CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP A – Epidemiological Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported for these regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a state public health professional who interviews patients to help determine the illness onset and contaminated transmission vehicle. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks

1. Determine illness onset date.
    a. Organize the individual patient data from your state according to illness onset date.
    b. Create an epidemic curve by plotting the illness onset dates on the x-axis and the number of patients who became ill on each date on the y-axis.
    c. If the incubation period (the time between exposure and onset of illness symptoms) for this illness ranges from 2 to 5 days, what was the *earliest date* of exposure to the disease agent?

2. Determine the common exposure.
    a. Organize the individual patient data from your state according to foods consumed.
    b. Organize data from control individuals (the people who were exposed to the same foods but who did not become ill).
    c. Complete the table and calculate the odds ratio for each food consumed. Which number food has the highest odds ratio that is also greater than one (and therefore has the greatest likelihood of being the source of contamination exposure)?

    $$\text{Odds Ratio} = \frac{[(\#\text{ Ate and became sick}) \div (\#\text{ Did not eat and became sick})]}{[(\#\text{ Ate but did not get sick}) \div (\#\text{ Did not eat and did not get sick})]}$$

3. The numerical answers from Tasks 1c (use only the number for the day, do not include the number of the month in your answer) and 2c form your 3-digit code.

Group A

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions.

2. Define the term *incubation period.*

3. Describe the purpose of calculating the *odds ratio* and the information needed to do so.

4. Your group's observations regarding the severity of symptoms as related to patient characteristics.

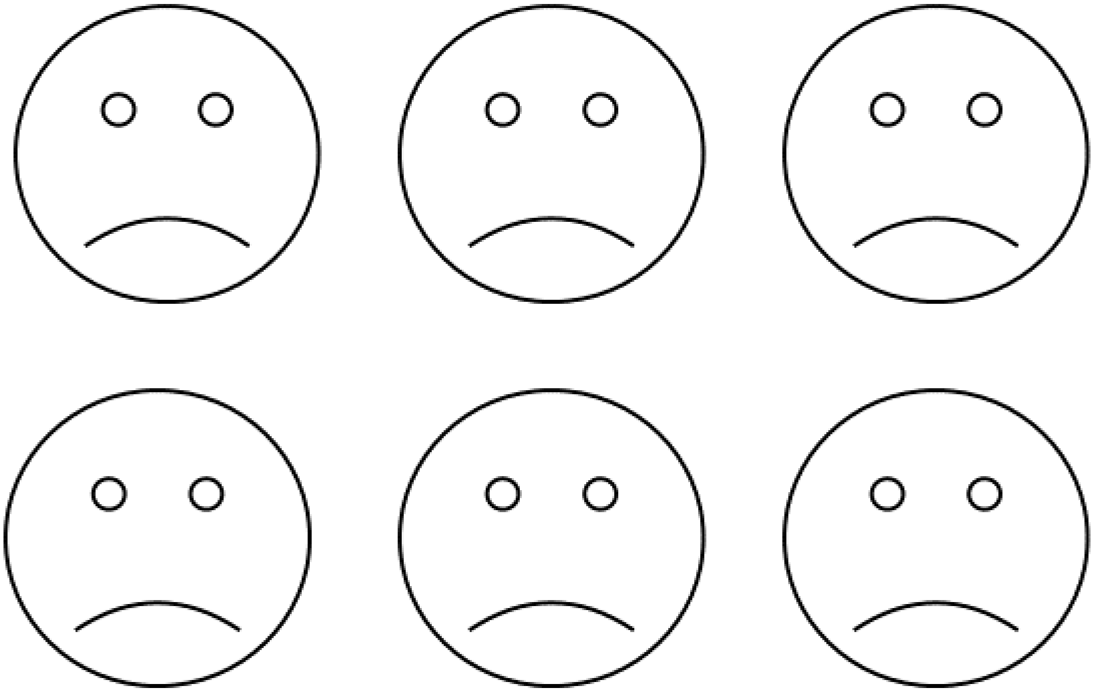
5. Your thoughts on why the date of exposure is important. (How do you think this information is critical to the rest of the investigation)?

Task 1 DATA

Individual	Sick or Not Sick	Gender	Age (yrs)	Symptoms	Illness Onset	Foods Consumed	Prior Health Concerns	Current Health Status
1	Sick	Female	12	Bloody diarrhea, fever, pain	April 27	1, 2	N/K	Poor
2	Sick	Female	45	Diarrhea, fever, pain, nausea	April 28	2	N/K	Recovering
3	Sick	Male	43	Diarrhea, fever, pain, nausea	April 29	1, 3	N/K	Recovering
4	Sick	Male	15	Bloody diarrhea, fever, pain	April 28	3	N/K	Recovering
5	Sick	Female	23	Diarrhea, fever, pain, nausea	April 28	2, 3	Pregnant	Poor
6	Sick	Female	8	Bloody diarrhea, fever, pain, nausea, HUS	April 28	3	N/K	Critical
7	Sick	Female	29	Diarrhea, fever, pain, nausea	April 26	3	N/K	Recovering
8	Sick	Male	55	Diarrhea, fever, pain, nausea	April 27	1, 2, 3	N/K	Recovering
9	Sick	Male	72	Bloody diarrhea, fever, pain	April 28	1, 3	N/K	Recovering
10	Sick	Male	61	Diarrhea, fever, pain, nausea	May 4	1, 2, 3	N/K	Recovering
11	Sick	Male	25	Diarrhea, fever, pain, nausea	May 2	2, 3	N/K	Recovering
12	Sick	Female	31	Diarrhea, fever, pain, nausea	April 26	1, 3	N/K	Recovering
13	Sick	Male	7	Bloody diarrhea, fever, pain, HUS	April 23	3	N/K	Critical
14	Sick	Male	40	Diarrhea, fever, pain, nausea	April 24	2, 3	N/K	Recovering
15	Sick	Female	37	Diarrhea, fever, pain, nausea	April 27	2, 3	N/K	Recovering
16	Sick	Female	81	Bloody diarrhea, fever, pain, nausea, HUS, kidney failure	April 25	3	Immune-compromised	Deceased
17	Sick	Female	51	Diarrhea, fever, pain, nausea	April 25	3	N/K	Recovering
18	Sick	Female	54	Diarrhea, fever, pain, nausea	May 1	2	N/K	Recovering
19	Not Sick	Female	46	N/A	N/A	1, 2	N/K	Good
20	Not Sick	Male	31	N/A	N/A	1, 3	N/K	Good
21	Not Sick	Male	48	N/A	N/A	2	N/K	Good
22	Not Sick	Female	49	N/A	N/A	1	N/K	Good
23	Not Sick	Female	28	N/A	N/A	2, 3	N/K	Good
24	Not Sick	Female	33	N/A	N/A	1, 2	N/K	Good
25	Not Sick	Male	45	N/A	N/A	1, 2	N/K	Good
26	Not Sick	Male	36	N/A	N/A	2	N/K	Good
27	Not Sick	Female	37	N/A	N/A	2	N/K	Good
28	Not Sick	Male	49	N/A	N/A	1	N/K	Good
29	Not Sick	Male	25	N/A	N/A	1	N/K	Good
30	Not Sick	Male	28	N/A	N/A	1	N/K	Good

HUS, hemolytic uremic syndrome (destruction of red blood cells, compromised kidney function)
N/A, Not Applicable; N/K, None Known

Group A – Tasks 1 and 2 – Interactive Format (symptoms printed on back of faces)



Sick
Male
Age 7 years
Bloody diarrhea, fever, pain, HUS
Onset April 23
Critical Condition
Ate Food # 3

Sick
Male
Age 40 years
Diarrhea, fever, pain, nausea
Onset April 24
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 37 years
Diarrhea, fever, pain, nausea
Onset April 27
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 81 years
Bloody diarrhea, fever, pain, nausea, HUS, kidney failure
Onset April 25
Immunocompromised
Deceased
Ate Food # 3

Sick
Female
Age 51 years
Diarrhea, fever, pain, nausea
Onset April 25
Recovering
Ate Food # 3

Sick
Female
Age 54 years
Diarrhea, fever, pain, nausea
Onset May 1
Recovering
Ate Food # 2

Sick
Female
Age 8 years
Bloody diarrhea, fever, pain, nausea, HUS
Onset April 28
Critical Condition
Ate Food # 3

