# DABEC DIGEST

volume 1, issue 5 may, 2002


# STORM SEWER TERMS AND DEFINITIONS

D. A. Brown Engineering Consultants Inc.

It is unfortunate, but many engineers and their firms cloak engineering design in a shroud of mystery. While it is true that excellent application of engineering principles to real-world problems is not simple, the concepts behind most of the every-day engineering design world are very easy to understand. In this article, we will explore some of the "engineering-ese" of storm sewer design and define these sometimes confusing terms in a method that all can understand.

"**One hundred year storm**" is frequently misunderstood to mean that this design rainfall event will only happen once every hundred years. The "one hundred year" words are the confusing part of the term. In actuality, the probability of a "hundred year" storm happening in any given year is one percent. Therefore, the "one percent" storm is referred to as the "one hundred year" storm. By the same token, a "**ten year**" storm has a probably of happening once every ten years, or ten percent chance per year. If we relate this term to the Hoosier Lotto, where the odds of winning are about 1:8,835,488,640 (0.0000000113%), then winning the Hoosier Lotto would be an "Eight Billion, Eight Hundred Thirty Five Million, Four Hundred Eighty-Eight Thousand, Six Hundred Forty Year Event." There are obviously no guarantees that a "Hundred Year" storm won't happen this year, and in fact, it is possible to get "Hundred Year" storms twice in the same week!

"**Detention Basin**" or "**Retention Basin**". What is the difference? Actually, there is no technical difference in the definition of these terms. Both relate to a storage basin used to reduce the peak outflow from a given area. By convention, some design professionals and review agencies will use Retention to refer to a basin that is normally wet and Detention to refer to a basin that is normally dry.

"**Maximum Release Rate**" is that limit set as the peak discharge allowable from a detention basin during the design storm event. Release rate is usually limited by review agencies in units of cfs/acre. In fact, almost all flowrates in storm water calculations are expressed in cfs units. What is a "**cfs**"? CFS stands for Cubic Feet per Second and is used in storm sewer calculations rather than gpm (gal. per min) or gpd (gal. per day) in order to keep the numbers small and manageable. For example, one cfs=448.8 gpm=646,272 gpd. Therefore, a maximum release rate of 0.2 cfs/acre on a 40 acre property converts to a maximum discharge of 8 cfs, or 3,590 gpm.

"**Watershed**" is a term that relates to the contributing area to a given release point. In other words, for a certain release point (stream, pipe, river, detention basin, etc.) all the surface area that contributes stormwater to that discharge is part of the watershed. Watershed areas are critical in determining pipe sizes, detention basin volumes, flood plain elevations, etc.

Obviously, this short list does not cover all storm sewer terms you are likely to see. Please call if you have questions about other storm terms.

## DETENTION VOLUME

**How do you calculate the storage volume of a detention basin? Well, it's not as complicated as you might think. The first thing to keep in mind is that the storage volume is all that volume above normal pool (wet basin) or the ground (dry basin). Another important aspect of this calculation is to be consistent with your units of measurement. Most agencies want to see the detention volume in units of acre-feet. (One acre-foot is equal to 43,560 cubic feet.) However, it is easier to calculate the volume in terms of cubic feet and convert when you are done. Here is a sample problem:**

| | |
|---|---|
| **Normal pool:** | **800.0** |
| **Overflow Elev:** | **804.0** |
| **Contour Areas:** | |
| **800.0** | **50,000 sqft** |
| **801.0** | **55,000 sqft** |
| **802.0** | **62,000 sqft** |
| **803.0** | **72,000 sqft** |
| **804.0** | **85,000 sqft** |

**The volume can be approximated like this:**

**Take the average of the contour areas for the given intervals and multiply by the interval height:**

**First Interval (800 to 801)**
**=((55,000+50,000)/2)*(801-800)**
**=52,500 cubic ft**
**Second Interval (801 to 802)**
**=58,500 cubic ft**
**Third Interval (802 to 803)**
**=67,000 cubic ft**
**Fourth Interval (803 to 804)**
**=78,500 cubic ft**

**Then sum each of the interval volumes to find the total basin volume=256,500 cubic feet or (divide by 43,560 cubic feet/ac-ft) 5.89 Acre Feet.**

## potpourri

DA Brown Engineering Consultants, Inc. will be holding their second annual "**Corporate Invitational Golf Outing**" on May 24, 2002 at Noblehawk Golf Links in Kendallville, IN. If you didn't get an invitation, but would like to field a team, call Brian at our office to see if a spot for your team is available.

**This Issue's Quiz:**

**1) True or False:**

**A watershed is a building which houses water piping and valves.**

**2) True or False:**

**The allowable release rate for a development is frequently expressed as "CFS/Acre."**

**3) True or False:**

**A "One Hundred Year Storm" will only happen once every hundred years.**

**Fax your answers to Brian at D. A. Brown Engineering Consultants for a chance to win free rounds of golf or t-shirts.**

# So, Your Detention Basin Isn't Functioning Properly

Unfortunately, everything breaks. Detention basins are not exceptions to this rule. It is possible to reduce the likelihood of failure during design and construction, but it is impossible to guarantee that the basin you are building today won't be giving you trouble in a few years.

What do you do when your detention basin is "acting up?" The first thing is to correctly diagnose the problem. If your emergency overflow is washing out, it is very probable that the basin is not large enough, or the discharge is too restricted. If you are experiencing increased maintenance around the basin because the landscaping is drowning, or the grass is too wet to mow most of the year, you might have an inefficient discharge that is taking too long to fully empty the basin, or you might have too much vertical fluctuation in the pond.

In any event, retrofitting a detention basin to improve performance does not have to mean total reconstruction and enormous expenditures of money.

Here are a couple of case studies:

Problem: An apartment complex has a dry basin (for liability reasons) that has a perpetually wet bottom. It is virtually impossible to mow, even though subsurface drains were installed during initial construction to eliminate this condition. The property manager is fed up with the appearance of the basin and is considering "drastic" action to improve the situation.

Solution: An extensive examination of the basin must be made to determine the cause of the wet bottom. In this particular case, the basin invert is graded at a 0.5% slope and the discharge pipe is a 6" diameter PVC pipe. Many of the tenants wash their cars regularly and the sprinkler systems for the lawn area run every day during the summer. This "trickle" water into the basin is keeping the bottom wet and muddy.

