



AMERICAN ASSOCIATION OF STATE HIGHWAY  
AND TRANSPORTATION OFFICIALS

COMMITTEE CORRESPONDENCE

May 23, 2003

Address Reply to  
Philip L. Thompson, HIBT-20  
Senior Hydraulics Engineer  
Federal Highway Administration  
400 7th Street, SW., Room 3203  
Washington, D.C. 20590

TO: Members, AASHTO Task Force on Hydrology and Hydraulics  
Officers, AASHTO Subcommittee on Design (Attachment A)

FROM: Secretary

SUBJECT: Minutes of the Spring Meeting, Indianapolis, IN

Attached are minutes of the meeting of the Task Force on Hydrology and Hydraulics held at the Radisson Hotel in Indianapolis, IN on May 12-16, 2003. At the meeting, the task force members extended their appreciation to Merrill Dougherty for his outstanding handling of the meeting arrangements and for setting up the very interesting field trip. All members should check the minutes for action items which are identified with an \* on the left margin.

I would like to thank all the current and past members of the task force for their support and friendship over the 14 years that I have served as secretary. I reluctantly tender my resignation from the task force effective on my retirement from FHWA on June 27<sup>th</sup>. I have enjoyed participating in the last 29 task force meetings, representing FHWA on the task force and assisting in producing the 1991, 1999 & 2003 Model Drainage Manual and the 1992, 1999 & 2003 Highway Drainage Guidelines.

Sincerely,

Philip L. Thompson, P.E.

Enclosures



Chair Merrill Dougherty opened the meeting at 8 a.m. The following members were present unless noted absent or resigned. (See attachment A for addresses):

<b><u>TASK FORCE MEMBER</u></b>	<b><u>STATE</u></b>	<b><u>JOINED</u></b>	<b><u>REGION</u></b>
B. Bailey	Wyoming	1994	4
B. Booher	Arkansas	2002	2
J. Boynton	Minnesota	1998	3
S. Choudhary	Ontario	1998	3 (absent)
G. DeCou	California	1994	4 (absent)
M. Dougherty, Chair	Indiana	1994	3
M. Fazio	Utah	2001	4
P. Helms	South Carolina	2001	2
D. Henderson	North Carolina	2000	2
M. Miles	Alaska	2000	4
R. Mills	Virginia	1999	2
B. Newman	Pennsylvania	1997	1
F. Nishioka	Hawaii	1991	4
T. Ngo	Oklahoma	1991	4
M. O'Connor/Bob Dawe	Illinois	2001	3 (absent)
R. Phillips	South Dakota	2002	4
L. Reese	Idaho	1996	4
R. Renna	Florida	2001	2
J. Richardson, Vice Chair	Kansas	1996	3 (absent)
N. Schips	New York	2002	1 (absent)
D. Stolpa	Texas	2001	4 (absent)
P. Thompson, Secretary	Washington, DC	1989	1
Duc minh Tran	Quebec	1999	1 (absent)
R. Veeramachaneni	Maryland	1997	1

#### **VISITORS PRESENT** (see attachment B)

#### 1. **MEETING SUMMARY**

**MEETING AGENDA** (See attachment C)

**PAST MEETINGS** (Minutes available from Secretary)

<b><u>YEAR</u></b>	<b><u>MEETING</u></b>	<b><u>ZONE</u></b>	<b><u>LOCATION</u></b>	<b><u>DATE</u></b>
2003	65-Fall	4	Cody, WY	October
2004	66-Spring	2	Little Rock, AR	May
2004	67-Fall	4	TX	October
2005	68-Spring	2	SC or NC	May

## 2. WELCOME AND INTRODUCTIONS

- A. Chair Merrill Dougherty welcomed the members of the task force and:
- Asked everyone to introduce themselves (see attachment B for visitors).
  - Noted that the meeting registration cost would be \$85.
  - During the business meeting, thanked Philip Thompson, secretary, for his support of the task force and presented him a plaque in recognition of his service since 1989.
- B. Merrill introduced Tim Jeffers, INDOT chief of staff, who welcomed the task force and provided the following remarks:
1. He is also Deputy Commissioner of Highway Operations and manages about 80% of the 4800 INDOT employees. He came to the DOT after working 8 years for the IN Speaker of the House.
  2. He indicated that Indiana is the “Cross Roads of America.”
  3. INDOT awards about \$100M in road construction which should help the economy that is not in the best shape. The highest profile project is the “hyper fix” which is a project where I-66/I-70 come together. The project involves two interchanges that are split. The section between the interchanges will be closed for the 85 days of the design/build project that will cost \$30M. Another large project is moving I-70 south of the airport which the task force visited.
  4. INDOT is initiating “Hosier Helpers” which is a motorist assistance program and a traffic management center.
- C. Merrill described highlights of the field trip and the group dinner on Wednesday.

## 3. BUSINESS MEETING ACTIVITIES (Monday & Friday)

- A. Membership - current
- B. Treasurer Report - current.
- C. Officers - Since this was the end of Merrill’s two year term, new officers were elected. Unfortunately, vice-chair Jim Richardson had to decline being chair, because of travel funding problems. Merrill will notify the SOD chair that the new chair is Raja Veeramachaneni of MD and the vice-chair is Barry Newman of PA. In addition, this meeting was the last for the secretary, Phil Thompson, who will be resigning from the task force and retiring from FHWA at the end of June.
- D. The chair or secretary discussed the following attachments:
- A. Membership List
  - B. Visitors List
  - C. Agenda
  - D. HDG & MDM Status and assignments (updated this meeting)
  - E. Task Force Publication History
  - F. Scour Evaluations Progress Report
  - G. FHWA Technology Applications
  - H. FHWA NHI Training Activities
  - I. FHWA Publication List (not handed out)
  - J. FHWA Software List (not handed out)
  - K. Status of NCHRP projects and Prioritized list of proposed FY 2005 projects
- E. Handouts - The following items were provided before or at the meeting:
1. For NCHRP 15-23, Roy Jorgensen provided CDROM with 2003 SI & US MDM and 2003 Dual unit HDG to all reviewers. The secretary consolidated comments and emailed them to all reviewers.
  2. For NCHRP 15-23, Ken Shearin, Roy Jorgensen, provided a hard copy of the final draft 2003 SI MDM & HDG to chair and secretary before the meeting.
  3. HDG 15, Guidelines for Selecting and Utilizing Hydraulics Engineering Consultants was handed out at the meeting and a camera ready copy was provided to Jim McDonnell by Raja Veeramachaneni.
- \* F. Future meeting locations were discussed and sites selected (see page 1). The Fall 2003 meeting will be held at the Holiday Inn in Cody, WY (\$65/day) which is about 50 miles from the east gate of Yellowstone Park. Cody can be reached by air from Denver or Salt Lake City or by car from Billings, MT. The Spring 2004 meeting will be in Little Rock, AR. The Fall 2004 meeting will be held in Texas. The Spring 2005 meeting will be in SC (Preston Helms will report at next meeting if he

receives permission to host). NC will be the alternate.

G. The following agenda items are proposed for the next meeting:

1. Resolution of SOD ballot comments of rewrites for 2003 Dual unit HDG and US customary MDM, if needed
- \* 2. Topics for new guidelines (HDG chapters) - possible topics are: MS4 guidelines, workflow processing guideline, marketing, ground water hydraulics, hydroplaning.
- \* 3. Enhancements to MDM & HDG - Each chair will identify proposed improvements.
  - a. The secretary distributed the list of enhancements that was developed by Roy Jorgenson reviewer's after the meeting.
  - b. Items identified at Spring 2003 meeting are:
    - (1) MDM- Should NPDES discussion be expanded?
    - (2) MDM - Should environmental "buy out" for permits be discussed?
    - (3) MDM - Why duplicate HECs?
    - (4) MDM 8 - Should natural channel design be included?
    - (5) MDM 12 - Consider storm water management (quality and quantity).
    - (6) MDM 15 - Should fish passage be moved to somewhere else?
    - (7) MDM 17 - Consider including NCHRP 24-19 results.
    - (8) HDG - Why should we have separate guidelines?
    - (9) HDG 4 & 9 - Should management systems be discussed (see NCHRP Synthesis 303)?
- H. See attachment D which contains assignments for MDM & HDG chapters. Chair indicated that the assignments of the resigning secretary would be handled by new secretary for now.
- \* I. The Chronicles were discussed at the 10/02 meeting. Phil and Dan agreed to add items such as the numerous visits that were made to the Creamery when we met at PSU. Recommended that pictures be added and Te agreed to provide some electronic pictures.
- J. Jim McDonnell provided a handout and briefed the task force on AASHTO activities:
  - \* 1. Pointed out at a previous meeting that the web site [design.transportation.org](http://design.transportation.org) contains links to State DOT manuals. He requested that members provide links to their manuals on line.
  2. TEA21 reauthorization [SAFETEA] - AASHTO proposes same funding categories, including retaining enhancements. The funding should be \$34B in FY 04 to \$45B in FY 09. The projected needs are \$90B/year. See web site for funding alternatives which include a Transportation Finance Corps.
  3. Discussed Accessible Public Rights-of-Way, [www.access-board.gov](http://www.access-board.gov), indicated that tabling of intersections may affect hydraulics.
  - \* 4. Task Force is requested to have a speaker at the upcoming June 12<sup>th</sup> SOD meeting in Boston. Barry Newman agreed to represent the task force.
  5. Future SOD meetings will be 2004 in Utah with Standing Committee on Environment and in 2005 they will meet with the TRB Subcommittee on Geometric Design.
  - \* 6. He noted that the AASHTO web site for the task force is static. It now only contains membership and the recently added minutes of the last four meetings. He recommended that the task force consider adding other material.
  7. Bridging Document will be published this year and is the result of NCHRP project. The document will address legal liability for contact sensitive design. The document will be between the Green book and the FHWA Flexibility Document.
  8. Task Force was asked to review AASHTO glossary of terms. The CDROM was viewed and it was decided to retain all the HDG & MDM Glossary terms.
  9. He noted that the NCHRP contractor could send copies of the final deliverable CDROM to task force members [FHWA reviewers should also be included.]. The 2003 MDM and HDG will be balloted by SOD. Three alternates for review are printed, CDROM or web. The ballot period will be for 30 days. Comments will be sent to the Chair. After comments are resolved, SCOH ballot period will be 30 days. If passed, it will take about 8 weeks to publish.
  10. HDG 15 will be formatted by AASHTO staff and will not be included with 2003 HDG for SOD ballot. Secretary agreed to provide formatting guidelines to Jim.

#### 4. **FHWA ACTIVITIES AND SCOUR EVALUATION PROGRESS REPORT**

Phil Thompson briefed the task force on the status of FHWA priorities and organization, Technology Applications projects, and NHI course development. Peter Osborn discussed the reorganized FHWA Resource Center. Jorge Pagán provided an update on scour evaluation activities. (Some FHWA publications are available at [isddc.dot.gov](http://isddc.dot.gov).)

- A. Phil provided a handout of his Power Point presentation (to view a similar presentation from Western Hydraulics Conference go to [http://www.cflhd.gov/design/hyd/presentation02a\\_thompson.pdf](http://www.cflhd.gov/design/hyd/presentation02a_thompson.pdf))
- B. The following is a summary of items discussed from attachments G and H:
  1. Users Manual for FESWMS (Flo2DH) is complete.
  2. Overview of NHI 135081, Introduction to Highway Hydraulic Software, will be provided by Roger Kilgore.
  3. Updated SI nomographs for HDS 5 were recently posted.
  4. HY8InpGen software was updated to fix a problem with constant tailwater.
  5. Pump Station software is being finalized and will be available by July.
  6. New NHI course has been funded for Tidal Hydrology, Hydraulics & Scour
- C. The overview of scour evaluations progress was provided by Jorge Pagán. Jorge provided a handout of his Power Point presentation (to view a similar presentation from Western Hydraulics Conference go to [http://www.cflhd.gov/design/hyd/presentation03\\_pagan.pdf](http://www.cflhd.gov/design/hyd/presentation03_pagan.pdf). Attachment F was provided which indicated a Summary of Scour Evaluations Nationwide. He also provided a copy of a Generic Plan of Action. Jorge noted the following which is summary of 4/15/03 data:
  1. Only 150 of 484,479 bridges over water have not been screened. Of bridges screened, 18.1% (87,927 bridges) have unknown foundations.
  2. 93.3% (370,165) of 396,552 bridges needing evaluation have been evaluated for scour and 6% (27,338) still need evaluation.
  3. 8 DOTs have completed 100% and 35 DOTs have completed more that 90% of needed evaluations (10 > 90%, 7 > 95% and 18 > 98%), see attachment F (Part 2)
  4. 9 DOTs have not completed 90% of their needed evaluations (5 > 80%, 3 > 70%, & 1 @ 65 %).
  5. 24 DOTs have over 1000 bridges to evaluate if unknown foundations are included.
  6. When unknown foundations are included, only 18 DOTs have completed > 90%.
- D. Research Topics - not presented, see [www.tfhrcc.gov](http://www.tfhrcc.gov) or contact Sterling Jones, FHWA.
- E. Peter Osborn, Technical Service Team Leader for the Geotechnical & Hydraulics (G&H) Team of the FHWA Resource Center, discussed the following using a Power Point presentation (available from the secretary).
  1. The Resource Center (RC) is now one RC in four locations. In the case on the G&H Team, five locations since Larry Arneson and Barry Seil are in Lakewood, CO.
  2. The RC Vision is to be the best at deploying transportation technologies.
  3. The RC mission is to advance the use of transportation technologies through training and technical assistance.
  4. The RC provides technical assistance, training and technology deployment, but has no program authority or project approval authority.
  5. FHWA changed from 9 Regions to 4 RC in September 1998. In 2003, changed to one RC with 4 locations. The RC works closely with headquarters. The RC provides expert technical & program assistance, interagency coordination, technology transfer and training.
  6. The RC now has 10 Technical Service teams. The G&H team and the Structures team are located in Baltimore, MD. The hydraulics engineers on the team are Larry Arneson, Dan Ghery, Joe Krolak (thru June) and Cynthia Nurmi.
  7. In addition to discussing the services available from the other teams, he indicated that each RC location will have the following services: administrative staff, information analysis, marketing, strategic planning/quality journey, technology and innovation deployment.
  8. He answered questions on RC operations.