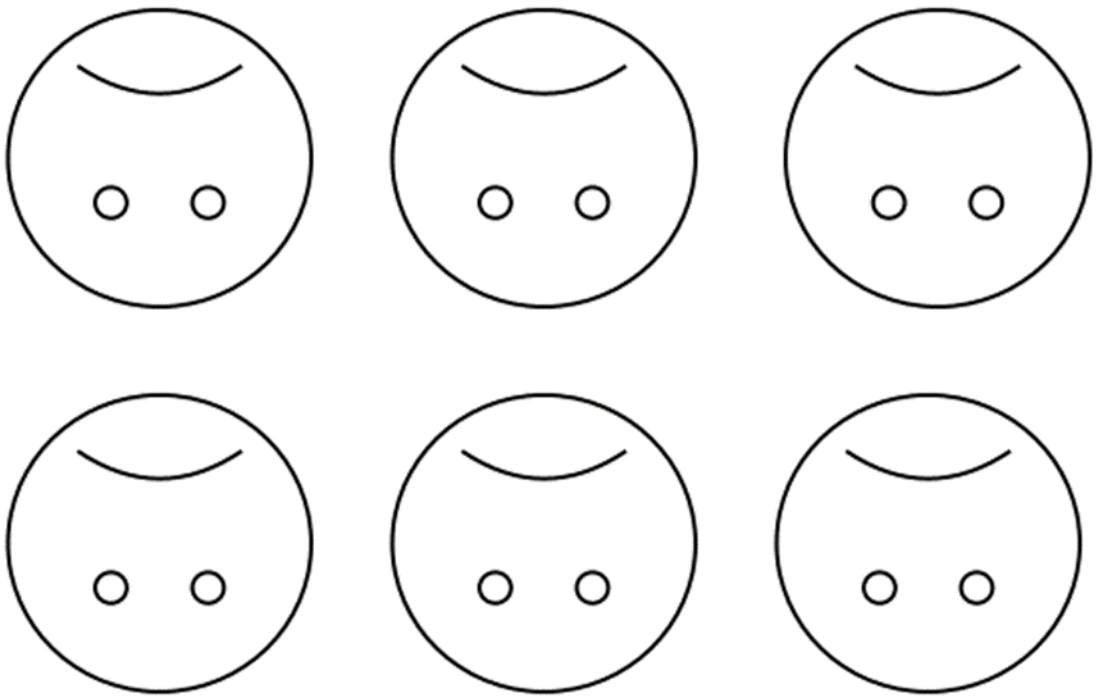
Sick
Female
Age 23 years
Diarrhea, fever, pain, nausea, HUS
Onset April 28
Pregnant, Poor Condition
Ate Foods # 2 and 3

Sick
Male
Age 15 years
Bloody diarrhea, fever, pain
Onset April 28
Recovering
Ate Food # 3

Sick
Male
Age 43 years
Diarrhea, fever, pain, nausea
Onset April 29
Recoverying
Ate Foods # 1 and 3

Sick
Female
Age 45 years
Diarrhea, fever, pain, nausea
Onset April 28
Recovering
Ate Food # 2

Sick
Female
Age 12 years
Bloody diarrhea, fever, pain
Onset April 27
Condition Poor
Ate Foods # 1 and 2



Sick
Female
Age 31 years
Diarrhea, fever, pain, nausea
Onset April 26
Recovering
Ate Foods # 1 and 3

Sick
Male
Age 25 years
Diarrhea, fever, pain, nausea
Onset May 2
Ate Foods # 2 and 3

Sick
Male
Age 61 years
Diarrhea, fever, pain, nausea
Onset May 4
Recovering
Ate Foods # 1, 2, and 3

Sick
Male
Age 72 years
Bloody diarrhea, fever, pain
Onset April 28
Recovering
Ate Foods # 1 and 3

Sick
Male
Age 55 years
Diarrhea, fever, pain, nausea
Onset April 27
Recovering
Ate Foods # 1, 2 and 3

Sick
Female
Age 29 years
Diarrhea, fever, pain, nausea
Onset April 26
Recovering
Ate Food # 3






Not Sick
Female
Age 33 years
Ate Foods # 1 and 2

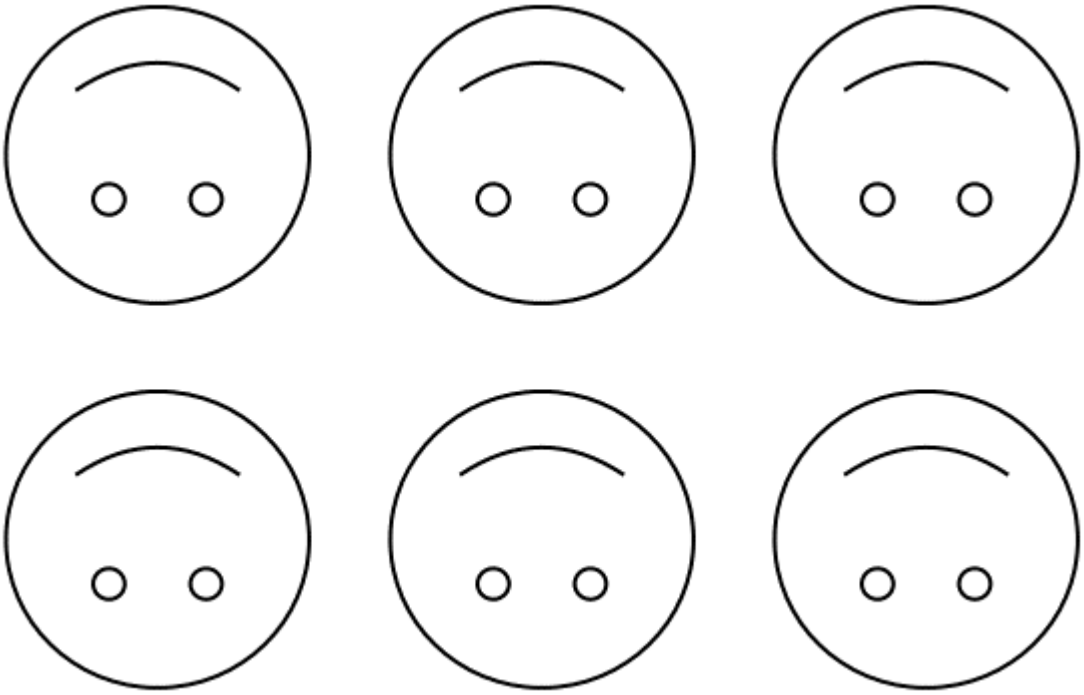
Not Sick
Female
Age 28 years
Ate Foods 2 and 3

