphthalene	-	-
Naphthalene	160	2,100
Phenanthrene	240	1,500
Pyrene	-	-
LPAH	552	3,160
HPAH	1,700	9,600
tPAH	4,000	45,000

The standards were selected considering the density level of the contaminated material and the main contaminants of local sediments

Remediation standard of contaminated sediments (Ministry of Maritime Affairs and Fisheries, 2005)

New environmental standards are needed based on biological effects as well as chemical analyses.

Main contaminated materials from each sea area (Korea)

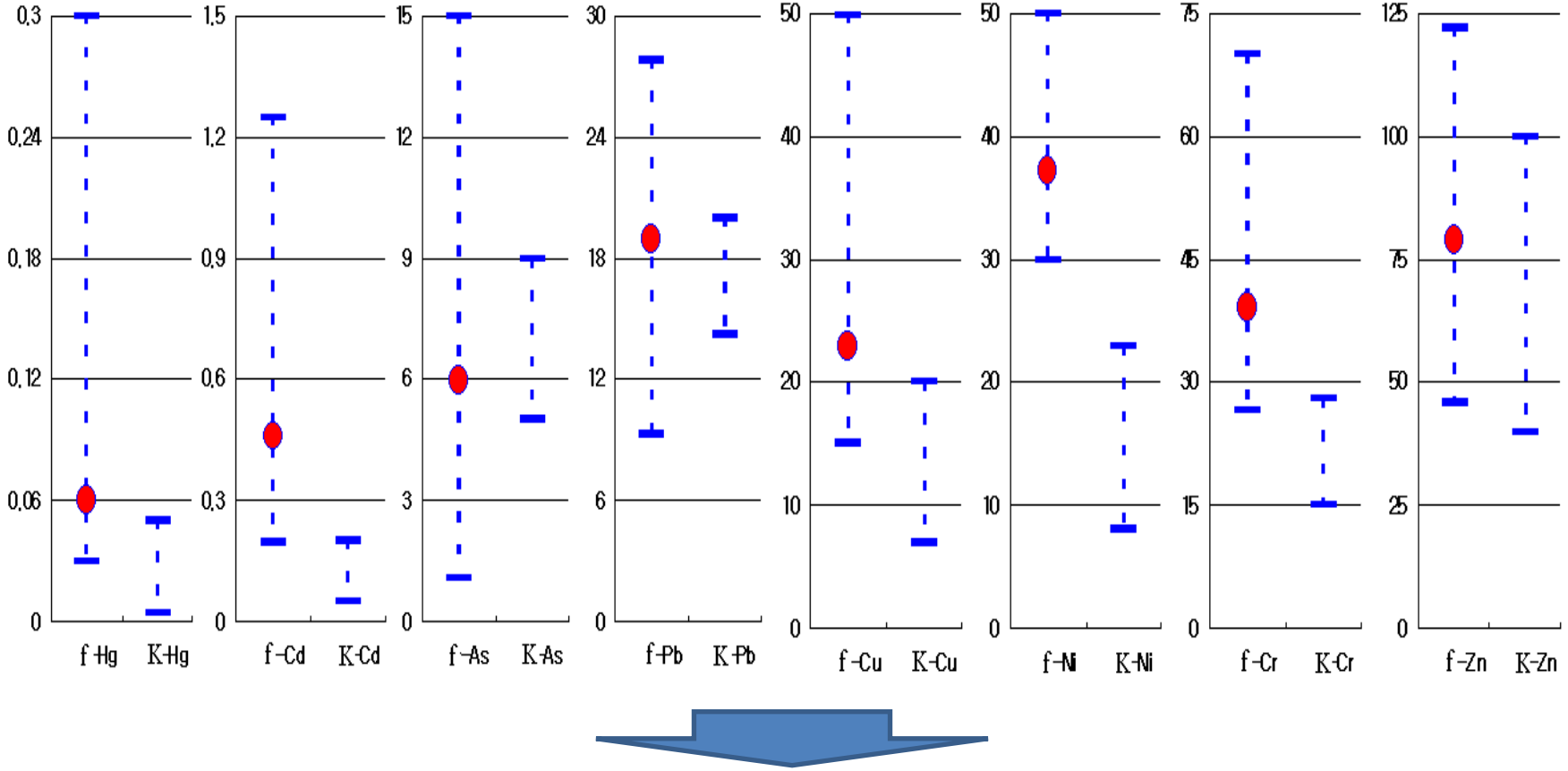
item / location	COD	IL	TOC	Cr	Ni	Cu	Zn	As	Cd	Pb	Hg	Mn	Fe	TBT	tPCBs	tPAHs
Ko-heung	○	○	○	○	○	○	-	-	-	-	-	●	●	○		
Gam-man harbor	○	○	-	○	○	●	○	○	○	○	○	○	●	●	○	
Nam harbor	○	●	○	●	●	●	●	○	○	●	●	○	●	●	●	○
Buk harbor	○	●	-	○	●	●	●	○	○	●	●	○	●	●	○	
Jang-saengpo harbor	●	●	○	○	○	●	●	●	●	●	●	●	●	●	●	-
In-cheon	○	-	-	○	○	●	○	○	-	○	○	○	●	○		
Haengan-man	○	●	○	-	○	●	●	○	○	○	○	○	●	●		
Tong-young	○	●	○	○	○	●	○	○	○	○	○	○	●	●	○	-
Pyoung-taek	○	○	○	○	○	○	-	○	-	-	-	●	●	-		
Po-hang	○	○	○	-	-	●	-	○	○	○	-	-	●	●		
Kwang-yang	-	○	○	-	○	○	-	○	-	-	-	○			●	○
Ma-san	○	●	○	○	○	●	●	○	○	○	○	●	●	●	-	○
Mok-po	-	○	○	○	●	●	○	○	○	○	○	○			●	○
Yeo-su	-	○	○	-	○	●	○	○	○	○	-	●			●	○
On-san	○	○	○	○	○	●	●	○	●	●	○	○	●	●	-	-
Mook-ho	-	○	○	○	○	●	○	○	○	○	○	○	●		○	-
Sam-cheok	-		○	○	○	●	○	○	○	○	○	●	●		-	-
Si-hwa	○	●	○	○	●	●	●	○	○	○	○	●	●			