It is determined that the most cost effective means of reducing maintenance on the basin is to install concrete paved inverts to carry this "trickle" water to the discharge, which will be upgraded to a horizontal orifice (2"x12") placed in the end of a new 12" pipe to facilitate rapid de-watering of the last foot of the basin.

Problem: The 10" discharge at pond surface level in a wet pond in an outlying subdivision keeps plugging with debris and causing overflow problems upstream and downstream of the basin.

Solution: Reconstruction of the discharge with a submerged outlet below the surface of the pond will virtually eliminate plugging problems in the discharge pipe. Care must be taken to size the pipe correctly, and the pond will probably have to be pumped down a few feet prior to construction.

Most detention basin problems can be remedied with proper design prior to construction, or careful retrofits after problems arise. Continued maintenance expense and reduced "curb appeal" are not headaches that we have to endure. Detention basins can be an asset rather than a liability. Please call if you have any questions.

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# DABEC DIGEST

volume 1, issue 6 june, 2002


# SANITARY SEWER TERMS AND DEFINITIONS

Sometimes, the terminology used by engineers and reviewing agencies can be confusing. In our continuing efforts to reveal the deep, dark mysteries of the engineering world, we have put together this article about Sanitary Sewer Terms and Definitions.

"**Ten State's Standards**" is a term you might never hear if you live in Colorado, and here is why: The "Ten State's" part of the term refers to the member states and provinces that were involved in the development of the design standards. Those ten states are: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, and Wisconsin. The Province of Ontario is also a member (which makes the total eleven members, just like the Big Ten Conference). The Ten State's Standards are simply recommended design standards for the construction of wastewater facilities. Contained within the Standards are recommendations for: Engineering Reports and Facility Plans, Engineering Plans and Specifications, Design of Sewers, Wastewater Pumping Stations, Wastewater Treatment Facilities, Screening, Grit Removal, Flow Equalization, Settling, Sludge Processing, Storage and Disposal, Biological Treatment, Disinfection and Supplemental Treatment Processes. It is obvious that the Standards contain a lot of information regarding Sanitary Sewage Systems. However, most people not involved with a wastewater treatment plant will only be concerned with two sections: Design of Sewers and Wastewater Pumping Stations.

The "Design of Sewers" Section contains information about the minimum grades for sewer lines, separation requirements from water mains, inspection and testing, special construction situations and many other details regarding sewer design and construction. This section is the basis for most sewer main design in the midwest. The "Wastewater Pumping Stations" section is similar in nature and is the basis for most Lift Station designs in the midwest.

"**Design Flow**" refers to the estimated contributing flow of whatever development or individual is being added to the sanitary sewer system. Design Flows for almost anything can be found in Bulletin S.E. 13 produced by the Indiana State Board of Health. This bulletin is similar to Ten State's, but it covers water supply and includes design loading rates for development. Flowrates published in this bulletin are given in units of gallons per day (gpd) and are the estimated average flow volume for a 24 hour period.

The "**Peaking Factor**" applied to the average flowrate allows for instantaneous maximum flowrates that occur at regular intervals during the day. In other words, if the average flowrate over a 24 hour period is 20 gallons per minute (gpm) there will be times when the flowrate is less and times when the flowrate is more to achieve that average. The magnitude of the spike above the average flowrate must be accounted for with the "Peaking Factor."

Obviously, this short list does not cover all the sanitary sewer terms you are likely to see. Please call if you have questions about other sanitary terms.

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## PEAK FLOWRATE

**The Peak Flowrate of a sanitary sewer network is very important to determine. Even though the average flows may be easily carried by a smaller pipe, the maximum peak flows must also fit within the pipe to reduce chances of backing up and damaging properties connected or adjacent to the sewer line. Here is an example of design using average and peak flowrates to size a sanitary sewer main:**

**Single Family Development**
**Number of Homes: 800**
**Ave. Flow per Home: 310 gpd**
**Approx. Daily Flow: 248,000 gal**

**Using the approximate total daily flow to determine the average flow per minute we arrive at:**
**(248,000 gpd/(24hr/day*60min/hr))=172 gpm**

**An 8" PVC SDR 35 pipe at minimum grade (0.4%) has peak gravity capacity of about 440 gpm, so it looks like we are fine specifying that pipe. However, at certain times during the day the sewage flowrate will be substantially above the average we have calculated. In fact, the Ten State's Standard for design Peaking Factor is a formula based upon the population of the contributing area. Unless you are designing a large sewer (more than 2,000 contributing people), a factor of 4.0 should be sufficient. So, for our example, we must take the average flowrate of 172 gpm and multiply it by 4.0 to allow for peak flowrates. That means our pipe must have capacity for 688 gpm. Our 8" pipe at 0.4% will not be large enough for this development. In fact, maintaining 0.4% grade we have to use a 10" pipe (800 gpm cap.).**

## potpourri

Congratulations go out to:
Michael Wendt
Jerry Foust
Last month's golf winners!!!

**This Issue's Quiz:**

**1) True or False:**

**The membership for the development of Ten State's Standards includes a province from another country.**

**2) True or False:**

**Pipe networks and lift stations should be designed to handle the average flow only.**

**3) True or False:**

**Design flowrates for different types of developments can only be estimated by monitoring similar developments in your region.**

**4) True or False**

**GPD stands for gallons per day.**

**Fax your answers to Brian at D. A. Brown Engineering Consultants for a chance to win free rounds of golf or t-shirts.**

# Lift Station/Force Main or Gravity Sewer Main?

Virtually everyone needs a sanitary sewage discharge point. The only people that don't are those who still utilize outhouses, and even outhouses need to be moved from time to time. The primary sanitary questions for most developing properties are: Where is my discharge point? And, how will I get there?

The location of the discharge point is usually dictated by the sewage treating authority. Some treatment plants are at or near capacity and can not receive additional effluent. Some interceptor lines are in the same condition. Other plants and/or interceptors will still have capacity and those are the areas in which the sewage treating authority will permit additional connections. Hopefully, capacity is available near the area you propose to develop. For the purposes of the rest of this article, we will assume that a suitable discharge point is available in your general area. If a discharge point is unavailable, then development must proceed elsewhere.

So, the appropriate discharge point has been identified by your sewage treatment authority, and now you want to get your sanitary sewage to that point. The question still remains, "How will I get there?"

