Lecture Notes

Course Number: PE Exam Review - Civil Engineering
Instructor: Russell Briggs, PE
Lecture Number: 04 Water Resources & Environmental 01
P.E. Review

Water Resources & Environmental
• Introduction
• Expectations of this review
• How many problems do you need to know to pass?
• The one page in Lindeburg that you need to know
• Topics we will cover
Russell Briggs, P.E.

BSCE, MSCE    NC State

P.E. Registration No. 11889 (1984)

Current Registration #s are 39000+

> 2/3 of all PE registrations ever conferred after 1984.

Principal in B&F Consulting.

I use the material from this review daily.
• Introduction

• Expectations of this review

• How many problems do you need to know to pass?

• The one page in Lindeburg that you need to know

• Topics we will cover
What this course is:

A review of Water Resources & Environmental

A means to prepare by illustrating typical problems you may encounter.

What this course isn’t:

A high school algebra class

A means to show every problem you may see on the exam.

An exhaustive treatment of the topics selected that we will review.
• Introduction & Contact information
• Expectations of this review
• How many problems do you need to know to pass?
• The one page in Lindeburg that you need to know
• Topics we will cover
Passing Rate is +/- 70%

80 Problems, means you must score correctly on 
70% x 80 = 56 Problems

Multiple choice, so if you “know” 48 problems, and 
guess on the remaining 32, you should score correctly 
48 + (25% X 32) = 56 Problems

Then, actually, 48/80, or 60% is the number of problems you must “know”.

Strategy: get all the morning problems, then, after you do 8 problems in the afternoon, you can leave early... say around 2 p.m.
How many problems would a 1st grader score correctly?
20 out of 80

Correct from guessing 8
First-grader score 20
“4 years of experience & 
16 years of education” 28

\[ \underline{56} \]

The State of North Carolina will confer upon you the title of Professional Engineer if you “know” 28 more problems than a first-grader answers correctly on an 80 problem test.
• Introduction
• Expectations of this review
• How many problems do you need to know to pass?
• The one page in Lindeburg you must know
• Topics we will cover
processing of wastewater, the municipality accepts responsibility for final treatment and disposal. The manufacturing plant may be required to pretreat the wastewater and equalize flow by holding it in a basin for stabilization prior to discharge to the sewer.

Uncontaminated streams (e.g., cooling water), in many cases, can be discharged into sewers directly. However, pretreatment at the industrial site is required for wastewaters having strengths and/or characteristics significantly different from sanitary wastewater.

To minimize the impact on the sewage treatment plant, consideration is given to modifications in industrial processes, segregation of wastes, flow equalization, and waste strength reduction. Modern industrial/manufacturing processes require segregation of separate waste streams for individual pretreatment, controlled mixing, and/or separate disposal. Process changes, equipment modifications, by-product recovery, and in-plant wastewater reuse can result in cost savings for both water supply and wastewater treatment.

Toxic waste streams are not generally accepted into the municipal treatment plant at all. Toxic substances require appropriate pretreatment prior to disposal by other means.

3. MUNICIPAL WASTEWATER

Municipal wastewater is the general name given to the liquid collected in sanitary sewers and routed to municipal sewage treatment plants. Many older cities have combined sewer systems where storm water and sanitary wastewaters are collected in the same lines. The combined flows are conveyed to the treatment plant for processing during dry weather. During wet weather, when the combined flow exceeds the plant's treatment capacity, the excess flow often bypasses the plant and is discharged directly into the watercourse.

4. WASTEWATER QUANTITY

Approximately 70 to 80% of a community's domestic and industrial water supply returns as wastewater. This water is discharged into the sewer system, which may or may not also function as storm drains. Therefore, the nature of the return system must be known before sewage can occur.

Infiltration, due to cracks and poor joints in old or broken lines, can increase the sewer flow significantly. Infiltration per mile (kilometer) per in (mm) of pipe diameter is limited by some municipal codes to 500 gpd/mi-in (56 Lpc/km-mm)

Modern piping materials and joints easily reduce the infiltration to 200 gpd/mi-in (13 Lpc/km-mm) and below. Infiltration can also be roughly estimated as 3 to 6% of the peak hourly domestic rate or as 10% of the average rate.

Inflow is another contributor to the flow in sewers. Inflow is water discharged into a sewer system from such sources as roof downspouts, yard and area drains, parking area catch basins, curb inlets, and holes in manhole covers.