Not Sick
Female
Age 49 years
Ate Food # 1

Not Sick
Male
Age 48 years
Ate Food # 2

Not Sick
Male
Age 31 years
Ate Foods # 1 and 3

Not Sick
Female
Age 46 years
Ate Foods # 1 and 2



Not Sick
Male
Age 28 years
Ate Food # 1

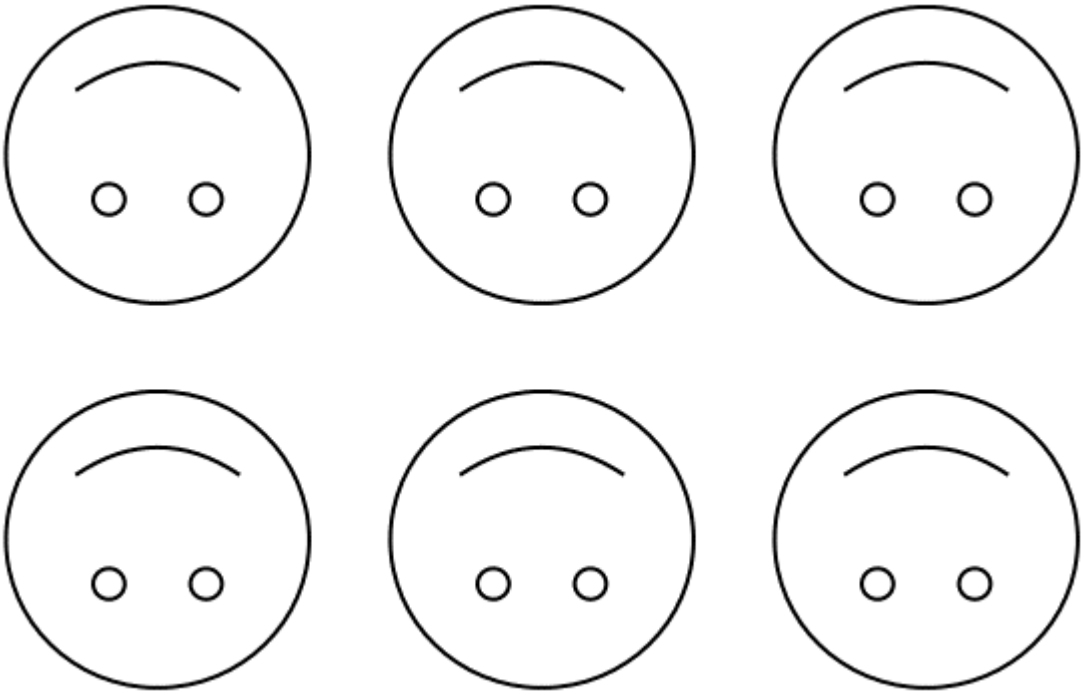
Not Sick
Male
Age 25 years
Ate Food # 1

Not Sick
Male
Age 49 years
Ate Food # 1

Not Sick
Female
Age 37 years
Ate Food # 2

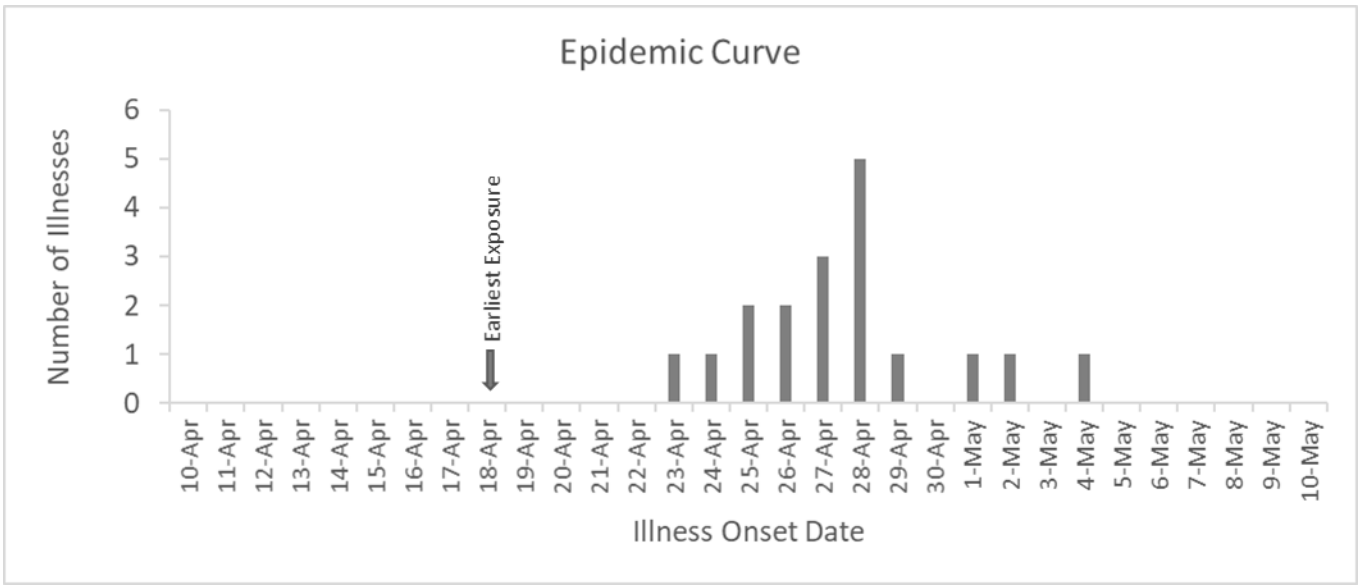
Not Sick
Male
Age 36 years
Ate Food # 2

Not Sick
Male
Age 45 years
Ate Foods # 1 and 2



Group A - Task 1

Group A – Task 1 Answer



Group A - Task 2

Food	# Ate and Sick	# Ate and Not Sick	# Not Eat and Sick	# Not Eat and Not Sick	Odds Ratio
1	*6*	*8*	*12*	*4*	*0.25*
2					
3					

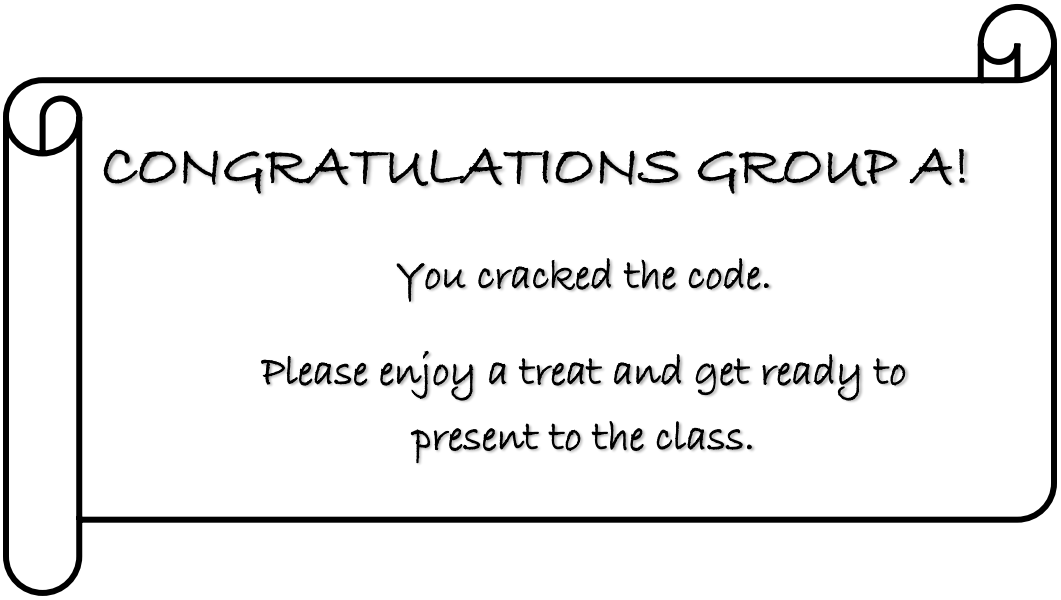
Odds Ratio = $\frac{[(\#\text{Ate and Sick}) \div (\#\text{Not Eat and Sick})]}{[(\#\text{Ate Not Sick}) \div (\#\text{Not Eat and Not Sick})]}$

Group A – Task 2 Answer

Food	**# Ate and Sick**	**# Ate and Not Sick**	**# Not Eat and Sick**	**# Not Eat and Not Sick**	**Odds Ratio**
1	*6*	*8*	*11*	*4*	*1.09*
2	9	7	9	4	0.57
3	15	2	3	10	25

Group A

Code Solution: 183



CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP B – Laboratory Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a laboratory professional who determines what tests should be run and interprets the data. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks (Note: Task 2 information will be helpful for interpreting results for Task 3)

1. Determine lab tests to be conducted on patient stool samples.
    a. Review patient symptoms and compare to food and waterborne pathogen characteristics.
    b. Determine which pathogen number is most likely responsible for disease symptoms.

2. Determine time frame for results.
    a. Review the protocol for the suspected disease agent.
    b. Determine the minimum number of experimental days that will be needed to obtain results on the identity of the contaminant in clinical samples.

3. Determine which, if any, of the food sample data matches patient clinical samples.
    a. Complete the puzzle to rebuild the broken gel for lab data.
    b. Review data for clinical and food samples.
    c. Determine which food sample has an isolate indistinguishable from the reference clinical sample (lane 1).

4. The numerical answers from Tasks 1b, 2b and 3c form your 3-digit code.

Group B

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. *E. coli* STEC symptoms and transmission vehicles

3. Your thoughts on if a food sample does not test positive for the same disease agent identified in stool samples, does it *guarantee* the food product was *not* associated with the outbreak?