Well, the first point of investigation is to determine if your development lies within the same watershed (see DABEC DIGEST Volume 1, Issue 5) and upstream of the receiving sewer. If the answer to both questions is "Yes," then chances are good that you will be extending gravity sewer to your property.

If your property does not lie within the same watershed, you might be looking at the construction of a lift station to pump the sewage over the watershed line and into the receiving sewer. It is possible in some cases to install gravity sewer across the watershed line, but depth of bury can become a major factor in that decision.

In either case, the decision to go with gravity sanitary mains, or pumps and force mains is predominantly an economic decision. Gravity sanitary mains generally cost 20-80% more to bury for similar capacities than force mains. Lift stations cost quite a bit of money to install and even more to maintain (electrical expense, pump maintenance, etc.). Each cost must be considered in order to make the decision. Here is a typical scenario:

Development to Receiving Sewer: 4,500'
Required Capacity for Develop.: 900 gpm

| | | |
|---|---|---|
| Gravity Sanitary Size: | | 12" |
| Average Bury: | | 15' |
| Force Main Size: | | 8" |
| Pump Size: | 6" | 30 hp |

Cost Estimate:

| | | |
|---|---|---|
| Gravity Line: | $60/ft | $270,000 |
| Force Main: | $35/ft | $157,500 |
| Lift Station\Valve Vault: | | $100,000 |

As you can see from this brief example, if easements can be obtained for the gravity line, the installation costs are very similar. Please call if you have questions.

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# DABEC DIGEST

volume 1, issue 7 july, 2002


# WATER SUPPLY TERMS AND DEFINITIONS

If you've ever been confused by the relationships between the design terms used for water supply systems, we hope this article will help you out:

The water in a public water system generally comes from above-ground "**Reservoirs**", or from "**Wells**." Both of these water sources are usually treated at an approved "**Water Treatment Plant**" for contaminants and tested to ensure the safety of the public. After the water is treated, it is generally pumped into an "**Elevated Water Tank**" (or "**Water Tower**") which pressurizes the supply system and provides a reserve capacity for extreme events. In some areas, however, the system is pressurized with "**Pumping Stations**" which draw water from the supply and pump it into the "**Water Mains**" to provide pressure for operations. In these situations, the pumps must be designed to handle extreme events, or catastrophic losses can occur.

"**Pressure**" or "**Water Pressure**" is a widely-used term and is somewhat ambiguous. The "**Static Pressure**" of a water line is the pressure of that line with no water flowing in the pipe. The "**Static Pressure**" observed in a given water line is totally independent of the diameter of the pipe and is only a function of the pipe elevation and the elevation of the water in the "**Water Tower**", or the shut-off pressure of the "**Pumping Station**". The "**Dynamic Pressure**" is the pressure observed in the line at certain "**Flowrates**." The "**Flowrate**" is simply a measure of volume discharged per unit time and is generally expressed in the units of gallons per minute, "**gpm**." The "**Flowrate**" is dependent upon the "**Static Pressure**" of the line, the length, diameter, and material composition of the pipe, and the size of the "**Orifice**", or hole, from which the water is discharging. Generally speaking, "**Flowrates**" increase with increases in "**Static Pressure**", line diameter, and "**Orifice**" size and with decreases in line length. "**Flowrates**" decrease with decreases in "**Static Pressure**", line diameter, and "**Orifice**" size and with increases in line length.

"**Fire Protection Load**" is that flowrate and dynamic pressure required to adequately extinguish expected fire events in a given locality. Generally, flowrates must exceed 1000 gpm at 20 psi, but increased flowrate may be required in certain developments.

"**Domestic Load**" is that flowrate and dynamic pressure required to adequately service the normal loading on the system during day-to-day use. The "**Domestic Load**" is calculated very similarly to the Peak Flowrate for sanitary sewer (see Volume 1, Issue 6), but additional factors such as car washing and lawn sprinkling must be taken into consideration. One gpm/single family home is generally a good rule of thumb for the "**Domestic Load**" on a given water supply network. In other words, in a moderately dense single-family neighborhood, it takes about 1000 homes at design "**Domestic Load**" to equal the minimum "**Fire Protection Load**."

We will explore many of these terms in detail in later issues, however, please give us a call if we can answer any additional questions at this time.

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## STATIC PRESSURE

**The Static Pressure at a given point in a supply system is important to know. While the static pressure does not directly indicate the dynamic pressure under certain flow conditions, you can be sure that the dynamic pressure will never exceed the static pressure. Therefore, areas that indicate a substandard static pressure are not likely to develop without additional improvements to the water supply system. Here is a sample calculation put together to estimate the static pressure for a proposed hotel:**

| | |
|---|---|
| **Water Supply:** | **Elevated Tank** |
| **Tank Base Elevation:** | **800′** |
| **Height to Overflow:** | **150′** |
| **Height to Release Pipe:** | **100′** |
| **Diameter Water Main:** | **16″** |
| **Hotel First Floor Elev:** | **750′** |
| **Hotel Roof Elev:** | **850′** |
| **Ave. Domestic Flow:** | **200 gpm** |
| **Required Fire Flow:** | **2000 gpm** |
| **Required Dyn. Press:** | **25 psi** |

**As stated previously, the static pressure is only a function of the elevation of the water in the tank and the elevation of the pipe we are evaluating. In this case, the water in the tower will have a peak elevation of 950′, and the piping in the hotel will be somewhere below 850′. Therefore, the static pressure in the hotel when the tank is full will be at or above 100 feet of head (43.3 psi). When the tank is just empty (900′), the static pressure observed in the hotel will be at or above 50′ (21.6 psi). It is important to note that the dynamic pressures will be less than the anticipated static pressures and may become a problem for the sprinkler systems.**

## potpourri

Congratulations go out to:
Bryce Cordell
Last month's golf winner!!!

**This Issue's Quiz:**

**1) True or False:**

**The static pressure of a pipe is dependent on the diameter and length of the pipe.**

**2) True or False:**

**For a given flowrate, the dynamic pressure will increase with increased pipe diameter and decrease with decreased pipe diameter.**

**3) True or False:**

**The flowrate of a water main is a measure of time over gallons discharged and usually has the units of minutes per gallon.**

**4) True or False**

**Some communities use surface water for public water use.**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by July 31, 2002 for a chance to win free rounds of golf or t-shirts.**

# DABEC GOLF OPEN ANNOUNCEMENT

We are going to host the First Annual DABEC Golf Open at Noble Hawk Golf Links in Kendallville, IN on August 24, 2002 with a shotgun start at 1:00 pm.