Sanitary sewer sizing is commonly based on an assumed average of 100 to 125 gpcd (350 to 474 Lpcd). There will be variations in the flow over time, although the variations are not as pronounced as they are for water supply. Hourly variations are the most significant. The flow rate pattern is essentially the same from day to day. Weekend flow patterns are not significantly different from weekday flow patterns. Seasonal variation depends on the location, local industries, and altitude.

Table 28.1 lists typical variations in wastewater flows typical time location variation

<table>
<thead>
<tr>
<th>Flow description</th>
<th>Typical time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average</td>
<td>10 to 12 A.M.</td>
<td>Treatment plant</td>
</tr>
<tr>
<td>Daily peak</td>
<td>12 A.M.</td>
<td>Outside</td>
</tr>
<tr>
<td>Daily minimum</td>
<td>4 to 5 A.M.</td>
<td>Treatment plant</td>
</tr>
<tr>
<td>Seasonal average</td>
<td>May, June</td>
<td>Inside</td>
</tr>
<tr>
<td>Seasonal peak</td>
<td>Late summer</td>
<td>Outside</td>
</tr>
<tr>
<td>Seasonal minimum</td>
<td>Late winter</td>
<td>Inside</td>
</tr>
</tbody>
</table>

For recommended standards for sewage works ('Ten States Standards,' abbreviated TSS) specifies that new sanitary sewer systems should be designed for an average flow of 100 gpcd (350 Lpcd) or 0.03 cfs/day, which includes an allowance for normal infiltration (TSS Sec. 11.24). However, the sewer pipe must be sized to carry the peak flow as a gravity flow. In the absence of any study or other justifiable methods, the ratio of peak hourly flow to average flow should be calculated from the following relationship in which F is the population served in thousands of people at a particular point in the network.

\[
\frac{Q_{peak}}{Q_{ave}} = \frac{15 - \sqrt{F}}{4 + \sqrt{F}}
\]

Collector systems (i.e., collector sewer, trunk, or mains) are pipes that collect wastewater from individual sources and carry it to interceptors (see Fig. 28.1). Collector lines must be designed to handle the maximum hourly flow, including domestic and infiltration, as well as additional discharge from industrial plants nearby. Peak flows of 400 gpcd (1500 Lpcd) for laterals and submains flowing full and 250 gpcd (900 Lpcd) for main, trunk, and outlet sewers can be assumed for design purposes, making the peak factors approximately 4.0 and 2.5 for
The Engineer sees:
3. MUNICIPAL WASTEWATER

Another bunch of words, and more words following that. Words words words. Words to the right of me, words to the left of me. More words. Words, words words. Words, words words. Words here, words there... When will all these words quit?? More words and more words.

4. WASTEWATER QUANTITY

Another bunch of words, and more words following that. Words words words. Words to the right of me, words to the left of me. More words. Words, words words. Words, words words. Words here, words there... When will all these words quit?? More words and more words.

<table>
<thead>
<tr>
<th>Method</th>
<th>Typical Rise</th>
<th>Location</th>
<th>Typical Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average</td>
<td>0.51 ft/day</td>
<td>codebook</td>
<td>10%</td>
</tr>
<tr>
<td>Daily peak</td>
<td>1.0 ft/day</td>
<td>codebook</td>
<td>25%</td>
</tr>
<tr>
<td>Daily minimum</td>
<td>0.0 ft/day</td>
<td>codebook</td>
<td>5%</td>
</tr>
<tr>
<td>Weekly average</td>
<td>1.25 ft/day</td>
<td>codebook</td>
<td>10%</td>
</tr>
<tr>
<td>Weekly peak</td>
<td>2.5 ft/day</td>
<td>codebook</td>
<td>25%</td>
</tr>
<tr>
<td>Weekly minimum</td>
<td>0.25 ft/day</td>
<td>codebook</td>
<td>5%</td>
</tr>
</tbody>
</table>

Back to the boring words... more and more words. They never end!! Words and words and words. Lots and lots of words. Words here, words there.

Another bunch of words, and more words following that. Words words words. Words, words words. Words to the right of me, words to the left of me. More words. Words, words words.
The Test-Maker sees:
processing of wastewater, the municipality accepts responsibility for final treatment and disposal. The manufacturing plant may be required to pretreat the wastewater and equalize flow by holding it in a basin for stabilization prior to discharge to the sewer.

