



A National Survey of Potential Wetland Hydrology Regional Indicators

by Chris V. Noble, Daniel J. Martel, and James S. Wakeley

PURPOSE: This technical note summarizes the results of a national survey of potential wetland hydrology indicators by personnel representing all Army Corps of Engineers District Regulatory Offices from across the country.

BACKGROUND: The *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987), hereafter called the Corps Manual, presents a short list of indicators of wetland hydrology that is used as part of a three-parameter test for wetland determination. The purpose of hydrology indicators is to provide evidence that the site has a current wetland hydrologic regime. The list includes: recorded gauge data and historical records, visual observation of inundation, visual observation of soil saturation, watermarks, drift lines, sediment deposits, and drainage patterns. The Corps Manual states that "Indicators of wetland hydrology may include, but are not necessarily limited to" the list above. It goes on to describe the indicators and discuss some of the problems associated with each one. While the Corps Manual clearly states that the listed indicators are simply examples, the list has sometimes been interpreted as the only indicators of wetland hydrology that can be used for wetland determinations and delineations. In a memo dated 6 March 1992, four new indicators were added to the official field data form for routine wetland determinations: oxidized rhizospheres, water-stained leaves, local soil survey data, and the FAC-neutral test (U.S. Army Corps of Engineers (USACE) 1992). The addition of indicators in 1992 provides precedent for the further refinement and possible expansion of the list of hydrology indicators.

In 2003 a project was initiated under the Wetland Regulatory Assistance Program (WRAP) to update and revise lists of wetland hydrology indicators for each region of the country. The project is part of a larger, multi-year effort addressing the recommendations of the National Academy of Sciences (National Research Council 1995) to increase the accuracy and regional sensitivity of the Corps Manual. A working group from the U.S. Army Engineer Research and Development Center (ERDC), with the help of Dan Martel of the USACE San Francisco District, developed what they hoped was a comprehensive list of potential hydrology indicators that could be identified readily in the field by trained and experienced Regulatory personnel. The list was then developed into a survey that could be distributed by email to points of contact (POC) in each District that were designated by Regulatory Chiefs. POCs were asked to rate each potential indicator for applicability in that District or region.

METHODS: The survey included all of the indicators currently listed in the Corps Manual and the 1992 field data form, as well as 53 possible additions. The list was sorted and indicators were grouped under the following categories:

1. Indicators based on direct observation of water and/or reduced soil conditions during a site visit.
2. Indicators based on indirect evidence of recent inundation (ponding or flooding).

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3. Indicators based on indirect evidence of recent soil saturation.
4. Indicators based on inferences from other site conditions or data.

The survey was developed in a spreadsheet format that asked the District POC to evaluate each potential hydrology indicator for its application to the following wetland types in the POC's District or region:

1. All wetlands.
2. Depressional wetlands.
3. Seep/slope wetlands.
4. Riverine/floodplain wetlands.
5. Fringe wetlands.
6. Other regional wetland types.

Participants were asked to rate each indicator in each wetland type using the following scale:

- 1 = More than 99% of observations of this indicator are in wetlands.
- 2 = Between 67% and 99% of observations are in wetlands.
- 3 = Between 34% and 66% of observations are in wetlands.
- 4 = Between 1% and 33% of observations are in wetlands.
- 5 = Less than 1% of observations are in wetlands.
- NI = The indicator is applicable in this region, but it is not possible to give it a rating.
- NA = The indicator is not applicable in this region.

Respondents were also asked whether they recommended the indicator for use in the region, or they had no basis to judge the use of the indicator in the region.

RESULTS: Responses were received from all 38 District Regulatory offices. As requested, some large Districts submitted multiple surveys if there were recognized subregions in their Districts that may have differed in wetland conditions. Table 1 shows the frequency of ratings for each wetland type. "NI" and "NA" responses have not been included in Table 1. As might be expected, scores and recommendations varied widely.

One of the more useful questions was "Do you recommend this indicator for use in your region?" For some indicators, the responses were universal. For example, there were 54 (100 percent) "yes" responses for "A. Visual observation of surface water (flooding or ponding)" and for "B. Observed water table within 12 inches of the soil surface." None of the indicators on the survey received 100 percent negative responses. Indicator "NN. Presence of elevated lichen lines on trees, shrubs, or other upright objects" received 30 negative responses out of 37 total responses for the indicator.