5. **NCHRP**

Timothy Hess, NCHRP Program Officer who handles hydraulics, geotechnical and roadside design, provided an overview of NCHRP projects related to hydraulics. He provided a handout of his presentation slides (some of the material below was provided at earlier meetings):

- A. Background - TRB is a unit of the National Academy of Sciences which is the operating arm for the National Academies. TRB has 5 Divisions. The two divisions of most interest to the task force are Division A Technical Activities and Division D Cooperative Research Council. NCHRP started in 1962 and the Transit CRP started in 1992. NCHRP has 13 FTEs that administers 157 active panels with 1039 panel members. The CRP homepage is [trb.org](http://trb.org).
  1. Financial support is from State DOTs which provide a 5.5% contribution from their State Planning and Research Federal-aid funds. The contribution is voluntary and comes through FHWA. The funding was \$3.5M in 1968, \$8.5M in 1991, \$15.3M in 1992 and \$17.7M in 1997. TEA21 increased funding to \$27M through 2003.
  2. Division B synthesis projects are provided funds by SCOR through project 20-5 which is managed by Jon Williams ([JWilliams@nas.edu](mailto:JWilliams@nas.edu)).
- B. Problem Statements - Ideas come from States, AASHTO and FHWA.
  1. TRB committees can submit statements through AASHTO subcommittees.
  2. The review process begins on June 1 with problem statements, FHWA and NCHRP review the statements. The revised statements must be submitted to NCHRP by November 1 in order to be considered at the March SCOR meeting. Both Research Advisory Committee and SCOR rank projects and then a combined ranking is prepared.
  3. Most awards go to industry, 45%, and universities, 36%. About 90% of projects are published.
  4. The task force members should send proposed projects to: Robert J. Reilly, Secretary, Standing Committee on Research, TRB, 2101 Constitution Avenue, Washington, D.C. 20418.
- C. NCHRP Project Status Reports for Hydrology and Hydraulics (updated 5/13/03). Current status can be found at <http://www4.nationalacademies.org/trb/crp.nsf/NCHRP+projects>
  1. 21-5(2) Unknown Foundation Instrumentation - research has stopped, final report is complete and will not be printed. Report will be made available as an agency report.
  2. 24-7(2) Countermeasures - \$450k Ayres will include partnering with states for field verification. Phase 1 report is available for loan. Phase 2 guidelines start 4/01 for 3 years to 10/2004.
  3. 24-14 Scour at Contracted Bridge Sites - \$500k Art Parola/Dave Mueller - interim report, complete June 2003. USGS is matching with \$500k. Final report is due.
  4. 24-15 Bridge Scour in Cohesive Materials - \$350k TX A&M, have draft final report, complete 8/2002. The panel received \$400k for FY 2003 to study abutments. The project is finished and the report is going to publication.
  5. 24-16 Channel Migration - \$550k Ayres, Pete Lagasse, extended to 6/2003 to include photo interpolation handbook.
  6. 25-12 Wet Detention Pond Research - \$580k by David Young of WSU, final report is being published.
  7. 21-07 Development of Portable Scour Monitoring Equipment - \$300k Ayres, Jim Schall, started 4/00 and is complete. Final report will be printed soon.
  8. 24-8, Scour at Bridge Foundations Research Needs - FY 98 three projects were funded from list: 24-14, 24-15 and 24-16. No projects funded in FY 99 or 2000 and 3 in FY 2001.
  9. 15-23 Technical support for MDM and HDG - \$279k (see below), \$79k added in FY 2003.
  10. 24-18 Countermeasures to Protect Bridge Abutments - #12 on 24-8, \$450k, Brian Bartoff has 3 year contract to July 2004. New contract will be issued to Michigan Tech Univ, August 2003.
  - \* 11. 24-19 Environmentally Sensitive (Non-structural) Channel & Bank Protection - \$350k, John McCallum, Redding, CA (see Erosion draw and Biodraw software) awarded 6/2001, target completion 5/2004 If a MDM chapter is needed, a continuation should be requested.
  12. 24-20 Prediction of Scour at Bridge Abutments - \$500k, contract awarded 4/2002 to Robert Ettama, University of Iowa, complete 10/2005. Project is limited to sand material.
  13. 20-07(146) Development of Software Verification Protocol for Hydrologic and Hydraulic Models - \$100k, panel members are: Saeed (chair), Barry, Te, Mark, Bill and Joe Krolak. Awarded to Univ. of SC recently for 1-year, \$100k

14. 15-24 Hydraulic Loss Coefficients for Culverts (FY 2003) - \$325K project awarded to USU and has a 2006 completion.
  15. 24-23 Riprap Design Criteria, Specifications, and Quality Control (FY 2003) - \$350K project awarded to Ayres Associates with a 2006 completion.
  16. 24-24 Criteria for Selecting Hydraulic Models (1D/2D) (FY 2004)
  17. 24-25 Risk-based Guidelines for Determining the Need for Investigation of Unknown Bridge Foundations (FY 2004)
  18. 24-26 Effects of Debris on Pier Scour at Bridges (FY 2004)
- D. NCHRP Projects for 2001 - 3 of 5 (60%) task force submitted projects approved. Overall success rate is 40% (20 of 51) for AASHTO Committees and 15% (6 of 66) for AASHTO members. Overall, 45 of 144 (35%) submitted projects were funded for \$17.2M plus 19 of 20 continuations for \$9.2M. Total funded was \$26.4M of \$58M requested. The approved hydraulics projects are:
1. 15-23 Technical support for MDM and HDG - (see below)
  2. 24-18 Countermeasures to Protect Bridge Abutments (see above)
  3. 24-19 Environmentally Sensitive (Non-structural) Channel & Bank Protection (see above)
- E. NCHRP Projects for 2002 - The chair sent the following problem statements to Tim Hess of NCHRP with a copy to Ken Kobetsky on August 18, 2000:
1. Effects of Debris on Pier Scour at Bridges - prepared by Phil Thompson and Dr. Art Parola based on #14 of 24-8
  2. Coordinated Update of Rainfall Maps in U.S. - prepared by Sterling Jones and Will Thomas
  3. Software Validation and Certification Protocol for Hydrologic and Hydraulic Models for All Aspects of Storm Drainage - prepared by Bill Hulbert and Saeed Choudhary
  4. Riprap Design Criteria, Specifications and Quality Control - prepared by Dr. Larry Arneson
  5. Effects of Fractured or Degradable Rock on Pier Scour at Bridges - prepared by Phil Thompson and Dr. Joe Haggerty based on #13 of 24-8
- F. NCHRP Projects for 2002 - None of the above submitted projects were funded.
1. 24-20 Prediction of Scour at Bridge Abutments that was submitted by AZ was funded. This project which was similar to 24-8 project 5 was funded for \$500k
  2. SCOR funded \$14.6M (28 out of 147) new projects and \$9M, 20 project continuations, for a total of \$23.6M. The total requested was \$63.3M for 167 projects.
- G. NCHRP Projects 2003 - The following priority order was agreed to 5/2001. Tim Hess indicated at 5/2002 meeting that the problem statements were considered at March 2002 SCOR meeting and that the top two projects were funded. This year 42 of 121(35%) funded for \$15.5 M and 17 continuations for \$9.2 M. DOTs got 16 of 72 (24%), AASHTO 23 of 41 (56%) and task force 3 of 8 (38%).
1. Riprap Design Criteria, Specifications and Quality Control - prepared by Dr. Larry Arneson who included reference to 24-18 and 24-7(2). [see 24-23]
  2. Develop Hydraulic Loss Coefficients for Culverts - prepared by Saeed Choudhary [see 15-24]
  3. Effects of Debris on Pier Scour at Bridges - prepared by Phil Thompson and Dr. Art Parola based on #14 of 24-8 [**Note - email Tim Hess if you would like a printed copy of 24-8**]
  4. Criteria for Selecting Hydraulic Models (1D/2D) - prepared by Shawn McLemore
  5. Effects of Fractured or Degradable Rock on Pier Scour at Bridges - prepared by Phil Thompson and Dr. Joe Haggerty based on #13 of 24-8
  6. Effects of Riprap on Fish Habitat - prepared by Dave Bryson
  7. Time Rate of Scour at Wide & Skewed Bridge Piers - #8 on 24-8, Phil Thompson/Jorge Pagán
- \* H. NCHRP Projects 2004 - 15 projects were proposed at the 5/2003 meeting. Problem statements were developed for each. An electronic ballot was sent to the task force. The secretary forwarded the top 8 statements and request to fund continuation of unknown foundations identification project. Projects 24-24, 24-25 and 24-26 were funded see above status.
- I. NCHRP Projects 2005 - The following project priority was determined by a show of hands at the Spring 2003 meeting. The first 7 received 14 or more votes and will be submitted to NCHRP by the secretary. In addition, it was agreed that Dr. Larry Arneson would draft a one page 20-7 request for funding to update the 24-8, see # 8.
1. Time Rate of Scour at Wide & Skewed Bridge Piers - #8 on 24-8, Phil Thompson/Jorge Pagán
  - \* 2. Coordinated Update of Rainfall Maps in U.S. - David Stolpa updated based on TXDOT study



- (Joe Krolak and Mark Miles will review and update Problem Statement.)
3. Effects of Fractured or Degradable Rock on Pier Scour at Bridges - prepared by Phil Thompson and Dr. Joe Haggerty based on #13 of 24-8
  4. Procedure For Determination of Joint Probability of Design Peak Flows At Confluences - Barry Newman will develop Problem Statement
  5. Development of Bench Test Method for Determining Manning's n for Culverts - Phil Thompson
  6. Effects of Riprap on Fish Habitat - prepared by Dave Bryson
  7. Evaluation of Long Term Performance of Stormwater BMPs - Barry Newman/Raja Veeramachaneni
  8. 24-8, Scour at Bridge Foundations Research Needs - *Dr. Larry Arneson drafted a one page 20-7 request for SCOH funding after the meeting and provided to Jim McDonnell.*
  9. Development of a Specification to Mitigate Hydroplaning Effects - Phil Thompson drafted with consideration of NCHRP 1-29 and legal case studies
  10. Develop Hydraulically Efficient Bridge Rail - David Stolpa
  11. Development of a Prediction Model for Ice Jam Formation - Saeed Choudhary
  12. In-Situ Scour Measuring Device - Bart Bergendahl
  13. Integration of Water Quality and Drainage Structure Design - Raja Veeramachaneni/Dave Henderson (tabled until 2007)
  14. Coastal and Tidal Waterway Stability and Scour - Mark Miles will use NCHRP 24-8 (tabled)
  15. Turbidity and Wash Load Effect on Scour Depth - Rich Renna (FL is studying, see website)
- J. NCHRP 15-23 Technical support for MDM and HDG, \$200k (Tim Hess, project manager) - Task force panel is Merrill Dougherty (chair), Phil Thompson, Dave Bryson, Shawn McLemore, Roy Mills, and John Boynton.
1. At the 5/01 meeting, Roy Jorgensen PI, Ken Shearin, and Don Potter provided a handout and discussed their vision of the project. The following items were discussed:
    - a. P2, 1A3 - Don will do all conversions and accuracy consistent determinations.
    - b. P3 - Peter Smith will provide independent review of both HDG and MDM.
    - c. P4 - Units will generally be kept as used in manual. Ken gets "US Metric Association Newsletter" which indicates that only about 10 states are primarily SI.
    - d. P7 - Don will rerun all problems with new versions of programs. Joe Krolak agreed to provide Don with a Windows version of HYDRAIN.
    - e. P8 - Word 97 to Word 2000 conversions are better than earlier conversions.
    - f. P8, 8D3 - agreed to use one column in HDG with small figures on right of text wrapped left.
    - g. P9 - DGN micro station format graphics will be converted to EPS or DXT format so that they can be read into Word.
    - h. Agreed to use the following: 11 pt, Arial with 1.1 line spacing, block letters in equations, margins left and right will be 1", margins top and bottom will be tried at 0.75", line numbers will be used down margin for the draft, and that lines in margins will be considered to indicate where major changes have been made.
  2. At the 10/01 meeting, Roy Jorgensen PI, Ken Shearin, and Don Potter provided handouts and discussed the following items:
    - a. Ken passed around a mock up of the SI MDM to demonstrate the format used. Handed out & discussed Style and Format Guide and the Editing Recommendations. Ken Kobetsky provided guides to AASHTO staff for review. AASHTO style recommendations were adopted.
    - b. Ken passed out inventory of graphics and indicated that Phil would review and provide updates.
    - c. Don will rerun computer models, review metric numbers using Green Book as a guide.
    - d. Ken reviewed schedule: SI drafts in Jan 2002, draft approved in April, conversion strategy will need to be approved by May 2002.
    - e. Don reviewed the task 1 & 2 requirements. He noted that 300 hours of review provided 635 suggestions. He indicated that there were differences between HYDRA 6.1 and previous calculations. (NOTE: 6.2 should be obtained from Joe Krolak)
    - f. Task Force chairs reviewed and approved the majority of comments. The remainder were