Uncontaminated streams (e.g., cooling water), in many cases, can be discharged into sewers directly. However, pretreatment at the industrial site is required for wastewaters having strengths and/or characteristics significantly different from sanitary wastewater.

To minimize the impact on the sewage treatment plant, consideration is given to modifications in industrial processes, segregation of weaker, flow equilibrium, and waste strength reduction. Modern industrial/manufacturing processes require segregation of separate waste streams for individual pretreatment, controlled mixing, and/or separate disposal. Process changes, equipment modifications, by-product recovery, and limited wastewater usage can result in cost savings for both water supply and wastewater treatment.

Toxic waste streams are not generally accepted into the municipal treatment plant at all. Toxic substances require appropriate pretreatment prior to disposal by other means.

3. MUNICIPAL WASTEWATER

Municipal wastewater is the general name given to the liquid collected in sanitary sewers and routed to the municipal sewage treatment plants. Many older cities have combined sewer systems whose storm water and sanitary wastewaters are collected in the same lines. The combined flows are conveyed to the treatment plants for processing during dry weather. During wet weather, when the combined sewer plant capacity is exceeded, the excess flow often bypasses the plant and is discharged directly into the watershed.

4. WASTEWATER QUANTITY

Approximately 70 to 80% of a community's domestic and industrial wastewater returns as wastewater. This wastewater is discharged into the sewer system, which may or may not also function as storm drainage. Therefore, the volume of the return system must be known before design can commence.

Infiltration, due to cracks and poor joints in old or broken lines, can increase the sewer flow significantly. Infiltration per mile (kilometer) per in (mm) of pipe diameter is limited by some municipal codes to 500 gpd/mi (46 Lpd/km-m). Modern piping materials and joints easily reduce the infiltration to 200 gpd/mi (13 Lpd/km-m) and below. Infiltration can also be roughly estimated as 2 to 5% of the peak hourly domestic rate or as 20% of the average rate.

Jog flow is another contributor to the flow in sewers. Jog flow is water discharged into a sewer system from such sources as roof downspouts, yard and area drainage, packing area catch basins, mock inlets, and leaks in multiple covers.

Sanitary sewer aging is commonly based on an assumed average of 100 to 125 gpd/mi (380 to 474 Lpd/km). There will be variations in the flow over time, although the variations are not as pronounced as they are for wastewater. Daily variations are the most significant. The flow rate pattern is essentially the same from day to day. Weekend flow patterns are not significantly different from weekday flow patterns. Seasonal variation depends on the location, local industries, and infiltration.

Table 38.1 lists peaking factors (i.e., peak multipliers) for treatment plant influent volume. Due to storage in ponds, clarifiers, and sedimentation basins, these multipliers are not applicable to all processes in the treatment plant.

| Table 38.1 Typical Variations in Wastewater Flows (based on average daily flow) |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Flow Description | Typical Time | Location | Variation |
| Daily Average | 10 to 12 A.M. | Treatment Plant | 100% |
| Daily Peak | 12 A.M. | Influent | 250% |
| Daily Minimum | 4 to 5 A.M. | Treatment Plant | 40% |
| Seasonal Average | May, June | Year | 100% |
| Seasonal Peak | Late Summer | Year | 120% |
| Seasonal Minimum | Late Winter | Year | 50% |

Recommended Standards for Sewage Works ("The States' Standards," abbreviated TSSS) specifies that new sanitary sewer systems should be designed for an average flow of 100 gpd/mi (380 Lpd/km) or 0.35 m³/day, which includes an allowance for normal infiltration (TSS, Sec. 11.24). However, the sewer pipe must be sized to carry the peak flow as a gravity flow. In the absence of any studies or other justifiable methods, the ratio of peak hourly flow to average flow should be calculated from the following relationship in which P is the population served in thousands of people at a particular point in the network:

\[Q_{peak} = 18 \times \sqrt{P} \]

Collectors (i.e., collector sewers, trunk or main) are pipes that collect wastewater from individual sources and carry it to interceptors (see Fig. 28.1). Collectors must be designed to handle the maximum hourly flow, including domestic and infiltration, as well as additional discharge from industrial plants nearby. Peak flows of 400 gpd (1500 Lpd) for laterals and sub mains flowing full and 800 gpd (3000 Lpd) for main, trunk, and influent sewer can be assumed for design purposes, making the peaking factors approximately 4.0 and 2.5 for
A Municipality has an aggressive infiltration and inflow program that minimizes stormwater and groundwater flow into the sewer system. Therefore, what is the most likely size of a wastewater treatment plant for a municipality that has a 2 MGD water treatment plan?

a) 1.0 MGD      c) 2.0 MGD
b) 1.4 MGD      d) 2.8 MGD
processing of wastewater, the municipality accepts responsibility for final treatment and disposal. The manufacturing plant may be required to pretreat the wastewater and equalize flow by holding it in a basin for stabilization prior to discharge to the sewer.