Indicators that received mostly scores of 1 or 2 could be viewed as more widely applicable and reliable than those receiving lower scores, if potential regional differences or distinctions among wetland types are ignored. For example, among the indicators not currently listed in the manual or on the 1992 field data form, the following may deserve further consideration: "D. Soil sample from the upper 12 inches changes color upon exposure to air (due to oxidation of ferrous iron)," "E. Sulfidic odor in the upper 12 inches of the soil profile," "O. Presence of crayfish burrows,"

Table 1

Nationwide Average Scores From Survey of Potential Wetland Hydrology Regional Indicators

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit

	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Do You Recommend this Indicator for Use in this Region?	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Yes	No
A. Visual observation of surface water (flooding or ponding)	16	14	4	2	0	6	16	6	0	0	5	8	5	3	3	14	3	3	0	5	17	2	0	0	1	54	0
USE THE LINES BELOW TO RECORD YOUR RATINGS																											
B. Visual observation of soil saturation (rate each of the following variations):																											
B1. Observed water table within 12 inches of the soil surface	20	2	0	0	7	11	5	0	0	8	11	3	0	0	3	14	3	3	0	5	17	2	0	0	7	54	0
B2. Observed water table within 6 inches in sands	16	11	3	2	0	4	9	2	2	0	1	10	1	2	0	11	6	4	0	3	9	3	4	0	6	51	2
B3. Evidence of capillary fringe "saturation" within 12 inches (rate each potential indicator below):																											
B3a. Observed glistening of soil sample	7	26	13	2	0	12	3	0	0	1	10	3	0	0	1	10	5	0	0	1	10	5	0	0	4	39	11
B3b. Gently shaking the soil sample releases pore water	11	16	8	7	0	1	5	3	2	0	1	4	4	2	0	3	5	3	0	1	4	2	5	0	3	35	10
B3c. Squeezing the soil sample displaces pore water	11	16	12	5	1	1	8	3	0	0	1	8	2	0	0	1	5	6	1	0	1	7	3	2	0	32	17
C. Positive reaction to a ferrous iron test in the upper 12 inches of the soil profile	8	7	3	1	0	1	2	1	0	0	1	2	1	0	0	1	2	1	0	0	1	2	1	0	0	23	9
D. Soil sample from the upper 12 inches changes color upon exposure to air (due to oxidation of ferrous iron)	20	8	4	0	0	2	1	1	0	0	3	2	1	0	0	3	2	1	0	0	3	3	1	0	0	29	10
E. Sulfidic odor (hydrogen sulfide) in the upper 12 inches of the soil profile	33	6	2	5	2	3	4	0	5	1	4	2	2	3	2	3	4	1	3	3	4	2	2	3	5	47	3

Table 1 (Continued)

Indicators Based on Direct Observation of Water and/or Reduced Solids During a Site Visit																													
	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?		
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Yes	No							
F. List other regional indicators based on direct observation of water and/or reduced soils	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Indicators Based on Indirect Evidence of Recent Inundation (Ponding or Flooding)																													
G. Watermarks (i.e., stains or elevated silt/pollen lines)	4	11	12	0	0	5	17	10	2	0	1	8	6	5	4	3	20	14	0	0	4	21	6	5	0	6	52	2	
H. Drift lines, wrack lines, or rafted debris	12	14	3	0	0	1	13	7	6	1	1	5	5	4	5	6	16	11	2	0	3	19	6	7	0	7	51	3	
I. Sediment deposits (i.e., thin layers of mineral or organic sediment coating objects on or near the ground)	3	14	9	1	0	2	19	8	4	1	1	8	7	8	2	4	19	8	6	0	5	20	6	4	0	8	49	3	
J. Crusted algae (possibly mixed with other detritus) on or near the ground surface	7	13	3	6	0	5	9	7	3	2	0	7	3	1	6	3	9	5	6	2	3	9	6	4	3	5	42	7	
USE THE LINES BELOW TO RECORD YOUR RATINGS																													
K. Drainage patterns in wetlands (rate each of the following variations)	0	11	9	5	0	0	4	8	0	5	1	13	5	1	5	5	16	15	2	0	1	12	8	4	4	3	46	7	
K1. Presence of braided channels or a network of minor channels	0	8	4	11	3	1	0	2	6	7	0	9	4	4	7	3	12	8	10	0	1	12	4	6	4	4	36	17	
K2. Absence of leaf litter and debris due to removal by flowing water	0	7	8	9	2	0	3	2	3	7	0	6	7	6	5	2	12	12	8	0	1	13	4	6	2	4	30	18	
K3. Scouring of soil from around plant roots	0	5	15	5	2	0	0	3	7	5	0	5	8	3	5	1	15	15	6	0	0	10	7	9	2	3	37	16	
K4. Living plants bent over or lying in the direction of water flow	0	6	9	6	4	1	2	3	0	4	0	4	2	1	5	2	5	8	4	4	2	8	1	2	4	0	26	17	
K5. Flood scars (abrasion) on woody stems	1	17	5	8	0	7	1	4	3	2	2	8	5	3	1	4	14	6	4	1	4	10	6	5	2	6	47	7	
L. Water-stained leaves	1	14	13	3	0	2	12	11	1	2	0	4	5	4	6	1	9	13	2	2	2	12	8	4	0	9	43	9	
M. Presence of surface polygons or mud cracks	9	9	2	2	2	6	5	1	1	0	3	1	1	0	2	5	4	3	2	2	5	3	2	1	0	3	33	7	
N. Presence of live or dead remains of aquatic																													