The format for the one-day tournament will be four person Florida Scramble. Cash payouts will be awarded to the winning teams and for individual proximities, a skins game will be available, and we will have a **New 4WD Chevy Avalanche** up for grabs at our hole-in-one contest.

Entry for the tournament is quite simple: It is "open" to anyone. The invitations will only be sent out through this newletter, but anyone can enter, whether they receive the newsletter, or not. The field is restricted to 30 teams and will be handled on a first-come, first-served basis.

It will cost $240 per team to enter the tournament. This fee includes: greens fees, cart fees, practice range fees, a chance at the **New 4WD Chevy Avalanche,** prize money and dinner after the tournament for everyone on the team. Estimated team payouts with a full field are:

| | |
|---|---|
| 1st Place | $480 |
| 2nd Place | $400 |
| 3rd Place | $320 |
| 4th Place | $240 |
| 5th Place | $160 |

The Skins Purse will be an estimated additional $600. The registration deadline is August 16, 2002. Start putting your teams together and get registered now, because the field will fill up fast. Feel free to use the form below for your entry. Fax, email, or mail them to us at our addresses shown below:

Team Members:

_____

_____

_____

_____

(_____) _____ - _____phone #

_____ Entry Fee Enclosed
(make checks payable to:
D. A. Brown Engineering)

_____ Entry Fee in the Mail
(make checks payable to:
D. A. Brown Engineering)

We would love to see everyone of you at the tournament. Please call Brian at the numbers below if you have any questions.

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# DABEC DIGEST

volume 1, issue 8 august, 2002


# TRANSPORTATION TERMS AND DEFINITIONS

All of us spend some time in the transportation network of the United States. The following terms and definitions will help you understand the technical terms used in the design of that system.

A "**Public Road**" is a road that has generally been designed and constructed according to local, state, or federal guidelines and has been accepted by the respective highway department for maintenance. A "**Private Road**" is a road that is maintained by a private entity and is not supported by tax dollars.

Virtually all Public Roads have a "**Right of Way**" associated with them. This Right of Way is a dedication of access rights for public use on and through that property. Rights of Way vary in width; smaller, less-traveled roads generally have narrower Rights of Way than larger, heavily-traveled highways. Frequently, utilities such as gas, electric, telephone, cable TV, water mains, sanitary sewer, and storm sewer are laid within the dedicated Right of Way. As you can see by this list, Rights of Way can get very crowded.

Most Public Roads are made up of several predictable parts. The "**Travel Lanes**" are the lanes that are identified for vehicular travel. The number of Travel Lanes is determined as a function of the "**Peak Hour Volume**" of traffic on the road. The Peak Hour Volume is the total number of vehicles passing a given point on the road during a given hour (usually one of the rush hour periods). Public Roads usually also have either "Shoulders" or "Curbs." Shoulders serve as a safety feature to give motorists some room for maneuvering outside the Travel Lanes and to protect the Travel Lane edge from decay. Curbs keep motorists within the Travel Lanes and function as a stormwater conveyance to inlets or ditches.

All Public Roads should be designed for an optimum driving speed (or "**Speed Limit**.") Designing a Public Road for a given Speed Limit requires that specific standards be followed for "**Horizontal Curves**" (curves that cause the motorist to turn the steering wheel right or left), "**Vertical Curves**" (curves that transition pavement between grades), "**Sight Distance**" (that distance motorists can see while driving their vehicles), and "**Superelevation**" (tipping the pavement toward the center of the curve.)

Provision must be made, of course, for vehicles to exit and enter Public Roads in the course of their travels. These provisions can include: "**A/D Lanes**" (Acceleration and Deceleration Lanes-giving motorists the opportunity to blend with traffic speed and to reduce their speed without backing up traffic), "**Left/Right Turn Lanes**" (separating traffic into lanes specifically designed for their turning movements, which reduces back-up), "**Traffic Control Devices**" (a very long list of devices which direct motorists in their travel, including signals, signs, paint markings, etc.) and "**Cross-overs**" (pavement placed over a median strip to allow motorists to cross the opposite lanes of a highway).

This is not a complete list of terms, please give us a call if we can answer any additional questions at this time.

D. A. Brown
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## UNSAFE TRAVEL

**Have you ever wondered how safe a driver you really are? Everything we do while in the "cock pit" of our vehicles impacts our driving abilities. Consider these calculations of "incapacitated" time and distance:**

**Driving Speed: 65 mph**
**95 ft per sec**

**Activity:**

**Sneezing**
**Time Required 4 seconds**
**Distance Traveled**
**380 ft**

**Adjusting Radio**
**Time Required 5 seconds**
**Distance Traveled**
**475 ft**

**Dialing Cell Phone**
**Time Required 8 seconds**
**Distance Traveled**
**760 ft**

**Eating Breakfast**
**Time Required 10 seconds**
**Distance Traveled**
**950 ft**

**Shaving**
**Time Required 15 seconds**
**Distance Traveled**
**1425 ft**

**Putting on Make-up**
**Time Required 20 seconds**
**Distance Traveled**
**1900 ft**

**The next time you're driving on the Interstate, think about the distance those around you travel while distracted by these and other things.**

## potpourri

**This Issue's Quiz:**

**1) True or False:**

**All Rights-of-Way for a public roads are the same width.**

**2) True or False:**

**A/D Lanes is another term for Acceleration and Deceleration Lanes.**

**3) True or False:**

**Turning movements must be accounted for in the design of public roads.**

**4) True or False**

**Vertical curves required motorists to turn the steering wheel to stay on the pavement.**

**5) True or False**

**Peak Hour Traffic always occurs at 12:00 noon and 12:00 midnight**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by July 31, 2002 for a chance to win free rounds of golf or t-shirts.**

# DABEC GOLF OPEN REANNOUNCEMENT

I apologize for all of the confusion last month regarding our Golf Open. Due to circumstances beyond our control, the date published in last month's newsletter got changed the day after we mailed it.

I have also received several questions regarding the follow-up mailing I sent out as a registration form for the tournament. So, I am taking this last opportunity to set the record straight:

We are hosting an Open Golf Tournament on September 21, 2002 (shotgun start at 1:00 pm) at Noblehawk Golf Links in Kendallville, IN.