Uncontaminated streams (e.g., cooling water), in many cases, can be discharged into sewers directly. However, pretreatment at the industrial site is required for wastewaters having strengths and/or characteristics significantly different from sanitary wastewaters.

To minimize the impact on the sewage treatment plant, consideration is given to modifications in industrial processes, segregation of wastes, flow equalization, and waste strength reduction. Modern industrial/manufacturing processes require segregation of separate wastewater streams for individual pretreatment, controlled mixing, and/or separate disposal. Process changes, equipment modifications, by-product recovery, and in-plant wastewater reuse can result in cost savings for both water supply and wastewater treatment.

Toxic waste streams are not generally accepted into the municipal treatment plant at all. Toxic substances require appropriate pretreatment prior to disposal by other means.

3. MUNICIPAL WASTEWATER

Municipal wastewater is the general name given to the liquid collected in sanitary sewers and routed to municipal sewage treatment plants. Many older cities have combined sewer systems whose storm water and sanitary wastewaters are collected in the same lines. The combined flows are conveyed to the treatment plant for processing during dry weather. During wet weather, when the combined flow exceeds the plant's treatment capacity, the excess flow overbypasses the plant and is discharged directly into the watercourse.

4. WASTEWATER QUANTITY

Approximately 70 to 80% of a community's domestic and industrial water supply returns as wastewater. This water is discharged into the sewer systems, which may or may not also function as storm drains. Therefore, the nature of the return system must be known before strong consent can be obtained.

Infiltration, due to cracks and poor joints in old or broken lines, can increase the sewer flow significantly. Infiltration per mile (kilometer) per in (mm) of pipe diameter is limited by some municipal codes to 500 gpd/1000 ft (6 lps/km-km). Modern piping materials and joints easily reduce the infiltration to 200 gpd/1000 ft (3 lps/km-km) and below. Infiltration can also be roughly estimated as 3 to 6% of the peak hourly domestic rate or as 20% of the average rate.

Inflow is another contributor to the flow in sewers. Inflow is water discharged into a sewer system from such sources as roof downspouts, yard and area drains, packing area, catch basins, curb inlets, and holes in manhole covers.

Sanitary sewer sizing is commonly based on an assumed average of 100 to 125 gpd (380 to 474 lps) per capita. There will be variations in the flow over time, although these variations are not as pronounced as they are for water supply. Hourly variations are the most significant. The flow rate pattern is essentially the same from day to day. Weekend flow patterns are not significantly different from weekday flow patterns. Seasonal variation depends on the location, local industries, and infiltration.

Table 38.1 lists peak factors (i.e., peak multipliers) for treatment plant influent volumes. Due to storage in ponds, clarifiers, and sedimentation basins, these multipliers are not applicable throughout all processes in the treatment plant.

Table 38.1 Typical Variations in Wastewater Flows (based on average daily flow)

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<thead>
<tr>
<th>Flow Description</th>
<th>Typical Time</th>
<th>Location</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Average</td>
<td>10 to 12 A.M.</td>
<td>Treatment Plant</td>
<td>22%</td>
</tr>
<tr>
<td>Daily Peak</td>
<td>12 A.M.</td>
<td>Untreated</td>
<td>150%</td>
</tr>
<tr>
<td>Daily Minimum</td>
<td>4 to 5 P.M.</td>
<td>Treatment Plant</td>
<td>5%</td>
</tr>
<tr>
<td>Seasonal Average</td>
<td>May, June</td>
<td>Untreated</td>
<td>120%</td>
</tr>
<tr>
<td>Seasonal Peak</td>
<td>May, June</td>
<td>Untreated</td>
<td>100%</td>
</tr>
<tr>
<td>Seasonal Minimum</td>
<td>May, June</td>
<td>Untreated</td>
<td>90%</td>
</tr>
</tbody>
</table>