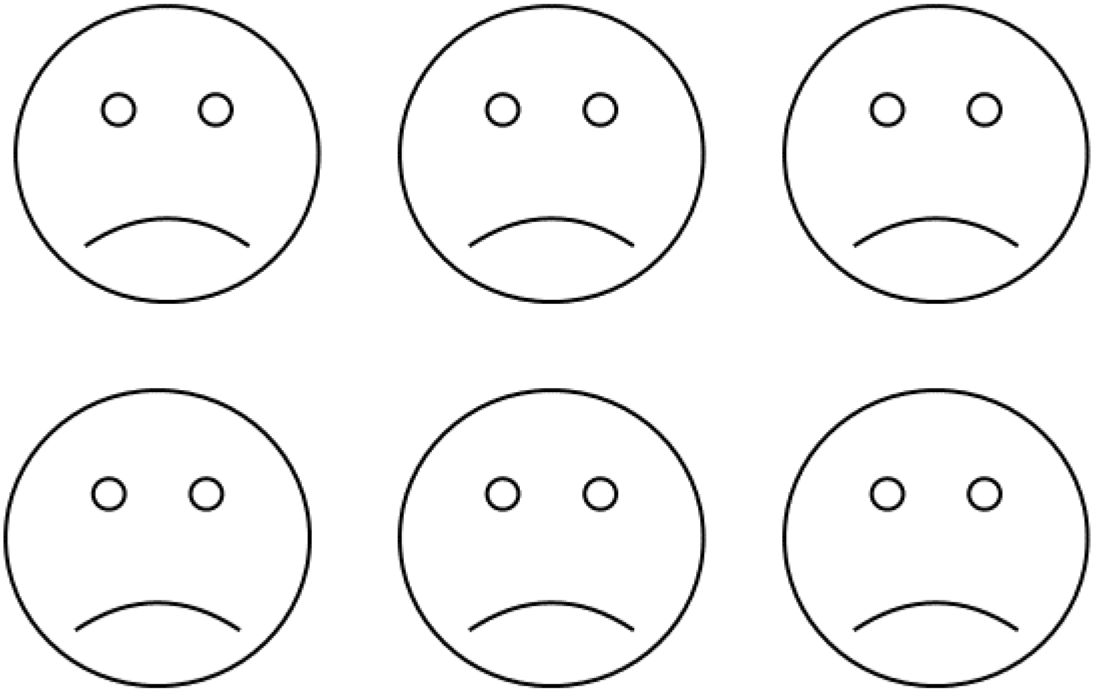
Group B – Task 1

Patient Symptoms

Patient Stool Sample Bar Code	Sick or Not Sick	Gender	Age (yrs)	Symptoms	Illness Onset	Foods Consumed	Prior Health Concerns	Current Health Status
111111	Sick	Female	12	Bloody diarrhea, fever, pain	April 27	1, 2	N/K	Poor
111112	Sick	Female	45	Diarrhea, fever, pain, nausea	April 28	2	N/K	Recovering
111113	Sick	Male	43	Diarrhea, fever, pain, nausea	April 29	1, 3	N/K	Recovering
111114	Sick	Male	15	Bloody diarrhea, fever, pain	April 28	3	N/K	Recovering
111115	Sick	Female	23	Diarrhea, fever, pain, nausea	April 28	2, 3	Pregnant	Poor
111116	Sick	Female	8	Bloody diarrhea, fever, pain, nausea, HUS	April 28	3	N/K	Critical
111117	Sick	Female	29	Diarrhea, fever, pain, nausea	April 26	3	N/K	Recovering
111118	Sick	Male	55	Diarrhea, fever, pain, nausea	April 27	1, 2, 3	N/K	Recovering
111119	Sick	Male	72	Bloody diarrhea, fever, pain	April 28	1, 3	N/K	Recovering
111120	Sick	Male	61	Diarrhea, fever, pain, nausea	May 4	1, 2, 3	N/K	Recovering
111121	Sick	Male	25	Diarrhea, fever, pain, nausea	May 2	2, 3	N/K	Recovering
111122	Sick	Female	31	Diarrhea, fever, pain, nausea	April 26	1, 3	N/K	Recovering
111123	Sick	Male	7	Bloody diarrhea, fever, pain, HUS	April 23	3	N/K	Critical
111124	Sick	Male	40	Diarrhea, fever, pain, nausea	April 24	2, 3	N/K	Recovering
111125	Sick	Female	37	Diarrhea, fever, pain, nausea	April 27	2, 3	N/K	Recovering
111126	Sick	Female	81	Bloody diarrhea, fever, pain, nausea, HUS, kidney failure	April 25	3	Immune-compromised	Deceased
111127	Sick	Female	51	Diarrhea, fever, pain, nausea	April 25	3	N/K	Recovering
111128	Sick	Female	54	Diarrhea, fever, pain, nausea	May 1	2	N/K	Recovering

HUS, hemolytic uremic syndrome (destruction of red blood cells, compromised kidney function)
N/K, None Known

Group B – Task 1 – Clue (symptoms printed on back of faces)



Sick
Female
Age 12 years
Bloody diarrhea, fever, pain
Onset April 27
Condition Poor
Ate Foods # 1 and 2

Sick
Female
Age 45 years
Diarrhea, fever, pain, nausea
Onset April 28
Recovering
Ate Food # 2

Sick
Male
Age 43 years
Diarrhea, fever, pain, nausea
Onset April 29
Recoverying
Ate Foods # 1 and 3

Sick
Male
Age 15 years
Bloody diarrhea, fever, pain
Onset April 28
Recovering
Ate Food # 3

Sick
Female
Age 23 years
Diarrhea, fever, pain, nausea, HUS
Onset April 28
Pregnant, Poor Condition
Ate Foods # 2 and 3

Sick
Female
Age 8 years
Bloody diarrhea, fever, pain, nausea, HUS
Onset April 28
Critical Condition
Ate Food # 3

Sick
Female
Age 31 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Foods # 1 and 3

Sick
Male
Age 25 years
Diarrhea, fever, pain,
nausea
Onset May 2
Ate Foods # 2 and 3

Sick
Male
Age 61 years
Diarrhea, fever, pain,
nausea
Onset May 4
Recovering
Ate Foods # 1, 2, and 3

Sick
Male
Age 72 years
Bloody diarrhea, fever,
pain
Onset April 28
Recovering
Ate Foods # 1 and 3

Sick
Male
Age 55 years
Diarrhea, fever, pain,
nausea
Onset April 27
Recovering
Ate Foods # 1, 2 and 3

Sick
Female
Age 29 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Food # 3






Sick
Female
Age 54 years
Diarrhea, fever, pain,
nausea
Onset May 1
Recovering
Ate Food # 2

Sick
Female
Age 51 years
Diarrhea, fever, pain,
nausea
Onset April 25
Recovering
Ate Food # 3

Sick
Female
Age 81 years
Bloody diarrhea, fever,
pain, nausea, HUS,
kidney failure
Onset April 25
Immunocompromised
Deceased
Ate Food # 3

Sick
Female
Age 37 years
Diarrhea, fever, pain,
nausea
Onset April 27
Recovering
Ate Foods # 2 and 3

Sick
Male
Age 40 years
Diarrhea, fever, pain,
nausea
Onset April 24
Recovering
Ate Foods # 2 and 3

Sick
Male
Age 7 years
Bloody diarrhea, fever,
pain, HUS
Onset April 23
Critical Condition
Ate Food # 3






Group B – Task 1 - Select Foodborne and Waterborne Pathogens (incomplete list)

	Etiology	Symptoms	Incubation Period	Illness Duration	Foods Associated	Additional Notes
1	*Campylobacter jejuni*	Diarrhea (often bloody), abdominal pain, fever	2 to 10d, usually 2 to 5 d	2 to 10 d	Undercooked poultry, unpasteurized milk, contaminated water	Long-term sequela: Guillain-Barré Syndrome
2	*Clostridium perfringens*	Diarrhea, abdominal cramps	8 to 22 h, usually 10 to 24 h	24 to 48 h	Temperature-abused cooked meats, gravy, beans	Sporeformer, endoenterotoxin
3	*Cyclospora cayetanensis*	Fatigue, protracted diarrhea, often relapsing	1 to 11d, medium: 7d	Weeks to months with relapse	Fresh produce (raspberries, lettuce, basil), contaminated water	Humans only known reservoir, cannot be propagated in laboratory or model animal.
4	*Escherichia coli* (Enterohemorrhagic, (EHEC), shiga-toxin producing (STEC))	Diarrhea (often bloody), abdominal cramps (often severe), low-grade fever, hemolytic uremic syndrome (HUS), kidney failure	1 to 10 d, typically 2 to 5 d	5 to 10 d	Undercooked animal products, raw produce, unpasteurized juice	chronic kidney disease; antibiotic therapy may be contraindicated
5	*Listeria monocytogenes*	Diarrhea, abdominal cramps, fever. If invasive, meningitis, neonatal sepsis, fever	3 to 70 d, usually 4 to 21 d	Variable	Soft cheese, unpasteurized milk, RTE meats, hot dogs	Can cause stillbirth, miscarriage
6	Norovirus	Vomiting, cramps, diarrhea, headache	15 to 77 h, usually 24 to 48 h	12 to 60 hours	Fecally-contaminated foods. Shellfish, fresh produce, RTE handled foods.	Cannot be propagated in laboratory
7	*Salmonella* spp.	Fever, abdominal pain, vomiting, diarrhea	6 to 72 h, typically 18 to 36h	4 to 7 d	Undercooked eggs, poultry, unpasteurized milk or juice, raw produce, chocolate	
8	*Staphylococcus aureus*	Vomiting, diarrhea, abdominal pain	1 to 8h, usually 2 to 4h	24 to 48 h	Improperly refrigerated meats, cream-filled pastries, high protein leftover foods	Intoxication due to preformed toxin
9	*Vibrio parahaemolyticus*	Diarrhea, vomiting, abdominal pain, fever	4 to 96 h, typically 12h	2 to 5 d	Undercooked seafood	

Sources:
Morbidity and Mortality Weekly Report, October 25, 1996, vol. 45, No. SS-5, pp. 58-67
Procedures to Investigate Foodborne Illness, 5th Ed. 1999. IAFP, Des Moines, IA.
Diagnosis and Management of Foodborne Illness, A Primer for Physicians and Other Health Care Professionals, AMA, ANA, CFSAN/FDA, FSIS/USDA,2004.

Group B – Task 2

Protocol for Isolation and Identification of Bacteria

1. Combine test sample with enrichment medium to enhance bacterial growth. Incubate at 37°C for 24 hours.

2. Transfer one ml of enrichment medium to a selective broth medium containing nutrients to enhance growth of suspected bacterial contaminant. Incubate at 37°C for 24 hours.

3. Spread a sample of selective broth medium onto differential agar medium containing nutrients to enhance growth of suspected bacterial contaminant in sample and indicator reagents to aid detection of pathogen among other nonpathogenic microorganisms. Incubate at 37°C for 24 hours.

4. Observe microbial growth on agar plates of differential growth medium. Note the appearance of bacterial colonies including colony shape, color, sheen, and the color of surrounding medium for indications of the nutrients in the media that were utilized by the bacteria and the products of bacterial growth. Determine whether the colony appearance is consistent with the suspected etiology for the illness outbreak.

5. Remove a colony from the agar plate, and suspend it in water. Heat the water to 100°C for 10 min to inactivate the bacteria and to release genetic material.

6. Perform analyses of DNA. (Analyses can be done simultaneously requiring approximately 3 hours for each.)

    a. Polymerase Chain Reaction (PCR) - to check for the presence of genes that encode virulence factors (such as toxins) that can cause the illness symptoms.
        i. Suspend DNA in reagents (buffer, nucleotides, and specific sequences of nucleotides that match unique DNA segments).
        ii. Incubate in a thermocycler to select for and make copies of genes that encode virulence factors. A sufficient number of copies is needed for detection.
        iii. Detect copies of DNA that encode for virulence factors (if present) by mixing with fluorescent molecules and measuring fluorescence during incubation, *or* by staining DNA loaded into a gel.