The format for the tournament will be Four Person Florida Scramble. Anyone can play in this event and team handicap is not an issue.

It will cost $240 per team to enter the tournament. This fee includes: greens fees, cart fees, practice range fees, a chance to win a **NEW 4WD CHEVY AVALANCHE,** prize money and dinner after the tournament for everyone on the team. Estimated team payouts with a full field are:

| | |
|---|---|
| 1st Place | $600 |
| 2nd Place | $500 |
| 3rd Place | $400 |
| 4th Place | $300 |
| 5th Place | $200 |

The Skins Purse will be an estimated additional $1400. The registration deadline is September 13, 2002. Start putting your teams together and get registered now, because the field will fill up fast. Feel free to use the form below for your entry. Fax, email, or mail them to us at our addresses shown below:

Team Members:

_____

_____

_____

_____

(_____) _____ - _____phone #

_____ Entry Fee Enclosed
(make checks payable to:
D. A. Brown Engineering)

_____ Entry Fee in the Mail
(make checks payable to:
D. A. Brown Engineering)

We would love to see everyone of you at the tournament. Please call Brian at the numbers below if you have any questions.

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# DABEC DIGEST

volume 1, issue 9 september, 2002

# WHAT'S A FLOODWAY, ANYWAY?

Flooding ditches, streams, and rivers can do a lot of damage. We have seen incredible flooding events here in northeastern Indiana just this summer. The eight inches of rain that fell on west-central Fort Wayne overtopped roads, flooded basements, and damaged commercial buildings. The Federal, State and Local governments have systems in place to reduce the amount of flood damage incurred during extreme events. These systems can be complicated and difficult to understand. We will attempt to simplify and define these systems in this newsletter.

The Federal Emergency Management Agency (FEMA) is an independent federal agency reporting to the President tasked with responding to, planning for, recovering from, and mitigating against disaster. (see their webpage at www.fema.gov) Their Technical Services Division conducts hydrologic and hydraulic analyses to determine flood hazards in communities throughout the United States as part of FEMA's administration of the National Flood Insurance Program (NFIP). The maps that are accepted by the Technical Services Division delineating the flood hazard zones are called Flood Insurance Rate Maps (FIRM) and are used to determine the insurance rates for flooding as part of the NFIP.

The FIRM Panels indicate the the Base Flood Elevation (BFE), which is the flood surface elevation resulting from a 100 year storm. The FIRM panels are used by many other agencies, as well. These maps and the corresponding Flood Insurance Study books are used by local goverment agencies to review development plans for impact to streams and by the Indiana Department of Natural Resources (IDNR) to determine and permit Floodway impacts.

So, what's a Floodway, anyway? In technical terms, the Floodway is that portion of the Floodplain that must be reserved in order to discharge the Base Flood without cumulatively increasing the water surface elevation. In layman's terms, the Floodway is generally that portion of the Floodplain that is "actively" transporting water downstream (flowing water). The Floodway Fringe (or the remainder of the Floodplain) is generally that portion of the Floodplain that is stagnant or moving very slowly.

I have included a very helpful illustration that is published by IDNR to delineate the areas along streams in which they have jurisdictional control over construction. In essence, unless improvements are proposed within the Floodway itself, IDNR does not have jurisdictional control. Local agencies like the county surveyor's office, planning director, drainage board, or building department will (see next page)

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## DABEC OPEN

**I have included the last DABEC OPEN registration form you will see this year. The deadline for registration is September 13, 2002. Hopefully, everyone that wants to come will get a chance to register.**

## COMPENSATING VOLUMES

**Here is a rough approximation for calculating the compensating volumes necessary for a project in the Floodway Fringe:**

**Base Flood Elevation (BFE): 810.0**
**Ave. Exist. Ground Elev.: 809.0**
**Floodway Fringe (FF) Area: 5 Ac**
**Total FF Storage: 5 AcFt**
**=5 Ac x 43560 sqft/ac x 1ft**
**=217,800 cu ft**
**Proposed Fill Area: 2 Ac**
**Average FF Depth: 1 ft**
**Total FF Fill: 2 AcFt**
**=87,120 cu ft**

**Proposed Excavation Area: 1 Acre (wet pond)**
**Pond Surface Elevation: 808.0**
**Average Exist. Ground: 809.0**
**Average Pond Depth: 8 ft**
**Earth Removed: 8 AcFt**
**=348,480 cu ft**
**FF Storage Above Pond: 2 AcFt**
**=(BFE-Pond Elev)*Pond Area**

**Final FF Storage:**
**=Original-Fill+Add'l Storage**
**=5 AcFt - 2 AcFt +2 AcFt=5 AcFt**

**You will note from this example that only the "air" volume above the normal pool counts for storage, not the entire volume of soil removed for the pond.**

## potpourri

Congratulations go out to:
Bryce Cordell
Last month's golf winner!!!

**This Issue's Quiz:**

**1) True or False:**

**All work in the Floodplain must be approved by FEMA.**

**2) True or False:**

**All work in Indiana's Floodways must be approved by IDNR.**

**3) True or False:**

**FIRM Panels indicate how much property owners will have to pay for Flood Insurance.**

**4) True or False**

**All dirt taken out of the Floodplain to construct a pond in the Floodplain counts in the removal column for compensating volume calculations.**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by September 30, 2002 for a chance to win free rounds of golf or t-shirts.**

# FLOODWAY (CONTINUED)

probably have requirements for construction in the Floodway Fringe. These requirements will usually include elevation certificates for lowest opening (to verify it's above the flood water) and compensating volume calculations (to verify the storage capability of the Floodplain hasn't been compromised). Compensating volumes can be confusing, but it simply means that for every cubic yard of material (dirt, concrete, stone, or even water!!) that gets placed in the Floodplain below the BFE, a cubic yard must be removed to obtain a net zero impact to the storage capability of the Floodplain within the construction zone.

Construction in the Floodplain is really not that complicated. If the project is located in the Floodway Fringe only, then local permits are all that is required to remove and fill dirt. If the project extends into or crosses the Floodway, then IDNR approval is required in addition to the local permits. This will usually involve modeling the stream and demonstrating before/after impacts prior to construction.

FEMA only has to be contacted if a revision is required on the FIRM Panels for the project area. A revision to the FIRM Panel is called a Letter of Map Revision (LOMR).

