WATER OPERATION AND MAINTENANCE

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The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging information for use by Bureau personnel and water user groups for operating and maintaining project facilities.

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Cover photograph:

Havel Lake in Germany

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SHORELINE EROSION CONTROL ON HAVEL LAKE IN GERMANY[1]

by Hollis H. Allen[2]

A low-cost bioengineering technique for reservoir and lake shoreline erosion control has been successfully used on Havel Lake in Germany and has potential for application in the United States. By creating wetlands behind it, this technique offers the additional advantages of providing sediment entrapment, water quality improvement, aesthetic enhancement, and protection of cultural and archeological resources.

Developed and tested by Lothar Bestmann of Bestmann Ingenieurbiologie (Bioengineering) in Wedel, Germany, this technique was adapted from a method used to regain land lost to the North Sea along the north German coastline. It was further adapted for use in a demonstration study on the Havel Lake in Berlin 8 years ago. Various modifications have been used on reservoirs and lakes near Berlin, Pritzwalk, and other locations throughout Germany.

Havel Lake is a part of the Havel River that runs through Berlin. Its water level is controlled within 0.8 to 1.0 m (2.6 to 3.3 feet) in the vicinity of Berlin, and wind fetches vary from 2 to 5 km (1.2 to 3.1 miles). Originally, the lake had a wetland fringe on most of its perimeter. This edge reduced wave energies and protected the shoreline from erosion. In time, as urbanization impacted on the wetlands, the lake began to lose shoreline. The wetlands were gradually being destroyed by such factors as waves from motorboats (work and sport); choking out by drifting garbage; trampling from people and boats, which kinks the stems of plants; depredation by waterfowl; discharge of toxins and contamination of water by oil, heavy metals, etc.; and shading by trees close to the shore.

The technique used on Havel Lake consists of a combination breakwater with planted wetlands toward the shore (figure 1).

This method has been applied only in areas of Germany where water levels do not fluctuate more than 1 m (3.3 feet), but its use may be acceptable in situations where greater fluctuations exist. It has application for shoreline erosion control on many U.S. reservoirs with dense thickets of young, woody trees (e.g., willow, cottonwood, and alder) near them, since these provide the materials used in the breakwater.

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[1] Reprinted with permission from Mr. Lee Byrne, Technology Transfer Specialist, REMR Research Program, Waterways Experiment Station, Corps of Engineers, Department of the Army, from the September 1992 issue of The REMR Bulletin.

[2] Hollis H. Allen is a botanist with the Environmental Laboratory at the Waterways Experiment Station, Vicksburg, Mississippi.

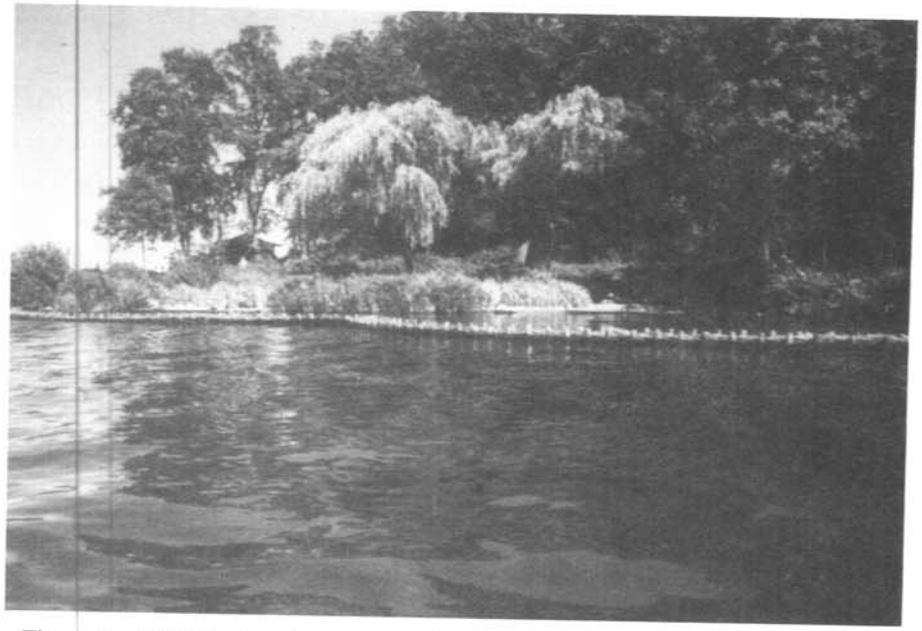

Figure 1. – Combination low-cost breakwater with planted wetlands for shoreline erosion control and habitat development.

There are several options for breakwater construction, and various materials such as stone or rocks, branches and poles, or fiberschines [large coconut fiber rolls (figure 2)] can be used. The branchbox breakwater was used for Havel Lake. It consists of biodegradable materials composed of long poles and faschines, bundles of small dead branches, such as willow and poplar, collected from woodlands (figure 3). This breakwater is usually constructed in about 1-m- (3.3-foot) deep water in the following sequence:

– Poles that are 2 to 3 m (6.6 to 10 feet) long are positioned vertically in the lake substrate in two rows about 1 m (3.3 feet) apart. This placement is accomplished initially by a hydraulic jet pump. At this point, the poles are not inserted all the way into the substrate, but are placed deep enough to be secure (figure 4).

– A 25-cm- (10-inch) thick layer of dead branches is positioned perpendicular to the rows of poles. The branches should be about 2.5 m (8.2 feet) long. These branches serve as filter material and retard scour at the bottom of the breakwater.

– Faschines are wedged between the rows of poles, and the bundles are secured to the poles by wire rope woven through screw eyes on each pole like a shoelace; each faschine is about 0.5 m (1.6 feet) in diameter and varies from 2 to 4 m (6.6 to 13.1 feet) in length. The screw eyes are placed on the poles a few centimeters above the faschines.

– The poles are driven down firmly with a pneumatic hammer mounted on a barge or some other mechanical device that serves the same purpose. This process tightens the whole breakwater system.

– The tops of the poles are sawed off about 30 to 60 cm (12 to 24 inches) above the tops of the faschines, and the breakwater is completed (figure 5).

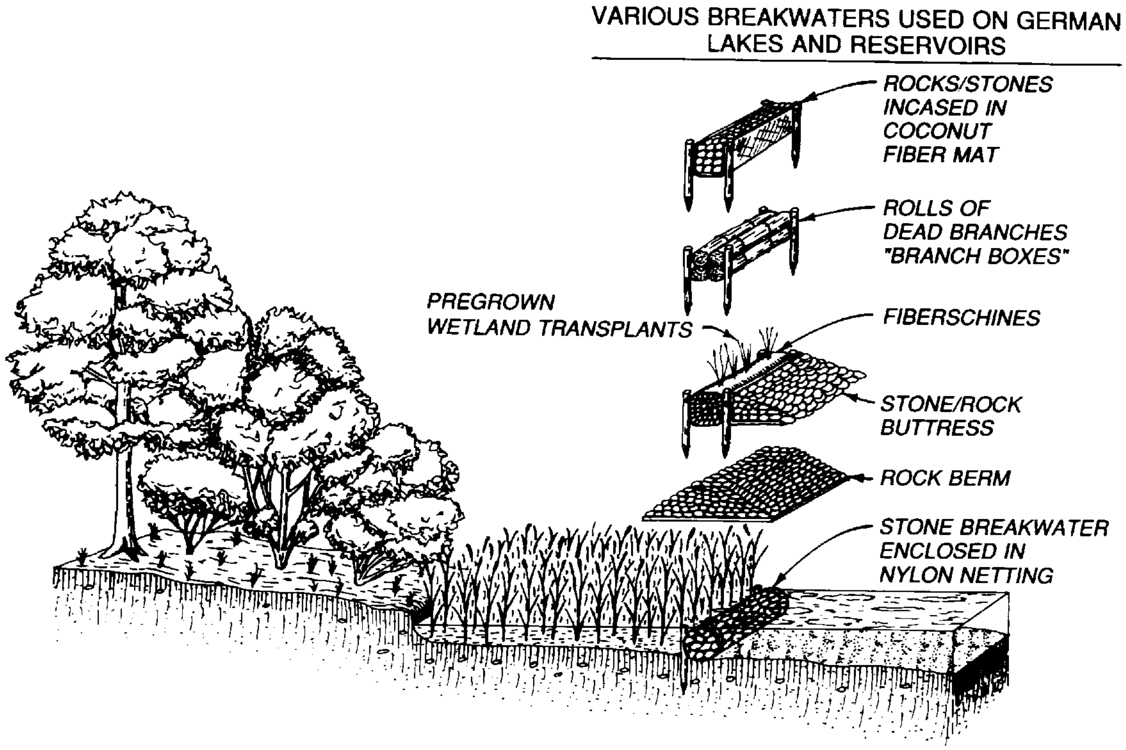

Figure 2. – Various combinations of breakwaters and wetlands used on German reservoir and lake shorelines.

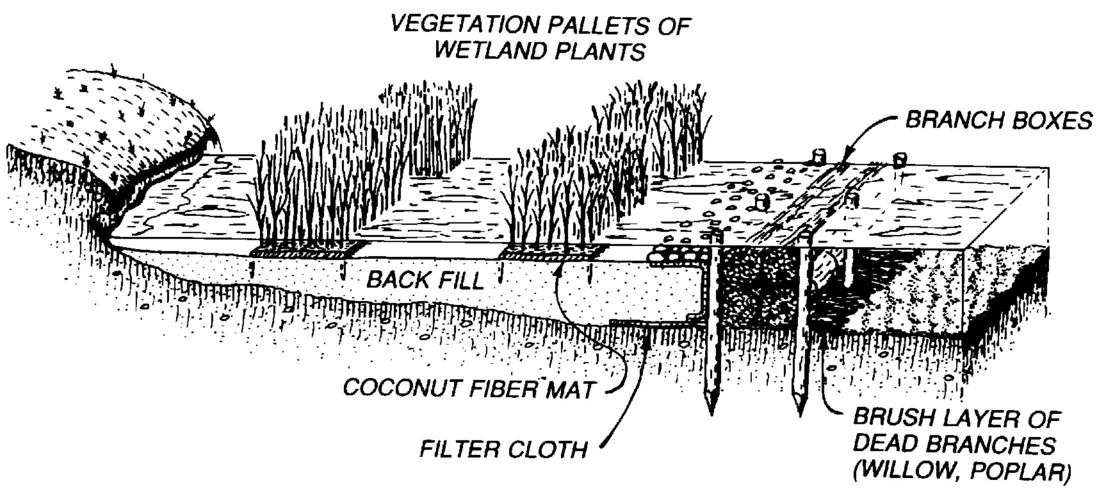

Figure 3. – Branchbox breakwater with wetlands shoreward.

Figure 4. – Poles that are initially placed with a jetpump.

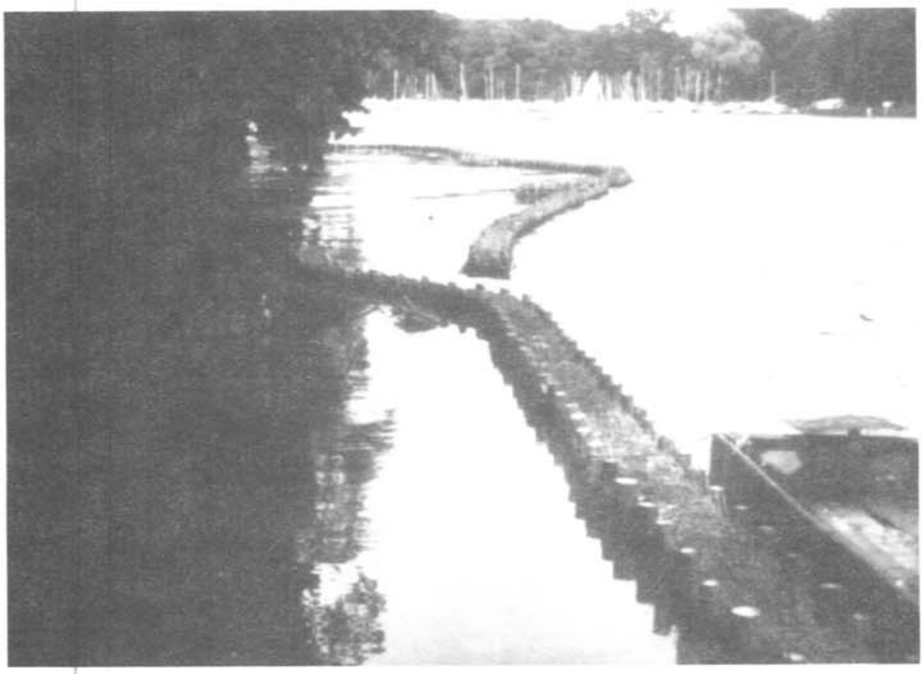

Figure 5. – Completed branchbox breakwater.