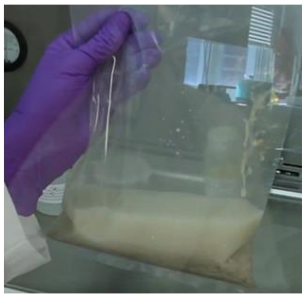
    b. Pulse Field Gel Electrophoresis (PFGE) – to determine if genetic profiles for clinical (stool) isolates and implicated food are indistinguishable.
        i. Suspend DNA in reagents (buffer and enzymes that cut the DNA into pieces at specific sequence locations).
        ii. Load the treated DNA suspension into wells of a gel. Apply an electric current to the gel to make the DNA pieces travel within the gel.
        iii. Stain the gel to detect how far the DNA pieces traveled within the gel; small pieces will travel a greater distance than large pieces.
        iv. Compare the staining patterns for the samples to see which have matching profiles.

Bacteria are single cellular microbes. Outer layers include a membrane and wall. Some contain pili and flagella on outer surfaces which aid in motility and attachment. Bacterial chromosomal DNA strands are circular.

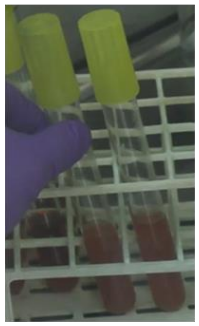
Bacteria can be detected in clinical, food, and environmental samples based on various metabolic (growth in nutrient media) and structural (genetic material, surface molecules) properties.

Food samples implicated in disease transmission are tested for bacteria in the laboratory. Ideally, the food sample would come from an unopened container.

Bacterial Growth Enrichment and Detection by Metabolic Properties

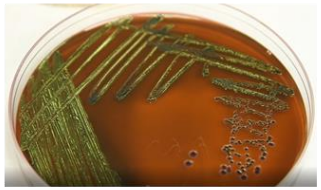


1. Samples are mixed with enrichment medium to enhance bacterial growth.



2. Growth from the enrichment broth are transferred to selective medium to enhance growth of suspected bacterial pathogen.

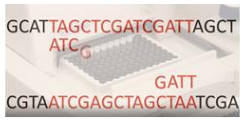
3. Selective broth is transferred to differential agar medium.



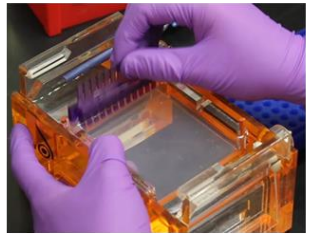
4. Bacterial growth is observed on differential agar medium.

5. Bacterial colony is suspended and heated to release bacterial DNA.

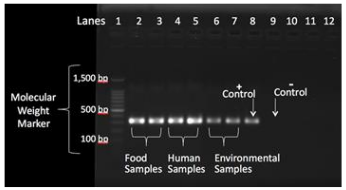
Detection of Bacteria by Unique DNA Sequences



6a. Unique segments of pathogenic bacterial DNA are selected and copied by polymerase chain reaction.

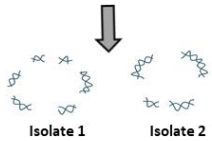


6a cont'd. The presence of copied DNA segments are detected by gel electrophoresis and staining. Positive samples appear as bands in a gel.

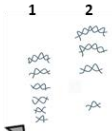


Comparing Bacterial Isolates by Patterns of Cut DNA Sequences

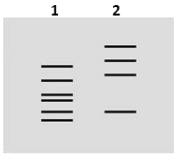
6b. The DNA of two bacterial isolates is treated by enzymes that cut the DNA at specific nucleotides.



The patterns of cut DNA segment sequences are compared. Identical isolates have identical cut patterns.



PFGE
Pulsed Field Gel Electrophoresis



6b cont'd. Cut DNA segments are detected by the distances traveled in a gel after application of an electrical current. These two isolates have different DNA segment sizes indicating they have different DNA sequences. These isolates are not identical.

Group B – Task 3

PFGE Data for Clinical and Food Samples

Determine which, if any, of the food sample data matches patient clinical samples.

- Complete the puzzle to rebuild the broken gel for lab data.
- The gel visualizes DNA of bacteria isolated from various samples.
- Bacterial DNA is cut experimentally with enzymes into smaller pieces. The pieces are separated and visualized as bands by gel electrophoresis whereby all of the DNA of each isolate is loaded into a well at the top of a horizontal gel. This gel has seven wells for seven sample isolates. The gel is subjected to an electric current and pieces of DNA move through the gel. Smaller pieces of DNA move through the gel faster and appear farthest from the well (just below the lane numbers).
- Sample isolates that are the same will have the same DNA banding pattern.
- Review data for clinical (lane 1) and food samples (lanes 2 through 7).
- Determine which food sample has an bacterial isolate indistinguishable from the reference clinical stool sample (lane 1).

Group B – Task 3 – (jigsaw puzzle)

Group B

Code Solution: 445

CONGRATULATIONS GROUP B!

You cracked the code.

Please get ready to present to the class.

CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP C – Traceback

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is to trace the implicated food product back to its source and determine the full distribution of the implicated product.

Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

<u>Tasks</u>

1. Begin traceback to product source by interpretation of product label codes.
    a. Align the wheel puzzle to reveal clues to interpret the bar codes.
    b. Determine the single-digit facility number associated with the implicated product.

2. Trace product back to source through distribution records.
    a. Review the packing facility records for the production date of the product implicated in the illness outbreak.
    b. Determine the product source (producer #) associated with the implicated product.

3. Determine breadth of distribution of implicated product to support recall efforts.
    a. Review the distribution records for the packing house.
    b. Using the production date of the implicated product (determined in Task 1) and the product source (determined in Task 2), identify the states to which implicated product was distributed.
    c. Determine how many states to which implicated product was distributed.

4. Your numerical answers from tasks 1b, 2b, and 3c form your 3-digit code.

Group C

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

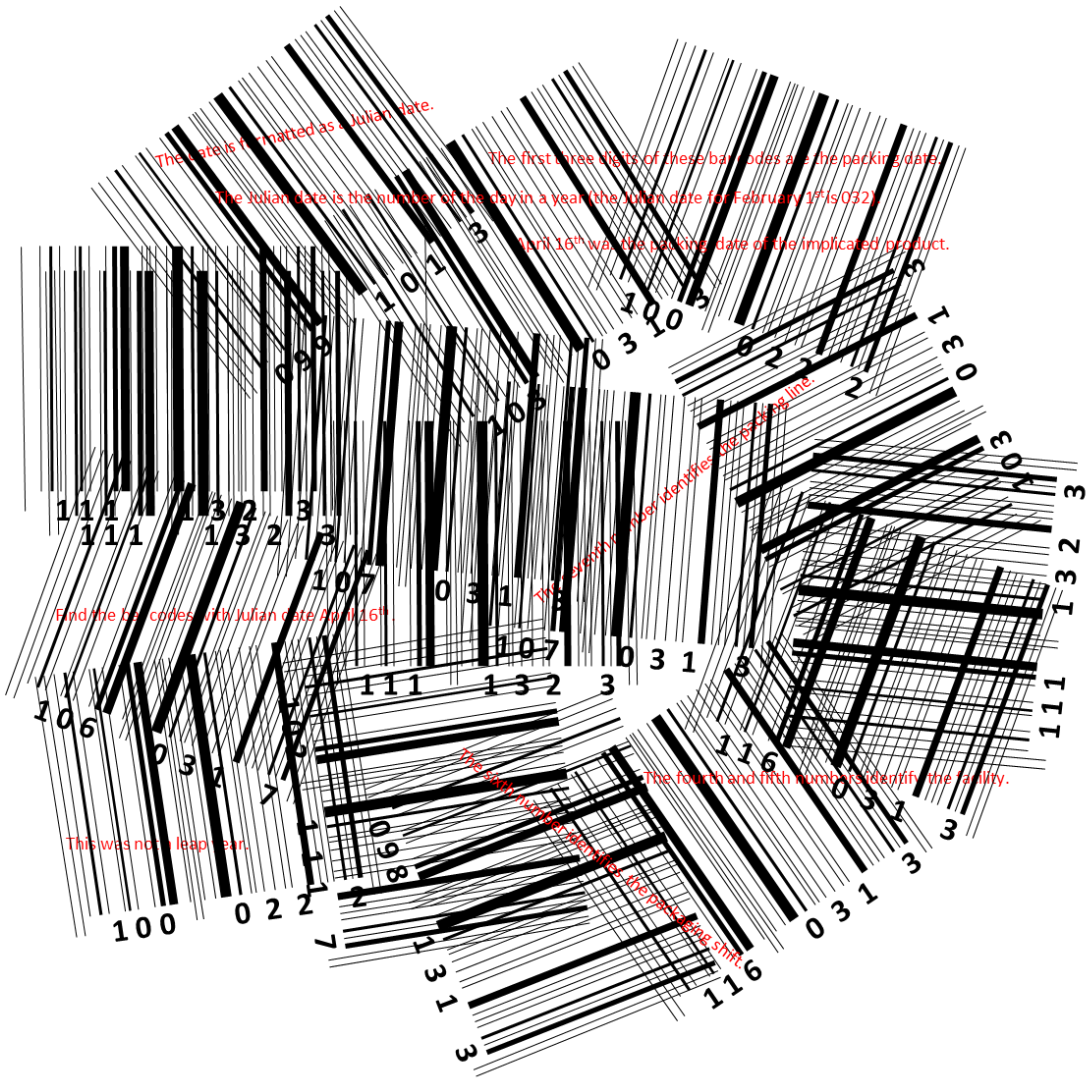
Present to the class:

1. The group's tasks and solutions

2. Your thoughts on how traceability software could impact investigations and product recalls.

3. Your thoughts on what measures would be needed to notify and protect the public from a contaminated product in commerce with a long shelf life or as a common ingredient in multiple products.