Recommended Standards for Sewage Works ("The States' Standards", abbreviated TSS) specifies that new sanitary sewer systems should be designed for an average flow of 100 gpd (380 lps) or 0.38 m³/day, which includes an allowance for normal infiltration (TSS Sec. 11.24). However, the sewer pipe must be able to carry the peak flow as a gravity flow. In the absence of any studies or other justifiable methods, the ratio of peak hourly flow to average flow should be calculated from the following relationship in which F is the population served in thousands of people at a particular point in the network:

$$ Q_{peak} = \frac{180 - \sqrt{F}}{4 + \sqrt{F}} $$

Collectors (i.e., collector sewers, trunk sewers, or mains) are pipes that collect wastewater from individual houses and carry it to interceptors (see Fig. 28.1). Collectors must be designed to handle the maximum hourly flow, including domestic and infiltration, as well as additional discharge from industrial plants nearby. Peak flows of 400 gpd (1500 lps) for lateral and sub-branches flowing full and 200 gpd (750 lps) for main, trunk, and outfall sewers can be assumed for design purposes, making the peak factors approximately 4.0 and 2.5 for...
A Municipality has an aggressive infiltration and inflow program that minimizes stormwater and groundwater flow into the sewer system. Therefore, what is the most likely size of a wastewater treatment plant for a municipality that has a 2 MGD water treatment plan?

2 MGD Water Treatment X 75% return
= 1.5 MGD Wastewater Treatment
What is the best estimate, in MGD, of sewer flow for new development for 2300 people?

a) 0.2 MGD  

b) 0.5 MGD

c) 0.1 MGD

d) 0.8 MGD
processing of wastewater, the municipality accepts responsibility for final treatment and disposal. The manufacturing plant may be required to pretreat the wastewater and equalize flow by holding it in a basin for stabilization prior to discharge to the sewer.

Uncontaminated streams (e.g., cooling water), in many cases, can be discharged into sewers directly. However, pretreatment at the industrial site is required for wastewaters having strengths and/or characteristics significantly different from sanitary wastewater.

To minimize the impact on the sewage treatment plant, consideration is given to modifications in industrial processes, segregation of weaker, flow equalization, and waste strength reduction. Modern industrial/manufacturing processes require segregation of separate waste streams for individual pretreatment, controlled mixing, and/or separate disposal. Process changes, equipment modifications, by-product recovery, and in-plant wastewater usage can result in cost savings for both water supply and wastewater treatment.

Toxic waste streams are not generally accepted into the municipal treatment plant at all. Toxic substances require appropriate pretreatment prior to disposal by other means.

3. MUNICIPAL WASTEWATER

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4. WASTEWATER QUANTITY

Approximately 70 to 80% of a community's domestic and industrial water supply returns as wastewater. This water is discharged into the sewer systems, which may or may not also function as storm drainage. Therefore, the nature of the return system must be known before storm can be determined.

Infiltration, due to cracks and poor joints in old or broken lines, can increase the sewer flow significantly. Infiltration per mile (kilometer) per in (mm) of pipe diameter is limited by some municipal codes to 300 gpd/m (46 Ldp/m) (46 L/s/km). Modern piping materials and joints easily reduce the infiltration to 200 gpd/m (31.5 Lpdr/m) and below. Infiltration can also be roughly estimated as 3 to 6% of the peak hourly domestic rate or as 10% of the average rate.

Inflow is another contributor to the flow in sewers. Inflow is water discharged into a sewer system from such sources as roof downspouts, yard and area drainage, packing area catch basins, catch ponds, and losses in multiple sewers.

Sanitary sewer aging is commonly based on an assumed annual average of 100 to 125 gpd (380 to 747 Lpd). There will be variations in the flow over time, although the variations are not as pronounced as they are for water supply. Monthly variations are the most significant. The flow rate pattern is essentially the same from day to day. Weekend-flow patterns are not significantly different from weekday flow patterns. Seasonal variation depends on the location, local industries, and infiltration.

Table 28.1 lists peak factors (i.e., peak multipliers) for treatment plant influent volumes. Due to storage in ponds, clarifiers, and sedimentation basins, these multipliers are not applicable to all processes in the treatment plant.