- discussed and either adopted, rejected or modified. Ken and Don took notes and will revise the recommendations report to indicate the changes and corrections. The chairs will draft material for the Appendix C enhancements and provide to the secretary by 11/9/01 so that they can be reviewed by task force by 11/26/01 and provided to Ken by 12/1/01.
- g. Ken Kobetsky recommended SOD balloting of the draft 2003 SI MDM and HDG when complete 4/2001.
  - h. Task Force agreed to request \$50k from NCHRP to enhance graphics. The chair who is also chair of the NCHRP panel will formally send the request to Tim Hess. Funding approved.
3. At the 5/02 meeting, Roy Jorgensen PI, Ken Shearin, and Don Potter provided hard copies of the draft 2003 SI HDG & MDM to the chair and secretary. A CDROM was provided before the meeting to all task force members which included files of the manuals and comments. The following items were discussed at the meeting:
- a. Ken summarized the improvements made to the HDG and MDM and the issues remaining to be resolved such as format of references. He circulated copies of the 85 figures that had been updated and they looked great. Don Potter summarized items remaining to be accomplished in conversion to US units and checking of computations.
  - b. Task force decided the following:
    - (1) Bullets - open bullets will be used for 2nd level bullets
    - (2) Header - use comma and space instead of “/” to separate title
    - (3) Table of Contents - add chapter #, all caps, center and bold title
    - (4) Changes - from the meeting will be shown in yellow highlight
    - (5) References - number in order used in the text, Word endnotes will be used, combination of forms will be used in the text, that acronym can be used with number, figures should contain reference, and HDG chapters may retain alphabetic order if used.
    - (6) References were reviewed, secretary emailed to Ken Shearin.
    - (7) Next draft will retain track changes.
    - (8) Some figures which are examples do not need to be converted, e.g. Fig. 18.13.
    - (9) Culvert dimensions should be soft converted. Roadway geometry should be hard converted and should conform to AASHTO green book.
    - (10) Readme file - add doc file which contains notes to assist State DOTs in revising Word files. Note styles/format feature used and instructions on changing features like template, endnote, binder and numbering.
  - c. Ken requested and received the metric version of Chapter 18 from Billy Edge.
  - d. Ken and Noreen Arvin used a computer and projector to effectively show text which needed to be discussed. Fixes were agreed to on the spot and changes incorporated in the files as highlighted text. Some corrections were identified at the meeting, but most were provided before the meeting in electronic format by chapter chairs and by FHWA reviewers. Since Noreen had fixed about half of the corrections before the meeting, a quick review of the fix was all that was needed.
4. At the 10/02 meeting, Roy Jorgensen PI, Ken Shearin, and Don Potter provided hard copies of the final 2003 SI HDG & MDM to the chair and secretary. A CDROM was provided before the meeting to all reviewers. Each chapter chair received their chapter of the final 2003 SI HDG. The following items were discussed at the meeting:
- a. Ken indicated that the following items had been accomplished for this draft: changed headers, table of contents automated, open bullet used for 2nd level bullets, task force changes received after the meeting have been incorporated, 140 figures have been upgraded (80 have been drafted), reference strategy has been implemented and references have been corrected, turned off track changes and reformatted, fixed all equations, added enhancements prepared by chairs, and received final editorial comments at this meeting.
  - b. Next task is to convert MDM and HDG to US customary units and get to the task force for review before the Spring 2003 meeting.
  - c. Don discussed the following items concerning conversion to US customary units:
    - (1) numerous SI figures are new and were not in the 1991 US MDM

- (2) the 1991 US MDM contains 25 low quality figures which need to be drafted
- (3) reformatting has made MDM and HDG consistent
- (4) some conversions are soft, like convert diameter, and some hard, like gutter width
- (5) MDM, chapter 7, wetlands hydrology, is only in 1999 MDM
- (6) 1999 MDM has 56 SI figures to convert to US and 1999 HDG has 31
- (7) all the example problems have been reworked and computer solutions redone.
- d. Ken indicated that the target for completion of the SI MDM and HDG is November 15<sup>th</sup>.
- 5. At the 5/03 meeting, Roy Jorgensen PI, Ken Shearin, and Don Potter provided hard copies of the final 2003 US HDG & MDM to the chair and secretary. A CDROM was provided before the meeting to all reviewers. Most chairs provided comments before the meeting and the secretary combined into a list that was provided to the reviewers and to Ken Shearin. The following items were discussed at the meeting:
  - a. Ken Shearin made all the US conversions in the HDG and Don Potter made the US conversions to the MDM. Don accepted the text and SI values as correct. Don computed all the examples.
  - b. Ken resolved his questions with the list of comments and each chair discussed comments on their MDM and HDG chapter. The task force commended Ken and Don for a well done job.
  - c. Ken will incorporate minor corrections and provide the secretary a hard copy of both the HDG and MDM for confirmation of corrections. A CDROM of the final manuals will be sent to the reviewers when it is forwarded to NCHRP.

## 6. AASHTO HIGHWAY DRAINAGE GUIDELINES

- A. See attachment D for status. [Guideline development time is at least 30 months: 6 months for a draft, 6 months for a table review, 6 months for SOD review, 6 months for SOD ballot, and 6 months for SCOH ballot.]
- B. HDG, 1999 Edition 3, Metric Conversion
  - 1. The chair previously send a letter to AASHTO and requested that HDG and MDM be provided to the States in electronic format and on CDROM.
  - 2. The secretary has PDF files for all volumes except 7. As of 5/02, all volumes have now been converted to Word.
- C. HDG 2003, Edition 4, Updates and Revisions - The task force initiated this revision project in 1997 to prepare an updated version of the metric Edition 3. All volumes were reviewed and updated.
  - 1. Accomplishments to date:
    - a. Fall 1997, volume chairs identified editorial corrections and sections which should be updated.
    - b. Spring 1998, secretary handed out a consolidated list of comments. The list was updated after the meeting and emailed to the task force.
    - c. Fall 1998, revised sections were handed out at the meeting for volumes 4, 6, 7, and 9.
    - d. Fall 1999, secretary handed out a consolidated list of comments.
    - e. Spring 2000, revised sections were handed out at the meeting for volumes 1, 8 and 10.
    - f. Fall 2000, consolidated list of comments provided by email after the meeting.
    - g. Spring 2001, revised sections were handed out at the meeting for volumes 2, 9 and 13.
    - h. Secretary updated approved list of comments dated 7/20/01& provided to NCHRP 15-23 contractor.
    - i. Fall 2001, NCHRP 15-23 corrections reviewed and most adopted.
    - j. Spring 2002, draft SI edition reviewed before the meeting, email list of corrections provided to Ken Shearin before the meeting and final comments resolved at the meeting.
    - k. Fall 2002, final SI edition (emailed to chairs) reviewed before the meeting and corrections provided at the meeting by Ken and chapter chairs.
    - l. Spring 2003, final Dual unit version on CDROM reviewed, corrections provided before the meeting and comments were discussed at the meeting. A final draft will be provided to the secretary in 2 to 4 weeks. Contract is over July 31, 2003
  - 2. The status of all chapters are listed below. Chapter chairs and FHWA reviewers, identified corrections. All corrections have been incorporated, except as noted below and in the list of

corrections dated 5/5/03

0 Front Matter (Secretary) - complete

1. Planning (Danny Landry thru 5/2002, Mike Fazio) - complete

2. Hydrology (John Boynton) - complete

3. Erosion & Sediment (Dave Henderson)

\* Dave agreed to find a replacement for figure 3-30.

4. Culverts (Phil Thompson) - complete

5. Legal (Jim Richardson) - complete

6. Channels (Dave Bryson thru 5/2002, Brooks Booher)

6-41 *After the meeting, Larry Arneson provided a file for replacement for figure 6-22*

7. Bridges (Roy Mills)

\* 7-70 complete, but references to “spur dikes” will be changed to “guide banks”

8. Restoration (John Boynton) - complete

9. Storm Drains (Bill Bailey)

\* 9-54 Make reference to table 9-2 consistent with MDM chapter 13 reference.

10. Environment (Mark Miles) - complete

10-32 L6 add dual units

10-49 L23 fix subscript

10-67 *Mark provided corrections to figures 10-10 & 10-11 after the meeting.*

11. Coastal Zone (Raja Veeramachaneni thru 10/02, Rick Renna)

\* 11-26 Rick agreed to provide a better figure 11-13

12. SWM (Merril Dougherty) - complete

13. Training (Mark Miles thru 10/02, Rich Phillips) - complete

14. Culvert Rehabilitation (Glenn DeCou)

14-16 L28 add (8) to the end.

14-20 L28 delete (8) *Phil Thompson confirmed after the meeting that this reference does not contain any discussion on debris and so the cite was moved.*

15. Consultants - AASHTO SCOH ballot complete, provided to AASHTO on 5/16/03

Glossary (Bill Bailey thru 10/02, Norm Schips) - The definition of “guide” and “guideline” on page 40 of the glossary should be combined. The AASHTO supplied definition of a guideline is: “Guidelines - Provides direction, illustrates established practices and is intended to form a comprehensive reference manual for assistance in administrative, planning, “design,” and educational efforts in a particular area.” Note: “design” added by the task force to definition provided by AASHTO staff.

D. HDG Volume 15, Guidelines for Selecting and Utilizing Hydraulic Engineering Consultants - The drafting team is Raja Veeramachaneni (leader), Newman, and Richardson.

1. The proposed outline of the guideline was approved at the fall 1998 meeting. At that meeting, it was decided to:

a. Reference the AASHTO consultant document and reduce the size of section 1.

b. Reference ACEC joint group 1996 document and planned update.

2. A draft was read at 10/2000 meeting. The task force agreed to include checklists. The very well written draft received minor editing at the meeting. The task force adopted the draft and voted to send it to SOD for review by Jan 15, 2001. Since review draft was not completed, SOD review was deferred until summer 2001.

3. At Fall 2001 meeting, final draft provided to AASHTO (Ken Kobetsky) for SOD ballot.

4. Spring 2002 meeting, SOD ballot comments received provided to task force by email before the meeting. Raja Veeramachaneni discussed comments at the meeting. Raja will make the corrections, add a column to the comment matrix to discuss resolution and provide the updated files to Jim McDonnell and the secretary.

5. Fall 2002 meeting, SCOH ballot is complete. Jim McDonnell indicated that SOD was asked to confirm that guideline does not duplicate other guides.

6. Spring 2003, modifications were discussed by Raja at the meeting and adopted. The final camera ready copy of the guideline was provided to Jim Mc Donnell of AASHTO at the meeting.

a. Raja indicated that responsibility of consultants came from AASHTO preconstruction

engineering publication. He confirmed that guideline does not contain material from other documents, just reference to them.

- \* b. Rick Renna proposed adding a separate section for Coastal engineering to page 16. While there was general agreement to add the section, the task force agreed to forward the document to AASHTO for printing. Rick will draft a section.

## 7. MODEL DRAINAGE MANUAL (MDM)

### A. Metric Edition 2 (1999 MDM)

1. The text of all chapters was updated and graphics converted to TIF format by Dr. Tom Debo. The graphics were integrated into the WP 6.1 files by TTI. On June 30, 1998, TTI sent deliverables to NCHRP who sent to AASHTO by letter dated July 8, 1998.
2. 7E Wetlands Hydrology - The Water Budget, distributed February 2000.
3. 15G Wetland Creation and Restoration, distributed February 2000.

### B. Edition 3, (2003 MDM) - Accomplishments to date:

1. Fall 1997, leaders identified editorial corrections and sections which should be updated.
2. Spring 1998, secretary handed out a consolidated list of comments. The list was updated after the meeting and emailed to the task force.
3. Fall 1998, revised sections have been emailed or handed out for chapters 2, 6, 8, 9, and 10.
4. Fall 1999, secretary handed out a consolidated list of comments.
5. Spring 2000, revised sections were handed out for chapters 6, 17, 18, 20 and 21.
6. Fall 2000, consolidated list of comments provided by email after the meeting.
7. Spring 2001, revised sections were handed out for chapters 13, 15-19. Secretary updated approved list of comments dated 7/31/01 & provided to NCHRP 15-23 contractor.
8. Fall 2001, NCHRP 15-23 corrections reviewed and most adopted.
9. Spring 2002, draft SI edition CDROM reviewed before the meeting, email list of corrections provided to Ken Shearin before the meeting and final comments resolved at the meeting.
10. Fall 2002, final SI edition comments were discussed.
11. Spring 2003, final US customary edition comments were discussed. A final draft will be provided to the secretary in 2 to 4 weeks. Contract is over July 31, 2003

### C. Edition 3, (2003 MDM) - All corrections have been incorporated, except as noted below and in the list of corrections dated 5/7/03.