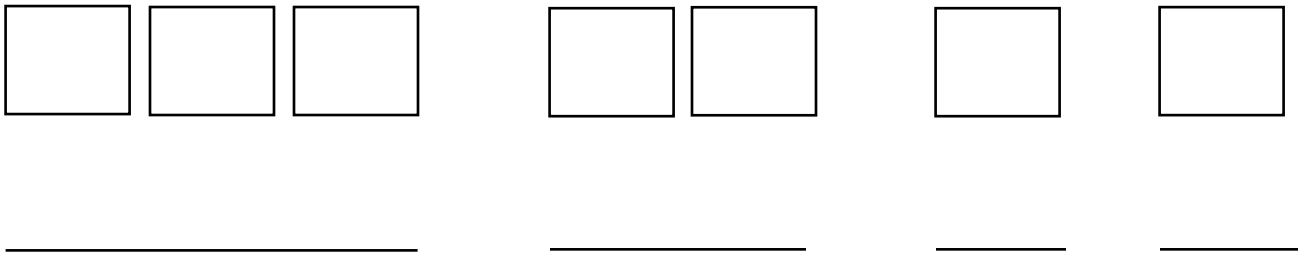
Group C – Task 1



Group C – Task 1

Wheel Puzzle Solution (Bar Code of Implicated Product and Bar Code Identifiers)

- Align the wheel puzzle to reveal clues in red font behind the bar codes.
- Use the magnifier to read the clues in red font.
- Use the clues to identify the bar code of the implicated product found on the puzzle.
- Use the boxes to fill in the numbers of the implicated product.
- Use the lines below the boxes to indicate what the numbers of the bar code identify.
- Use the bar code of the implicated product to solve Task 1.
- Use the rest of the bar code to help solve Tasks 2 and 3.



Group C - Task 1 Solution

1 0 6 0 3 1 7

Digits 1, 2, 3: Julian date 106 (April 16th)
Digits 4, 5: Facility Number (03)
Digit 6: Production Shift (1)
Digit 7: Production Line (7)

Group C – Task 2

Packing Facility Records for Sources of Products

Date	Shift	Production Line	Product Source (Producer #)
April 15	2	7	3
April 15	2	8	3
April 15	2	9	3, 4
April 16	1	1	1
April 16	1	2	1
April 16	1	3	2
April 16	1	4	2, 3
April 16	1	5	3
April 16	1	6	3
April 16	1	7	4
April 16	1	8	4
April 16	1	9	5
April 16	2	1	6
April 16	2	2	6
April 16	2	3	7, 8
April 16	2	4	9
April 16	2	5	1
April 16	2	6	2
April 16	2	7	2
April 16	2	8	3
April 16	2	9	3
April 17	1	1	1
April 17	1	2	3
April 17	1	3	3

Group C – Task 3

Packing House Distribution Records

Date	Shift	Production Line	Product Source (Producer #)	Wholesale	Retail
April 15	2	7	3	AZ, CA, NM	AZ, CA, NM
April 15	2	8	3	AZ, CA, NM	AZ, CA, NM
April 15	2	9	3, 4	AZ, CA, NM	AZ, CA, NM
April 16	1	1	1	AZ, CA, NM	AZ, CA, NM
April 16	1	2	1	AZ, CA, NM	AZ, CA, NM
April 16	1	3	2	AZ, CA, NM	AZ, CA, NM
April 16	1	4	2, 3	AZ, CA, NM	AZ, CA, NM
April 16	1	5	3	AZ, CA, NM	AZ, CA, NM
April 16	1	6	3	AZ, CA, NM	AZ, CA, NM
April 16	1	7	4	AZ, CA, NM	AZ, CA, NM
April 16	1	8	4	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	1	9	5	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	1	6	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	2	6	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	3	7, 8	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	4	9	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	5	1	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	6	2	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	7	2	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	8	3	DE, MD, NJ, NY, PA	DE, MD, NJ, NY, PA
April 16	2	9	3	DE, MD, NJ, NY, PA	DE, MD, NJ, NY, PA

Group C

Code Solution: 348

CONGRATULATIONS GROUP C!

You cracked the code.

Please get ready to present to the class.

CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP D – Environmental Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role as an outbreak investigator is to evaluate the practices and conditions that may have contributed to contamination of the implicated product. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

<u>Tasks</u>

1. To evaluate the production environmental conditions that may have contributed to contamination of the implicated food product. Heavy rainfall can cause runoff of surface microbial contaminants from areas surrounding growing fields.
    a. Organize rainfall data for two potential growing regions of the product implicated in the illness outbreak.
    b. Plot the rainfall data on the provided graph of illness onset and exposure dates.
    c. If product distribution occurred within 48 hours after harvest, for which growing operation was rainfall a *potential* factor in pathogen transmission from surrounding surfaces.
2. To evaluate the production environment and practices that may have contributed to contamination of the implicated food product.
    a. Complete the puzzle.
    b. Review the image for potential risks for microbial contamination.
    c. Identify the food production field with the water source at greatest risk for pathogen contamination.
3. Determine the risk for foodborne disease transmission by irrigation method and commodity.
    a. Review the images.
    b. Select the irrigation method that poses the greater risk for spread of microbial pathogens to the edible portion of produce in the event of contamination of the irrigation water.
    c. Select the produce item with the least risk for foodborne disease transmission in the event of irrigation with contaminated water.
    d. Add the selected numbers from answers 3b and 3c.
4. The numerical answers from Tasks 1c, 2c, and 3d form your 3-digit code.

Group D

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. The role of environmental waters for potential transmission of microorganisms to food crops

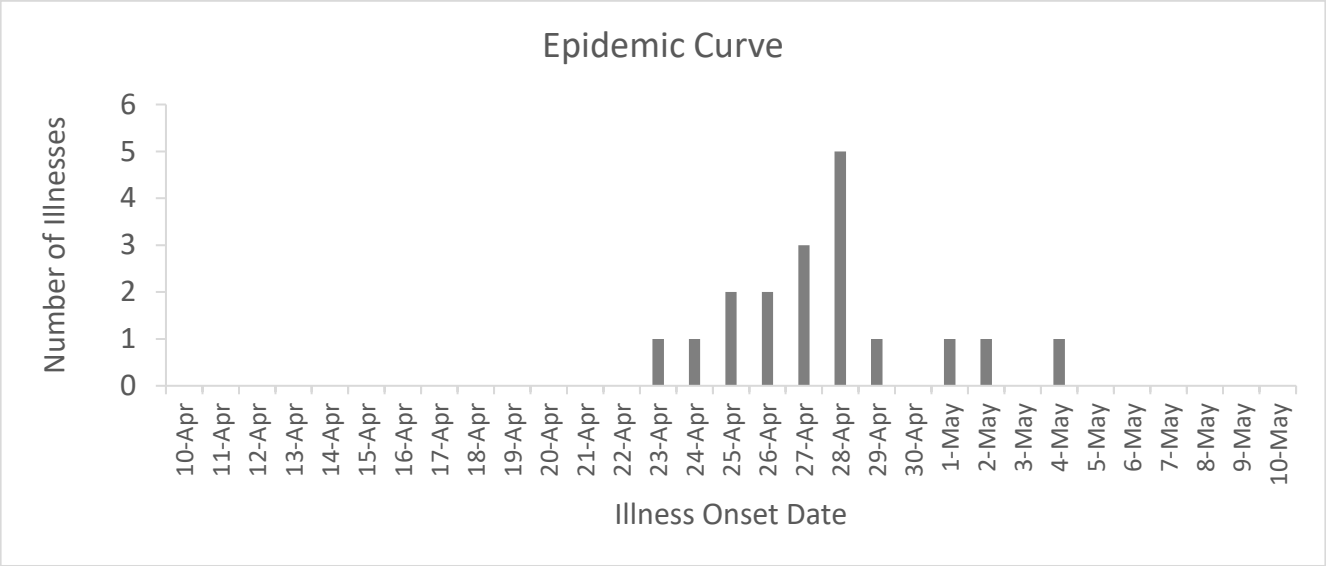
3. Your thoughts on what actions a grower could take to minimize risk of contamination to harvested crops if there were a heavy rain event shortly before harvest