Table 1 (Continued)

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit																													
	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?		
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		Yes	No	
invertebrates (e.g., gastropods, clams)																													
O. Presence of crayfish burrows	4	14	1	1	5	5	4	3	3	2	1	4	2	2	0	5	9	2	3	2	4	8	3	3	0	4	13	13	
P. Presence of "aufwuchs" or periphyton (the community of freshwater sponges, other invertebrates, and nonvascular plants that cling to inundated surfaces)	5	0	2	0	5	1	1	1	0	2	0	0	0	1	0	0	2	0	0	3	0	3	0	0	0	1	13	14	
Q. Aerial photograph shows the site to be flooded or ponded	8	19	8	4	0	2	14	4	2	0	1	8	3	4	1	3	9	10	0	1	2	15	3	4	0	5	49	3	
R. List other regional indicators of recent flooding or ponding	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Indicators Based on Indirect Evidence of Recent Soil Saturation																													
S. Oxidized rhizospheres in the upper 12 inches of the soil profile (rate each of the following variations)																													
S1. Presence of iron oxide plaques (orange mineral coatings) on the surfaces of living roots	12	23	8	3	0	0	9	2	4	0	1	5	4	3	0	0	8	2	4	0	1	6	3	4	0	2	45	1	
S2. Presence of redox concentrations in the soil adjacent to living roots	15	25	9	3	0	0	6	1	5	0	0	6	2	4	0	0	6	4	3	0	0	6	4	3	0	1	48	2	
T. Presence of muck or mucky mineral material on the immediate soil surface	21	11	5	3	0	10	6	3	0	0	13	6	1	0	0	6	3	5	0	0	5	3	3	2	0	1	43	4	
U. Presence of deep soil cracks due to shrink/swell action (e.g., in Vertic soils)	1	8	12	8	4	2	8	9	1	2	0	0	5	1	4	0	6	9	1	2	0	8	6	2	2	3	26	13	
V. Presence of salt deposits on the soil surface	0	8	8	2	2	5	0	7	2	2	0	4	0	4	2	1	4	2	2	2	0	5	5	4	2	4	26	10	
W. Presence of redox features in the surface	6	10	6	1	2	1	5	3	0	0	0	5	2	0	0	0	6	1	0	0	0	8	1	0	0	0	25	5	

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Table 1 (Continued)