Table 28.1: Typical Variations in Wastewater Flows (Based on Average Daily Flow)

<table>
<thead>
<tr>
<th>Flow Description</th>
<th>Typical Time</th>
<th>Location</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Average</td>
<td>7 a.m. - 11 a.m.</td>
<td>Treatment Plant</td>
<td>100%</td>
</tr>
<tr>
<td>Daily Peak</td>
<td>4 p.m. - 6 p.m.</td>
<td>Peak Flow</td>
<td>125%</td>
</tr>
<tr>
<td>Daily Minimum</td>
<td>4 a.m. - 6 a.m.</td>
<td>Minimum Flow</td>
<td>100%</td>
</tr>
<tr>
<td>Seasonal Average</td>
<td>May, June</td>
<td>Overall</td>
<td>100%</td>
</tr>
<tr>
<td>Seasonal Peak</td>
<td>May, June</td>
<td>Peak Flow</td>
<td>125%</td>
</tr>
<tr>
<td>Seasonal Minimum</td>
<td>May, June</td>
<td>Minimum Flow</td>
<td>25%</td>
</tr>
</tbody>
</table>

Recommended Standards for Sewage Works ("The States' Standards," abbreviated TSS) specify that new sanitary sewer systems should be designed for an average flow of 100 gpd (380 Lpd) or 0.85 m³/day), which includes an allowance for normal infiltration (TSS Sec. 11.24). However, the sewer pipe must be sized to carry the peak flow as a gravity flow. In the absence of any studies or other justifiable methods, the ratio of peak hourly flow to average flow should be calculated from the following relationship in which P is the population served in thousands of people at a particular point in the network:

\[
C_{peak} = \frac{C_{avg}}{1 + \sqrt{P}}
\]

Collection systems (i.e., collector sewers, trunk sewers, or mains) are pipes that conduct wastewater from individual sources and carry it to interceptors (see Fig. 28.1). Collector systems must be designed to handle the maximum hourly flow, including domestic and infiltration, as well as additional discharge from industrial plants. Peak flows of 400 gpd (1500 Lpd) for laterals and submersible flows full and 250 gpd (950 Lpd) for main, trunk, and outfall sewers can be assumed for design purposes, making the peak factors approximately 4.0 and 2.5 for
What is the best estimate, in MGD, of sewer flow for new development for 2300 people?

a) 0.2 MGD  c) 0.1 MGD
b) 0.5 MGD  d) 0.8 MGD

2300 people X 100 gpd/person = 230,000 gpd
= 0.23 MGD
• Combined sewer systems occur most often in
  
a) Planned developments
b) Older cities
c) California
d) Rural counties
processing of wastewater, the municipality accepts responsibility for final treatment and disposal. The manufacturing plant may be required to pretreat the wastewater and equalize flow by holding it in a basin for stabilization prior to discharge to the sewer.

Uncontaminated streams (e.g., cooling water), in many cases, can be discharged into sewers directly. However, pretreatment of industrial waste is required for wastewaters having strengths and/or characteristics significantly different from sanitary wastewater.

To minimize the impact on the sewage treatment plant, consideration is given to modifications in industrial processes, segregation of wastes, flow equalization, and waste strength reduction. Modern industrial/manufacturing processes require segregation of separate waste streams for individual pretreatment, controlled mixing, and/or separate disposal. Process changes, equipment modifications, by-product recovery, and in-plant wastewater usage can result in cost savings for both water supply and wastewater treatment.

Toxic waste streams are not generally accepted into the municipal treatment plant at all. Toxic substances require appropriate pretreatment prior to disposal by other means.

3. MUNICIPAL WASTEWATER

Municipal wastewater is the general name given to the liquid collected in sanitary sewers and routed to municipal sewage treatment plants. Many older cities have combined sewer systems whose storm water and sanitary wastewater are collected in the same lines. The combined flows are conveyed to the treatment plant for processing during dry weather. During weather, when the combined sewer plant's treatment capacity is exceeded, the excess flow overflows bypasses the plant and is discharged directly into the watercourse.

4. WASTEWATER QUANTITY

Approximately 70 to 80% of a community's domestic and industrial water supply returns as wastewater. This water is discharged into the sewer systems, which may or may not also function as storm drain. Therefore, the nature of the return system must be known before storm can occur.

Infiltration, due to cracks and poor joints in old or broken lines, can increase the sewer flow significantly. Infiltration per mile (kilometers) per in (mm) of pipe diameter is limited by some municipal codes to 500 gpd/m²-in (6 Lpd/m²-mm) for concrete pipe and joints and 120 gpd/m²-in (15 Lpd/m²-mm) for below. Infiltration can also be roughly estimated at 3 to 5% of the peak hourly domestic rate or as 20% of the average rate.

Inflow is another contributor to the flow in sewers. Inflow is water discharged into a sewer system from such sources as roof downspouts, yard and well drainage, packing area catch basins, curb inlets, and holes in manhole covers.