(○: over low level, ●: over high level)

Professional organizations in Korea have collected data on the sea that have been analyzed by category since 2003

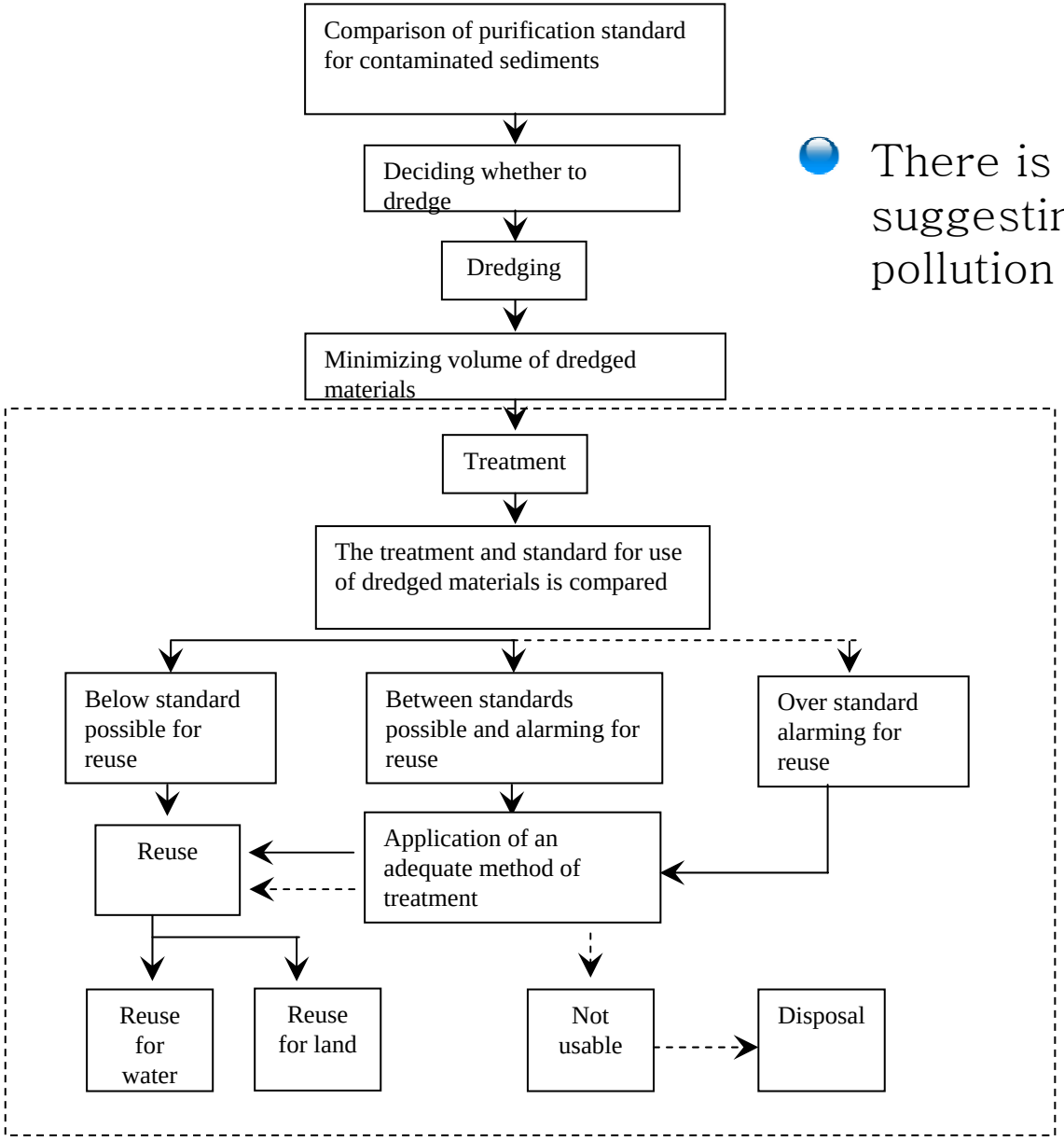
The Cu and Fe levels exceeded the remediation standards for sediments with a high pollution level