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit																																								
	All Wetlands										Depressional Wetlands					Seep / Slope Wetlands					Riverline / Floodplain Wetlands					Fringe Wetlands	Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?												
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5			Yes	No											
horizon despite churning by soil organisms (bioturbation)																																								
X. Presence of deep impressions in the soil left by heavy objects (vehicles, livestock)	1	10	26	3	2	0	4	7	1	0	0	2	8	0	0	0	4	7	1	0	0	0	4	7	1	0														
Y. Water table is between 12-24 inches of the surface during the dry season or during a dry year	15	13	8	5	3	8	3	4	1	0	4	1	5	3	0	4	2	2	3	0	4	1	4	1	2															
Z. List other regional indicators of recent soil saturation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Indicators Based on Inferences from Other Site Conditions or Data																																								
AA. Site has confirmed hydric soils and hydrophytic vegetation, with no evidence of significant hydrologic alteration	18	22	3	2	0	0	12	0	2	0	0	7	5	2	0	0	7	5	2	0	0	9	2	2	0															
BB. Site is located in a landscape position where water naturally accumulates or discharges (rate each of the following variations)																																								
BB1. Site is located within a small depression	2	10	19	2	0	0	6	16	4	4	0	0	2	0	5	4	0	6	10	2	0	1	5	6	5	0														
BB2. Site is located within a drainage way or on a floodplain	2	3	15	8	0	0	4	8	2	0	1	4	1	10	2	3	10	18	1	0	6	5	5	2	0															
BB3. Site is located immediately adjacent to a lake, estuary, or ocean	0	11	17	5	2	0	3	6	3	2	0	2	0	5	4	1	6	4	3	2	2	6	11	2	2															
BB4. Site is located at the toe of a slope	0	6	14	11	0	0	1	7	4	2	1	15	7	5	2	0	1	8	3	2	0	1	7	3	2															
BB5. Site is located in an extensive flat	0	2	15	7	0	0	2	5	8	0	0	0	2	6	2	0	2	4	6	2	0	0	2	8	0															
CC. Soil profile in the potential wetland has a darker (lower value)	3	10	15	7	1	2	11	8	1	0	2	4	6	3	0	2	6	5	3	0	2	8	5	1	0															

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Table 1 (Continued)

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit																																					
	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?										
																											Yes	No									
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5												
surface horizon than in the adjacent upland																																					
DD. Soil profile includes a shallow, relatively impermeable layer (an aquitard) capable of perching water from rainfall or run-off (rate each of the following variations)																																					
DD1. Presence of a shallow clay layer, hardpan, etc.																																					
DD2. Presence of shallow permafrost or seasonally frozen soil																																					
EE. For an identified soil series, local soil survey data indicates long duration flooding or ponding during the growing season	2	22	10	3	3	5	8	6	0	2	0	7	2	0	5	8	0	2	0	4	0	0	5	1	5	3	2	2		2	39	9					
FF. For an identified soil series, local soil survey data indicates a seasonal high water table within 12 inches of the surface during the growing season	9	26	9	3	0	5	9	0	0	2	0	4	3	2	2	1	7	5	0	0	1	6	6	0	0	0	0	2		45	5						
GG. Vegetation passes the FAC-neutral test	3	20	14	3	0	2	10	3	0	0	2	5	2	1	2	2	6	2	2	0	2	5	5	0	0	0	0		1	40	10						
HH. Presence of OBL herbaceous annual or biennial plants	18	23	8	0	0	2	6	2	0	0	2	6	1	0	2	3	6	0	2	0	2	6	3	0	0	0	0		1	43	5						
II. More than 50% of dominant annual and/or biennial herbaceous plants are rated FAC, FACW, and/or OBL	10	18	19	0	0	2	5	5	0	0	2	3	5	3	0	3	4	6	0	0	2	5	6	0	0	0		3	35	13							
JJ. More than 50% of dominant annual and/or biennial herbaceous plants are	18	26	4	0	0	2	8	1	0	0	2	5	3	2	0	2	9	1	0	0	2	8	2	0	0	0		3	45	3							

USE THE LINES BELOW TO RECORD YOUR RATINGS

Table 1 (Continued)