Sanitary sewer aging is commonly based on an assumed average of 100 to 125 gpd (250 to 350 Lpd). There will be variations in the flow over time, although the variations are not as pronounced as they are for water supply. Hourly variations are the most significant. The flow rate pattern is essentially the same from day to day. Weekend flow patterns are not significantly different from weekday flow patterns. Seasonal variation depends on the location, local industries, and infiltration.

Table 28.1 lists peak factors (i.e., peak multipliers) for treatment plant influent volume. Due to storage in ponds, clarifiers, and sedimentation basins, these multipliers are not applicable to processes in the treatment plant.

| Table 28.1 Typical Variations in Wastewater Flows (based on average daily flow) |
|---------------------------------|----------|----------|
| Flow description | typical time | location | variation |
| daily average | 10 to 12 A.M. | treatment plant | 20% |
| daily peak | 3 A.M. | overall | 20% |
| daily minimum | 3 to 5 A.M. | plant outlet | 40% |
| seasonal average | May, June | 100% |
| seasonal peak | late summer | 120% |
| seasonal minimum | late winter | 50% |

Recommended Standards for Sewage Works ("The States Standards," abbreviated TSS) specify that new sanitary sewer systems should be designed for an average flow of 100 gpd (250 Lpd) or 0.85 cfs (2.5 m³/day), which includes an allowance for normal infiltration (TSS Sec. 11-249). However, the sewer pipe must be sized to carry the peak flow as a gravity flow. In the absence of any standards or other justifiable methods, the ratio of peak hourly flow to average flow should be calculated from the following relationship in which P is the population served in thousands of people at a particular point in the network:

\[ F_{peak} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}} \]

Collector (i.e., collector sewers, leaders, or mains) are pipes that collect wastewater from individual properties and carry it to interceptors (see Fig. 28.1). Collector must be designed to handle the maximum hourly flow, including domestic and infiltration, as well as additional discharge from industrial plants nearby. Peak flows of 400 gpd (1,000 Lpd) for laterals and sub mains flowing full and 250 gpd (650 Lpd) for main, trunk, and outfall sewers can be assumed for design purposes, making the peaking factors approximately 4.0 and 2.5 for...
Combined sewer systems occur most often in:

a) Planned developments
b) Older cities
c) California
d) Rural counties
• Introduction
• Expectations of this review
• How many problems do you need to know to pass?
• The one page in Lindeburg you must know
• Topics we will cover
Civil Breath (AM) Exam
EIGHT Questions from
Water Resources and Environmental
including:

A. Hydraulics - Closed Conduit
B. Hydraulics - Open Channel
C. Hydrology
D. Wastewater Treatment
E. Water Treatment
A. Hydraulics - Closed Conduit

- Energy and/or Continuity Equation
- Pressure Conduit (e.g. force mains)
- Closed pipe flow equations
  - Hazen-Williams, Darcy-Weisbach
- Friction/Minor Losses
- Pipe network analysis
  - e.g. pipeline design, loop networks
- Pump application and analysis
Civil Breath (AM) Exam
EIGHT Questions from *Water Resources and Environmental* including:

A. Hydraulics - Closed Conduit
B. **Hydraulics - Open Channel**
C. Hydrology
D. Wastewater Treatment
E. Water Treatment
B. Hydraulics - Open Channel

- Open-channel flow (e.g. Manning’s eq.)
- Culvert design
- Spillway capacity
- Energy dissipation (hydraulic jump)
- Stormwater collection (inlets, gutter flow, street flow, storm sewer pipes)
- Flood plains/floodways
- Flow measurement - open channel
Civil Breath (AM) Exam

EIGHT Questions from *Water Resources and Environmental* including:

A. Hydraulics - Closed Conduit
B. Hydraulics - Open Channel
C. **Hydrology**
D. Wastewater Treatment
E. Water Treatment
C. Hydrology

- Storm characterization
- Storm frequency
- Hydrographs application
- Rainfall intensity, duration and frequency
- Time of concentration
- Runoff analysis (Rational & NRCS)
- Erosion
- Detention/retention ponds
Civil Breath (AM) Exam

EIGHT Questions from *Water Resources and Environmental* including:

A. Hydraulics - Closed Conduit
B. Hydraulics - Open Channel
C. Hydrology
D. **Wastewater Treatment**
E. Water Treatment
D. Wastewater Treatment