0 Front Matter (Phil Thompson) - complete

1. Introduction (Phil Thompson) - complete
2. Legal (Jim Richardson) - complete
3. Policy (Francis Nishioka) - complete
4. Documentation (Glenn DeCou) - complete
5. Planning (Danny Landry through 5/2002, Mike Fazio) - complete
6. Data Collection (Lotwick Reese) - complete
7. Hydrology (John Boynton) - complete
8. Channels (Dave Bryson thru 5/22/02, Brooks Booher)
  - 8-11 figure 8-1a change yc/2g to yc/2
  - 8-19 figure 8-3 check screen display
  - 8-21 figure 8-4 delete "1.486" from abscissa caption

### 9. Culverts (Phil Thompson)

- \* Insert revised Charts 10A, 11A, 13A, 14A, 35A, 58A and 59A
- \* 9.E-4 revise equation 13 coefficient should be 0.64 SI and 0.35 US [SI]
- \* 9.E-5 revise equation 15 coefficient should be 0.64 SI and 0.35 US [SI]

### 10. Bridges (Roy Mills)

- \* 10.B-4 use Larry Arneson's revised table 10.B-1
- 11. Energy (Phil Thompson) - complete
- 12. Storage (SWM) (Merril Dougherty) - complete
- 13. Storm Drains (Bill Bailey) - complete
- \* 13-47 Figure 13-11 is OK in US, but needs to be replaced in SI
- 14. Pump Stations (Dan Ghere) - complete

- 15. Environment (Mark Miles) - complete
  - \* 15-49 figure 15-6 make edits provided by Mark after the meeting
  - \* 15-50 figure 15-7 make edits provided by Mark after the meeting
- 16. Erosion & Sediment Control (Dave Henderson) - complete
- 17. Bank Protection (Bill Hulbert thru 10/2001, Barry Newman)
  - \* 17-29 figure 17-10 add blank semi-log plot to both US & SI editions
  - \* 17-53 L21 change Figure 17-10 to new figure for both US & SI which includes plots.
- 18. Coastal Zone (Raja Veeramachaneni thru 10/02, Rick Renna) - complete
- 19. Construction (Te Ngo) - complete
- 20. Maintenance (David Stolpa) - complete
- 21. Restoration (John Boynton) - chapter deleted from this edition at 5/00 meeting
- Glossary (Bill Bailey thru 10/02, Norm Schips) - complete

## 8. **FIELD TRIP**

**I-70 Fast Track** - On Wednesday, the task force received an excellent overview of the project and the design issues in the meeting room and then toured the extensive project to relocate I-70 near the airport.

The following items were discussed:

- A. **Drainage Issues** - Steve Fleming, PB, noted the design was a joint effort of PB, ACI and KCI. The project was being driven by the need for FedEx to expand their cargo hub and the need for a new mid-field terminal. A major part of the project is the moving of I-70 to the south to accommodate the FedEx expansion. The fast track project will be a Continuous Design/Construction Interface (CD/CI) project where the owner maintains control. The dirt contract was let for about \$3/cy and will be done by September so that structures contracts can be awarded. He indicated that 1.5 M of 2.8 M cy have been moved and that the 96" outfall was 50% complete.
- B. **Drainage Design** - Beth Anderson, PB of Virginia Beach, said that the project has a 80' drop in grade and so they were able to accommodate drainage in a gravity storm drain even though the roadway was depressed 30'. The depressed section has a 480' wide roadway, 3 to 1 slopes, 4600' length of roadway and an area of 7.5 acres. The trunk line below the roadway was designed for 100-yr Q of 300 cfs. The 2 mile long pipe is a double wall 8' CMP pipe with a smooth interior and polymer coated that cost about \$3 M. [The CONTECH supplied pipe is SmoothCor with Trenchcoat.] She said that the design n value was .013, but the pipe has a tested n value of .011. Ponds were designed in the infields of the interchange so that post construction Q does not exceed preconstruction Q. Because of Bird Airplane Strike Area (BASH) requirements dry ponds were designed that empty in 24 hours. An airport biologist will control vegetation. Netting over ponds was considered to minimize birds, but went with bird balls and a cage on the outlet to retain the balls.
- C. **Structure Design** - Robert Hittle, ACI, discussed the structures required, because of the relocation of the airport access from I-465 to new I-70 and the new 6 points road interchange. The cost of I-70 move is \$165 M of the \$225 M total project. Drainage is generally to the north. Eleven major structures and 5 pipes are required to handle creeks and 4 waterways. He showed how waterways were relocated to minimize the number of required structures. The environmental review was completed with a FONSI on 4/9/2002. Permits were required for 404/401 and for floodway. Flood easements were required for two areas.
- D. **Endangered Species** - Chris Meader, ACI, discussed permits for endangered species. A Habitat Conservation Plan (HCP) was developed for the Indiana bat. The HCP limits tree clearing, requires 35 acres of new forest, and requires 15 years of monitoring for the bats. The section 404/401 permit document is 15 pages and requires low flow analysis for 1 and 2-yr floods, 7 years of monitoring and reconstruction of preconstruction habitat. The waterways contributing area is rural now, but is developing.
- E. **Channel Design** - Rick Pfingsten, KCI, discussed the channel design goals of providing a low flow channel, vegetated banks and in stream fish habitat. HEC-RAS, DEMs and TR-20 were used to assess base flow and 1 & 2-yr floods. A hydrologic report and a stream condition report were produced. The channels are sand & gravel, urban and have a low gradient. The channels will have a low flow channel and be designed as alluvial channels that have wooded banks. However, North Creek is a cobble bed stream that was designed using Rosgen approach.

- F. Construction - Neil Mulrooney, Assistant Project Manager, Walsh Construction, handed out a diagram of the project and provided an excellent overview of construction operations at the construction office. He explained the innovative use of farm tractors for pulling multiple pans for moving dirt. After an overview of the project, he introduced representatives of CONTECH who discussed the 8' diameter "SmoothCor" pipe with "Trenchcoat" and provided a CONTECH Site Solutions brochure. Neil accompanied the group to the site and provided an overview of operations. Stops were made at a completed precast box culvert, the relocated channel and the 8' diameter main drain. At the 8' diameter location, CONTECH personal answered questions and we were able to view 20' sections of pipe that were ready for installation.

## 9. TECHNOLOGY PRESENTATIONS

- A. Fish Passage Culvert Design Issues - Dr. Mark Browning, FHWA Western FLH, provided a color handout of his Power Point presentation. He discussed his design criteria and the USFW Regional Guidance for Fish-Passage Structural Design. He recommended putting culverts on a flat gradient with a depressed invert if possible. The flat grade encourages deposition. Baffles are used for stream slopes that are greater than 5%. He showed photographs of culverts on the Middle Fork John Day (MFJD) in Oregon and the North Fork of the Salmon River in ID. His handout included FLH Culvert Design Methods and he noted that monitoring is required. He discussed a case study on the North Fork Little Joe Creek in MT and presented his analysis. The USFS had tested the site with FishXing software and required an analysis. He used HEC-RAS buried culvert option. For n value, he used Jarret's method (1984 WR Bulletin). He determined that cost governed the solution: \$30k for 12' pipe and \$130k for a 20' pipe. He provided a list of future needs and design criteria in the handout and noted that he is the project manager for FHWA's HEC-26, Hydraulic Design of Culverts with Fish Passage. **Mark Miles indicated that AK has a steep stream study that is about complete.**
- B. Digital Vegetation Analyzer Tool for Erosion Control - Dr. Bob McCullough, School of CE at Purdue Univ., discussed this INDOT research project. Because INDOT likes warranty provisions for contracts, erosion control is being considered. As a test, three projects (intersection, bridge rehabilitation, and new route) were selected to try process. The warranty will be for 24 months (2 growing seasons) and will require 85% ground cover. He showed a photograph of the sign that was posted at the intersection project which stated that no mowing or spraying were permitted. The objective of the project was to develop a digital inspection tool. He discussed the technical constraints and the challenge of determining which of the millions of green shades to use. They determined that the color threshold should be red > 240, green < 50 and blue < 50. The field procedure requires that the grass be < 8", sunlight between 1000 to 3000 foot candles using a light meter, direct sunlight is unacceptable, sun directly overhead is best, and camera should be perpendicular. A 3' square reference template is used. Digital picture is taken from 3 to 7' away without zoom. The digital image is converted to R/G/B values using "Image Savant" software which is described at <http://www.adept.net.au/software/ioindustries/imgsav.shtml>. The results are total pixels, total green, % green, # dark spots and % dark spots. A quality control calibration is used that is 50% green and 13% black. He showed inspection examples and noted that visual and digital inspections agreed. In conclusion, he noted that the tool could be used to mitigate contested areas, but the method has not tested to see if it will hold up in court. The use of warranties and digital analyzer would eliminate the need to approve erosion control materials and to have a construction inspector. (See <http://rebar.ecn.purdue.edu/JTRP/>)
- C. New Developments for WMS & SMS Software Packages - Dr. Larry Arneson provided an overview of both packages using Power point and live demonstrations:
1. WMS is licensed by FHWA for State DOTs. FHWA has NHI course 135080 for WMS training. He said that 13 states are using the software. WMS is a GIS for hydrologic design and analysis that uses DEMs. WMS 7 contains interfaces for NFF, HEC1, HEC-RAS, FHWA Storm Drain and calculators for culverts, stream channels and detention. He demonstrated the data acquisition website that EMRL supports ([emrl.byu.edu/gsda](http://emrl.byu.edu/gsda)). The site provides access to the National Elevation Dataset ([seamless.usgs.gov](http://seamless.usgs.gov)) which was demonstrated for Indianapolis. The site also provides access to images ([terraserver.homeadvisor.msn.com](http://terraserver.homeadvisor.msn.com)). He downloaded a jpeg which showed the Indianapolis airport. He noted that EPA basins is also available through EMRL. New

- features are TIN/DEM modules, NFF update, HYDRA, uncertainty (sensitivity analysis) module, and HEC-RAS support. A similar WMS 7.0 presentation can be viewed at the Western Hydraulics Conference site at: [http://www.cflhd.gov/design/hyd/presentation19\\_nelson.pdf](http://www.cflhd.gov/design/hyd/presentation19_nelson.pdf)
2. SMS functional modules are map, scatter point, mesh, river and 8.1 will have HEC-RAS. He demonstrated the modules. SMS has a Flo2DH interface. For hydraulic structures, Flo2DH can handle 1D features (weirs, culverts, gates, channels and drop spillways) and 2D features (embankments, guide banks and highways). He demonstrated the new incremental loading strategy (steering module) by using it to solve a hydraulic jump. He also demonstrated the 3D and animation capability. A similar SMS presentation can be viewed at the Western Hydraulics Conference site at: [http://www.cflhd.gov/design/hyd/presentation20\\_zundel.pdf](http://www.cflhd.gov/design/hyd/presentation20_zundel.pdf)
  3. SAMWin is a sediment transport calculator for a single cross section. He said that FHWA FLH has purchased licenses for FHWA and State DOTs. He will be providing copies on CDROM within the next month. A similar SAMWin presentation can be viewed at the Western Hydraulics Conference site at: [http://www.cflhd.gov/design/hyd/presentation06\\_arneson.pdf](http://www.cflhd.gov/design/hyd/presentation06_arneson.pdf)
- D. NHI 135081 Introduction to Highway Hydraulic Software - Roger Kilgore discussed the draft course that he has delivered to FHWA project manager Joe Krolak to review using a Power Point presentation. He said that the goal of the course is to enable participants to select and effectively apply software tools. The learning objectives are to choose tool, identify data needs, input data and interpret results. The course agenda provides for 19 hours of instruction in 6 modules (1 WMS, 2 hydrology, 3 channels, 4 culverts, 5 inlets/storm drainage, and 6 detention. The audience is intended to be highway engineers and designers. The pre-training requirement is an overall knowledge of highway hydrology and hydraulics. He illustrated how this course will bridge the gap between FHWA's hydraulics courses that teach fundamentals using hand computations and the software model courses such as HEC-RAS, WMS and SMS. He showed the sketch for the integrated case study problem that will be used throughout the course. Lesson 1 will be an introduction to WMS. Lesson 2, hydrology (3.5 h), will include regression, NFF, SCS, rational, Log Pearson 3, peak method selection and HEC 1 workshop. Lesson 3, channels (1 h), will cover WMS channel calculator. Lesson 4, culverts (6 h), will cover HY8 and culvert hydraulics, HY8InpGen & PCViewer demo, capabilities of HY8 components, WMS integrated HY8 GUI, nomographs & charts, DOS HY8 and energy dissipator workshop. Lesson 5, inlets/storm drainage (5 h), will use WMS 7 HYDRA. Topics covered will be defining networks, design & analysis, storage, and performance assessment. Lesson 6, detention basins, will cover WMS detention basin calculator. The effectiveness of the course will be evaluated using workshops, lesson quizzes, and pre- & post-testing. Software used in the course will be distributed to each participant on CDROM. Pilot course will be August 2003 in Denver and the course will be available in October 2003. His presentation can be viewed at: [http://www.cflhd.gov/design/hyd/aashtoh\\_h2.pdf](http://www.cflhd.gov/design/hyd/aashtoh_h2.pdf) **It was recommended that a similar course be developed for Bridge Hydraulic Software.**
- E. Regionalization of Indiana Watersheds - Dr. A. R. Rao showed overheads of reports prepared for INDOT. He said that the objective of the studies were to take data and derive new equations for Indiana watersheds. He noted that Indiana has 3 river systems, plus the upper NW Kankakee area that has been modified by the USACE. He used 7 watersheds that had been identified in an earlier study that had large errors of estimation. Three approaches were tried:
1. Professor [Burn] procedure for Canada which used seasonality of floods. He found that IN floods are not grouped by season. Most occur in March. Canada is mostly snow melt or combination events where IN has mostly rainstorm events.
  2. L moments (Hoskins 1991) - The method is ok, but is not reproducible by others. Regions do not agree with watershed boundaries.
  3. Hybrid Cluster Analysis - similar data is grouped (soil data, area, precipitation, channel length, storage) and correlation is checked. Six regions were used with 5 being homogeneous. The regions matched the soil maps closely. Rainfall versus runoff was checked, but was not used. Fuzzy cluster analysis tried with fixed fuzzifier of 1.5. Ended up with 6 similar regions.
- Second part of project is flood frequency using the 6 regions. L moment and regression will be tried. The project starts July 1<sup>st</sup> for 2.5 years. He will follow USGS procedures, but current USG equations are not acceptable. Success for INDOT will be equations with errors at least 20% less. Reports are



available on Joint Transportation Research Program site: <http://rebar.ecn.purdue.edu/JTRP/>