After breakwater construction, wetland plants pregrown in pallets and bulbs are transferred intact to the site and installed (see figure 3). The pallets are secured to the substrate by driving long stakes into them and tying rope between the stakes. Then everything is tightened by driving the stakes farther into the substrate so that all is secure.

Wetland plants most often used in the lake around Berlin include the following:

Acorus calamus	Sweetflag
Carex gracilis	Sedge
Iris pseudacorus	Yellow flag
Phragmites australis	Common reed
Schoenoplectus lacustris	Bulrush
Typha angustifolia	Narrow-leaved cattail
Typha latifolia	Broad-leaved cattail

These wetland plants and others are usually placed in zones of water levels ranging from approximately 0.5 m (1.6 feet) below to 0.3 m (1 foot) above the average water level. Wetland plants are often pregrown in a coconut fiber substrate in one of the following forms: fiber pallets (80 by 125 cm)(32 by 49 inches); coconut fiber vegetation carpets rolled out onsite (0.5 to 2.0 m wide by 5 m long)(1.6 to 6.6 feet wide by 16.4 feet long); or 20- by 20- by 20-cm (8- by 8- by 8-inch) bulbs. All of these lend themselves to immediate transfer to the site and short-term shore stabilization until the vegetation becomes established. Wetlands are not usually planted until the breakwater is in place.

Costs for these wetland systems (1991 prices) including the branchbox breakwater, wetland plants installed as pallets and bulbs, and coconut-fiber filter fabric were between $400 and $460 per linear metre ($122 and $140 per linear foot). These costs are for about a 10- to 20-m (33- to 66-foot) swath from the breakwater landward. Generally, costs for bioengineering alternatives are a fraction of the cost of traditional alternatives such as riprap armorment. It should be noted that construction costs could be less in Germany because the equipment used there, such as barge-mounted pneumatic hammers and shallow-draft barges and boats, was made for this purpose. However, similar equipment could be manufactured in the United States.

The technique permits effective, low-cost erosion control without destroying shoreline habitat; in fact, the wetlands that are created enhance the shoreline habitat of the reservoir. Through the use of this technique or a modification of it, several kilometres of wetlands have been and continue to be restored along the shore of Havel Lake. At the same time, the shore is being protected from further erosion.

The branchbox breakwater with associated wetlands is a feasible technique for cost effectively controlling shoreline erosion in reservoirs with little water-level fluctuation. It has the added benefit of restoring wetland habitat in harmony with nature. The breakwater is also biodegradable, a fact that makes it more acceptable to environmental agencies and groups. This system is feasible for reservoir shorelines receiving fluctuation more than 1 m (3.3 feet), but caution should be exercised and a low-cost demonstration is advised before pursuing large-scale shoreline erosion control efforts on reservoirs of this type.

For additional information, call Hollis H. Allen at (601) 634-3845.

Hollis H. Allen has been with the Waterways Experiment Station (WES) for almost 23 years and has conducted studies on man's impacts on the environment and ways to correct negative impacts. Allen has spent a majority of those years using bioengineering techniques, a combination of vegetation and low-cost building materials and structures, on dredged material and reservoir shorelines, and on stream and riverbanks for both shoreline erosion control and habitat development for wildlife and fisheries. Allen has attended Oklahoma State University, Oregon State University, and Colorado State University and holds degrees in Forestry and Forest Ecology.

Metric measurements

1 m	=	3.281 feet
1 cm	=	0.3937 inch
1 km	=	0.6214 mile

ENSURING PREPAREDNESS: TESTING AN EMERGENCY ACTION PLAN[1]

For dam owners, having a plan for responding to dam failure is not enough. To ensure that operating personnel and local authorities and emergency response agencies are prepared, the plan needs to be tested periodically. Here's how one U.S. utility approached EAP testing.

by John Z. Gibson and Lisa G. Hildebrand[2]

It's Wednesday, September 19, 1990, in Clark Fork, Idaho. The weather is clear; the temperature is in the 80's. At 11 a.m., an earthquake registering 5.8 on the Richter scale shakes the area. The hydro station operator at Cabinet Gorge Dam, on the Clark Fork River about 80 miles northeast of Spokane reports to The Washington Water Power (WWP) Company's hydro control room center in Spokane that the spillway has several cracks that are leaking water. Conditions are deteriorating rapidly. At 11:15 a.m., the station operator observes a total failure of the arch spillway. An approximately 1 million cubic-foot-per-second flood wave is moving downstream and will reach the community of Clark Fork — population 450 – in approximately 40 minutes.

This dam failure scenario initiated "CABEX 90," a test that The Washington Water Power Company, an investor-owned utility in Spokane, Washington, conducted of the emergency action plan for its 200-MW Cabinet Gorge hydro project.

More than a decade ago, the Federal Energy Regulatory Commission (FERC) began requiring that all non-federal hydroelectric projects under its jurisdiction have an emergency action plan, commonly referred to as an EAP. This plan is to be followed if a dam fails or an emergency occurs that lessens the integrity of the structure. However, the staff in FERC's Division of Dam Safety and Inspections believes that a plan is only part of the solution. Some sort of testing that involves all participants — including the licensee and local disaster relief agencies, sheriffs, fire chiefs, police chiefs, the National Weather Service, and affected business owners — is needed to ensure that the plan is workable and that everybody understands his or her role in an emergency. To that end, FERC established a five-tiered testing program, described in the following article titled "FERC's Approach to EAP Testing." Licensees are required, as a minimum, to conduct a functional exercise on one of their projects every 5 years.

In January 1990, Washington Water Power received a letter from FERC, requesting that the utility facilitate a comprehensive test of the EAP at its Cabinet Gorge project. Consequently, we organized CABEX 90, an emergency action plan test held September 20, 1990, in Post Falls, Idaho. The name for the test was derived by combining terms for Cabinet Gorge (CAB), exercise (EX), and the year (1990).

In adhering to FERC's requirements for a comprehensive test, CABEX 90 included tabletop and functional exercises, both held the same day. Prior to the exercises, we held orientation meetings.

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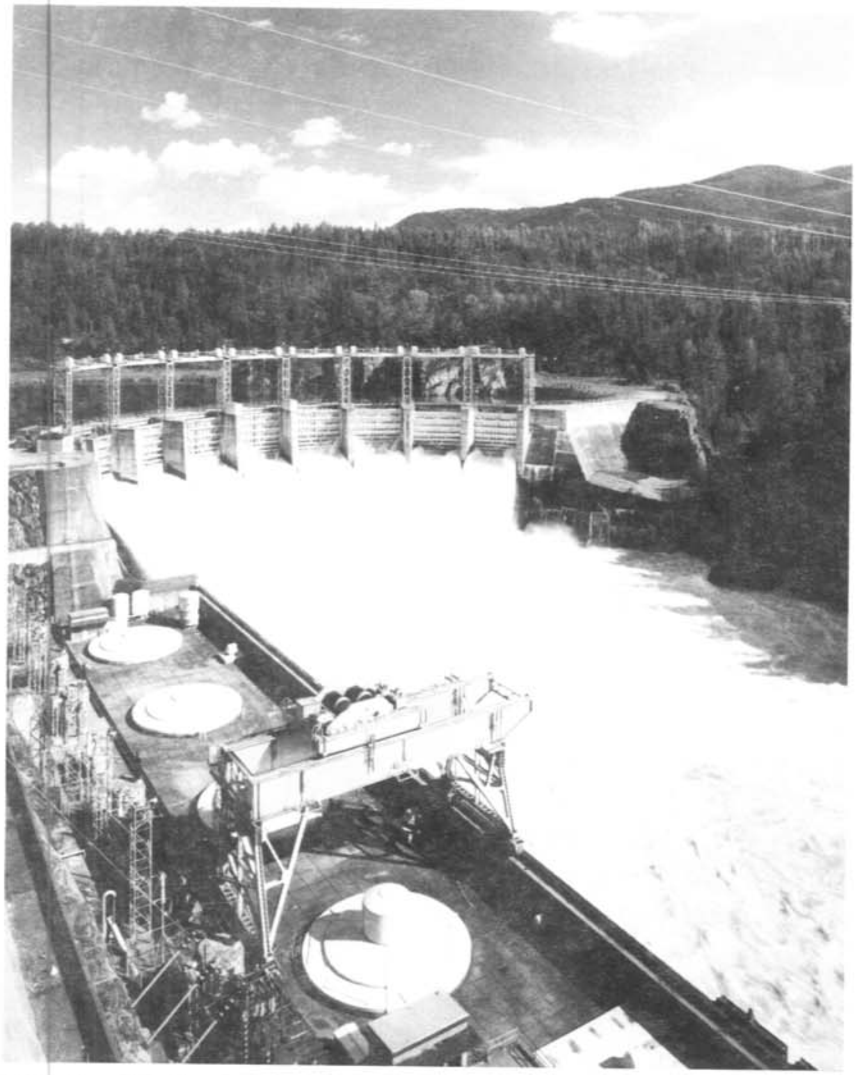
[1] Reprinted with permission from Hydro Review magazine, December 1992 issue, HCI Publications, Kansas City, Missouri.
[2] John Gibson is a civil engineer and Lisa Hildebrand is the emergency action plan coordinator for The Washington Water Power Company, PO Box 3727, Spokane WA 99220; telephone (509) 489-0500.



If the dam failed at the 200-MW Cabinet Gorge hydroelectric project in Idaho shown in this photograph, it would endanger the property and lives of residents downstream. The Washington Water Power Company conducted its CABEX 90 emergency action plan test to ensure the preparedness of WWP personnel and local response organizations and agencies in the event of a failure.

WWP PLANS ITS EXERCISES

Washington Water Power's Hydro Safety Section, which is responsible for FERC compliance, formed a team to coordinate planning of the exercises. The hydro safety team consisted of the EAP coordinator, hydro safety administrator, generation engineer, engineering technician, and records management secretary. Team members were chosen based on their familiarity with the existing EAP, established relationships with local agencies, technical experience in inundation modeling, and planning skills needed to facilitate the exercise. The team spent approximately 1,700 man-hours planning and implementing CABEX 90.

Washington Water Power was one of the first utilities selected by FERC to design and implement the tabletop and functional exercises. Therefore, we had to create our own exercise formats, which increased the time commitment by the team. Time required for future exercises should be greatly reduced.

Exercise Format

The hydro safety team developed the formats for the tabletop and functional exercises using information gathered at an FERC-sponsored EAP training seminar, at Duke Power Company's tabletop exercise, and through discussions with Bonner County (Idaho) Disaster Services and FERC's regional office in Portland. These discussions helped the hydro safety team identify appropriate test objectives. Objectives for each exercise, established by the hydro safety team, are listed in Table 1.

Table 1. – Washington Water Power's Objectives for the Tabletop and Functional EAP Exercises at Cabinet

The following objectives helped facilitate coordination between all participants at CABEX 90:

Tabletop Exercise Objectives

- Clarify notification responsibilities of the participants
- Establish priorities for evacuation
- Compile an inventory of existing resources

Functional Exercise Objectives

- Test emergency response times
- Facilitate effective communications among players
- Coordinate internal and external emergency action plans

Meetings with the Idaho Department of Disaster Services and Bonner County Disaster Services helped answer questions such as which local agency is responsible for evacuating residents, who has legal authority to evacuate during a dam failure, which local agency is responsible for taking the lead in coordinating evacuation, what emergency warning and communication systems exist, and what resources are available among the agencies involved? To avoid confusion and possible "turf wars" during an exercise, we believe it's important to address these issues ahead of time.