Group D – Task 1

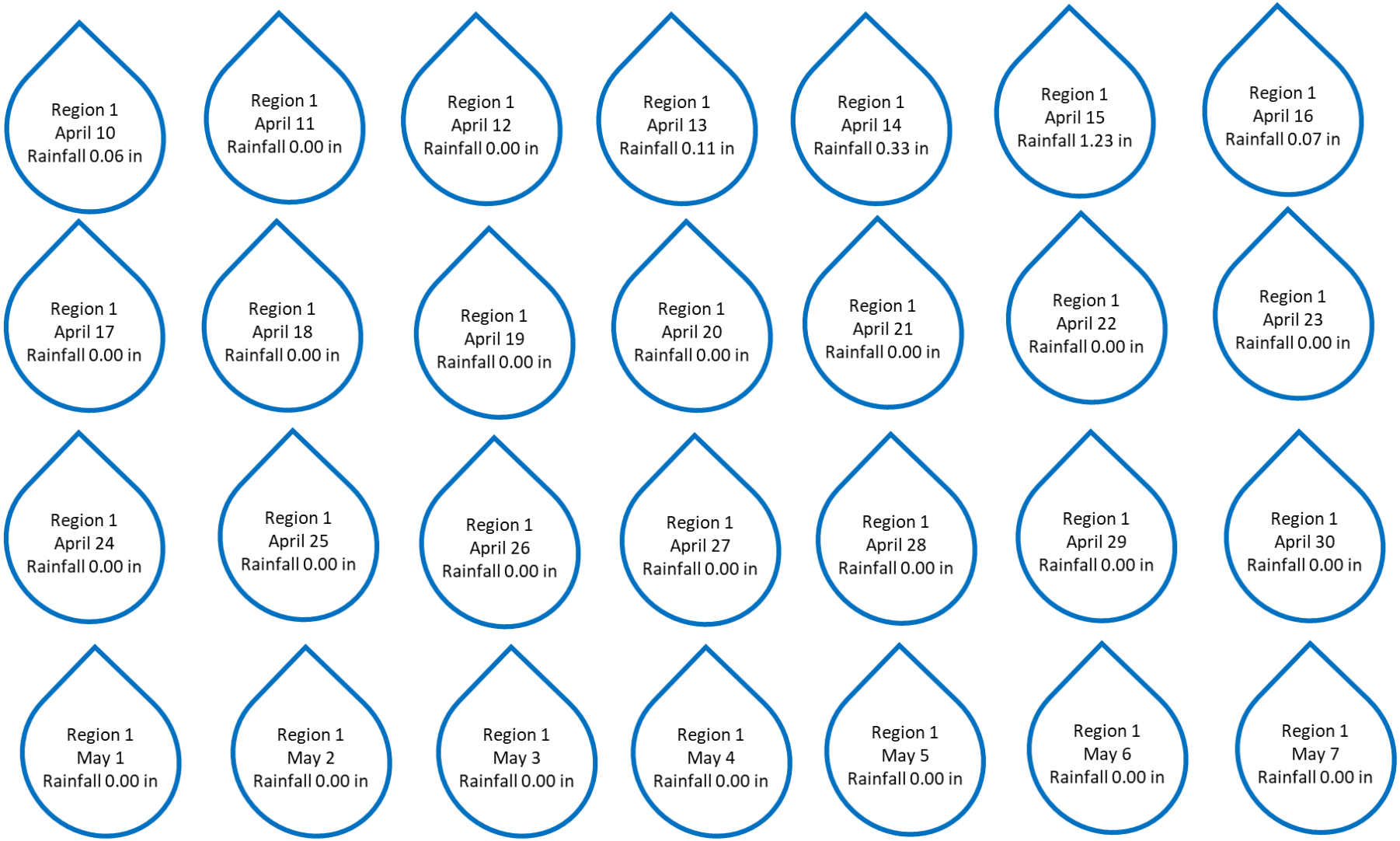
Illness Onset	Number Ill	Rainfall Region 1	Rainfall Region 2
10-Apr	0	0.06	0
11-Apr	0	0	0
12-Apr	0	0	0
13-Apr	0	0.11	0
14-Apr	0	0.33	0.03
15-Apr	0	1.23	0
16-Apr	0	0.07	0
17-Apr	0	0	0
18-Apr	0	0	0
19-Apr	0	0	0
20-Apr	0	0	0
21-Apr	0	0	0
22-Apr	0	0	0
23-Apr	1	0	0.1
24-Apr	1	0	0.06
25-Apr	2	0	0.07
26-Apr	2	0	0.09
27-Apr	3	0	0.3
28-Apr	5	0	1.3
29-Apr	1	0	0.02
30-Apr	0	0	0
1-May	1	0	0.01
2-May	1	0	0.2
3-May	0	0	0
4-May	1	0	0.08
5-May	0	0	0
6-May	0	0	0
7-May	0	0	0
8-May	0	0	0
9-May	0	0	0
10-May	0	0	0

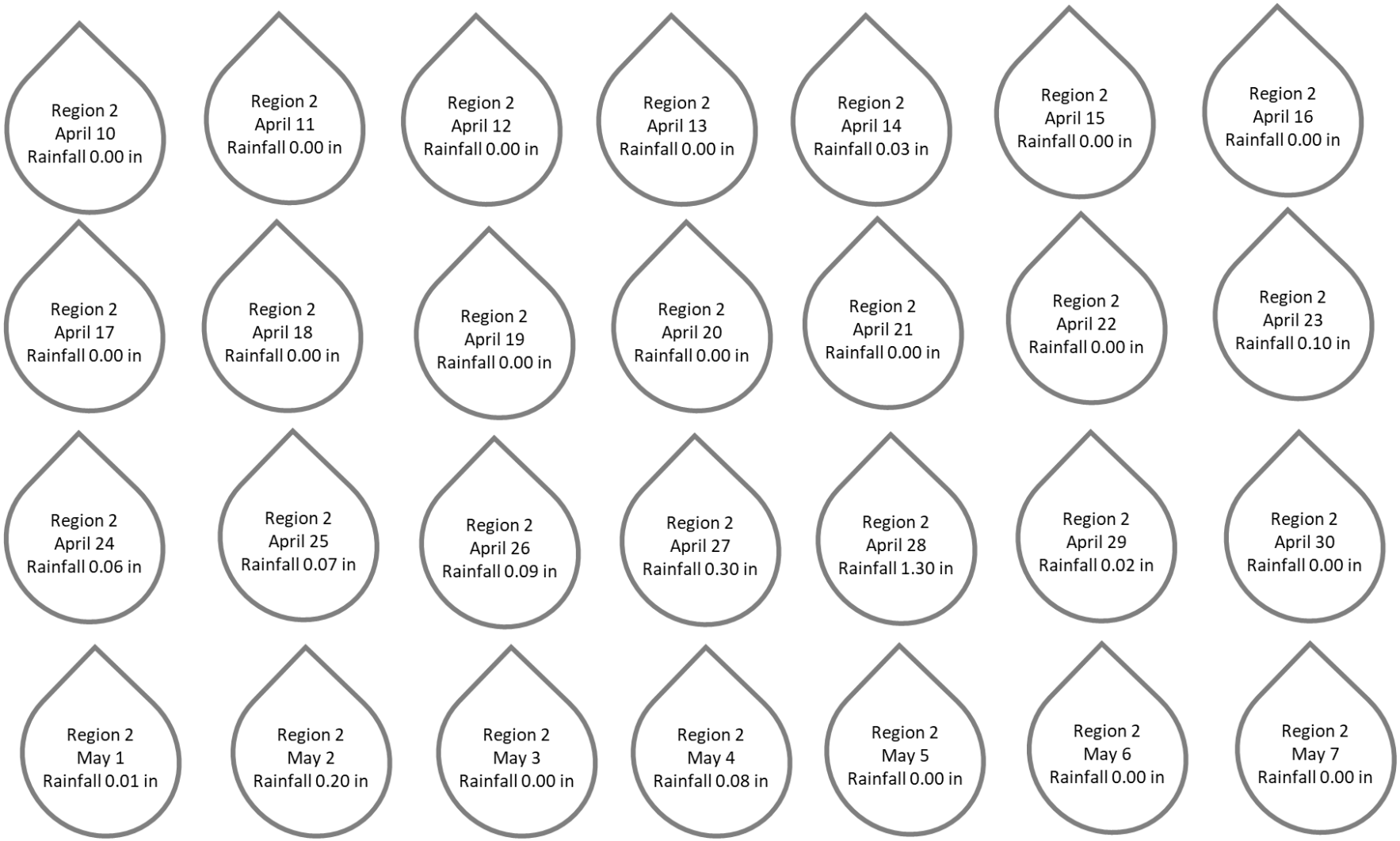
https://www.wunderground.com/history/monthly/us/ca/salinas/KSNS/date/2018-5