When is a LOMR necessary? That is usually a question of return on investment. Let's say you are building an apartment complex next to a stream and most of your property lies within the Floodplain, but the Floodway is contained within the banks of the stream. The local permits for construction can be handled without contacting IDNR (since no Floodway impacts will be taking place), but the FIRM Panel for the property will still show the majority of the apartment buildings to be in the Floodplain, and therefore require Flood Insurance for the lenders. An elevation certificate (affidavit signed by a land surveyor demonstrating that the apartments are above the Floodplain) may remove the Flood Insurance requirement, but probably not.

Getting the a LOMR to indicate actual conditions on the property is expensive in time and money, but it will probably be justified considering the cost of the Flood Insurance, which will be at a higher rate since the property is shown in the Floodplain on the map.

Please give us a call if we can answer any additional questions you might have on this topic.

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# DABEC DIGEST

volume 1, issue 10 october, 2002

# SURVEYING MYSTERIES REVEALED

Please pardon the headline. We really aren't going to reveal any mysteries in this newsletter. We are, however, going to attempt to define some key terms and clear up some confusion regarding frequently-used surveying terminology.

The Public Land Survey System is not a system everyone hears about each day, but it is the very foundation for land ownership in the majority of the United States. This system is the basis for locating parcels of ground, reducing gap/overlap problems, and delineating large areas within counties and states for public sector use. The Public Land System separates land into Townships and Sections. (See the included sheet from the Bureau of Land Management's Manual of Instructions) Townships are the major building block of this system. "Normal" Townships are nominally six miles on each side and contain 36 sections. Therefore, each Section is nominally one mile on each side.

Due to the nature of the terrain, and the equipment available (much of northern Indiana was originally surveyed in the 1830's) for surveying these original Townships and Sections, each Section is not exactly one mile square and each Township is not exactly six miles square. Each Section line was surveyed and monumented (usually with wood posts and/or stones) to delineate the boundaries of the Section.

Individual parcels within Sections are usually either described as a fractional section (e.g. the northwest quarter of section 12, or the west half of the northwest quarter of section 12), or by "Metes and Bounds" descriptions. A simplified definition for Metes and Bounds is that the property line directions and dimensions are itemized (Metes) as well as specifying the adjoining property lines and owners (Bounds).

Metes and Bounds descriptions usually contain bearings and distances. The distance part can be confusing because older descriptions frequently use units of measurement that are uncommon today. Older descriptions usually record distance measurements in Rods, Chains, and Links. One Chain is equal to 66 feet, One Rod is equal to 1/4 Chain (16.5'), and one Link is equal to 1/100 Chain (0.66'). The Bearing calls can also be confusing. Bearings are broken into the quadrants of the compass, with due east and west being 90 degrees and due north and south being 0 degrees. Directions are given before (North/South) and after (East/West) the actual angle to identify the quadrant and direction of the call. For instance, North 90 degrees East is actually East and is the same as South 90 degrees East. North 0 degrees West is actually North and is the same as North 0 degrees East.

Incorrect Metes and Bounds descriptions can create problems. Gaps and overlaps on property lines can come about by careless description writing and poor field work. Additionally, the legal description provided for the survey may not "close" (which means the final call of the description should mathematically fall on the point at which the description began), and that can create problems in determining the location of the true property line.

We will continue this exploration of surveying terms in a later issue. Give us a call if you can't wait :-)

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## DISTANCE CALCULATION

**As mentioned in the article to the left, older legal descriptions usually have units of measurement that are uncommon today. We are going to convert some of those measurements into our common units in these sample calculations:**

**How many Chains in a Mile?**
**1 Chain=66 feet**
**1 Mile=5280 feet**
**1Mile=5280/66=80 Chains**

**How far is 22 Chains, 1 Rod, 12 Links?**
**1 Chain=66 feet**
**1 Rod=16.5 feet**
**1 Link=0.66 feet**
**Total Distance=1476.42 feet**

**Now, here is a tougher one:**

**How many acres are in the west 15 Chains of the Northwest Quarter of Section 2, Twp 32 N, Range 11 East?**

**In order to complete this calculation, an assumption must be made. We will assume that the Northwest Quarter of Section 2 is a perfect square measuring 1/2 mile on each side. (Otherwise, an accurate area calculation is impossible.)**

**So, the west 15 Chains is the same as the west 990 feet. Using that as our east/west dimension and multiplying by 1/2 mile (2640 ft) as our north south dimension we conclude that the referenced property has an area of 2,613,600 sq ft. Dividing by 43,560 sq ft per acre we find that this property is 60 acres.**

## potpourri

Congratulations go out to:
Brian Yoh-Last month's golf winner!!!
and to:
Ralph Holler, Larry Brost, Lynn Bosler and David Rosendaul, Winners of the First Annual DABEC Open!!!

**This Issue's Quiz:**

**1) True or False:**

**There are 50 Sections in a Standard Township.**

**2) True or False:**

**A Standard Section is approximately one mile square.**

**3) True or False:**

**One Chain=100 feet.**

**4) True or False**

**A square that measures 40 chains on each side has an area of 160 acres.**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by October 31, 2002 for a chance to win valuable DABEC Merchandise.**

# BOUNDARY SURVEY VARIETIES

You might think that all Boundary Surveys are created equal. Unfortunately, that is not the case. The term "Boundary Survey" is actually a generic term that refers to all surveys performed to determine the location of the bounding line for an individual piece of property.

A Professional Land Surveyor does not establish property lines. Simplistically, the surveyor reports on the location of the line of title (e.g., as described in a recorded deed) and how it relates to the line of occupation or possession. Ideally, these two lines coincide, but they often don't. Surveys are performed for a variety of reasons (e.g., mortgages, construction, litigation) that determine the requirements for conducting the survey.

In Indiana the requirements for conducting basic property surveys are described in 865 IAC 1-12. This Administrative Rule governs the acceptable procedures for completing these surveys and helps assure consistency in the determination and perpetuation of boundaries. This includes appropriate corner markers, drawing information, surveyor's reports, and recording of the completed surveys.

Title Companies and Lenders often need additional information in order to remove standard exceptions from a Title Insurance Policy and/or to provide additional coverage for commercial or industrial property. Land Title Surveys are often complex and provide more information regarding the tract of land than just the location of the boundary. These surveys are normally known as ALTA/ACSM Surveys because the requirements have been jointly prepared by the American Land Title Association (ALTA) and the American Congress on Surveying and Mapping (ACSM).