Scheduling

To ensure participation by key agencies, scheduling was initiated early in the process. In scheduling the orientation meetings, tabletop exercise, and functional exercise, we conducted a telephone survey of the participants 3 months before the first orientation meeting. We wanted to briefly describe what was planned and to find times that would accommodate participants' schedules. We followed up with an invitation letter to participants, formally announcing the date, location, and time of the exercises, and the purpose and agendas. Invitees included Washington Water Power personnel (including executive officers and managers), local emergency response agencies, local city officials, other electric utilities, and FERC personnel from the regional office and Washington, D.C., headquarters.

Facility Arrangement

Based on comments received during the telephone survey, we chose a centrally located site for participants and held both exercises on the same day. Approximately 60 people participated in both exercises (we had invited 92). We were satisfied with the high degree of participation.

During the test, Washington Water Power provided lunch and refreshment breaks, and at the end of the day hosted a dinner on Coeur d'Alene Lake, The dinner gave participants the opportunity to network and discuss items of concern not formally addressed during the exercises.

Orientation Provides Background

The hydro safety team organized two orientations prior to the exercises — one for Washington Water Power personnel and another for local and state agencies. We held the utility orientation in Spokane, Washington. During the meeting, the hydro safety team explained the objectives of functional and tabletop exercises, and Washington Water Power's role in each exercise. The team also reviewed notification responsibilities, operation procedures, and plans for evacuating the plant as outlined in the Cabinet Gorge EAP. The orientation helped identify inconsistencies in the EAP, which were corrected prior to the tabletop and functional exercises.

We held the agency orientation at Clark Fork, Idaho. Orientation participants included representatives from the Idaho Department of Disaster Services, Bonner County Disaster Services, Bonner County Sheriff's office, Idaho State Police, Clark Fork Search and Rescue, and residents whose homes or resorts would be inundated by a dam failure. During the meeting, we explained the content and purpose of the Cabinet Gorge EAP, and WWP's overall dam safety program. WWP staff explained the purpose of the tabletop and functional exercises, reviewed each agency's response plan, inventoried available resources, and explained how notification priorities were established. We also gave the group a tour of Cabinet Gorge Dam. With all of the attention being given to the hypothetical failure and emergency response, we wanted to assure local residents and agencies that an imminent dam safety problem did not, in fact, exist.

CARRYING OUT THE TEST

CABEX 90 was held September 20, 1990, at Templins Conference Center in Post Falls, Idaho. Participants received an information packet that contained agendas for both exercises. EAP notification flow charts, an EAP brochure, seating arrangements, and evaluation forms. The brochure explained that the test was an FERC requirement, and that having an EAP did not reflect on the integrity of the dam or probability of a dam failure.

Tabletop Exercise

Before the tabletop exercise began, the facilitators displayed the notification flow charts to be used in the event of an emergency in Bonner County. The facilitators then asked each participant, in the order listed on the notification charts, to verbally share:

- Who notified them of the emergency;
- The message they received;
- Their notification responsibilities;
- Their agency's plan of action; and
- Their agency's available resources.

The tabletop exercise allowed participants to gain an appreciation of other agencies' capabilities and responsibilities. The exercise helped focus evacuation efforts so that there were no overlaps or missed areas.

Participants began the tabletop exercise at 9 a.m. and finished by 11:30 a.m. When the tabletop exercise concluded, each player was given the opportunity to critique the exercise, focusing on the areas of notification responsibilities, evacuation priorities, and communication procedures. The tabletop exercise provided a forum for agencies to get a better idea for what was required in an emergency.

Functional Exercise

The afternoon session of CABEX 90 featured the functional exercise. The functional exercise was designed with a high level of realism and simulate the experiences that might happen in an actual emergency. This was achieved by timing the response of the participants to simulated events, separating participants into groups, and requiring all communication between participants to occur by telephone. Participants that would coordinate with each other during an actual emergency were seated at the same table. For example, representatives of local emergency services responsible for evacuation were placed at one table and WWP plant operators responsible for plant mitigative activities were placed at another. The following describes the roles for the six categories of participants in the exercises.

Setting Up the Roles for Test Participants

The Washington Water Power Company identified six categories of participants in the tabletop and functional emergency action plan exercises, and defined roles for each category. The roles were defined as "players," "simulators," "controllers," "assistant controllers," "evaluators," and "observers."

All local agencies and/or individuals identified on the EAP notification flow chart who are responsible for evacuating people in an emergency were "players" in the exercises. During the exercises, players "acted" only after formal notification of the flood.

The players coordinated with other appropriate agencies and verbally detailed plans to a "simulator." WWP managers and engineers served as simulators.

The simulators repeated messages to the players as necessary, relayed information to the exercise "controller," and kept a log of messages and interaction among various agency representatives. WWP's EAP coordinator served as the controller during the exercises, beginning and ending the exercises, announcing major events, and interjecting messages as necessary.

A WWP generation engineer served as "assistant controller." His job was to observe whether objectives were being achieved and if discussion was staying focused, and to communicate his observations to the controller.

Three "evaluators" observed whether the exercises' objectives were being met and made recommendations for improvements for future exercises. Representatives from Duke Power Company, Montana Power Company, and Puget Sound Power & Light who were familiar with EAP test requirements served as evaluators.

Ten to twenty "observers" were invited to view the exercises, but could not interact with exercise participants. Observers, including WWP personnel, other licensees, local city officials, and FERC representatives, were interested in observing the test either because they would be affected by this flood or had an interest in dam safety issues.

In all, five tables were used for: state and federal agencies, local residents and resort owners, local emergency services, WWP interoffice personnel, and WWP plant operators.

A special telephone system was installed at the conference center to facilitate telephone communications among the groups. Temporary walls were placed between the tables to prevent any visual communication among groups. However, each group had a view of an enlarged U.S. Geological Survey (USGS) inundation map that had been placed at the front of the room. The inundation map was used to show the travel time of the front of the flood wave corresponding with the timed exercise.

The controller started the functional exercise by announcing a major event (i.e., earthquake strikes the Clark Fork area) and stating the time the event occurred. The announcing of this event started the timed exercise and notification procedures. During the exercise, the controller announced timed events. For example, the controller might say: "The flood wave has washed out the Clark Fork city bridge stranding several families on the south side of the river. The time is 45 minutes into the flood event." Participants were required to modify their evacuation procedures to respond to events announced by the controller. The controller also had the responsibility of tracking the movement of the flood wave on the inundation map by positioning a red arrow at the front of the flood wave. The exercise was conducted in real-time; however, several minutes were skipped in the middle of the scenario to keep the participants actively involved.

A simulator (a WWP employee) sat with each group to encourage discussion and ask questions. The simulators addressed specific resource questions and announced events that affected particular groups. For example, one event announced by a simulator was this: "The state police have received a call that a group of horseback riders are meeting for a trail ride in an area within the flood-wave boundary." In this event and others, the simulator encouraged the group to discuss how evacuation priorities will be modified and to inventory available resources to assist in the evacuation. The simulator kept the participants active and involved throughout the exercise.

A Critique Of The Functional Exercise

Oral and written feedback gathered at the close of the functional exercise identified both positive and negative aspects. Positive results included:

- Participants recognized the benefits of communication and cooperation with other agencies involved in mitigating the consequences of a dam failure;
- Many agencies identified the need to improve their internal plans;
- Participants appreciated the opportunity to meet representatives from each agency face to face (prior communications had been by telephone during annual drills);
- Many agencies found creative ways to improve and utilize existing resources to assist in evacuating residents;
- Agencies gained a better understanding of how priorities for the notification flow charts were developed; and
- Participants came to recognize the importance of radio communications.

The exercise identified improvements needed in the EAP, including changes to the inundation map and notification flow charts. For example, WWP decided that the inundation map should be changed to: incorporate local terminology instead of USGS terminology; incorporate additional back roads; and list front of flood-wave times (the time when structures and property are first affected by the flood waters). Changes needed on the notification flow charts included corrections to names and telephone numbers and an adjustment in priorities on calls.

LESSONS LEARNED

CABEX 90 achieved its goal: to test and to improve the Cabinet Gorge EAP. We believe that the improvements identified during the exercise will enhance the safety and welfare of people and property downstream of Cabinet Gorge Dam. Now that we have been through one functional test, we identified improvements to make in the exercise format:

- Provide a functional exercise script for the observers (individuals who viewed the exercise but did not participate);

- Arrange for critiques to be submitted before participants leave the exercises;

- Provide an improved sound system so that all participants can hear comments clearly; and

- Keep the exercise focused on improvement of the EAP, rather than on educating people who did not attend orientation meetings prior to the test. (Orientations were held to familiarize participants with the purpose of the exercise and its requirements, and explain their respective roles.)

The success of CABEX 90 was shown by the motivated and cooperative spirit that was evident among participants at the conclusion of the test. Since the test, participants have taken actions to increase their levels of preparedness. For example, Bonner County Search and Rescue received radio communication equipment from Washington Water Power to enable them to better communicate with the county sheriff; the organization also plans to outline and assign evacuation routes. Actions such as these were prompted by the CABEX 90 emergency action plan test and, in the event of a real emergency, will provide a heightened awareness and capability for dealing with it.

During CABEX 90, John Gibson served as co-facilitator for the tabletop exercise and assistant controller for the functional exercise. Lisa Hildebrand served as co-facilitator for the tabletop exercise and controller for the functional exercise.

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FERC'S APPROACH TO EAP TESTING[1]

by Jerrold W. Gotzmer[2]

Confidence in the quality of design, construction, operation, and maintenance of a dam does not guarantee freedom from unexpected events. Whether the event is a dam failure or another incident that causes the sudden release of water, loss of life and/or property damage can result. To help mitigate this problem, the Federal Energy Regulatory Commission (FERC) has included an Emergency Action Plan (EAP) Program as part of its dam safety program.

An EAP has two important phases in its development. First, a dam owner develops a plan that will enable its employees to properly react to emergency situations. Second, to ensure successful implementation of an EAP, it is crucial that all parties — the licensees and state and local agencies that are responsible for evacuation of downstream inhabitants — have a good understanding of their roles. To accomplish this, FERC's Division of Dam Safety and Inspections in 1990 adopted a five-level exercise testing program.

First Level: Orientation Seminar

The orientation seminar prepares licensees and state and local emergency preparedness agencies for higher-level exercises and familiarizes them with the EAP, their roles and responsibilities, and standard procedures.

Second Level: Annual Drill

An annual drill is the lowest level exercise a licensee conducts. Drills involve the initiation of notification telephone calls for one of two emergency conditions -- "failure is imminent or has occurred" or "a potentially hazardous condition is developing." Names and phone numbers are updated in the EAP as a result of the drill.

Third Level: Tabletop Exercise

A tabletop exercise, which presents a simulated emergency, involves all participants on the licensee's EAP notification flow charts (a list of who contacts who, and in what priority). The participants meet to discuss each agency's response to the emergency and its role in the EAP.

Fourth Level: Functional Exercise

A functional exercise tests each participant's ability to respond to a dam failure scenario. The licensee and state and local government officials review each step of the plan. Each participant receives a message, and "acts" his part, responding with the appropriate action to mitigate the emergency. Participants can observe the interaction among all parties and agencies. The exercise is timed to coordinate with the expected travel time of the flood. Communication by phone or radio is simulated, and discussions pertain to emergency response actions. Functional exercises are considered comprehensive exercises in the FERC EAP guidelines because they involve the actual simulation of a dam failure (or other event) in a stress-induced environment with time constraints.

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1 Reprinted with permission from Hydro Review magazine, December 1992 issue, HCI Publications, Kansas City, Missouri.

2 Jerrold W. Gotzmer is Senior Hydrologic Engineer, Division of Dam Safety and Inspections, Federal Energy Regulatory Commission.

Fifth Level: Full-Scale Exercise

A full-scale exercise tests manpower and equipment in the field within a realistic time constraint. Participants usually do not take a break until the full exercise has been completed. The non-stop action contributes to the sense of urgency and stress found in real emergencies.