- F. Debris Accumulation at Bridge Piers - Dr. Dennis Lyn provided an overview of this INDOT research project using a Power Point presentation. He introduced his research associate, Tom Cooper. He noted that Tim Diehl's debris work provided background for the laboratory part of this project. The lab was used to perform a series of controlled experiments to understand mechanisms. Video monitoring was performed at two field sites. The lab study was concerned with debris movement, hydraulic conditions (depth & velocity). Issues were how to characterize a log, similitude and what is a debris pile. The lab channel was 49' and 16" wide with 100 gpm capability. The model pier was 1.5". The debris was actual twigs that were 1/4" by 4". Froude scaling based on pier width was used (1/48). Reynolds number scaling may be important for drag forces, but is not possible. He compared lab and field values of both numbers. For lab tests, a stable debris pile was defined as one that lasts 15 minutes. A test consisted of 70 logs put in one at time 25' upstream. The test was repeated 50 times and number accumulated recorded. He determined that the results were affected by depth and velocity. Field studies were conducted at Eel River, SR 59, which is a straight reach and Vermillion River, SR 63, which is a reach with a bend. Both sites have areas > 1000 sm and Q about 45k cfs. Video clips showed some rafts of material and that most debris accumulates at the peak. The effect of the deflectors is weak. Future research will be to monitor debris sweeper.
- G. Hydraulic Activities in the Midwest - Dan Ghere provided an overview of activities using a Power Point presentation. He discussed the following major structures: I-70/64 over the Mississippi at St. Louis (\$365M), I-280 over Mawmee at Toledo (\$220M), US 20 over the Iowa River (\$20M), I-494 over the Mississippi at Minneapolis (\$58M), and US 20 over Mississippi River at Dubuque. He showed scour measures that were being used: riprap, articulated flowable mattress, A-Jacks and spread footings embedded into rock (rather than placed on rock). Midwest flood damage was shown for US 40 in IL on a 2 mile floodplain on the Kaskaskia River and I-80 in NE where 11" of rain fell in a short period. Research projects discussed were MNDOT plastic pipe study and INDOT video monitoring of debris. He encouraged publications like MNDOT Pipeline Newsletter. He noted that Midwest Hydraulic Conference will be August 26-28 at East Lansing, MI (see FHWA web site for information). A similar presentation is available at the Western Hydraulics Conference site: [http://www.cflhd.gov/design/hyd/presentation12\\_ghere.pdf](http://www.cflhd.gov/design/hyd/presentation12_ghere.pdf)
- H. Eastern Resource Center Activities - Joe Krolak provided an overview of activities using a Power Point presentation. He discussed NPDES and indicated that MDSHA hydraulic group is a leader in the NE in identifying and inspecting hydraulic features. He noted that tidal flooding and scour are issues that the NE states have to deal with. The TAR River area experienced a 10-yr surge from hurricane Floyd plus a Q25 from the watershed. The resulting flood was a 500-yr flood level and caused \$70 M in damage. He discussed the Indian River Inlet. He showed the original inlet in 1932 and the 1937 bridges. The current bridge has two foundations in the inlet with significant scour holes upstream and downstream of the bridge. DELDOT is considering spanning the inlet. Junction losses (surcharged and super critical flow) are being investigated by PA and others. Ice debris which causes pressure scour is a concern in ME, VT and CT. Wetlands are a concern in VT, because of the short growing season and the need for mitigation. Subsurface drainage of pavements is being looked at by VA and Joe is helping them to use 2D tools. High frequency events are being studied by MD, NY and WV to better define 1-yr event for stream restoration. The advisory Committee on Water Information is working on FAQs for 17B and guidance for regulated streams. He discussed the following major projects: Woodrow Wilson Bridge including Cameron Run in VA, bridge over Ohio River at Blennerhassett Island in WV, Great Egg Harbor Causeway in NJ, Hampton Roads Tunnel in VA (\$4.4B 14 year project), and limestone scour in VA & WV. A similar presentation is available at the Western Hydraulics Conference site: [http://www.cflhd.gov/design/hyd/presentation10\\_krolak.pdf](http://www.cflhd.gov/design/hyd/presentation10_krolak.pdf)

## 10. CONCERNS OF THE STATES

- FL Rick Renna discussed Florida DOT Research Projects: Service life test for plastic pipe including slow crack growth and creep are being developed and Florida DOT scour equation for wide piers. Rick agreed to present this at the next meeting.
- AR Brooks Booher has questions about what the other States are using to design storm drains in Micro-station and asked the Task Force about requirements for designers to field verify off site drainage to

storm drain systems.

- AK Mark Miles talked about research to determine Manning's  $n$  values for steep basins, discussed problems with ice forces on riprap, and discussed the problem with resource agencies not responding in a timely fashion. It was suggested that this may be an area for FHWA assistance and may be a good topic for the next meeting.

## AASHTO TASK FORCE MEMBERS/MEMBER'S REPRESENTATIVES (May 21, 2003)

[Please Review Your Address, Make Corrections, &amp; Initial]

MEMBER	ADDRESS	TELEPHONE
Mr. Bill Bailey Hydraulics Engineer	Wyoming Transportation Department 5300 Bishop Blvd., Cheyenne, WY 82009	(307) 777-4045, FAX 777-4279 <i>william.bailey@dot.state.wy.us</i>
Mr. Brooks Booher Staff Hydraulics Engineer	AR State Highway & Transportation Dept. 10324 I-30, Little Rock, AR, 72209 PO Box 2261, Little Rock, 72203-2261	(501) 569-2589 FAX 569-2057 <i>brooks.booher@ahtd.state.ar.us</i>
Mr. John Boynton State Hydraulics Engineer Office of Bridges and Structures	Minnesota Department of Transportation 3485 Hadley Avenue North Oakdale, MN 55128	(651) 747-2162 FAX 747-2108 <i>john.boynton@dot.state.mn.us</i>
Mr. Saeed Choudhary Senior Hydrotechnical Engineer Highway Design Office	Ministry of Transportation 301 St. Paul St, 2nd Floor North St. Catherines, Ontario L2R 7R4	(905) 704-2238 FAX 704-2051 <i>saeed.choudhary@mto.gov.on.ca</i>
Mr. Glenn DeCou Headquarters Hydraulic Engineer State Highway Drainage Design	CALTRANS, 1120 N Street, Room 2206, Sacramento, CA 95814, P.O. Box 942874 Sacramento, CA 94274-0001	(916) 653-1302 FAX 653-1446 <i>Glenn_S_DeCou@dot.ca.gov</i>
Mr. Merrill E. Dougherty Hydraulics Engineer Supervisor (Chair)	Indiana Department of Transportation 100 North Senate Avenue, Rm N642 Indianapolis, IN 46204-2228	(317) 232-6776 FAX 233-4929 <i>mdougherty@indot.state.in.us</i>
Mr. Mike Fazio Hydraulic Engineer	Utah Department of Transportation 4501 South 2700 West Salt Lake City, Utah 84119	(801) 957-8556 FAX 965-4564 <i>mfazio@utah.gov</i>
Mr. Preston Helms Hydraulics Engineer	SC Department of Transportation P.O. Box 191, Columbia, SC 29202 955 Park Street, Columbia, SC 29201	(803) 737-1723 FAX 737-9868 <i>helmspw@dot.state.sc.us</i>
Mr. David Henderson State Hydraulics Engineer	NC DOT, 1590 Mail Service Center Raleigh, North Carolina 27616 1020 Birch Ridge Rd., 27610 (deliveries)	(919) 250-4100 FAX 250-4108 <i>dhenderson@dot.state.nc.us</i>
Mr. Mark D. Miles State Hydraulic Engineer D&ES/Bridge	Alaska DOT and Public Facilities 3132 Channel Drive, Rm 100 Juneau, Alaska 99801	(907) 465-8893 FAX 465-6947 <i>mark_miles@dot.state.ak.us</i>
Mr. Roy T. Mills <i>State Hydraulics Engineer</i>	VA Dept. of Transportation 1401 East Broad St. Richmond, Virginia 23219	(804) 786-9013 FAX 225-3686 <i>roy.mills@virginiadot.org</i>
Mr. Barry A. Newman Chief, Hydrology and Hydraulics Section	Bureau of Design, PADOT 400 North St, 7th Floor, P.O. Box 3560 Harrisburg, PA 17105-3560	(717) 787-5024 FAX 787-2882 <i>banewman@state.pa.us</i>
Mr. Te Anh Ngo Roadway Drainage Engineer Roadway Design Division	Oklahoma Dept. of Transportation 200 N.E. 21st Street Oklahoma City, Oklahoma 73105	(405) 521-6772 FAX 522-4519 <i>tngo@odot.org</i>
Mr. Francis H. Nishioka Hydraulic Engineer	Department of Transportation 601 Kamokila Boulevard, Rm 636 Kapolei, Hawaii 96707	(808) 692-7561 FAX 692-7617 <i>francis.nishioka@hawaii.gov</i>
Mr. Matt O'Connor Hydraulics Engineer or Mr. Bob Dawe (785-2917)	Illinois Department of Transportation 2300 S. Dirksen Parkway Springfield, Illinois 62764	(217) 782-2714 FAX 782-7960 <i>oconnormr@nt.dot.state.il.us</i> <i>dawerl@nt.dot.state.il.us</i>
Mr. Richard Phillips Bridge Hydraulics Engineer Office of Bridge Design	South Dakota Department of Transportation 700 East Broadway Pierre, South Dakota 57501	(605) 773-3285 FAX 773-2614 <i>rich.phillips@state.sd.us</i>

**AASHTO TASK FORCE MEMBERS/MEMBER'S REPRESENTATIVES (May 21, 2003)****[Please Review Your Address, Make Corrections, & Initial]**

<b>MEMBER</b>	<b>ADDRESS</b>	<b>TELEPHONE</b>
Mr. Lotwick I. Reese Hydraulics Engineer	Idaho Transportation Department P.O. Box 7129, Boise, Idaho 83703 3311 West State Street Boise, Idaho 83707-1129	(208) 334-8491 FAX 334-8040 lreese@itd.state.id.us
Mr. Rick Renna State Drainage Engineer	Florida Department of Transportation 605 Suwannee Street M.S. 32 Tallahassee, Florida 32399-0450	(850) 414-4351 FAX 922-9293 rick.renna@dot.state.fl.us
Mr. James R. Richardson Road Design Leader (Vice Chair)	Kansas Department of Transportation Bureau of Design, 9th Floor Docking State Office Bldg. Topeka, Kansas 66612-1568	(785) 368-8292 FAX 296-6946 jimr@ksdot.org
Mr. Norman P. Schips Senior Civil Engineer	NY State Department of Transportation 1220 Washington Avenue State Campus, Building 5, Rm 408 Albany, NY 12232	(518) 485-8611 FAX 457-6477 nschips@gw.dot.state.ny.us
Mr. David Stolpa Manager, Hydraulics Branch	TX DOT, 125 E. 11th Street (for mail) 118 E. Riverside (for overnight) Austin, Texas 78701-2483	(512) 416-2271 FAX 416-2354 dstolpa@dot.state.tx.us
Mr. Philip L. Thompson Senior Hydraulics Engineer (Secretary)	FHWA, HIBT-20 400 7th Street, SW., Room 3203 Washington, D.C. 20590	(202) 366-4611 FAX 366-3077 philip.thompson@fhwa.dot.gov
Dr. Duc minh Tran	Ministère des Transports du Québec 930 Chemin Sainte-Foy 7è étage Ville Québec Province Québec, Canada G1S 4X9	(418) 644-0894 FAX 646-5415 mdtran@mtq.gouv.qc.ca
Mr. Raja Veeramachaneni Chief, Highway Hydraulics Division	Maryland State Highway Adm. 707 N. Calvert St, C-201 Baltimore, Maryland 21202	(410) 545-8390 FAX 209-5031 rveeramachaneni@sha.state.md.us
<b>AASHTO HIGHWAY SUBCOMMITTEE ON DESIGN OFFICERS</b>		
Dr. Kam K. Movassaghi (Chair) Secretary, LA DOT & Development	P.O. Box 94245 1201 Capitol Access Road Baton Rouge, LA 70804-9245	(225) 379-1200 FAX 379-1851 kammovassaghi@dotd.state.la.us
Mr. Dwight Horne (Secretary) Director, Office of Program Administration	FHWA, (HIPA-1) 400 7th Street, SW., Room 3134 Washington, D.C. 20590	(202) 366-5530 FAX 366-7298 dwright.horne@fhwa.dot.gov
Mr. Jim McDonnell, Associate Program Director for Engineering	AASHTO, Suite 249 444 North Capitol Street, NW. Washington, D.C. 20001	(202) 624-5448 FAX 624-5469 jimm@ashto.org