Neither one of these surveys should be confused with a Surveyor's Location Report. These reports are governed by 865 IAC 1-12 (Sec 27-29) and are defined as "designed for use by a title insurance company with loan policies on small tracts containing a one (1) to four (4) family house even if now used for commercial purposes." Only the description for the subject tract is used, no corner markers are set, size and location of improvements (e.g., buildings, drives, fences, etc.) are shown in relationship to any monuments which may have been found. The uncertainty of location is one (1) foot for platted subdivisions and two (2) feet for small unplatted tracts.

As always, please give us a call if you would like further clarification.

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# DABEC DIGEST

volume 1, issue 11 november, 2002


# WHAT IS A DESIGN LOAD?

Structural Engineers determine the required strength of building members, but they must also determine the required loads to apply to the members. Structural engineers tend to think of the design loads in two groups: (1) the loads which are always present, and (2) the loads which are possible to move or change. For example, we will assume that the reader is sitting in a multistory office building. As you look around, you can see ceiling tiles and lights, carpet, and walls. These are loads which are not likely to change and are called "dead loads"; also included as dead loads would be the concrete floor and bar joists supporting the 2nd floor as well as the items which you may not be able to see, such as ceiling lighting in the first floor, insulation, and even the air-conditioning ductwork which hangs from the second floor joists.

If you look again, you may see items on desks and tables such as books, file cabinets, and computers. All of these items are considered as "live loads", because they can move or change throughout the life of the building. If you were to weigh all of these items and average them based on the area of your office, you can find your actual office live load. However you and I both know that tomorrow, someone will bring in more paperwork for you and your average will go up. Keeping this in mind, the codes have given loads which try to maintain a safe design. The usual design floor live load for an office building is 50 pounds per square foot (psf). This means that the design required by the code should consider the possibility of each square foot of floor having 50 lbs on it. In the real world, there may be a few spots in your office which exceed the 50 psf loading, but the average should be less than this value. Once the total loading information has been determined, the structural engineer will then design a floor system capable of carrying the total load. Parts to be designed will include all of the items carrying loads all the way to the ground. The floor deck rests on joists; the joists rest on beams. The beams rest on columns; the columns sit on footings. The footings transfer the loads to the ground. Obviously this is a simplified summary, because the roof and additional upper floors will need to be added to the loads, and connections and details also need to be designed, but the ideas remain the same.

This concept is called the "load path" approach; the design needs to check all of the items in the path of the load, from the point where the loads are applied to the point where the loads are resisted by the ground. Additional items which need to be considered are wind, snow, earthquakes, groundwater pressure, vehicular impact, concentrated loads, as well as certain construction activities, vibration, and deflections. The structural engineer will keep all of these items in mind when determining the required loads in order to design a safe structure.

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## LOADING RATE TERMS

Loads used in example floor load calculations:

**Dead Loads** -
- Steel joists - 3 psf
- Concrete floor- 36 psf
- Ceiling tile - 2 psf
- Insulation - 3 psf
- Mechanical ductwork- 4 psf
- Lighting - 2 psf

**Live Loads**-
- Office use - 50 psf floors

**Other common design live loads:**

NE Indiana Snow- 30 psf
Construction - 20 psf
Ceilings - 10 psf

**Floor Loads:**
- Exit Corridors - 100 psf
- Storage (Resid) - 40 psf
- Storage (Comm) - 125 psf
- Storage (Indust) - 250 psf
- Assembly Areas- 100 psf
- Manufacturing (Lt)- 75 psf
- Manufacturing (Hv)-125psf

If a column carries 200 sf of floor load at a total load of 100 psf, then the column will be required to safely carry 100 psf * 200 sf = 20,000 lbs

(1 kilopound, abbreviated as kip= 1,000 pounds)
20,000 lbs = 20 kips

If this same column is required to also carry roof loads of 12 kips, then the total required strength of the column will be 20 + 12 = 32 kips.

## potpourri

Congratulations go out to: Last Month's Coffee Mug Winners:

Sheri Auld
Keith Hood
Lisa Ramos

**This Issue's Quiz:**

**1) True or False:**

**PSF stands for Proper Structural Footing.**

**2) True or False:**

**The Design Load for a Structure equals the average loading for that structure.**

**3) True or False:**

**The foundation is typically above ground.**

**4) True or False**

**A example of a dead load is a plant which has not been watered.**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by November 30, 2002 for a chance to win valuable DABEC Merchandise.**

# STRUCTURAL TERM DEFINITIONS

We use structures everyday. From our homes to our offices, and even during the drive from our homes to our offices. In this article, we want to clearly define some frequently misused and misunderstood terms of structural engineering.

Structural engineering is itself somewhat misunderstood. A structural engineer is charged with designing physical structures (generally stationary) for use by the public that protect the safety and welfare of the public. These structures include but are not limited to: bridges, foundations, floor systems, walls, ceilings, retaining walls, roof systems, support systems, structural dams, crane rails, etc. Structural engineers were even involved with the frame design of the car you drove to work. You can imagine what might happen if the items included on that list were just thrown together and not designed for safety in their use.

We are going to discuss some of the structural terms associated with a building project, since that is the type of structure most people deal with everyday. The portion of the building that is in contact with the ground is generally called the foundation. Foundations are typically composed of footings. A footing (commonly referred to as a "footer" by contractors) is the widened area of concrete beneath a column or wall that transfers loads to the ground below. The purpose of the footing is to spread out the structure's loads over enough soil so that the soil can safely carry the load without undesirable settlement.

The superstructure is typically the portion of the structure above the ground line such as columns, walls, beams, and joists. The columns (also referred to as posts) and/or walls are usually vertical elements attached to the foundation to assist in supporting the upper portions of the building. The beams and joists, usually horizontal members, combine with some form of a deck to create the upper floors and roof elements. (The term "member" is commonly used to refer to main parts of the structure.)

The structural engineer designs the above mentioned items to find the most economical solution that can withstand the design loads that are appropriate for the specified use and location. It has been said that the job of the engineer is to do with one dollar what anyone could do with two. We will continue this exploration of structural terms in a later issue. Please contact us if you need clarification, or if we can assist you with a particular project.