A comprehensive exercise (either functional or full scale) provides the necessary training, testing, and practice to improve the EAP and the operational readiness and coordination efforts of all parties responsible for responding to emergencies.

As part of their license agreement, licensees are required, at a minimum, to perform a comprehensive exercise once every 5 years at one of their facilities. FERC's and licensees' experiences from actual exercises have shown that a functional or full-scale exercise identifies and resolves questions regarding the EAP and response procedures so that everyone involved is better prepared to respond to an actual emergency. Full-scale and functional exercises have many benefits and objectives: EAP's are improved, new resources are identified, responsibilities are clarified, a cooperative spirit is developed among the parties involved, and a sharing of information takes place. As a result, we believe all parties benefit from the experience.

LUBRICATION MYTHS DEBUNKED[1]

A Large number of myths surround the topic of lubricating farm equipment. Dennis Boggs, technical director of lubricants for Phillips 66, debunks 12 of these myths in the following.

Myth #1: *Separate engine oils must be used in mixed fleets.–*

Most farm fleets are mixed -- some vehicles are gasoline powered while others run on diesel. Modern engine oils are designed to have universal characteristics that accommodate all types of engines. Using a multi-grade universal lubricant offers two major benefits: inventory consolidation and reduction and reduced application errors -- putting in the wrong oil. Also, multi-grade oils are more versatile because they meet specific requirements for old and new vehicles in the same fleet.

Myth #2: *You must use the brand of oil recommended by your dealer to protect your warranty.–*

Many farm equipment manufacturers recommend a specific brand of oil or its equivalent for use in their equipment. It is a misconception that only one brand of lubricant will satisfy warranty requirements. Labeling on all containers specifies how the oil product meets the manufacturer's requirements for each engine.

Myth #3: *The higher the TBN, the better the engine oil.–*

TBN (Total Base Number) is the measure of an oil's ability to neutralize acids. However, just because an oil has a TBN of 10 doesn't mean it's better than an oil with a TBN of 9 for a particular application. Also, a particular engine design may require an oil with a lower TBN, as may be the case in a farm fleet in which some of the engines were designed to use TBN 6 oils. TBN should be used to determine oil suitability for a particular engine only if there is a specific need for a high TBN. We are not aware of high-sulfur fuels in the United States which require the use of oils with a TBN greater than 8.5.

Myth #4: *Switching from one brand of oil to another causes mechanical damage in engines.–*

Switching brands, as long as those brands are formulated for the same application, will not substantially affect an engine's performance. All motor oils that meet the same American Petroleum Institute (API) quality designation, such as CE, CD, CDII, or SG, are completely compatible. Therefore, no flushing or special cleaning process is needed in the process of a changeover.

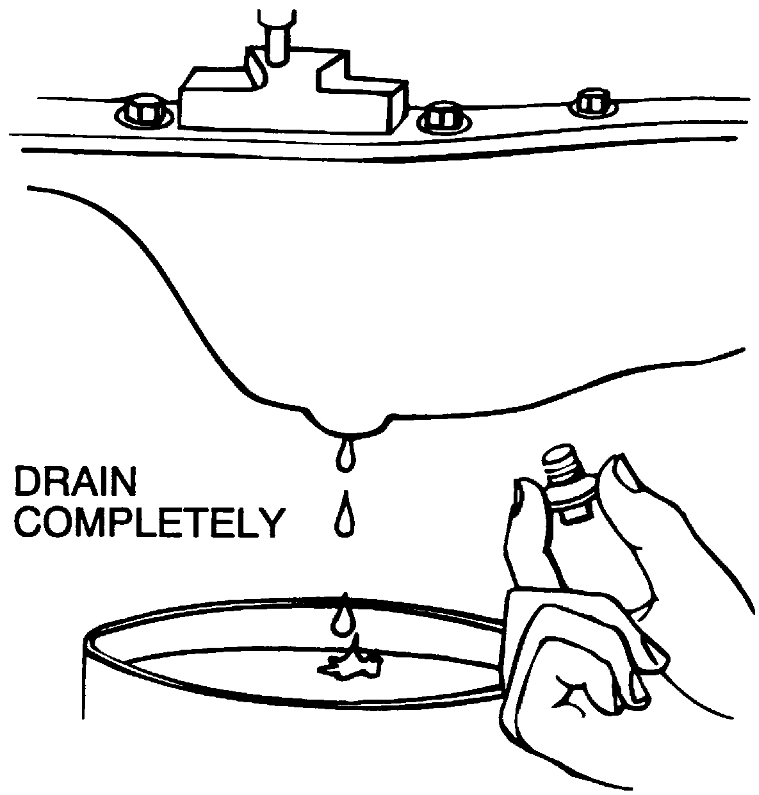
However, certain greases should not be mixed. Lithium soap greases are compatible with each other, but should not be mixed with other types of soap-based greases, such as sodium. A good practice when changing soap bases is to flush, or clean out the grease previously used. If unsure about compatibility, check with your supplier's technical services representative.

Myth #5: *Switching to a high detergent oil will cause accumulated deposit buildup to wash out into the engine.–*

The detergent/dispersant in modern oils deals only with new or recently formed deposits. These additives keep the engine clean and prevent particulate matter from accumulating in the engine. They do not, however, loosen hardened deposits that have built up over many years. Switching the engine

[1] Reprinted with permission from the Managing Editor, Arizona Farmer-Stockman, November-December 1992 issue.

to a quality oil which does have detergent/dispersant properties may produce lower oil consumption and improved performance.



Myth #6: *Change oil at the start of a new season, but not at the end.–*

When an engine is allowed to sit idle without an oil change from the end of one operating season to the start of the next, acid, water, and other contaminants which are in the used oil can cause corrosion in the engine. In addition to regular oil changes throughout the operating season, the best practice is to change oil in tractors, combines, and irrigation engines prior to shutting down the equipment for the winter season. Flushing out the engine by draining the oil at the end of the operating season will remove the contaminants before long-term storage. For best results, the engine should be allowed to run 20 to 30 minutes before shutdown after the last oil change of the season.

Myth #7: *Heavier oils make better lubricants.–*

It is widely assumed that if a 30-weight oil is recommended, a 40-weight oil is better. This is not necessarily the case. The weight, or viscosity, of an oil should be carefully selected to match the piece of equipment and operating conditions. Equipment manufacturer recommendations should always be followed. In certain situations, a lighter oil is more desirable than a heavier oil because it places less drag on the engine operating parts. A 50-weight oil, for example, is too heavy (it has a thicker oil film) for use in some farm equipment engines because of their relatively high speeds and close design tolerances.

Myth #8: *Motor oil never wears out.–*

Technically, oil does not wear out. However, the oil's additives do wear out or become depleted. The best example is an oil's suspension quality. Oil is designed to suspend contaminants such as dirt and wear particles picked up in an engine. Eventually, the oil will become "over-suspended." The main reason oil is changed at regular intervals is to rid the engine of these suspended impurities.

Old oil which has a high degree of contaminants begins to lose its effectiveness and this may lead to bearing corrosion and deposit buildup. Also, overworked oil can get to the point where it will not suspend the additional particles created during engine operation. This produces particle buildup and sludge. Overworked oil will result in similar depletion of the oil's other additives and, as a result, the additives will no longer perform the tasks for which they were designed.

To ensure that an oil's additive package is working to its potential, many oil companies recommend that oil drain intervals never exceed manufacturer's recommendations. Also, operating conditions should be considered and oil drain intervals shortened if necessary.

Myth #9: *If a motor oil is doing its job, it should appear light in color and clean when drained.–*

If an oil is doing its job properly, it should suspend dirt, metallic wear materials, and byproducts of combustion. Therefore, used or drained oil that has turned a dark color has effectively suspended contaminants.

Myth #10: *Hydraulic fluid is the least important of all lubricants.–*

It is ironic that while the benefits of using a quality engine oil or grease are largely recognized in farming circles, the importance of hydraulic oil is sometimes overlooked. For example, if a hose is leaking, many farmers will add the cheapest fluid available until the leak can be fixed. Saving a few dollars by buying low-priced replacement hydraulic fluid can create a costly repair bill by contributing to deterioration throughout the rest of the system. For example, using an inferior (usually non-branded) hydraulic fluid that does not contain protective additives can damage the pump or seals. A quality universal hydraulic fluid which is specially formulated to meet specifications for a variety of small and large tractors using a single fluid for the hydraulic system, transmission, differential, and wet brakes should provide long oil life, pump protection, oxidation stability, and anti-wear properties.

Myth #11: *A quality grease can be distinguished by smelling, feeling, or tasting it.–*

Human senses are not helpful in distinguishing the quality of one grease from another.
In addition, certain "homemade" tests passed on from generation to generation are of little value in verifying the performance properties of greases. These tests include: the spider web test (grease forming lots of strands when scooped from the container is supposed to be superior), the hammer head test, and the Popsicle-stick test. A tackifier makes the hammer head test impressive (hit a spot of grease and it does not splatter) but tells you nothing about how it will perform in farm equipment; neither does the Popsicle-stick test in which grease at the end of a Popsicle stick is subjected to flame. Grease made only with clay as an ingredient will not drip readily in the flame, but this has little relevance to its durability and function.

Modern greases have been formulated with excellent high-temperature resistance with a dropping point above 500 °F. They can also exceed a 55-pound Timken OK load. EP on a grease label usually means extreme pressure.

Myth #12: *Price should be the main criteria for choosing a motor oil.–*

One constant that exists in the lubricants field is that oil will always be cheaper than metal – whether you buy it by the pound or by the gallon. Investing in the right oil for a vehicle can lead to increased engine longevity and improved engine performance. Selecting a branded motor oil product, therefore, should be based on the following:

– Proper weight/viscosity (review owner's manual)

– API quality designation (read the motor oil label)

– Advice from a mechanic or oil manufacturer/supplier's technical services department

– The supplier's service record.

WHAT ABOUT THOSE SYNTHETIC LUBRICANTS?[1]

by Norman Herdrich[2]

Synthetic lubricants have been around since World War II in one form or another, so they really aren't new. Two which have gotten a lot of bad press in recent years are CFC (chlorofluorocarbons) and PCB (polychlorinated biphenyl).

In the late 1970's, oil companies and others started touting the advantages of using what might be termed a new generation of synthetic lubricants.

Just what are they and what do they do better than conventional mineral oil-based lubricants, so far as farmers and ranchers are concerned? That question might be of a great deal of interest. An even more pertinent question in today's economic climate in agriculture, is: Are they worth the extra cost?

Just what is a synthetic lubricant? One easily understood definition is: "a product which consists of stocks manufactured by chemical synthesis and containing necessary performance additives." Another differentiates a synthetic from a mineral oil thusly: "A mineral oil is produced by refining and extraction, with the raw material coming out of the ground. A synthetic oil is synthesized; i.e., built up from components which may come from any source. In practice, the greater part of many synthetic lubricants is derived from mineral oil."

The needs of the aerospace program and the military have stimulated the development of most synthetic lubricants. This is due to the fact that the demands of operational conditions in these two areas could not be met by existing lubricants. Extremes of cold and heat, and the need for fire resistance were the main problem areas.

Compared to synthetics, a mineral oil has eight performance limitations: pour point, resistance to oxidation, viscosity index, tendency to spread, volatility, fire resistance, anti-wear properties, and toxicity.

Synthetic hydrocarbons are one base for synthetic lubricants. These are chemically similar to mineral oils. The difference is that the mineral oil is a random mixture of hydrocarbons while the composition of the synthetic hydrocarbon is carefully chosen for the desired performance. This is usually greater thermal stability and reduced volatility.

In one process for making a synthetic hydrocarbon, ethylene is refined from petroleum. This is then subjected to a chemical reaction called catalytic polymerization to produce Decene-1 which is normal aplhaolefin. Decene-1 then goes through another catalytic polymerization process to produce unhydrogenated polyalphaolefin. The polyalphaolefin is then hydrogenated in another chemical process to produce the finished polyalphaolefin, known as a PAO. PAO's are the base stock for many synthetic lubricants on the market today.

Another process for making synthetic lubricants uses organic esters derived from plant or animal fats and/or oils. The process is called diester synthesis and oils made from this process were widely used in

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[1] Reprinted with permission from the Managing Editor, Arizona Farmer-Stockman, November-December 1992 issue.