**VISITORS**  
**Indianapolis, IN, May 12-16, 2003**

<b><u>NAME</u></b>	<b><u>ADDRESS</u></b>	<b><u>TELEPHONE/FAX/EMAIL</u></b>
Dr. Larry Arneson	Resource Center, FHWA, 555 Zang Street Rm 400, Lakewood, CO 80228	303-716-2144, FAX 969-5530 <a href="mailto:larry.arneson@fhwa.dot.gov">larry.arneson@fhwa.dot.gov</a>
Jorge Pagán	FHWA, HIBT-20, 400 7th Street, SW., Room 3203, Washington, D.C. 20590	202-366-4604, FAX 366-3077 <a href="mailto:jorge.pagan@fhwa.dot.gov">jorge.pagan@fhwa.dot.gov</a>
Peter Osborn	Resource Center, FHWA, 10 S. Howard St., Suite 4000, Baltimore, MD 21201-2532	410-962-0702, FAX 962-3655 <a href="mailto:peter.osborn@fhwa.dot.gov">peter.osborn@fhwa.dot.gov</a>
Joe Krolak	Resource Center, FHWA, 10 S. Howard St., Suite 4000, Baltimore, MD 21201-2532	410-962-0091, FAX 962-4586 <a href="mailto:joseph.krolak@fhwa.dot.gov">joseph.krolak@fhwa.dot.gov</a>
Dan Ghere	Resource Center, FHWA, Suite 301 19900 Governors Dr., Olympia Fields, IL 60461	708-283-3557, FAX 283-3501 <a href="mailto:dan.ghere@fhwa.dot.gov">dan.ghere@fhwa.dot.gov</a>
Dr. Mark Browning	Western Federal Lands Highway Div., FHWA, 610 Et Fifth Street, Vancouver, WA 98661	360-698-7964, FAX 696-7864 <a href="mailto:mark.browning@fhwa.dot.gov">mark.browning@fhwa.dot.gov</a>
Bart Bergendahl	Central Federal Lands Highway Division, FHWA, 555 Zang St., Lakewood, CO 80228	303-716-2288, FAX 969-5530 <a href="mailto:bart.bergendahl@fhwa.dot.gov">bart.bergendahl@fhwa.dot.gov</a>
Timothy Hess	TRB, NCHRP, 500 5th St. NW Washington., DC 20001	202-334-2049, FAX 334-2006 <a href="mailto:timhess@nas.edu">timhess@nas.edu</a>
Ken Shearin	Roy Jorgensen Associates, P.O. Box 70, 3735 Buckeystown Pike, Buckeystown, MD 21717	301-831-1000, FAX 874-2876 <a href="mailto:ken_shearin@royjorgensen.com">ken_shearin@royjorgensen.com</a>
Don Potter	Roy Jorgensen Associates 260 Grand FL5, Conway, AR 72302	501-514-4370, FAX 548-6008 <a href="mailto:donp@tcworks.net">donp@tcworks.net</a>
Roger Kilgore	Kilgore Consulting, 2963 Ash Street Denver, CO 80207	303-333-1408, FAX 333-1908 <a href="mailto:rkilgore@kcmwater.com">rkilgore@kcmwater.com</a>
Dr. Bob McCullough Dr. A. R. Rao Dr. D. A. Lyn T. J. Cooper	Purdue Univ, School of CE, 550 Stadium Dr. West Lafayette, IN 47907, FAX 494-0644	765-494-0643, <a href="mailto:bgm@ecn.purdue.edu">bgm@ecn.purdue.edu</a> 765-694-2176, <a href="mailto:rao@ecn.purdue.edu">rao@ecn.purdue.edu</a> 765-494-9615, <a href="mailto:lyn@ecn.purdue.edu">lyn@ecn.purdue.edu</a> 765-494-2179, <a href="mailto:coopert@ecn.purdue.edu">coopert@ecn.purdue.edu</a>
Tim Jeffers Bill Schmidt Richard Browder Gerald Swenson	Chief of Staff, N755 INDOT, 100 N. Senate Ave N642 Indianapolis, IN 46204	317-234-2780, <a href="mailto:tjeffers@indot.state.in.us">tjeffers@indot.state.in.us</a> 317-232-0936, <a href="mailto:wpschmidt@indot.state.in.us">wpschmidt@indot.state.in.us</a> 317-232-0936, <a href="mailto:rbrowder@indot.state.in.us">rbrowder@indot.state.in.us</a> 317-232-0936, <a href="mailto:gswenson@indot.state.in.us">gswenson@indot.state.in.us</a>
Steve Fleming Kimberly Lutz Beth Anderson Chris Meador Robert Hittle Rich Pfingsten Neil Mulrooney Charlie Alley	Parsons Brinkerhoff Parsons Brinkerhoff Parsons Brinkerhoff American Consulting, Inc American Consulting, Inc KCI Technologies Walsh Construction, Asst. Project Engineer CONTECH	317-972-1706, <a href="mailto:flemings@pbworld.com">flemings@pbworld.com</a> 317-972-1706, <a href="mailto:lutz@pbworld.com">lutz@pbworld.com</a> 757-466-9628, <a href="mailto:andersonbe@pbworld.com">andersonbe@pbworld.com</a> 317-547-5580, <a href="mailto:cmeador@amercons.com">cmeador@amercons.com</a> 317-547-5580, <a href="mailto:bhittle@amercons.com">bhittle@amercons.com</a> 410-316-3782, <a href="mailto:rpfungsten@kci.com">rpfungsten@kci.com</a> 219-324-4320, <a href="mailto:nmulrooney@walshgroup.com">nmulrooney@walshgroup.com</a> 317-842-7766, <a href="mailto:calley@contech-cpi.com">calley@contech-cpi.com</a>

**AASHTO TASK FORCE ON HYDROLOGY AND HYDRAULICS**  
**Fall 2002 MEETING**  
Indianapolis, IN, May 12-16, 2003

**AGENDA**

Monday 5/12	<ul style="list-style-type: none"> <li>● Call to Order</li> <li>● Status of Task Force projects</li> <li>● FHWA Activities &amp; Updates</li> <li>● FHWA Resource Center Overview</li> <li>● Scour Update</li> <li>● NCHRP 15-23 Project Update</li> <li>● NCHRP 15-23 Recommended Changes</li> <li>● MDM Review of 2003 SI Final</li> </ul>	Merril Dougherty, Chair Phil Thompson Phil Thompson Peter Osborn Jorge Pagán Ken Shearin Don Potter Chapter 1-14 Chairs
Tuesday 5/13	<ul style="list-style-type: none"> <li>● MDM Review of 2003 SI Final</li> <li>● HDG Review of 2003 SI Final</li> <li>● NCHRP Update</li> <li>● AASHTO Activities</li> </ul>	Chapter 15-20 Chairs Chapter 1-14 Chairs Tim Hess Jim McDonnell
Wednesday 5/14	<ul style="list-style-type: none"> <li>● Field trip</li> </ul>	All
Thursday 5/15	Technical Presentations <ul style="list-style-type: none"> <li>● Fish Passage for Highway Structures</li> <li>● Digital Inspection Tool for E&amp;S</li> <li>● WMS &amp; SMS New Developments</li> <li>● NHI 135081 Intro to Hydraulic Software</li> <li>● Regionalization of Indiana Watersheds</li> <li>● Debris Accumulation at Bridge Piers</li> <li>● Midwest Resource Center Activities</li> <li>● Eastern Resource Center Activities</li> </ul>	Dr. Mark Browning Dr. Bob McCullough Dr. Larry Arneson Roger Kilgore Dr. A. R. Rao Dr. Dennis Lyn Dan Ghere Joe Krolak
Friday 5/16	<ul style="list-style-type: none"> <li>● Business Meeting</li> <li>● Concerns of States</li> </ul>	All

## AASHTO TASK FORCE ON HYDROLOGY AND HYDRAULICS (May 2003)

[www.aashto.org/aashto/home.nsf/FrontPage](http://www.aashto.org/aashto/home.nsf/FrontPage)

for SOD use [design.transportation.org](http://design.transportation.org)

### **Highway Drainage Guidelines (HDG)** - overview, discussion and design philosophy

1999, Metric Edition 3 - Volumes 1-13 & Glossary, 740 pg, Cost \$125 (\$100 to members)

2000, Volume 14 - \$39 (\$32 to members)

### **HDG Edition 4, Dual Unit manual in progress for 2003**

2001, NCHRP 15-23 [www4.nationalacademies.org/trb/crp.nsf/rfps](http://www4.nationalacademies.org/trb/crp.nsf/rfps)

2001, Fall, review and discuss list of recommended changes prepared by Roy Jorgensen Associates.

2002, Fall, review and finalize 2003 SI Final prepared by Roy Jorgensen Associates.

2002, Volume 15, Guideline for Hydraulic Design Consultants, SCOH ballot complete

2003, April, SI Proof completed

2003, Spring, review 2003 Dual Unit draft prepared by Roy Jorgensen Associates.

<b><u>Chapter</u></b>	<b><u>GUIDES</u></b>	<b><u>Chair</u></b>	<b><u>Ch</u></b>	<b><u>GUIDES</u></b>	<b><u>Chair</u></b>
1	Planning	Fazio	9	Storm Drainage	Bailey
2	Hydrology	Boynton	10	Environmental	Miles
3	Erosion Control	Henderson	11	Coastal Zone	Renna
4	Culverts	Thompson	12	Stormwater Man.	Dougherty
5	Legal Aspects	Richardson	13	Training	Phillips
6	Channels	Booher	14	Culvert Materials	DeCou
7	Bridges	Mills		Glossary	Schips
8	Restoration	Boynton	15	<i>Consultants</i>	<i>Veeramachaneni</i>

### **Model Drainage Manual (MDM)** - recommended design policy, criteria and procedures.

1991 First Edition, 1368 pages, Cost \$260 (\$208 to members)

1999 Metric Edition [2<sup>nd</sup>] - WP6.1, 1248 pg, Cost \$400 (\$334 to members)

2000 Appendix 7E & 15G \$40 ( \$34 to members)

### **MDM 3<sup>rd</sup> Edition, separate SI & English manuals in progress for 2003**

2001, NCHRP 15-23 <http://www4.nationalacademies.org/trb/crp.nsf/>

2001, Fall, review and discuss list of recommended changes prepared by Roy Jorgensen Associates.

2002, Fall, review and finalize 2003 SI prepared by Roy Jorgensen Associates.

2003, April, SI Proof completed.

2003, Spring, review and finalize 2003 US draft prepared by Roy Jorgensen Associates.

<b><u>Chapter</u></b>	<b><u>Leader</u></b>	<b><u>Team - FHWA in italics</u></b>	<b><u>Chapter</u></b>	<b><u>Leader</u></b>	<b><u>Team - FHWA in italics</u></b>
1 Intro	<i>Thompson</i>		12 Storage (SWM)	Dougherty	<i>Veeramachaneni</i>
2 Legal	Richardson		13 Storm Drain	Bailey	<i>Reese, Jones</i>
3 Policy	Nishioka	Ngo, Richardson	14 Pump Station	<i>Ghere</i>	<i>DeCou, Reese</i>
4 Document.	DeCou	Bailey	15 Environment	Miles	<i>Henderson, Newman</i>
5 Planning	Fazio	Richardson, Tran	16 Erosion & Sed.	Henderson	<i>Dougherty</i>
6 Data Col.	Reese	Nishioka, <i>Veeramachaneni</i>	17 Bank Protection	Newman	<i>Choudhary, Bergendahl</i>
7 Hydrology	Boynton	Newman, Stolpa, <i>Krolak</i>	18 Coastal Zone	Renna	<i>Henderson</i>
8 Channels	Booher	<i>Choudhary, Browning</i>	19 Construction	Ngo	<i>Richardson</i>
9 Culverts	<i>Thompson</i>	Ngo, O'Connor	20 Maintenance	Stolpa	<i>Henderson</i>
10 Bridge	Mills	Nishioka, <i>Arneson</i>	21 Restoration	(only in 1991 & 1999 editions)	
11 Energy	<i>Thompson</i>	Newman, Ngo	Glossary	Schips	<i>Thompson</i>

## AASHTO TASK FORCE ON HYDROLOGY AND HYDRAULICS (October 2002)

[www.aashto.org/aashto/home.nsf/FrontPage](http://www.aashto.org/aashto/home.nsf/FrontPage)

for SOD use <http://www.transportation.org/committee/design/>

1. AASHTO Highway Drainage Guidelines (HDG) contain an overview, discussion and design philosophy for each of the covered topics:
  - A. HDG [Edition 1]
    - 1973, Volumes 1-3, Planning & Location, Hydrology, Erosion & Sediment Control
    - 1975, Volume 4, Hydraulic Design of Culverts
    - 1977, Volume 5, Legal Aspects of Highway Drainage
    - 1979, Volume 6, Hydraulic Analysis & Design of Open Channels
    - 1982, Volume 7, Hydraulic Analysis for the Location and Design of Bridges
    - 1987, Volumes 1-7 and 8, Hydraulic Aspects in Restoration & Upgrading of Highways
  - B. HDG [Edition 2]
    - 1992, Volumes 1-8 updated, Volume 9 (Storm Drain), Volume 10 (Environment) and Glossary
    - 1994, Volume 11, Coastal Zone
  - C. HDG, 1999 Metric Edition [3]
    - 1995, Volume 12, Stormwater Management approved, but printing was deferred.
    - Volume 13, Hydraulics Engineer Training and Career Development also deferred.
    - 1999, Volumes 1-13 and glossary were distributed on July 26, 1999.
    - 1999, Volume 14, Culvert Inspection, Material Selection and Rehabilitation was approved by SCOH. AASHTO distributed on 3/06/00.
  - D. HDG, 2003 Edition 4 (Dual Units)
    - 1997, Review and update of volumes 1-13 was initiated.
    - 1998, Volume 15, Guideline for Hydraulic Design Consultants, *SOD ballot complete*.
    - 2001, NCHRP 15-23 <http://www4.nationalacademies.org/trb/crp.nsf/>
    - 2001, Fall, review and discuss list of recommended changes prepared by Roy Jorgensen Associates.
    - 2002, Fall, review and finalize 2003 SI Final prepared by Roy Jorgensen Associates.
    - 2003, *Spring, review 2003 Dual Unit draft prepared by Roy Jorgensen Associates.*
  