Background level of sediments from Korea and foreign land



The background levels of Hg, Cd, As, Pb, Cu, Ni, Cr, and Zn were lower than the levels in foreign countries

Diagram for applying new standard for use of dredged materials



- There is no environmental standard suggesting applicability according to pollution level

New standard suggests "possible for reuse" and "alarming for reuse" as low and high standards that are based on the pollution level

History for developing environmental standard in Korea

- 2006. 2 : Revise the “treatment standard for discharging dredged material to ocean”
  - a newly established treatment standard for discharging dredged material (level 1 and level 2)

- 2007. 6 : Publish a report “standard for beneficial use of dredged material”
  - all dredged material is treated as waste
  - “standard for beneficial use of dredged material" is almost equal to “treatment standard for discharging dredged material to ocean”

- 2007. 12 : Proclaim new Ocean Environment Control Law

Environmental standards in Korea

- treatment standard for discharging dredged material to ocean

categories (unit: mg/kg)	Level 1	Level 2
Cr (mg/kg)	370	80
Zn	410	200
Cu	270	65
Cd	10	2.5
Hg	1.2	0.3
As	70	20
Pb	220	50
Ni	52	35
tPCB	0.180	0.023
tPAH	45	4

- standard alarming for ground pollution

categories	Area 1	Area 2	Area 3
Cd	4	10	60
Cu	150	500	2,000
As	25	50	200
Hg	4	10	20
Pb	200	400	700
Cr^{6+}	5	15	40
Zn	300	600	2,000
Ni	100	200	500
F	400	400	800
organic phosphorus	10	10	30
tPCBs	1	4	12
cyanogen	2	2	120
phenol	4	4	20
benzene	1	1	3
toluene	20	20	60
ethyl benzene	50	50	340
xylene	15	15	45
석유계총탄화수소	500	800	2,000
trichloroethylene	8	8	40
tetrachloroethylene	4	4	25
benzopyrene	0.7	2	7

Suggesting environmental standard in Korea (Yoon, 2008)

Chemical	Standard possible for reuse	Standard alarming for reuse
As (mg/kg)	21	65
Cd	1.55	11.8
Cr	134	652
Cu	60	278
Pb	62	404
Hg	0.32	2.47
Ni	46	123
Zn	247	615
PAHs(ug/kg)	4,000	45,000
tDDT(ug/kg)	3.5	69
tPCB(ug/kg)	28.8	300
TBT (ug/kg)	10	205
Total nitrogen(mg/kg)	1,500	-
Total phosphorus(mg/kg)	500	-

chemical	Standard possible for reuse	Standard alarming for reuse
Naphthalene (ug/kg)	160	2,100
phenanthrene	240	1,500
Fluorantheren	600	5,100
Pyrene	665	2,600
Benzanthracene	261	1,600
Chrysene	384	2,800
Benzopyrene	430	1,600
Chlordane	0.50	6.0
Dieldrin	0.02	8.0
PCB-28	2.0	6.0
PCB-52	1.0	3.0
PCB-101	2.0	6.0
PCB-118	3.0	10.0
PCB-138	4.0	12.0
PCB-153	5.0	15.0
PCB-180	2.0	6.0

- Applicable to: ground treatment, embankment construction, shore protection, replacement compaction, wetland restoration, etc.