[2] Norman Herdrich is Production Editor for the Arizona Farmer-Stockman.

the 1940's for military purposes because of their wide operating temperature range, good film strength, and low volatility.

Oils made with this process are used in turbines and in engines and compressors where cleanliness is important. Included among the esters are polyol esters derived from monobasic acids, one of which is stearic acid found in beef tallow. Other synthetic lubricant basestocks include silicone, polyglycol ether, polyphenylether, silane, perfluoroethers and cholorofluorocarbons, most of which have limited or specialized applications.

Why go to all the trouble to make synthetic lubricants? There are a number of reasons. Among them is the fact that the lubricant can be tailored to meet the needs of a specific application. Another reason is that they have better lubricating qualities at extreme temperatures, both hot and cold.

Also, their lubricating properties do not decline as quickly with age or use, meaning that they can be used with extended drain intervals. Linked to this latter reason is the fact that they are generally less volatile, meaning, among other things, that they are less prone to burning or scorching when exposed to hot surfaces and therefore become contaminated at a slower rate than petroleum-based lubricants. The synthetics are also said to reduce maintenance costs; make equipment last longer; allow equipment to run cooler; and, because of the extended drain periods, result in less used oil and reduced disposal problems.

The specific advantages of the PAO's are said to be a low pour point, meaning that they pour more readily in extremely cold weather; reduced volatility, which relates to lower oil consumption; good seal compatibility, meaning that they don't generally cause problems by reacting with engine and transmission oil seals; a good viscosity index, meaning that they don't thicken up at colder temperatures and don't thin out at higher temperatures; have thermal and oxidative stability, meaning that they resist oil thickening that can result from exposure to heat and oxygen; are chemically inert and have good lubricating qualities.

The disadvantages of the PAO's are that there is sometimes a problem with additive solubility and some seals made from elastomers will swell if an agent to prevent it is not used in the lubricant.

The properties of the diester products are that they are generally less expensive, they have excellent low temperature properties, they have excellent thermal and oxidation resistance, they have excellent solvency characteristics, and they resist sludge and varnish formation.

The polyol esters have good low temperature characteristics and exceptional oxidative and thermal stability. Their other properties are similar to those of the diesters. Polyol esters are sometimes used as friction modifiers, specifically as a blending agent in motor oils to improve fuel economy and in hydraulic fluids to control chatter and noise.

What does all this mean to the farmer in the field? It depends as much as anything else on what equipment is involved and where and how it is used.

The first point to consider is whether or not the equipment manufacturer recognizes the lubricating qualities of synthetic lubricants to be better than those of mineral oil-based lubricants and authorizes an extended drain interval if they are used. If this is not the case, especially with new equipment under warranty, using the synthetic lubricants with extended drain intervals may void the warranty. If the extended drain intervals are not used, the economics of synthetics versus conventional lubricants may not make a lot of sense since they tend to cost significantly more.

The synthetic lubricants have been more readily accepted for use in transmissions and differentials. Eaton, manufacturer of Roadranger transmissions used in heavy trucks, extends its normal warranty of 3 years/ 300,000 miles or 5 years/500,000 miles when conventional mineral oil-based gear oil is used to 5 years/750,000 miles or 7 years/750,000 miles when a synthetic meeting the firm's standards is used. The drain interval for conventional gear oil is 100,000 miles and it is extended to 250,000 miles with synthetics. This applies only to new vehicles.

Getting all this down to the field level, Roger Thieme of Evergreen Implement, a John Deere dealer with operations in both Moses Lake and Othello, Washington, said that they really haven't done much with synthetics. He also noted that there is a lot of misinformation floating around about oils, and added that synthetics have a place in extreme conditions.

These two conventional or mineral-based oils by separate major manufacturers are both the same weight and should be completely compatible if mixed in a crankcase.

John Deere has developed engines and mineral oils with a 300-hour change interval as compared to the normal 100 hours. John Deere's Torq-Guard Supreme Plus-50 is a mineral oil with an additive package that allows an additional 50 hours between oil changes for most engines. John Deere works with Chevron in developing oils, Thieme said.

Manufacturers are developing engines with extended oil change intervals, Thieme added. He also pointed out that most oils are first developed to meet military specifications, although some are also developed in conjunction with engine manufacturers such as Cummins and Caterpillar.

Jim Walton, a John Deere lubricants marketing specialist, said there haven't been many cost comparisons done between synthetics and conventional lubricants. Surveys show consumers are not willing to spend the extra money - that they feel the advantages of the synthetic oils do not justify the costs, he explained.

Regarding John Deere's extended drain intervals, Walton stressed this only applies if John Deere Plus-50 oil and John Deere filters are used. If other oils and/or filters are used, the extended drain interval is not appropriate.

So far as synthetic gear oils are concerned, the only application John Deere recognizes is in a gearbox on a lawn mower. Walton said that while synthetics are good lubricants, and do have advantages, they have not been proven in John Deere equipment and therefore are not recommended.

Walton pointed out that the testing is expensive and would involve running several engines and/or pieces of equipment under identical conditions and then doing a complete tear-down of all of them to determine and compare wear in every case.

He explained that machinery engineers work closely with oil company chemists when developing new farm equipment, and that the lubricants needed for the machinery are often developed right along with the machinery itself. He said that when an engineer makes a statement about a piece of machinery, it is based on fact and is not marketing hype. "Engineers know what they are talking about."

Walton also pointed out, "Considering the cost of new equipment, following the manufacturer's recommendations in regard to lubricants and filters is cheap insurance."

Don McEntee, general marketing manager of the Parts Group for Massey-Ferguson, said that they do not recommend synthetics. What Massey-Ferguson does recommend is a 15W-40 mineral oil with an API rating of SG/CF-4 which is made for them by Amoco.

McEntee said that synthetics are good lubricants and have the ability to last longer. However, he explained, tractors and combines operate in a very dirty environment. He said that the number of dirt particles which the oil had to keep in suspension will be the same, no matter whether it is a synthetic or mineral oil; and when a maximum number is reached, the oil will have to be changed. This means that the extended drain interval of the synthetic loses its value since the oil becomes contaminated before the limits of the extended period are reached.

Another problem mentioned by McEntee is with hydraulic systems. He said that synthetic hydraulic oils may not mix very well with mineral-based hydraulic oils. This means that all the tractors and implements with hydraulic systems must be the same or problems might develop.

"Although they are good oils, I really don't see a place for synthetics in the agricultural industry," McEntee said.

John C. Noal, a product engineer in Technical Services for Conoco, Inc., which produces and sells both conventional and synthetic lubricants, said that whether or not synthetics are worth the cost depends on the climate. In severe cold conditions, you can't beat them, he explained.

Both these containers of oil have the same API service rating, although it is easier to find on the one on the left. Neither container shows the TBN (Total Base Number) for the oil, however.

However, in terms of overall economics under normal conditions, Noal said that conventional oils may be best. Although synthetics can extend drain intervals, he added that he considers a crankcase to be very much like a garbage can and would stick with mineral-based oils in the crankcase of an internal combustion engine.

This is because the combustion process produces both chemical contaminants and water. As a result, the synthetic oils can become contaminated and have their lubricating qualities jeopardized in the same way that conventional oils are contaminated.

In air compressors, using synthetics can extend drain intervals from 500 hours to 2,000 hours, Noal said. The synthetics can be used in vane, rotary screw, and reciprocating piston compressors. They cannot be used in ammonia compressors which are sometimes used in refrigeration. Noal said synthetics also have value in situations where oil is difficult to change.

Under ideal conditions, he said that using the synthetics can extend drain intervals to 20,000 to 25,000 miles in passenger cars. At the present time, the only production passenger car made in the United States which is shipped with a synthetic oil in the crankcase is the Chevrolet Corvette, the high performance ZR-1 model.

Dennis Boggs, a lubricants technical director for Phillips 66, which does not sell a line of synthetics, said that the PAO's plus additives can make a very good oil for all piston engine applications. He also said the additive technology used with PAO's is much the same as that used for petroleum-based oils.

Boggs echoed what Noal also said - specifically that the high quality of the oil does not get around the problems with oil contamination in internal combustion engines. Acids and water still build up and extended oil change intervals cannot safely be used or are not recommended or approved by manufacturers. "Due to this factor, it is difficult to justify the cost of the synthetic oils," he said.

As has also been mentioned earlier, Boggs said synthetics do have a place in the gear oil market, especially in equipment used in a relatively clean environment such as over-the-road trucks.

For machinery used in harsh environment - logging, construction, farming - where contamination is possible or probable, extended oil change intervals cannot be used in gear boxes and this again makes it difficult to justify additional cost of synthetics, he added.

Regarding synthetics and temperatures, Boggs said that synthetics are better for conditions where actual oil temperatures will be below -25 °F or above 300 °F when the engine is operating for extended periods of time. He said that within that range, the right mineral oil can be found that will do the job. He also pointed out that he knows of no conditions where oil temperatures should consistently run above 300 °F for extended periods of time in an internal combustion engine.

On topic of turbocharger bearing failure, Boggs said most of the problem was due to heat soak after engine was shut off and that was mostly due to operator error. In some designs that do not have water jacket around bearings to cool them down, or an auxiliary pump to keep oil circulating after motor is shut down, engines should be idled for 3 minutes before shutdown to allow bearings time to cool off. In heat soak, oil in bearings is stagnant and heats to point where it may burn or char, creating very abrasive materials which then destroy the bearings. Boggs also said use of heavier than recommended oils in turbocharged engines may result in bearing failure because bearing speed may exceed the lubricating properties of the oil film. Also, heavier oil can be thrown out of bearing due to high centrifugal force, leaving them dry.

At this point, it must be noted that the manufacturers are making great strides with conventional petroleum-based lubricants. John Deere's Torq-Guard Supreme Plus-50 has already been mentioned. Conoco has developed Farm Master Universal Oil which is designed to operate in transmissions, hydraulic systems, engines, final drives, and wet brakes and clutches. It is rated as a 15W-40 oil, the same as the John Deere Torq-Guard Supreme Plus-50, and is also available in a 10W-30. Another product of a similar nature is Phillips 66 HD II motor oil.

Most oils, both synthetic and petroleum-based, contain additive packages which include:

- Viscosity index improvers which help control film strength under high heat conditions
- Oxidation inhibitors to prevent deposits and oil thickening that could otherwise result from exposure to heat and oxidation
- Rust and corrosion inhibitors to limit the corrosive impact of the acidic condensates that develop from combustion
- Detergents and dispersants to surround dirt particles with a shell of molecules and prevent them from adhering to engine surfaces or clumping in the oil itself
- Pour point depressants to lower the temperature at which oil will flow

Oil containers have a set of numbers and a series of letters printed on them which are extremely important. The numbers are the viscosity inidicator which has already be mentioned, such as 5W-40. In this instance, the 5W indicates that it pours like a 5-weight oil when cold – W indicating winter – and that it acts like a 40-weight oil when warm.

Heavier is not always better when it comes to oil. As Boggs explained, it is widely assumed that if a 30-weight oil is recommended, a 40-weight oil must be better. This is not necessarily the case. The weight, or viscosity, of an oil should be carefully selected to match the piece of equipment and operating conditions. Equipment manufacturer's recommendations should always be followed. In certain situations, a lighter oil is more desirable than a heavier oil because it places less drag on the engine operating parts. A 50-weight oil, for example, is too heavy (thicker oil film) for use in newer farm equipment engines because of their relatively high speeds and close design tolerances.

The series of letters is the API (American Petroleum Institute) designator indicating the service rating or quality designation of the oil. Service ratings start with the letter S for gasoline engines and C for diesel engines. All motor oils with the same API designator are completely compatible. The highest ratings now are GE/SG. Oils with higher ratings are permissible in applications calling for oils with a lower rating, such as CD or SE.