2. AASHTO Model Drainage Manual (MDM) contains recommended design policy, criteria and procedures:
  - A. MDM, 1991 Edition 1 distributed 1/92 to states, Cost \$235 and \$190 to members. The 21 chapters include design procedures, example problems, and computer solutions for most aspects of highway hydraulic design.
  - B. 1994 - All chapters have been updated and graphics have been converted to digital format in preparation for producing metric version of the manual (not distributed).
  - C. MDM, 1999 Metric Edition [2] - The NCHRP contractor was TTI and Dr. Tom Debo. Three chapters (storage, pump stations and storm drains) were substantially revised. The WP6.1 format includes graphics in electronic format. MDM distributed on April 26, 1999.
    - 2000 - Wetlands Hydrology appendices 7E & 15G distributed by AASHTO on 3/6/00.
  - D. MDM, 2003 Edition 3 (Dual Units), Review and update of chapters 1-21 was initiated
    - 2001, NCHRP 15-23 <http://www4.nationalacademies.org/trb/crp.nsf/>
    - 2001, Fall, review and discuss list of recommended changes prepared by Roy Jorgensen Associates.
    - 2002, Fall, review and finalize 2003 SI Final prepared by Roy Jorgensen Associates.
    - 2003, *Spring, review and finalize 2003 US draft prepared by Roy Jorgensen Associates.*



**TOTAL HIGHWAY BRIDGES AS OF 4/15/03 (5/08/03)**

**Attachment F**

State	Bridges Over Waterways	Scour Screening										Scour Evaluations		
		Low Risk				Scour Susceptible	Unknown Foundations	Tidal	Scour Critical	Total Screened	%	Total Evaluated	Evaluation Candidates	%
		Culverts	Screened	Assessed	Total									
AK	810	34	0	372	406	0	201	53	150	810	100	556	53	91
AL	14114	5618	0	2405	8023	3241	2658	1	191	14114	100	8214	3242	72
AR	11623	2304	0	3518	5822	0	5548	0	253	11623	100	6075	0	100
AZ	5561	3482	40	956	4478	71	172	0	840	5561	100	5278	111	98
CA	15386	2910	2507	5536	10953	412	3661	29	324	15379	100	8770	2955	75
CO	6793	1339	0	4987	6326	12	38	0	417	6793	100	6743	12	100
CT	2365	576	0	1272	1848	39	67	0	411	2365	100	2259	39	98
DC	94	0	0	93	93	0	0	0	1	94	100	94	0	100
DE	576	181	0	270	451	0	0	0	125	576	100	576	0	100
FL	8258	1711	653	2604	4968	196	2681	149	264	8258	100	4579	998	82
GA	12134	5354	0	734	6088	0	5970	0	76	12134	100	6164	0	100
HI	860	130	50	566	746	24	11	2	64	847	98	760	89	90
IA	23482	3218	705	14805	18728	95	3878	0	781	23482	100	18804	800	96
ID	3209	1073	0	1284	2357	0	587	0	265	3209	100	2622	0	100
IL	21641	3914	160	15633	19707	3	1272	0	614	21596	100	20161	208	99
IN	15903	1001	0	12703	13704	56	444	0	1699	15903	100	15403	56	100
KS	23803	6100	57	15685	21842	1432	93	0	441	23808	100	22226	1484	94
KY	11225	2641	0	8110	10751	11	424	0	39	11225	100	10790	11	100
LA	9891	0	0	3573	3573	0	5473	0	845	9891	100	4418	0	100
MA	2464	282	0	706	988	215	395	1	865	2464	100	1853	216	90
MD	3163	1017	0	992	2009	0	560	0	594	3163	100	2603	0	100
ME	1867	272	0	1039	1311	18	191	112	235	1867	100	1546	130	92
MI	7575	1111	0	2700	3811	2375	709	0	680	7575	100	4491	2375	65
MN	11331	4460	31	5474	9965	377	509	0	480	11331	100	10414	408	96
MO	20912	4026	0	16435	20461	308	18	0	101	20888	100	20562	332	98
MS	14790	2269	0	3137	5406	14	8608	0	762	14790	100	6168	14	100
MT	3578	154	304	1289	1747	34	1746	0	51	3578	100	1494	338	82
NC	14180	4549	67	3296	7912	14	6092	81	81	14180	100	7926	162	98
ND	4129	793	21	1130	1944	4	2097	0	84	4129	100	2007	25	99
NE	14808	2827	11	2658	5496	1229	7615	0	441	14781	100	5926	1267	82
NH	1755	163	80	1388	1631	30	50	0	44	1755	100	1595	110	94
NJ	3551	316	0	2428	2744	49	344	40	367	3544	100	3111	96	97
NM	3001	1563	172	671	2406	73	498	0	24	3001	100	2258	245	90
NV	889	555	31	114	700	33	53	0	102	888	100	771	65	92
NY	12090	1589	0	9520	11109	120	62	133	666	12090	100	11775	253	98
OH	23326	1338	0	16283	17621	5273	241	0	191	23326	100	17812	5273	77
OK	20835	5981	8	14345	20334	0	0	0	501	20835	100	20827	8	100
OR	5495	266	0	1824	2090	16	1877	67	1442	5492	100	3532	86	98
PA	17328	1680	886	7315	9881	1442	461	0	5544	17328	100	14539	2328	86
PR	1605	244	63	758	1065	26	372	33	109	1605	100	1111	122	90
RI	337	30	0	176	206	0	0	0	131	337	100	337	0	100
SC	7784	1054	0	1170	2224	0	3704	155	1701	7784	100	3925	155	96
SD	5373	1000	0	1653	2653	136	2584	0	0	5373	100	2653	136	95
TN	16520	7816	0	6022	13838	391	1236	0	1055	16520	100	14893	391	97
TX	40772	16919	0	12654	29573	913	9581	55	650	40772	100	30223	968	97
UT	1682	435	0	527	962	101	447	0	172	1682	100	1134	101	92
VA	9818	2747	0	7014	9761	2	0	0	55	9818	100	9816	2	100
VT	2304	68	0	1348	1416	373	246	0	298	2333	101	1714	344	83
WA	5133	147	0	3627	3774	41	295	0	965	5075	99	4739	99	98
WI	10689	1682	0	6722	8404	215	2002	0	68	10689	100	8472	215	98
WV	5742	350	4	3404	3758	25	1735	0	225	5743	100	3979	28	99
WY	1925	402	9	1063	1474	28	421	0	2	1925	100	1467	37	98
Totals	484479	109691	5859	233988	349538	19467	87927	911	26486	484329		370165	26387	
Percent		22.6%	1.2%	48.3%	72.1%	4.0%	18.1%	0.2%	5.5%	99.97%		93.3%	6.7%	

**BRIDGE SCOUR EVALUATION SUMMARY as of 4/15/03 (5/3/03)**  
**(SORTED BY "EVALUATIONS > 90%" AND "EVALUATIONS NEEDED," Bold if >1000)**

State	Scour Evaluation Progress				Substantial Progress		Action Plan		Unknown Foundations		
	Needed	Completed	Total	Percent	Evaluations Complete	Evaluations >90%	Revised Plan	Target Date	Unknown Needed	Total Needed	Percent
OH	<b>5273</b>	17812	23085	77%			No		241	<b>5514</b>	<b>76%</b>
AL	<b>3242</b>	8214	11456	72%			No		<b>2658</b>	<b>5900</b>	<b>58%</b>
CA	<b>2955</b>	8770	11725	75%			No		<b>3661</b>	<b>6616</b>	<b>57%</b>
MI	<b>2375</b>	4491	6866	65%			No		709	<b>3084</b>	59%
PA	<b>2328</b>	14539	16867	86%			No		461	<b>2789</b>	84%
NE	<b>1267</b>	5926	7193	82%			No		<b>7615</b>	<b>8882</b>	<b>40%</b>
FL	998	4579	5577	82%			No		<b>2681</b>	<b>3679</b>	<b>55%</b>
VT	344	1714	2058	83%			No		246	590	74%
MT	338	1494	1832	82%			No		<b>1746</b>	<b>2084</b>	<b>42%</b>
KS	<b>1484</b>	22226	23710	94%		Yes			93	<b>1577</b>	<b>93%</b>
TX	968	30223	31191	97%		Yes			<b>9581</b>	<b>10549</b>	<b>74%</b>
IA	800	18804	19604	96%		Yes			<b>3878</b>	<b>4678</b>	<b>80%</b>
MN	408	10414	10822	96%		Yes			509	917	92%
TN	391	14893	15284	97%		Yes			<b>1236</b>	<b>1627</b>	<b>90%</b>
MO	332	20562	20894	98%		Yes			18	350	98%
NY	253	11775	12028	98%		Yes			62	315	97%
NM	245	2258	2503	90%		Yes			498	743	75%
MA	216	1853	2069	90%		Yes			395	611	75%
WI	215	8472	8687	98%		Yes			<b>2002</b>	<b>2217</b>	<b>79%</b>
IL	208	20161	20369	99%		Yes			<b>1272</b>	<b>1480</b>	<b>93%</b>
NC	162	7926	8088	98%		Yes			<b>6092</b>	<b>6254</b>	<b>56%</b>
SC	155	3925	4080	96%		Yes			<b>3704</b>	<b>3859</b>	<b>50%</b>
SD	136	2653	2789	95%		Yes			<b>2584</b>	<b>2720</b>	<b>49%</b>
ME	130	1546	1676	92%		Yes			191	321	83%
PR	122	1111	1233	90%		Yes			372	494	69%
AZ	111	5278	5389	98%		Yes			172	283	95%
NH	110	1595	1705	94%		Yes			50	160	91%
UT	101	1134	1235	92%		Yes			447	548	67%
WA	99	4739	4838	98%		Yes			295	394	92%
NJ	96	3111	3207	97%		Yes			344	440	88%
HI	89	760	849	90%		Yes			11	100	88%
OR	86	3532	3618	98%		Yes			<b>1877</b>	<b>1963</b>	<b>64%</b>
NV	65	771	836	92%		Yes			53	118	87%
IN	56	15403	15459	100%		Yes			444	500	97%
AK	53	556	609	91%		Yes			201	254	69%
CT	39	2259	2298	98%		Yes			67	106	96%
WY	37	1467	1504	98%		Yes			421	458	76%
WV	28	3979	4007	99%		Yes			<b>1735</b>	<b>1763</b>	<b>69%</b>
ND	25	2007	2032	99%		Yes			<b>2097</b>	<b>2122</b>	<b>49%</b>
MS	14	6168	6182	100%		Yes			<b>8608</b>	<b>8622</b>	<b>42%</b>
CO	12	6743	6755	100%		Yes			38	50	99%
KY	11	10790	10801	100%		Yes			424	435	96%
OK	8	20827	20835	100%		Yes			0	8	100%
VA	2	9816	9818	100%		Yes			0	2	100%
GA	0	6164	6164	100%	Yes				<b>5970</b>	<b>5970</b>	<b>51%</b>
AR	0	6075	6075	100%	Yes				<b>5548</b>	<b>5548</b>	<b>52%</b>
LA	0	4418	4418	100%	Yes				<b>5473</b>	<b>5473</b>	<b>45%</b>
ID	0	2622	2622	100%	Yes				587	587	82%
MD	0	2603	2603	100%	Yes				560	560	82%
DE	0	576	576	100%	Yes				0	0	100%
RI	0	337	337	100%	Yes				0	0	100%
DC	0	94	94	100%	Yes				0	0	100%
Nationwide	26387	370165	396552	93.3%	8	35	9	0	87927	114314	76.9%

**TECHNOLOGY APPLICATIONS (May 2003)**  
**www.fhwa.dot.gov/bridge/hyd.htm**

**Chien-Tan Chang**, HIBT, (202) 366-6749 is the COTR (Contract Office Technical Representative) for all projects. The COTR and the hydraulic engineers shown in parentheses provide technical oversight. The lead hydraulic engineer for each project is shown in **BOLD**.

1. DOT Information Service Digital Document Center (isddc.dot.gov) (**Thompson**)  
 DOT publications can be obtained over the web or through the mail (one free copy).
  - 32 publications on CD in HTML are available in PDF format at [www.fhwa.dot.gov/bridge/hydpub.htm](http://www.fhwa.dot.gov/bridge/hydpub.htm)
  - New reports are being provided in PDF format and historic reports are being scanned.
  - HDS 5, FHWA-NHI-01-020 is available at [hydpub.htm](http://hydpub.htm).
  - HDS 6, FHWA-NHI-01-004 is available at [hydpub.htm](http://hydpub.htm).
  - *HDS 2, FHWA-NHI-02-001 has been posted at ISDDC.*
  - *HDS 1 & HEC 14 have been converted to HTML and will be posted at ISDDC.*
2. FHWA Hydraulics Library (CD ROM) (**Thompson**) - **Dr. Bill Grenney** & Pallas Inc.
  - The CD with HDS 5, video, and MDM Chapter 9 was distributed in February 1997.
  - Library includes 32 publications (7 HDS, 19 HEC, HIRE, & 5 TS/IP), 3 videos. CDs distributed on 6/8/00. Windows HY8Energy, HY8InpGen and *HDS 5 Calculator* available at bridge web site.
  - *HY8InpGen (Version 3) - includes all shapes and HY8PCViewer (posted 1/03).*
  - *HY8Energy (Version 2) - posted 1/03*
  - *Fish Passage Beta for HY8InpGen awarded 5/03*
3. SMS & WMS (**Arneson**) - Version 6.1 of WMS and Version 8 of SMS are available at "www.ems-i.com".  
*FHWA's 3 year unlimited licenses for State DOTs ended on 10/1/99.*
  - SMS contains FESWMS (FLO2DH), RMA2, and WSPRO interfaces; *BRI-STARS is being added.*
  - WMS contains HEC1, TR20, NFF and rational interfaces, HYDRA interface awarded summer 2001.
  - *"User's Manual for FESWMS (Flo2DH) 2-dimensional depth-average flow and sediment transport model," Version 3, Sept 2002 is being prepared for posting. Enhancements funded for FY 2003.*
  - *2003, Flo1D public domain interface & Bri-Stars enhancements funded FY 2003*
  - *2003, 4 year agreements and licenses were funded FY 2003.*
4. HEC 9, Design of Debris Control Structures (**Beucler**, Pagán, Krolak) - West Consultants, PI **Dennis Richards**.
  - Kick off meeting has been held 4/01.
  - *Draft manual is being reviewed, final manual spring 2003*
5. HEC 18, 20, and 23 conversion to Spanish (**Pagán**) - pool funded project with NHI, International & HIBT
  - *HEC 18 draft is being reviewed.*
6. HEC 24, Design of Highway Pump Stations (**Ghere**, Thompson) - FY97, Contract to develop a manual, software and training, PB (**Peter Smith**).
  - HEC 24 has been printed and is available at [hydpub.htm](http://hydpub.htm). NHI 135028 (1-day) course is available.
  - Test version of software received 5/3/02, *Final Version by June 2003.*
7. HEC 25, Tidal Hydrology, Hydraulics & Scour (**Arneson**, Pagán, Krolak) - Ayres (**Dr. Lyle Zevenbergen**) tidal pool funded project contractor awarded task to convert project material to HEC format.
  - *Outline has been finalized. Draft manual will be prepared by this summer.*
8. CAESAR Manual (**Pagán**, Arneson) - **Dr. Richard Palmer**, University of Washington awarded contract 9/01 to develop manual and customize CAESAR for use by State DOTs.
  - *Enhancements underway, beta version demonstrated at Western Hydraulics Conference.*
9. HEC Conversion to Dual Units (**Thompson**, Bergendahl)
  - *2003, HEC 14 and 15 proposed*
10. Rapid Assessment Procedure for Channel Stability (**Pagán**, Jones) - (FY 2004)