- Collection systems
  lift stations, sewer networks
infiltration and inflow
Civil Breath (AM) Exam

EIGHT Questions from *Water Resources and Environmental* including:

A. Hydraulics - Closed Conduit
B. Hydraulics - Open Channel
C. Hydrology
D. Wastewater Treatment
E. Water Treatment
E. Water Treatment

- Hydraulic loading
- Distribution system
Transportation Depth (PM) Exam

Ten Questions from Other Topics

A. Hydraulics
   - Flow measurement - closed conduits
   - Open channel, sub & supercritical flow

B. Hydrology
   - Hydrograph development & synthetic

C. Engineering properties of soils & materials

D. Soil mechanics analysis

E. Engineering Economics

F. Construction operations and methods
   - NPDES permitting

G. Temporary structures
Geotechnical Depth (PM) Exam

Five Questions from Other Topics

A. Groundwater and well fields
   - Well logging and subsurface properties
   - Aquifers
     - Groundwater flow (Darcy’s law)
   - Well analysis (steady flow only)
     - Groundwater control (drainage, deh20)

B. Loadings

C. Construction operations & methods

D. Temporary structures

E. Worker health, safety and environment
Structures Depth (PM) Exam

No Questions from *Water Resources & Environmental* topics
Water Resources & Environmental (PM) Exam

39 questions

A. Hydraulics - Closed Conduit
B. Hydraulics - Open Channel
C. Hydrology
D. Groundwater and well fields
E. Wastewater Treatment
F. Water Quality
G. Water Treatment
A. Hydraulics - Closed Conduit (+/-6 questions)
- Energy and/or Continuity Equation
- Pressure Conduit (e.g. force mains)
- Closed pipe flow equations
  - Hazen-Williams, Darcy-Weisbach
- Friction/Minor Losses
- Pipe network analysis
  - e.g. pipeline design, loop networks
- Pump application and analysis
- Cavitation
- Transient analysis (e.g. water hammer)
- Flow measurement - closed conduits
- Momentum equation (thrust block)
B. Hydraulics - Open Channel (+/- 6 questions)

- Open-channel flow (e.g. Manning’s eq.)
- Culvert design
- Spillway capacity
- Energy dissipation (hydraulic jump)
- Stormwater collection (inlets, gutter flow, street flow, storm sewer pipes)
- Flood plains/floodways
- Flow measurement - open channel
- Gradually varied flow
C. Hydrology (+/-6 questions)

- Storm characterization
- Storm frequency
- Hydrographs application
- Rainfall intensity, duration and frequency
- Time of concentration
- Runoff analysis (Rational & NRCS)
- Erosion
- Detention/retention ponds
- Hydrograph development, synthetic
- Depletions (transpiration, evap, infiltration)
- Sedimentation
D. Groundwater and Well Fields (+/- 3 quest.)

- Aquifers (e.g. characterization)
- Groundwater flow (Darcy’s law)
- Seepage analysis
- Groundwater control, drainage, dewatering
- Water quality analysis
- Groundwater contamination
- Erosion
- Detention/retention ponds
- Hydrograph development, synthetic
- Depletions (transpiration, evap, infiltration)
- Sedimentation
E. Wastewater Treatment (+/- 6 questions)

- Collection systems
  - lift stations, sewer networks
  - infiltration and inflow
- Wastewater flow rates
- Unit operations and processes
- Primary & Secondary treatment
- Secondary clarification
- Biological & Physical treatment
- Solids handling (thickening, drying)
- Disinfection, nitrification, denitrification
- Operations (e.g. odor & corrosion cntl)
- Advanced treatment, etc. etc. etc.
F. Water Quality (+/- 6 questions)

- Stream degradation (e.g. thermal, base flow, TDS, TSS, BOD, COD)
- Oxygen dynamics (oxygen sag curve)
- Risk assessment and management
- Toxicity
- Biological contaminants (algae, mussels)
- Chemical contaminants (organics, metals)
- Bioaccumulation
- Eutrophication
- Indicator organisms and testing
- Sampling and monitoring (e.g. QA/QC, laboratory procedures)
G. Water Treatment (+/- 6 questions)

- Hydraulic loading
- Distribution system
- Demands
- Storage (raw and treated water)
- Sedimentation
- Taste and odor control
- Rapid mixing
- Coagulation and flocculation
- Filtration
- Disinfection
- Advanced treatment (membranes, activated carbon, desalination)