A third number of considerable interest, although it may be necessary to work a little harder than just reading the label to determine it, is the TBN or Total Base Number. This is the measure of an oil's ability to neutralize acids. According to Boggs, just because an oil has a TBN of 10 doesn't mean it's better for a particular application than an oil with a TBN of 9. In fact, according to Boggs, there are instances where a higher TBN may be detrimental to an engine because of its design. As an example, he said that using a higher TBN oil may eventually lead to complications when used in a fleet made up of a variety of farm equipment since some of the vehicles may require only a TBN of 6. "TBN should be used to determine oil suitability for a particular engine only where there is a specific need for a high TBN," Boggs commented.

Just for reference, the Phillips 66 Super HD II oil noted earlier has a TBN of 8.5. A Conoco high performance 5W-30 synthetic with an API service rating of SG/CD/EECII has a TBN of 9.8.

The higher TBN found on many synthetics is an indication of why they are touted as having a longer drain interval. The argument is that the greater the oil's ability to neutralize acids, the longer it can remain in the crankcase since it can absorb more acids resulting from combustion over a longer period of time. Some of the newer petroleum-based oils are also being marketed with higher TBN's and extended drain intervals.

If the decision is made to go to synthetic motor oil, there is one other potential problem: The improved solvency of the synthetics is thought to do a good job of cleaning out an older engine, meaning that using a synthetic may actually loosen the engine up and increase oil consumption. In a newer engine, this would not be a problem. If a synthetic oil is used, some experts suggest that the recommended oil filter change interval be maintained, at least at first, and that filters be very carefully monitored at first if synthetic oil is used in an older engine.

Some older diesel engines were built to looser specifications and this resulted in high levels of soot in the oil. Newer engines are being built tighter because of potential emission control problems (they may be coming to farm tractors). In the older engines, however, soot will contaminate a synthetic oil just as fast as it will a mineral oil.

Tests of synthetic oils have indicated they do tend to keep the internal parts of an engine cleaner. There is noticeably less sludge formation in the crankcase and valve covers, and they have been found to substantially decrease buildup of carbon on intake valves. All of this is due to the superior dispersancy characteristics of the synthetics, and it is done with reduced levels of detergent compared to mineral oils with additives.

Another twist on the synthetic versus mineral-based lubricant question is the recent advent of motor oils which are combinations of the two. Presumably this is done to provide some of the superior performance of the synthetic at a reduced cost.

So what about the synthetics? Are they worth the cost? The answer to the last question is going to depend on the individual farmer or rancher. There is no doubt that synthetic lubricants are good products - nobody questions that. Are they better for agricultural environments where their extended drain intervals can't be used to best advantage? Most equipment manufacturers apparently don't think so. They may have a home in sealed gear cases where environmental contamination is a low risk.

The bottom line will depend on the guy shelling out the money for the barrel or case of lubricant. Are the synthetic products enough better to justify the price? He will have to decide.

HOW ABOUT ADDITIVES?

Everyone has run into them somewhere. They may be touted in magazine ads, at trade show booths and in parts houses and automotive supply stores. They are off-the-shelf oil additives, and they make a lot of grand claims. Unfortunately, there doesn't seem to be a lot of research to back up those claims.

So far as lubricant and machinery manufacturers are concerned, additives are not advised. Dennis Boggs, technical director of lubricants for Phillips 66, puts it this way: "Some people believe that no matter how good the motor oil is that they buy, a supplemental additive containing such ingredients as Teflon® will enhance the performance of that oil. However, if a quality oil, blended with the right additives, is purchased, there is no off-the-shelf additive which will improve on that quality. In fact, many off-the-shelf supplements may react with the oil formulation negatively, often hindering the working action of the existing additive package in the oil."

For these reasons, oil companies have taken position that they prefer that no supplementary additives be put into their products.

"Neither we nor the customer knows what is in the container," Boggs pointed out. He cited one instance in which an unnamed additive they evaluated had a very high lead content.

He said that he has seen supplemental additives that would unbalance the chemistry of the oil and keep it from doing the job it was designed to do. Boggs explained that most modern oils are about at the limit of their solubility, even though it is much higher than in older oil products. Adding something else might force something already in oil out of solution and degrade the product to where it cannot do the job it was designed to do, he elaborated.

Boggs said his firm has looked at thousands and thousands of additives over the years and probably will continue to do so, but hasn't found any that were worthwhile as something to add to oil chemistry. He added that many of the additives actually contain chemistry very similar to additives already in oil.

Jim Walton, a John Deere lubricants marketing specialist, said his firm's position with regard to off-the-shelf additives is very simple. They don't want any additives in engines or transmissions which are not in the lubricants recommended by the manufacturer. He elaborated that the recommended lubricants are designed to provide certain levels of protection and that anything added to them may unbalance that protection. He also noted that the lubricants recommended for new machinery are often designed and developed specifically to protect that machinery.

Don McEntee, general marketing manager of the Parts Group for Massey-Ferguson, said that if additives were supposed to be in an engine, they would be put in the engine when it was made.

EAL's MAY BE COMING

EAL's or Environmentally Acceptable Lubricants, may be not very far away. Such lubricants, often based on vegetable oils such as rape or soybean, or animal fats, biodegrade much faster in the environment than conventional lubricants if spilled. According to Chuck Peterson, an agricultural engineer at the University of Idaho who has been working with rapeseed oil to see if it can be used as an alternative to diesel, the EAL's may find some future in two-cycle engine oils and hydraulic fluids at first.

According to Dennis Boggs, technical director of lubricants for Phillips 66, there is a compromise involved with these materials. He said that they are less resistant to oxidation than either mineral oils or some of the synthetic lubricants, which means that they may not be as desirable for crankcase oils. On the other hand, the reduced resistance to oxidation may make them ideal for use in two-cycle engines where the oil is actually burned with the fuel charge. This would make two-cycle engines burn cleaner. So far as EAL-type hydraulic oils are concerned, Boggs said they likely would have pluses and minuses. On the minus side, he suggested, is the fact that some hydraulic systems operate at extreme temperatures and pressures which would compound the oxidation problem and inhibit their use. Boggs said that his firm is not doing anything with the EAL's.

Researchers at the University of Nebraska have also been working with animal and vegetable oils in a number of potential applications. Several of these products have involved making animal- or vegetable-based substitutes for diesel fuel. One of these, converting beef tallow into diesel, is promising enough that funds have been requested to set up a pilot plant to convert tallow to diesel so that the end-product can be evaluated on a larger scale.

The Nebraska researchers who have looked at the subject of synthetic lubricants made from tallows and greases say that there is good market potential for such products and they can make a lubricant that is better than the product it replaces. As one of the researchers pointed out, converting tallows and greases to lubricants is a lot more functional than the current use for most of this by-product material.

He also said that the soap market has good potential as a place to use more fats and tallows and that they would also be looking at it, especially in light of the move away from phosphate-based detergents across much of the nation.

TAKE OIL CHANGE ONE STEP FURTHER[1]

by Kathryn Farrell-Poe and Stephen Poe[2]

Next time you change your crankcase oil, consider these facts.

- Used oil from a single oil change can ruin a million gallons of water, a year's water supply for 50 people.
- Improper oil disposal and leaking oil from vehicles are responsible each year for 240 million gallons of crankcase oil finding their way into the nation's lakes, rivers and streams. That's 22 times more oil than was spilled by the Exxon Valdez in Alaska.
- Recovery of this "disposed" oil could save the U.S. 1.3 million barrels of oil per day and produce enough energy to power 360,000 homes.

Used oil is a major source of pollution in our nation's waterways. Oil is insoluble, meaning it doesn't dissolve in water. It's persistent, meaning it doesn't break down readily into simpler chemical forms. And it can contain toxic chemicals and heavy metals.

Used oil sticks to everything, from soil to birds, and you can taste and smell it in water at concentrations as low as 1 part per million.

Disposing of used oil by pouring it on dirt driveways or around fence lines as a weed killer is a bad idea because the oil can soak through the soil or be carried away with rain, irrigation water, or snowmelt. Putting used oil in the trash is also a bad idea because it has the potential to contaminate groundwater.

So, what do you do with used oil? Recycle it.

Recycling used motor oil has many benefits. Its saves money because used oil can be refined again for lubricating oil with a quarter to a third the energy required to produce new oil. It saves a precious nonrenewable natural resource; 1 gallon of used oil provides 2.5 quarts of lubricating oil, the same as provided by 42 gallons of crude oil. Used oil can be reprocessed into heating oil or lubricating oil or used in the manufacture of other products. Since oil never loses its lubricating ability, refined oil is as good as new oil.

Recycling is easy. First, put the used oil in a clean plastic container with a tight lid. Make sure you don't mix it with anything else such as paint, gasoline, solvents, or antifreeze. Then take the oil to a service station or other location that collects used oil for recycling, reclaiming, or re-refining.

Finding a suitable collection site can sometimes be difficult. If you change your own oil on automobiles or farm equipment, consider letting a professional do it. Or, dispose of it at an approved community site, full-service service station or an auto parts store. For information on disposing of used oil, call or write to one of the following:

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2 Kathryn Farrell-Poe is an environmental engineer and Stephen Poe is an agricultural engineer, both with Utah State University extension.

Arizona: Department of Environmental Quality, 2005 N. Central, Phoenix, AZ 85004; telephone (602) 257-2317.

Idaho: Department of Health and Welfare, 450 W. State St., 3d Floor, Boise, ID 83720; telephone (208) 334-5879.

Montana: Solid Waste Management Bureau, Department of Health and Environmental Sciences, Cogswell Building, Room B201, Helena, Mt 59620; telephone (406) 444-2821.

Oregon: Department of Environmental Quality, 811 SW 6th St., Portland, OR 97204; telephone (503) 229-5253.

Utah: Department of Natural Resources, Division of Oil, Gas and Mining, 355 W. North Temple, 3 Triad Center, Suite 350, Salt Lake City, UT 84180-1203; telephone (801) 538-5340.

Washington: Department of Ecology, Mail Stop PV-11, Olympia, WA 98504; telephone (206) 459-3656.

Used oil is not trash or an herbicide. It is toxic waste. Recycling saves money and protects the environment. If your community has an oil recycling program, consider joining it. If it doesn't, take the initiative and start one. Call for the EPA's free manual, *How to Set Up a Local Program to Recycle Used Oil*, at (800) 424-9346. Or, write to U.S. EPA, Office of Solid Waste, 401 M Street SW, Washington, DC 20460.

Help be part of the solution, not part of the problem.

THE FLOODING OF THE COLORADO

HOW THE SYSTEM WORKED TO PROTECT CENTRAL TEXAS[1]

by Mark Rose[2]

The rains of December have given Central and Mid-Texas a reprieve and the Lower Colorado River Authority (LCRA) would like to explain how the flood-control system worked to save lives and minimize damage.

In a nutshell, the wettest December on record dumped rain upstream of Lake Travis and then moved over and dumped water downstream. A portion of the floodplain on Lake Travis was utilized that had never been used to protect Austin and downstream communities from what would have been deadly floodwaters. Big rains happened everywhere and the lakes filled up. Here's how it happened.

Too Much Rain

1991 had been shaping up as a good year for the river. In the first 11 months, 600,000 acre-feet of water had come into the lakes, and Lake Travis was less than 5 feet from the top of the conservation pool, the optimum level for water supply and recreation, two important uses of Lake Travis. Lake Buchanan, which is not a constant-level lake, was nearly full. Then lingering rains during the second week of December broke into two massive storms. They bought more than twice as much water into Lake Travis in 2 weeks as had entered it during the previous 11 months.

The first storm hit Thursday, December 19, and Friday morning, December 20, in the Hill Country west and northwest of Austin. At Enchanted Rock 9 inches fell. The water poured into the Highland Lakes system like water bouncing off a saturated sponge into a kitchen sink. The Pedernales peaked at Fredericksburg at noon December 20 at 83,500 cubic feet per second (cfs). That's as much water as would leave the system at Lake Travis if 16 gates were opened, an event which has never happened. The Llano crested at 9 a.m. December 20 at 81,908 cfs. Those two tributaries alone were sending more water into Lake Travis than all 24 gates of Mansfield Dam could have passed through. Lake Travis was projected to rise into the floodplain, to 686 feet above sea level.

Then Storm No. 2 hit.