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# DABEC DIGEST

volume 1, issue 12 december, 2002


# STORM WATER PHASE II- FINAL RULE

If you aren't familiar with the legislation that shares the title of this article, you're not alone. The Environmental Protection Agency (EPA) developed Phase II in their continuing efforts to preserve, protect, and improve the Nation's water resources from polluted storm water runoff.

Current EPA efforts to improve water quality began legislatively with the Clean Water Act (CWA) of 1972. The CWA gave the EPA the authority to regulate and enforce the clean-up of surface waters in the USA. Obviously, that is a very large task, with many facets. For the purposes of this article, we are going to discuss just two of the Rules promulgated recently under the authority of the CWA. The first one is Phase I.

Phase I was implemented on the Federal level in 1990. Under Phase I, a National Pollutant Discharge Elimination System (NPDES) permit is required for storm water runoff from: 1) municipal separate storm sewer systems (MS4s) generally serving populations over 100,000 2) constructing activity disturbing 5 acres or more, and 3) ten categories of industrial activity.

Phase II was finalized on the Federal level in December, 1999. Under Phase II, an NPDES Permit is required for storm water runoff from: 1) MS4s generally serving populations over 10,000 and 2) construction activity disturbing 1 acre or more. Phase II also revises and implements the "No Exposure" exclusion for all categories of Phase I regulated industrial activity.

You may be wondering why we are discussing this Rule now, since it was promulgated on the Federal level three years ago. Here's why: The EPA has local permitting authorities that handle the individual permitting process on a state or regional level throughout most of the country. In Indiana that local permitting agency is the Indiana Department of Environmental Management (IDEM). Because of the time intensive process required in Indiana to implement Rules of this nature, the final Rule has not been officially promulgated here. IDEM is expecting to have Rule 13 (MS4s) and updates to Rule 5 (Erosion Control Plan) and Rule 6 (Industrial) in place early next year. When Rule 13 is finally passed, the MS4s that IDEM has identified as falling under the jurisdiction of the Rule will have to begin the procedure of securing an NPDES Permit for their storm water runoff. (The MS4 list can be viewed on the internet at www.in.gov/idem/water/compbr/wetwthr/storm/rule13criteria.html.)

The process of securing the NPDES Permit from IDEM begins with the Notice of Intent (NOI) and Storm Water Quality Management Plan (SWQMP) Part A: Initial Application being filed with IDEM within 90 days of the Rule's effective date. Part B: Baseline Characterization of the SWQMP must be filed within 6 months after the NOI submittal. SWQMP Part C: Program Implementation (usually includes new local ordinances) must be completed within 1 year after the NOI submittal. As you can see from this list, a significant amount of work must be completed rapidly after Rule 13's effective date. We will discuss the primary parts of the SWQMP on the reverse side.

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## HOW DO WE PAY FOR ALL THIS WORK?

The EPA passed Phase II as an "unfunded mandate", which simply means there are no federal dollars available for implementation of this program. Therefore, the money to implement and maintain the SWQMP will have to come from within already budgeted funds, bonds, or possibly grants.

The EPA did allow for "joint ventures" to be formed in complying with this Rule. That means that adjacent municipalities have the opportunity to work together under the umbrella of a joint SWQMP. Additionally, some communities may already have a governmental agency that handles part of the six MCMs. In that case, the agency that is already doing the work can continue to do so, and a totally new process may not be required.

## I NEED MORE INFO

If you are interested in attending a locally held one or two day seminar utilizing IDEM personnel to go into more detail on this Rule, please contact us for more information.

## I NEED SOME HELP

If you need help completing the documentation, NOI, SWQMP, or mapping your storm sewer system, contact us. We will be glad to provide whatever assistance you might require.

## potpourri

Information contained in this newsletter was taken from the IDEM's and EPA's website at: www.in.gov/idem/water/compbr/wetwthr/storm/index.html and www.epa.gov/own/sw/phase2 and from IDEM publications.

**This Issue's Quiz:**

**1) True or False:**

**MCM stands for Metro Coldwyn Mayer film company.**

**2) True or False:**

**SWQMP is an acronym for Storm Water Quality Management Program.**

**3) True or False:**

**The Federal Phase II regulations require urbanized areas to have an NPDES permit for their storm water discharge.**

**4) True or False**

**Federal funds are available for communities to use in order to comply with this mandate.**

**Fax or email your answers to Brian at D. A. Brown Engineering Consultants by December 31, 2002 for a chance to win valuable DABEC Merchandise.**

# RULE 13-HIGHLIGHTS AND DELIVERABLES

"Rule 13" is the verbal abbreviation for 327 IAC 15-13, part of the Indiana Administrative Code. Rule 13 is expected to pass in early 2003, which will start the clock for applications to IDEM for permits under the EPA's Storm Water Phase II. (See other side for explanation.)

The application process has several key milestones that must be met to obtain and then maintain the general permit.

First of all, the NOI must be filed with IDEM within 90 days of the Rule 13 effective date. Forms for the NOI letter can be secured from IDEM after Rule 13 officially passes. The SWQMP must also be filed with IDEM within 90 days of the Rule's effective date. The SWQMP has six primary sub-sections (called Minimum Control Measures (MCM)) which are as follows: 1) Public Education and Outreach, 2) Public Involvement/Participation, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Storm Water Run-off Control, 5) Post-Construction Storm Water Management, and 6) Pollution Prevention/ Good Housekeeping.

Secondly, six months after submission of the NOI and SWQMP, a baseline characterization of the water quality conditions within the MS4 must be delivered to IDEM. This characterization will include: receiving waters, land usages and current Best Management Practices (BMP), Identification of Sensitive and Problem Areas, Review Existing Water Data, and targeted BMP selection.

Thirdly, one year after the initial NOI and SWQMP submission, a Program Implementation Report is due to IDEM. This report will contain: evaluation of existing BMPs, program description for each MCM, implementation timetable, on-going characterization schedule, map showing MS4 boundaries, estimation of linear feet of conveyance, allowable BMPs, identify BMP criteria and standards, budget amounts, define measurable goals, completed certification forms and identify programmatic indicators.

The NPDES permit life is five years. Within that five years additional major milestones will be tracked, such as: 1st year-Local ordinances completed for construction and illicit discharges, 2nd year-ordinance for post construction controls and continued mapping of the storm system (25% each year after year one.)

Annual reports will also be required through the life of the first permit term. These reports will contain information on: monthly construction site summaries, measurable goal progress, programmatic indicators, self-assessment and on-going characterization data, and any complaints.

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