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit																													
	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?		
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		Yes	No	
rated FACW and/or OBL																													
KK. Presence of live stems or dead remains of true aquatic plants	25	11	8	1	0	8	3	0	1	0	6	1	2	2	0	7	5	1	0	0	8	3	1	1	0	3	40	6	
LL. Presence of Sphagnum or other wetland-specialist bryophytes	9	13	11	2	1	2	5	0	4	0	2	5	0	4	0	2	2	0	4	0	2	3	0	5	0	2	37	9	
MM. Presence of moss lines on trees, shrubs or other upright objects	2	4	16	7	2	1	2	6	1	0	0	1	7	0	0	1	2	6	2	0	1	1	7	0	1	1	20	25	
NN. Presence of elevated lichen lines on trees, shrubs, or other upright objects	1	2	9	8	2	2	1	0	6	0	0	0	1	5	0	2	0	1	5	0	1	0	1	5	1	1	7	30	
OO. Presence of unvegetated (bare) areas within otherwise vegetated sites	1	7	14	6	4	2	13	3	2	2	2	0	6	2	2	0	8	8	1	2	1	4	5	3	2	5	25	20	
PP. Presence of plant morphological adaptations for life in wet situations (rate each of the following variations)	USE THE LINES BELOW TO RECORD YOUR RATINGS																												
PP1. Swollen or buttressed tree bases	1	12	9	2	2	2	5	4	0	2	2	0	3	5	2	2	1	7	6	0	2	1	2	5	2	2	1	32	11
PP2. Adventitious roots	6	11	5	2	5	2	3	6	1	4	0	2	5	1	4	1	6	6	0	4	2	2	7	1	4	2	26	13	
PP3. Prop roots (e.g., mangroves)	4	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	9	23	
PP4. Pneumatophores and/or knees	5	6	4	1	0	0	5	5	0	0	0	0	0	5	2	0	0	7	4	0	0	3	7	0	0	1	19	19	
PP5. Shallow or exposed roots	0	16	13	3	2	4	2	6	0	2	2	4	2	4	2	2	4	2	9	0	0	4	1	9	0	0	29	16	
PP6. Enlarged lenticels on tree/shrub bases or exposed roots	2	12	2	7	0	4	0	1	1	0	0	0	2	0	0	0	1	1	0	0	0	0	2	0	0	0	21	15	
PP7. Stooling or multiple stems	1	5	15	2	5	0	1	2	4	2	0	1	5	6	0	0	2	5	6	0	0	1	1	6	0	1	19	24	
PP8. Floating leaves or stems	18	12	2	1	2	14	4	1	0	2	4	1	1	0	2	11	1	0	0	2	7	1	0	0	2	1	45	1	
PP9. Presence of aerenchyma	13	10	4	1	0	6	0	6	0	0	1	0	4	0	2	7	0	6	0	0	1	0	6	0	0	0	33	9	

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Table 1 (Concluded)

Indicators Based on Direct Observation of Water and/or Reduced Soils During a Site Visit																												
	All Wetlands					Depressional Wetlands					Seep / Slope Wetlands					Riverine / Floodplain Wetlands					Fringe Wetlands					Other Regional Wetland Type (# of responses)	Do You Recommend this Indicator for Use in this Region?	
																											Yes	No
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5			
PP-10. Plant roots are "pruned" within 12 inches of the surface due to a shallow water table	2	11	5	2	0	8										0	4	6	0	0	0	5	1	0	0	0	25	11
X – indicates no response																												

"T. Presence of muck or mucky mineral material on the immediate soil surface," "AA. Site has confirmed hydric soils and hydrophytic vegetation with no evidence of significant hydrologic alteration," and HH and JJ which deal with the presence of obligate and/or facultative wet annual or biennial plants.

Clearly, each indicator needs to be evaluated closely as it applies to each region of the country. Indicators with high frequencies of scores 1 or 2 may have a high potential for application throughout the country. Those with high frequency of scores 3, 4, or 5 are not likely to be useful indicators nationwide, although some of them may be applicable within specific regions or wetland types.

The next step is to focus on individual regions as part of the larger effort to regionalize all aspects of the Corps Manual. This effort has already begun in two regions: Alaska and the Arid West. Interagency working groups in those regions are now developing draft Regional Supplements to the Corps Manual that will contain updated and refined lists of indicators of hydrophytic vegetation, hydric soils, and wetland hydrology that are specific to the regions. The national survey of wetland hydrology indicators has proved to be a valuable starting point for developing regional indicator lists. It has stimulated thought and discussion within the Corps Districts and among other users of the Corps Manual. Although the process of developing regional indicators has started with only state or federal agency participation, draft documents will be subject to independent peer review, probably by university faculty or committees formed by professional societies. Draft documents will also be made available to the private consultant community for their technical insights and suggestions, and distributed for broader public review before being adopted for regulatory use.

POINTS OF CONTACT: For additional information, contact Mr. Chris V. Noble, Environmental Laboratory, U. S. Army Engineer Research and Development Center, Vicksburg, MS (601-634-3482, Chris.V.Noble@erdc.usace.army.mil) or the Manager of the Wetlands Regulatory Assistance Program, Mr. Bob Lazor (601-634-2935, Bob.L.Lazor@erdc.usace.army.mil). This technical note should be cited as follows:

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