**NATIONAL HIGHWAY INSTITUTE (May 2003)**  
**www.nhi.fhwa.dot.gov**

**Larry Jones**, (703) 235-0523, is the NHI Course Coordinator. Technical oversight of each course is provided by Larry Jones and the hydraulic engineers shown in parentheses. The lead FHWA and contractor hydraulic engineer for each course is shown in **BOLD**. Course descriptions can be found at [www.nhi.fhwa.dot.gov/coursecfff.htm](http://www.nhi.fhwa.dot.gov/coursecfff.htm) and [www.fhwa.dot.gov/bridge/hydrtrain.htm](http://www.fhwa.dot.gov/bridge/hydrtrain.htm). See [www.fhwa.dot.gov/bridge](http://www.fhwa.dot.gov/bridge) for study of alternatives for providing dual units. *Tasks have been awarded through FHWA-DTFH61-02-D-63000 for course presentations until 12/31/2006.*

1. NHI 135010, River Engineering for Highway Encroachments, 5 days (**Phil Thompson**) FHWA instructor Dr. Larry Arneson. Ayres instructors are **Dr. Pete Lagasse**, Dr. E.V. Richardson, Dr. Lyle Zevenbergen, Dr. Jim Schall, & *Dr. Jerry Richardson*. HDS 6 is available at [www.fhwa.dot.gov/bridge/hydpub.htm](http://www.fhwa.dot.gov/bridge/hydpub.htm)
2. NHI 135027, Urban Drainage Design, 3 days & NHI 135028, Pump Station Design, 1 day (**Dan Ghere**, Cynthia Nurmi, Bart Bergendahl and Brian Beucler FHWA instructors). Ayres instructors are: **Johnny Morris**, Dr. Jim Schall, Arlo Waddoups & Chris Doherty. HEC 22 & 24 are available at [hydpub.htm](http://hydpub.htm)
3. NHI 135041, HEC-RAS, 3 days (**Arneson**) Ayres instructors are **John Hunt**, Dr. Lyle Zevenbergen, William deRosset, Brian Varrella, & *Chris Doherty*. *Enhanced Participant manual proposed for 2003.*
4. NHI 135046, Stream Stability and Scour at Highway Bridges, NHI 135047 Stream Stability and Scour at Highway Bridges for Bridge Inspectors and NHI 135048 Countermeasure Design for Bridge Scour and Stream Instability, 3 days (**Jorge Pagán**, Larry Arneson, Sterling Jones, Joe Krolak, Cynthia Nurmi, Dan Ghere FHWA instructors); Ayres instructors are Drs. **Pete Lagasse**, E.V. Richardson, Lyle Zevenbergen, Jim Ruff, Jerry Richardson, *Bill Spitz, & Paul Clopper*.
  - *Dual unit conversion and updates are complete*
5. NHI 135056, Culvert Design, 3 days (**Phil Thompson**, Steve Toillion, Joe Krolak FHWA instructors) Ayres Associates instructors are **Dr. Jim Schall**, John Morris, Arlo Waddoups, John Hunt, Dave Frick & Scott Hogan. HDS 5 is reference manual. *The dual unit, 2001 edition, is available at [isdcc.dot.gov](http://isdcc.dot.gov).*
  - Metric HEC 14 in PDF format available at [www.fhwa.dot.gov/bridge/hydpub.htm](http://www.fhwa.dot.gov/bridge/hydpub.htm)
  - *Draft dual units instructor's manual is being reviewed.*
6. NHI 135065, Introduction to Highway Hydraulics, 3.5 days, (**Jorge Pagán**, Steve Toillion, Brian Beucler FHWA instructors) Ayres Associates instructors are **Dr. Jim Schall**, John Morris, Arlo Waddoups, Dave Frick, Doug Laiho & *Chris Doherty*. HDS 4 has been converted to dual units.
  - *Draft instructor's manual is being reviewed by FHWA.*
7. NHI 135067, Practical Highway Hydrology, 3 days, (**Joe Krolak** FHWA instructor ) Kilgore Consulting and Management instructors are **Roger Kilgore**, Dr. Gary Lewis and Tamim Atayee.
  - *HDS 2, Highway Hydrology - dual units edition, 2002, has been posted at ISDDC*
  - *Course Update has been completed.*
8. NHI 135071, FESWMS/SMS, 4.5 days, (**Dr. Larry Arneson** FHWA instructor) EMS-I Instructors are **Dr. Alan Zundel**, Darren Gonzales, Rusty Jones, Tom Moreland, and Jeff Davis.
9. NHI 135080, Hydrologic Modeling with the Watershed Modeling System (WMS), 3 days (**Dr. Larry Arneson** FHWA instructor) EMS-I instructors are **Dr. Jim Nelson**, Colby Manwaring, Chris Smemoe, Doug Gallup, and Jeff Davis.
10. NHI 135081, Introduction to Highway Hydraulics Software, 3 days, (**Joe Krolak** FHWA instructor) Kilgore Consulting and Management instructors are **Roger Kilgore**, Dr. Gary Lewis, and Tamim Atayee. *Course agenda and software have been determined. Draft lessons are being prepared.*
11. NHI 135082, Tidal Hydrology, Hydraulics & Scour, (**Dr. Larry Arneson**, *Jorge Pagán*, *Joe Krolak*) - *proposed for 2003*
12. NHI 135083, Tidal Software - *proposed for 2004*

**FHWA Hydraulic Engineering Publications**  
**[www.fhwa.dot.gov/bridge/hydpub.htm](http://www.fhwa.dot.gov/bridge/hydpub.htm)**  
**May 2003**

Publications are available from NTIS, National Technical Information Service, 5285 Port Royal Rd, Springfield, VA 22161, (703) 605-6000 ([www.fedworld.gov/ntis](http://www.fedworld.gov/ntis)). Electronic versions for some publications are available at DOT digital document center: [isddc.dot.gov](http://isddc.dot.gov).

HYDRAULIC DESIGN SERIES (HDS)		YEAR	FHWA-#	NTIS-#
HDS-1	Hydraulics of Bridge Waterways	1978	EPD-86-10	PB86-181708
HDS-2	Highway Hydrology (Dual Units)	2002	NHI-02-001	
HDS-3	Design Charts for Open-Channel Flow	1961	EPD-86-10	PB86-179249
HDS-4	Introduction to Highway Hydraulics (Dual Units)	2001	NHI-01-010	
HDS-5	Hydraulic Design of Highway Culverts *	1985	IP-85-15	PB86-196961
HDS-5	Hydraulic Design of Highway Culverts (Dual Units)	2001	NHI-01-020	
HDS-6	River Engineering for Highway Encroachments (Dual Units)	2001	NHI-01-004	
HYDRAULIC ENGINEERING CIRCULARS (HEC)		YEAR	FHWA-#	NTIS-#
HEC-9	Debris-Control Structures	1971	EPD-86-10	PB86-179801
HEC-11	Design of Riprap Revetment	1989	IP-89-016	PB89-218424
HEC-14	Hyd. Design of Energy Dissipators for Culverts & Channels *	1983	EPD-86-11	PB86-180205
HEC-15	Design of Roadside Channels with Flexible Linings *	1988	IP-87-7	PB89-122584
HEC-17	Design of Encroachments on Flood Plains using Risk Analysis	1981	EPD-86-11	PB86-182110
HEC-18	Evaluating Scour at Bridges, Edition 3 (Dual units)	2001	NHI-01-001	
HEC-20	Stream Stability at Highway Structures, Edition 2 (Dual units)	2001	NHI-01-002	
HEC-21	Bridge Deck Drainage Systems	1993	SA-92-010	PB94-109584
HEC-22	Urban Drainage Design Manual (Dual Units)	2001	NHI-01-021	
HEC-23	Bridge Scour & Stream Instability Countermeasures (Dual Units)	2001	NHI-01-003	
HEC-24	Highway Stormwater Pump Station Design	2001	NHI-01-007	
IMPLEMENTATION REPORTS (IMP)		YEAR	FHWA-#	NTIS-#
IMP	Underground Disposal of Storm Water Runoff, Design Guidelines	1980	TS-80-218	PB83-180257
IMP	Guide for Selecting Manning's Roughness Coef. for Natural Channels and Flood Plains	1984	TS-84-204	PB84-242585
IMP	Culvert Inspection Manual	1986	IP-86-2	PB87-151809
IMP	Structural Design Manual *	1983	IP-83-6	PB84-153485
PUBLICATIONS ON CD-ROM		YEAR	FHWA-#	NTIS-#
HDS-5	Hydraulic Design of Highway Culverts (CDROM), v1.00	1996	SA-96-080	N/A
	Installation and User's Guide (SI computation aids)	1996	SA-96-081	N/A
	FHWA Hydraulics Library	2000	IF-00-022	

\* Also available from McTRANS - 512 Weil Hall, Univ. of Florida, Gainesville, FL 32611-6585  
352- 392-0378, FAX 352- 392-3224, Messages 1-800-226-1013

**FHWA Hydraulics Software List**  
**[www.fhwa.dot.gov/bridge/hydsoft.htm](http://www.fhwa.dot.gov/bridge/hydsoft.htm)**  
**May 2003**

The software and related publications listed below are available at [www.fhwa.dot.gov/bridge/hydsoft.htm](http://www.fhwa.dot.gov/bridge/hydsoft.htm) or:

McTRANS - 512 Weil Hall, Univ. of Florida, Gainesville, FL 32611-6585, (352) 392-0378, FAX (352) 392-3224, Messages 1-800-226-1013 ([www-mctrans.ce.ufl.edu](http://www-mctrans.ce.ufl.edu))

PC-TRANS - 2011 Learned Hall, Lawrence, KS 66045, (913) 864-5655, FAX (913) 864-3199 ([kuhub.cc.ukans.edu/~pctrans/index.html](http://kuhub.cc.ukans.edu/~pctrans/index.html))

	TITLE	YEAR	MCTRANS	FHWA-#	NTIS-#
HY-7	Bridge Waterways Analysis Model	1999	WSPRO		
	WSPRO Research Report	1986	WSPRO.D	RD-86-108	PB87-216107
	WSPRO User's Manual (Version P60188)	1999	WSPRO.D	SA-98-080	
HY-8	FHWA Culvert Analysis (Version 6.1)	1999	HY8		
	Hydraulic Design of Highway Culverts	1985	HY8.D	IP-85-15	PB86-196961
	Research Report (Version 1.0)	1987	HY8.D		
	HY 8 User's Manual (see Hydrain)	1999			
HY8InpGen	HY 8 Input Generator (95/98/NT)	2003			
HY8Energy	HY 8 Energy (95/98/NT)	2003			
HY-10	BOXCAR (Version 1) [Version 2 ACPA]	1989	BOXCAR		
	BOXCAR Users Manual	1989	BOXCAR.D	IP-89-018	PB90-115486
	Structural Design Manual	1983	BOXCAR.DS	IP-83-6	PB84-153485
	PIPECAR (Version 2.1)	1993	PIPECAR		
	PIPECAR Users Manual (Version 1.0)	1989	PIPECAR.D	IP-89-019	PB90-115478
	Structural Design Manual	1983	PIPECAR.DS	IP-83-6	PB84-153485
	CMPCHECK (Version 1.0)	1989	CMPCHECK		
HY-11	Preliminary Analysis System for WSP	1989	PAS		
	PAS USERS MANUAL	1989	PAS.D	IP-89-013	PB90-112723
FESWMS	Flo2DH (Version 3)	2002			
	<i>Users Manual for FESWMS(Flo2DH)</i>	2003		RD-03-053	NA
	FESWMS-2DH, Research Report	1989	FESWMS.DS	RD-88-146	PB91-106492
HY-22	Urban Drainage Design (see HEC-22)	1999			
	VisualUrban (95/98/NT)	2001			
CANDE	CANDE-89 (Version 1.0)	1989	CANDE		
	CANDE, Users Manual	1989	CANDE.D	RD-89-169	NA
HYDRAIN	Drainage Design System (Version 6.1)	1999	HYD6		
	HYDRAIN Users Manual (PDF)	1999	NA	IF-99-008	NA
BRI-STARS	Bridge Stream Tube for Alluvial River Sim.	2000			
	BRI-STARS Users Manual (Version 5.03)	2000		RD99-190&1	