By late afternoon, December 20, 2 inches of additional rain showered the Hill Country and by Saturday morning, December 21, 3 to 7 inches had fallen from San Saba to Bastrop. The Llano peaked again, this time at 82,300 cfs. The Pedernales peaked again, at 90,000 cfs. Downstream, the rains on Austin caused creek and street flooding. That water combined to send the Colorado 12 feet out of its banks at Garfield.

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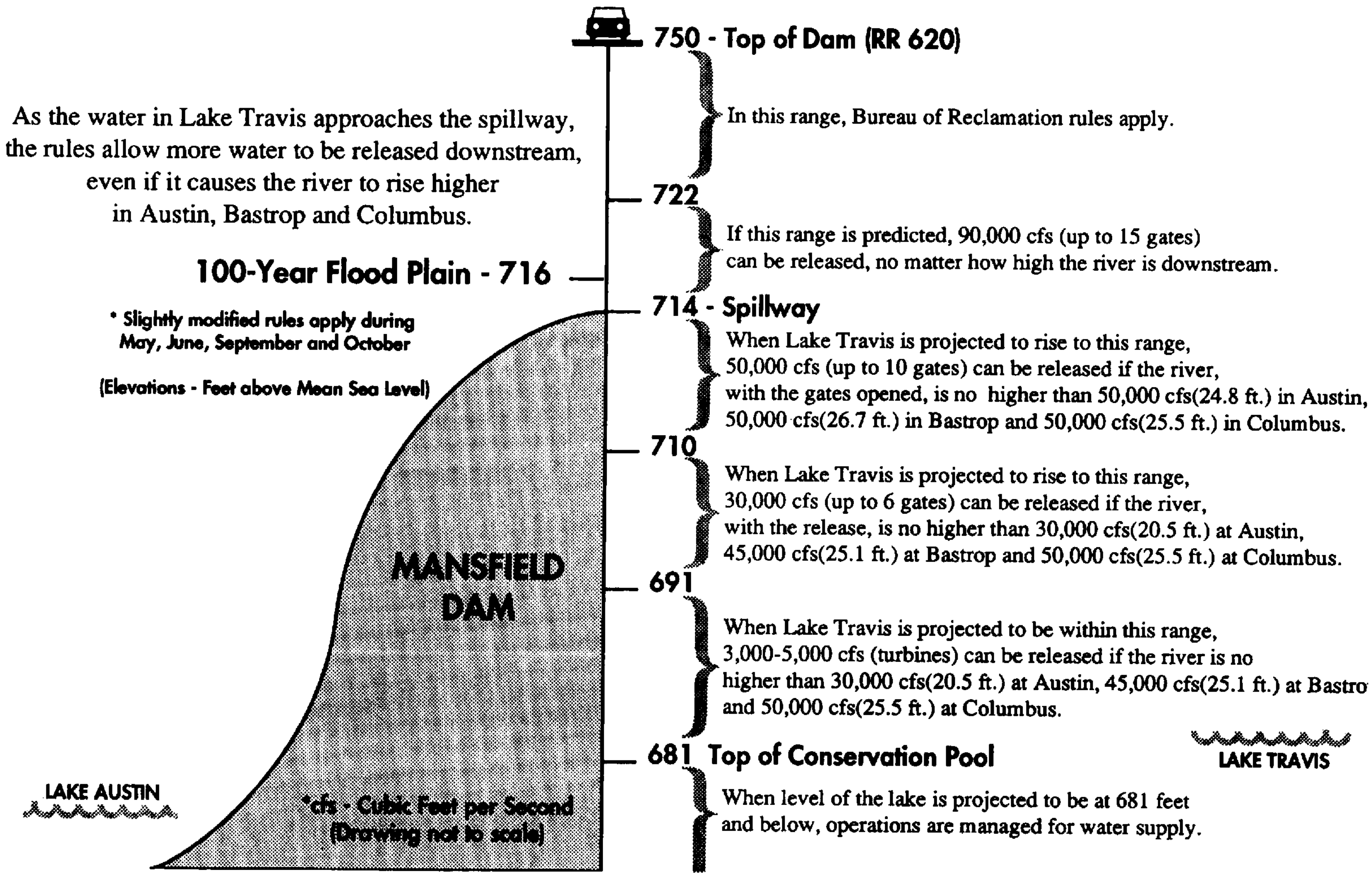
1 Reprinted with permission from the Lower Colorado River Authority, Austin, Texas.
2 Mark Rose is General Manager at the Lower Colorado River Authority.

How the Corps of Engineers Water Control Manual Regulates Mansfield Dam*



Two Floods – One Lake

The LCRA has one flood-control lake to handle this water – Lake Travis. Regulations of the U.S. Army Corps of Engineers tell how to balance downstream flooding and lake flooding. But regulations aside, there was only one responsible course of action to manage this flood without creating a manmade flood; Lake Travis had to rise. The issue was clear: If it is flooding downstream, you don't send down more water when you have room in the flood reservoir area. Doing so could kill people and cause more extensive property damage.

As the level of Lake Travis rose, hydrologists monitored rainfall gauges and streamflow indicators. Projections based on that data continued to forecast higher levels, even without additional rain. But rain continued to fall. The LCRA was faced with trying to find a place to put it.

As the level on Lake Travis reached the trigger point for additional releases, the river at downstream communities like Austin and Bastrop was rising too fast, with too much water to add additional water. The LCRA knew that keeping the water would cause flooding in the Lake Travis floodplain. But there's a difference between a lake that is rising and filling up and floodwater rapidly moving down a river. River floods have a greater tendency to kill people.

Gates Are Opened

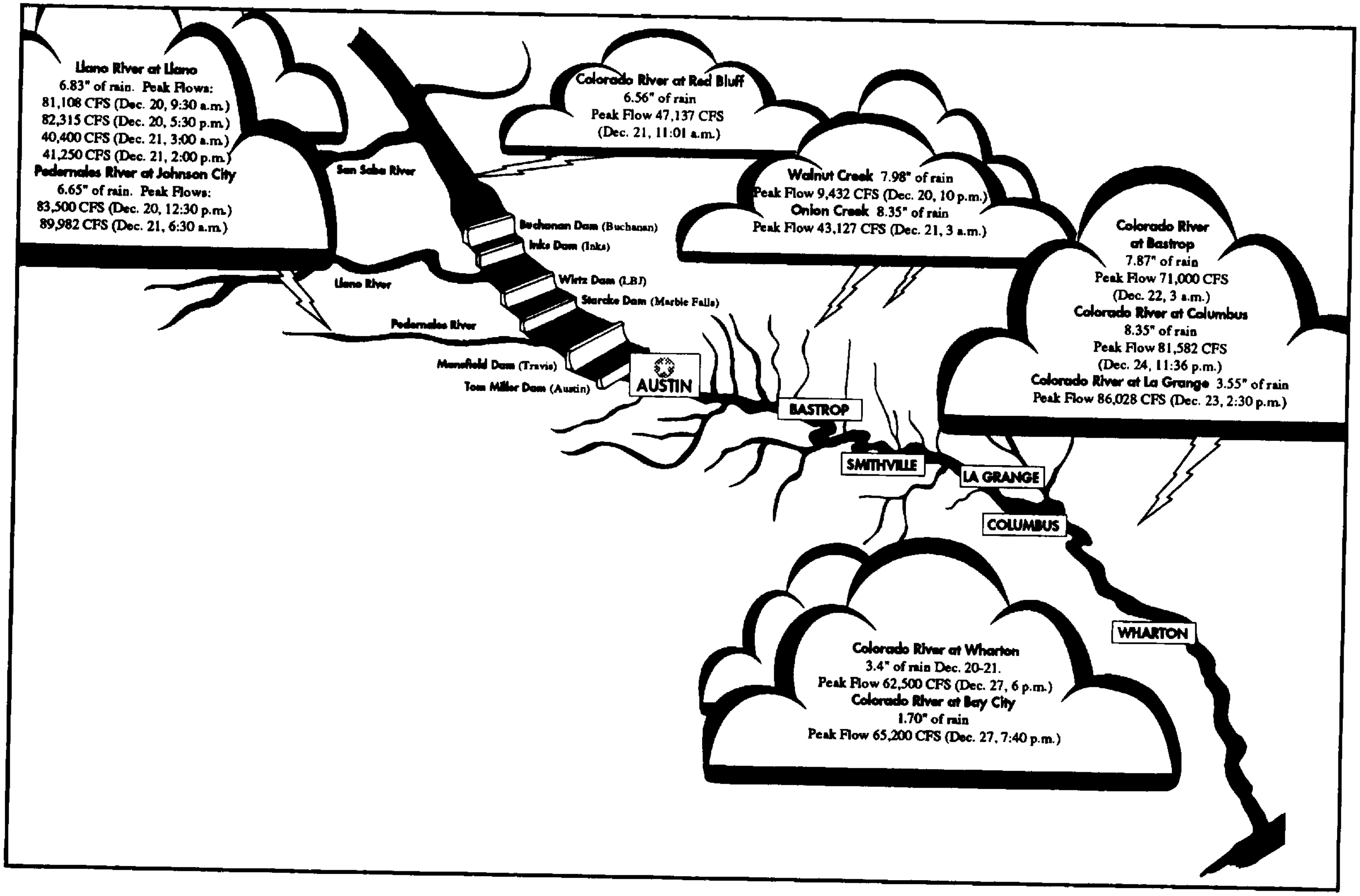
Lake Travis rose 16.7 feet in 24 hours, the greatest rise since 1952, when it rose 56.38 feet. At noon Saturday, December 21, the decision was made to open four gates on Lake Travis. Two trigger points had been reached. First, Lake Travis was projected to go above 710 feet mean sea level, 4 feet from the spillway. Second, the downstream flood had receded enough to begin absorbing some additional water. The pulse of water from the Friday night Austin rains, downstream from Lake Travis, reached Bastrop at a crest in the early hours of Sunday, December 22. The water released from Lake Travis reached Bastrop Sunday night, about 24 hours after it was released. The Bastrop flood was not caused by releases from Mansfield Dam.

Lake Travis crested at 710.4 feet on Christmas Day, setting a new record for the lake. The slug of floodwater hit La Grange, Columbus, and Wharton from December 23 to December 27. Good emergency operations, good communications, and good common sense - and a few lucky breaks along the way - saved lives and kept down property damage. Newspaper, television, and radio coverage has told the story of the families who lost property, livestock, and cherished belongings in the Christmas flood.

What Happens Next?

The basic weather pattern that gave Central Texas the rains of December has not been broken. The LCRA, with an eye on the weather at all times, is trying to restore the flexibility it has in river operations that was taken away by the double-storm nature of December's rains. If the river drops downstream, a normal level at Travis can be restored.

But the flood left the Colorado River basin changed forever, and the LCRA is assessing those changes and trying to protect the ecosystem of the river. Front-end loaders, dumpsters, and LCRA crews are going to where trash and debris problems are the worst. Water testing crews are fanning out over the 10-county area to test water wells and inspect septic systems. Environmental assessment teams are looking for unsafe water, chemical spills, and health threats.


Llano River at Llano
6.83" of rain. Peak Flows:
81,108 CFS (Dec. 20, 9:30 a.m.)
82,315 CFS (Dec. 20, 5:30 p.m.)
40,400 CFS (Dec. 21, 3:00 a.m.)
41,250 CFS (Dec. 21, 2:00 p.m.)
Pedernales River at Johnson City
6.65" of rain. Peak Flows:
83,500 CFS (Dec. 20, 12:30 p.m.)
89,982 CFS (Dec. 21, 6:30 a.m.)
San Saba River
Llano River
Pedernales River
Buchanan Dam (Buchanan)
Inks Dam (Inks)
Wirtz Dam (LBJ)
Starcke Dam (Marble Falls)
Mansfield Dam (Travis)
Tom Miller Dam (Austin)
AUSTIN
Colorado River at Red Bluff
6.56" of rain
Peak Flow 47,137 CFS
(Dec. 21, 11:01 a.m.)
Walnut Creek 7.98" of rain
Peak Flow 9,432 CFS (Dec. 20, 10 p.m.)
Onion Creek 8.35" of rain
Peak Flow 43,127 CFS (Dec. 21, 3 a.m.)
BASTROP
SMITHVILLE
LA GRANGE
COLUMBUS
WHARTON
Colorado River
at Bastrop
7.87" of rain
Peak Flow 71,000 CFS
(Dec. 22, 3 a.m.)
Colorado River at Columbus
8.35" of rain
Peak Flow 81,582 CFS
(Dec. 24, 11:36 p.m.)
Colorado River at La Grange 3.55" of rain
Peak Flow 86,028 CFS (Dec. 23, 2:30 p.m.)
Colorado River at Wharton
3.4" of rain Dec. 20-21.
Peak Flow 62,500 CFS (Dec. 27, 6 p.m.)
Colorado River at Bay City
1.70" of rain
Peak Flow 65,200 CFS (Dec. 27, 7:40 p.m.)