Standard for beneficial use of dredged material (approved by Minister of Land, Transport and Maritime Affairs, 2009)

Unit: mg/kg, dry weight

chemical	Limit
Cr	80
Zn	180
Cu	60
Cd	1.5
Hg	0.25
As	18
Pb	45
Ni	35
tPCB	0.023
tPAH	2.64
Total nitrogen	1,500
Total phosphorus	500

Comparison between domestic standard and foreign ones

categories (unit: mg/kg)	Domestic standard (Yoon, 2008)	Spain Reuse for shore protection	Italy Reuse for shore protection	San Francisco Reuse for wet land
As (mg/kg)	21	-	17	15.3
Pb (mg/kg)	62	60	25	43.2
Zn (mg/kg)	200	250	50	158
Cd (mg/kg)	1.55	0.5	0.2	0.33
Cr (mg/kg)	80	-	50	112
Cu (mg/kg)	60	50	15	68.2
Hg (mg/kg)	0.32	0.3	0.2	0.43
Ni (mg/kg)	46	-	40	112
tPCBs(mg/kg) PCB-52 PCB-28,101,180 PCB-118 PCB-138 PCB-153	0.028 0.001 0.002 0.003 0.004 0.005		0.005 - - - - -	0.018 - - - - -
tPAHs(mg/kg) Naphthalene phenanthrene Fluorantheren Pyrene Benzanthracene Chrysene Benzopyrene	2.64 0.16 0.24 0.6 0.665 0.261 0.384 0.43		0.9 0.035 0.087 0.113 0.153 0.075 0.108 0.080	0.0448
TBT(mg/kg)	0.001		0.0045	-
tDDT	0.0035		0.0012	0.0461

- Suggested standard is less strict than the standards of other countries

Comparing environmental standards in Korea

categories (unit: mg/kg)	Standard possible for reuse	treatment standard for discharging	Standard for beneficial use of dredged material
As(mg/kg)	21	20	18
Pb(mg/kg)	62	50	45
Zn(mg/kg)	200	200	180
Cd(mg/kg)	1.55	2.5	1.5
Cr(mg/kg)	80	80	80
Cu(mg/kg)	60	65	60
Hg(mg/kg)	0.32	0.3	0.25
Ni(mg/kg)	46	35	35
tPCBs(mg/kg) PCB-52 PCB-28,101,180 PCB-118 PCB-138 PCB-153	0.028 0.001 0.002 0.003 0.004 0.005	0.025 (PCB 28+52+101+118+138+153+180)	0.023

구분 (단위: mg/kg)	Standard possible for reuse	treatment standard for discharging	Standard for beneficial use of dredged material
tPAHs(mg/kg) Naphthalene phenanthren Fluorantheren Pyrene Benzanthracene Chrysene Benzopyrene	2.64 0.16 0.24 0.6 0.665 0.261 0.384 0.43	4 (Naphthalene+phenanthren+Fluorantheren+Pyrene+Benzanthracene+Chrysene+Benzopyrene)	2.64
TBT(mg/kg)	0.001	-	-
tDDT	0.0035	-	0.0258
Total nitrogen	1500	-	1500
Total phosphorus	500	-	500
Chlordane	-	-	0.00106
dioxin	-	-	0.85ng/kg

Conclusions

- International standards for dredged materials are based on chemical analysis of deposits and biological influence.
- Developing an environmental standard must adjust to the Korean situation for the treatment and use of dredged materials from port areas
- Possible for reuse and alarming for reuse standards for dredged materials were suggested considering the present pollution situation, local contaminated sediment data, and the main contaminants to designate remediation standards of sediments with low and high pollution levels
- Since the levels of the suggested environmental standards here are higher than the background pollution level of Korean sediments, they are appropriate for Korean environmental conditions

Conclusions (continued)

- Other domestic standards for beneficial reuse of dredged materialare reviewed: Waste Material Control Law, the Soil Environment Conservation Act, Standard for discharging dredged material to ocean, Standard Possible for reuse, etc.
- The Standard for beneficial use of dredged material was approved by Minister of Land, Transport and Maritime Affairs on December, 2009.
- A goverment policy to decrease pollution source, reuse of treated waste material is urgent, which is requiring a budget for treatment of reuse and commercialization

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Thank you for your attention !!