In closing, the system worked the way it was designed to 50 years ago. There were no manmade floods. The LCRA utilized a portion of the floodplain on Lake Travis for the purpose for which it was set aside.

Some folks want to keep the lake permanently lower so the chance of another flood would be decreased, but doing that would restrict the lake's ability to supply water for cities and agriculture throughout the basin. Such a change would dramatically increase the number of times Lake Travis is in drought conditions and forever alter the character and vitality of Central Texas.

Our eyes are never off the Colorado River. The LCRA was created because this river is not a river of moderation. It ends droughts with floods. Normally dry seasons are replaced with the wettest months on records.

That's why we integrated our flood warning system with our electric power dispatch system. Our remote sensors, automatic telecommunications devices, and computer modeling systems always have a human eye looking over their shoulder.

When the rains fell in December, our people applied good science and engineering principles, sound judgment, and the U.S. Corps of Engineers guidelines to manage the flood. Nature did not let us prevent all flooding this time. Rain hit us high in the watershed and filled the lakes. Then rain hit us in the lower part of the watershed and filled the river downstream. This one-two punch left us nowhere to put the water - except where it was supposed to go, Lake Travis. The harsh reality is that all of us have been reacquainted with Lake Travis's role as a flood-control lake. It was built to supply water and to hold back floodwaters as well as for recreation and tourism.

During the event, residents called us with advice. Those downstream told us not to open the floodgates at Mansfield. People along Lake Travis and Lake Austin told us to release the water and let it go downstream.

Had we done either, there is no doubt that we'd be in the same situation as Central Texas was in 1935 before the dams were built: people would have died. Downstream areas would have been ravaged.

Let's look at what would have happened. If we drained the lakes in anticipation of rain that had not fallen, we would have sent a slug of water downstream on Friday, December 20, and Saturday, December 21. That's when 8-inch rains hit Austin and Bastrop. The combined waters would have quadrupled the amount of water through downstream Austin. Shoal Creek and other urban waterways would have backed up for miles. People who had never been flooded before would have been inundated. Some would have died. Central Austin, Bastrop, Columbus, La Grange, and Wharton would have been devastated. The splintered houses and businesses and churches of mid-Texas would have been on the bottom of Matagorda Bay.

Likewise, if we had never opened the gates on Mansfield Dam, we would have created the 100-year-flood on Lake Travis. The level would have risen to 716 feet, 2 feet above the spillway. We would have had to "pull the cork" and send the 100-year-flood downstream, with the same devastating result.

The Colorado gave us its best shot - to date. But it didn't win. I'm proud of the tremendous effort and heart our employees showed. Having done everything they could to avert and manage the flooding, they dug deep into their own pockets, not LCRA funds, and made a $10,000 contribution to Red Cross relief efforts.

We regret the hardship caused by the flood to anyone, whether they are on the lakes or downstream. We will use this as an opportunity to improve all of our operations. But we take pride in knowing that the flood-control system did what it was supposed to do.

Mark Rose
General Manager

For further information, contact the Lower Colorado River Authority, PO Box 220, Austin, Texas 78767-0220; telephone 1-800-776-5272.

EYE LEVEL MEASURING UNIT![1]

Simple, But it Works

"It isn't high tech," says Larry Burr, a water supervisor for the St. Mary River Irrigation District, "but my eye level measuring unit sure works better than a staff gauge down in the Chin II measuring well. for the past two irrigation seasons, I've had to climb down the well to read the water level in the structure. It's inconvenient and often hard to read the staff gauge."

"This past winter, I persuaded Monty Flexhaug, our manager of operations, to allow me to build and install in the corrugated steel stilling well my eye level measuring unit. In the well, I installed a simple float device (toilet tank float) on a small diameter aluminum rod which protrudes up through the manhole cover. I used an aluminum tube because it's light and won't rust. Attached by a bracket to the lid is a staff gauge," Burr says. In order to calibrate the measuring device, Burr installed an adjustable pointer.

Burr adds, "Calibration is easy. I allow just enough water in the canal to trickle over the crest of the weir and then set the pointer at '0' on the staff gauge, then tighten the locknut. That's it – it's done," he smiles. "There is no need for a survey instrument or a highly trained technical person to calibrate this measuring device," he adds.

Flexhaug is so impressed with the measuring device, he is going to install a number of them this next winter. "They are easy to install and even easier to read," he adds.

For more information, please contact Mr. Larry Burr, Water Supervisor, or Mr. Monty Flexhaug, Manager of Operations; St. Mary River Irrigation District; PO Box 278, Lethbridge, Alberta T1J 3Y7; telephone (403) 328-4401.

Larry Burr reads his eye level measuring unit.

[1] Reprinted with permission from the Editor, The Water Hauler's Bulletin, Summer 1992 issue.

NEW ROD WEEDER BASKET[1]

District Designs and Builds New Bucket

The "Rod Weeder Basket" is a hydraulic hoe bucket specifically designed for removing vast quantities of aquatic vegetation from flowing irrigation canals. Based on the first year's results of the prototype basket, Neil Johnson, operations manager with the Eastern Irrigation District, is confident they have a winner.

Rod weeder basket.

As Johnson puts it, "The design of the basket was not the brain child of any one employee, but a conglomeration of ideas from engineering, maintenance, and operational staff. There didn't seem to be any commercially made bucket that fit our needs, so we took a shot at it and made our own in the Brooks shop." The cost was around $5,000.

"Our basket is 3 metres (3.3 feet) wide, 590 mm (23.2 inches) tall, 460 mm (18.1 inches) deep, and is made of 12 mm (0.5 inch) diameter steel rod spaced 7.5 mm (0.3 inch) apart," says Johnson. "Originally, our idea was to have a 25 mm (1 inch) diameter rotating shaft or rod attached to the front of the basket [powered by an Orbit hydraulic motor] which would wrap weeds around it and pull them out. This idea was soon abandoned. The weeds would wrap around but we couldn't get them to spin off. The weeds would soon begin to ball-up and eventually the mass quit turning even though the shaft continued," he concludes.

The basket is attached to a John Deere 790 hydraulic hoe. Operator Terry Smith says he can clean about 2 km (1.2 miles) of an average size canal or drain per day. He operates the basket so as to draw the rod basket through the bed material, thus up-rooting as many plants as possible but leaving the muck behind. Another use for the basket has been found. The district uses the basket to catch and remove the massive

[1] Reprinted with permission from the Editor, Water Hauler's Bulletin, Summer 1992 issue.

amount of floating weeds torn loose by the old traditional weed cleaning method. This method involves dragging a chain over the canal bottom attached to two crawler tractors on opposite banks of the canal.

Basket removes cattails including root material.

Johnson is left wondering just how much effect the up-rooting of the plants by the basket will affect next year's growth. He does know that the rod basket removes tonnes of the current year's plant growth, and again allows water to run unrestricted through the channel.

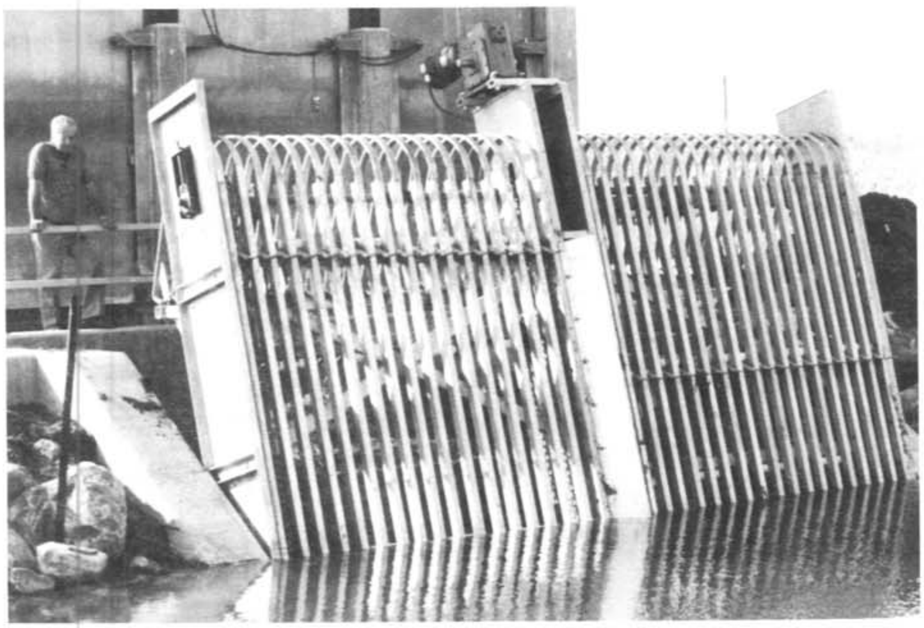
"Future improvements to the basket might include a swivel head to allow for better control on uneven slopes. Larger baskets are not contemplated, as they would become awkward to control and are flimsy," concludes Johnson.

For more information, please contact Mr. Neil Johnson, Operations Manager, Eastern Irrigation District, PO Box 8, Brooks, Alberta T1R 1B2; telephone (403) 362-1400.

AUTOMATED SCREEN REPLACES MANPOWER[1]

One of the most persistent problems irrigation districts face each summer is how to prevent floating aquatic weeds from entering their pumping plants and pipelines. A unique new design for a traveling screen has been developed by the Bow River Irrigation District (BRID) staff in conjunction with Urvold Industries Ltd. of Nobleford, Alberta, for their Lost Lake Water Re-use Pumphouse.

Like many irrigation impoundments, Lost Lake is full of submerged aquatic vegetation. This vegetation begins to break off in late summer and fall and floats up against the inlet channel and pumphouse bar-screens. Henry Holst, superintendent of maintenance and operations for the district, says the problem becomes so acute that he has to station, almost permanently at times, a Bantam hydraulic hoe to clean off the huge amounts of aquatic plant biomass that collects on the bar-screens. "Our ditchrider couldn't even begin to manually keep up with the mass and soon our pumps would shut down," says Holst.



Henry Holst stands beside screen built by Urvold Industries Ltd.

The idea for the screen came from Holland. Local farmer, Jan Lanser, took pictures of catenary-type screens he had seen when visiting the country and gave them to the district. From these came the basis for a new design.

The catenary-type screen was built by Urvold Industries Ltd. It was manufactured entirely from galvanized metal, except for the stainless steel chain and the Delrin composite rollers. An electric 5-hp motor powers through a gear box the continuous chain of rakes that travel up the rack face, then back down into the water. As the loaded rakes travel over the top, the weeds and debris fall off or are removed by the scraper bar. "The weed pile on the backside must be manually forked away," says Emil Johnson, district water master, "but in future, the district plans to fully automate with a conveyor belt."

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1 Reprinted with permission from the Editor, The Water Hauler's Bulletin, Summer 1992 issue.

Emil Johnson forks weeds from holding pit. An automated conveyor belt will make this manual task unnecessary in the future.

The screen is programmed through an auto-timer to cycle at whatever interval is required to keep the rack clean. "A normal cycle," says Johnson, "might be to program the screen to start up every 6 hours for 1 minute." The total cost of the screen including the timer was $32,000.

Johnson and Holst are pleased with the screen. "It has allowed me to remove the upstream channel trashrack and free-up a hydraulic hoe," says Holst. Johnson adds that "a real dollar savings has been gained in eliminating the overtime required to keep the structure free of weeds."

For more information, please contact Henry Holst or Emil Johnson, Bow River Irrigation District, PO Box 140, Vauxhall, Alberta T0K 2K0; telephone (403) 654-2111.

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