Group D – Task 1

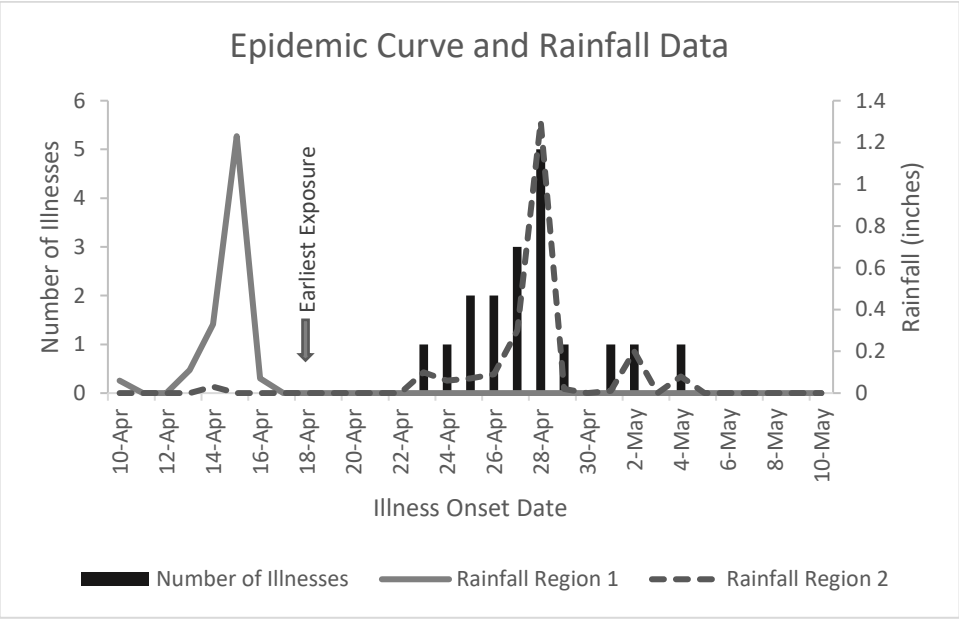


Group D – Task 1

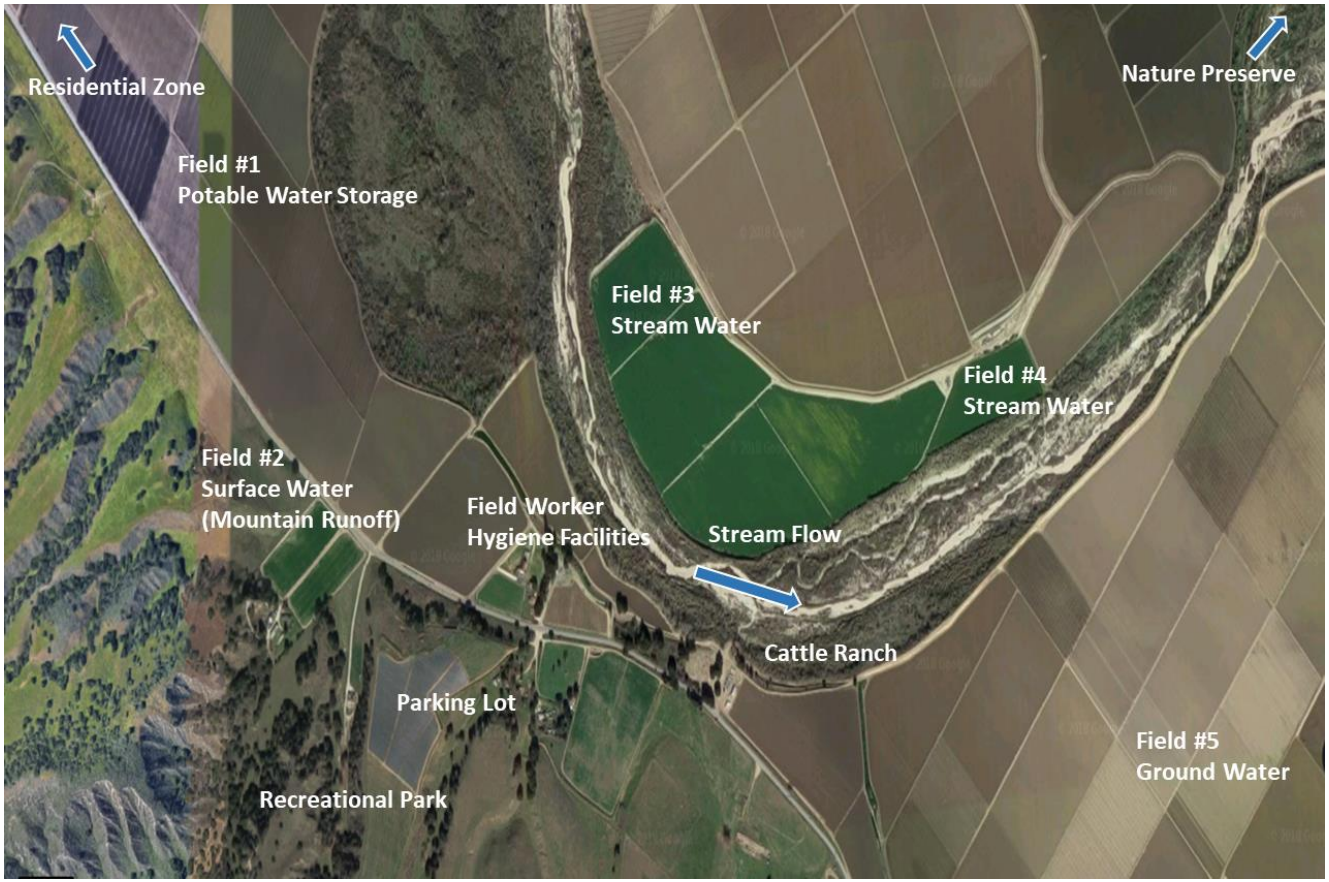



Region 2
April 10
Rainfall 0.00 in
Region 2
April 11
Rainfall 0.00 in
Region 2
April 12
Rainfall 0.00 in
Region 2
April 13
Rainfall 0.00 in
Region 2
April 14
Rainfall 0.03 in
Region 2
April 15
Rainfall 0.00 in
Region 2
April 16
Rainfall 0.00 in
Region 2
April 17
Rainfall 0.00 in
Region 2
April 18
Rainfall 0.00 in
Region 2
April 19
Rainfall 0.00 in
Region 2
April 20
Rainfall 0.00 in
Region 2
April 21
Rainfall 0.00 in
Region 2
April 22
Rainfall 0.00 in
Region 2
April 23
Rainfall 0.10 in
Region 2
April 24
Rainfall 0.06 in
Region 2
April 25
Rainfall 0.07 in
Region 2
April 26
Rainfall 0.09 in
Region 2
April 27
Rainfall 0.30 in
Region 2
April 28
Rainfall 1.30 in
Region 2
April 29
Rainfall 0.02 in
Region 2
April 30
Rainfall 0.00 in
Region 2
May 1
Rainfall 0.01 in
Region 2
May 2
Rainfall 0.20 in
Region 2
May 3
Rainfall 0.00 in
Region 2
May 4
Rainfall 0.08 in
Region 2
May 5
Rainfall 0.00 in
Region 2
May 6
Rainfall 0.00 in
Region 2
May 7
Rainfall 0.00 in

Group D – Task 1 (answer)



Group D – Task 2



Group D – Task 3

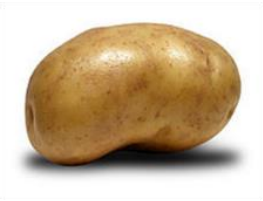
Irrigation Method #1
Drip Irrigation

Irrigation Method #2
Overhead Irrigation

Produce Item #1
Apple

Produce Item #2
Carrot

Produce Item #3
Lettuce



Produce Item #4
Potato

Group D

Code Solution: 146

CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP E – Prevention of Recurrence

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a food safety expert who evaluates both risks and potential food safety benefits associated with changes in food production practices. This includes evaluating new resources and emerging technologies. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

<u>Tasks</u>

1. Evaluate the potential microbial risk of various water sources for irrigation of edible crops.
    a. Organize the data for the various water samples based on water type and time.
    b. Plot the data on the provided graph.
    c. Which water sample number has the greatest variability of generic *E. coli* levels?

2. Determine whether water sources meet regulatory standards.

    The Food Safety Modernization Act (FSMA) was signed into law in 2011 and includes the Produce Safety Rule. One requirement of the Produce Safety Rule is that water quality used for irrigation of food crops is to be monitored over time in consideration for variability due to one-time events such as heavy rainfall. While somewhat an oversimplification of the rule, the water microbial standards for growing foods (other than sprouts) call for no more than an average of 126 colony-forming units (CFU) of generic *E. coli* (as an indicator of fecal contamination) in 100 ml of water (https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm#key).

    Which, if any, of the water samples meets this standard?

3. Evaluate potential treatment methods to improve the microbiological quality of irrigation water.

    Environmental water used to prepare drinking water is treated to meet microbiological safety standards. Treatment typically includes filtration to physically remove microorganisms and disinfection to inactivate any microorganisms that remain in the water

after filtration. Research continues on methods to improve the microbiological quality of irrigation water. One of those methods is to incorporate iron particles in sand filters in an effort to enhance retention of microorganisms in the filter and reduce the number remaining in the treated water.

a. Use the decoder to reveal the laboratory data for these filtration methods
b. Which treatment method was most effective in removal of tested microorganisms?

4. The numerical answers from Tasks 1c, 2, and 3b form your 3-digit code.

Group E

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. Examples of water sources investigated for irrigation of edible crops as alternatives to groundwater and emerging water remediation methods to address water scarcity issues.

3. Your thoughts on what contaminants other than microorganisms that might be present in environmental waters as result of human activity.

Group E – Task 1

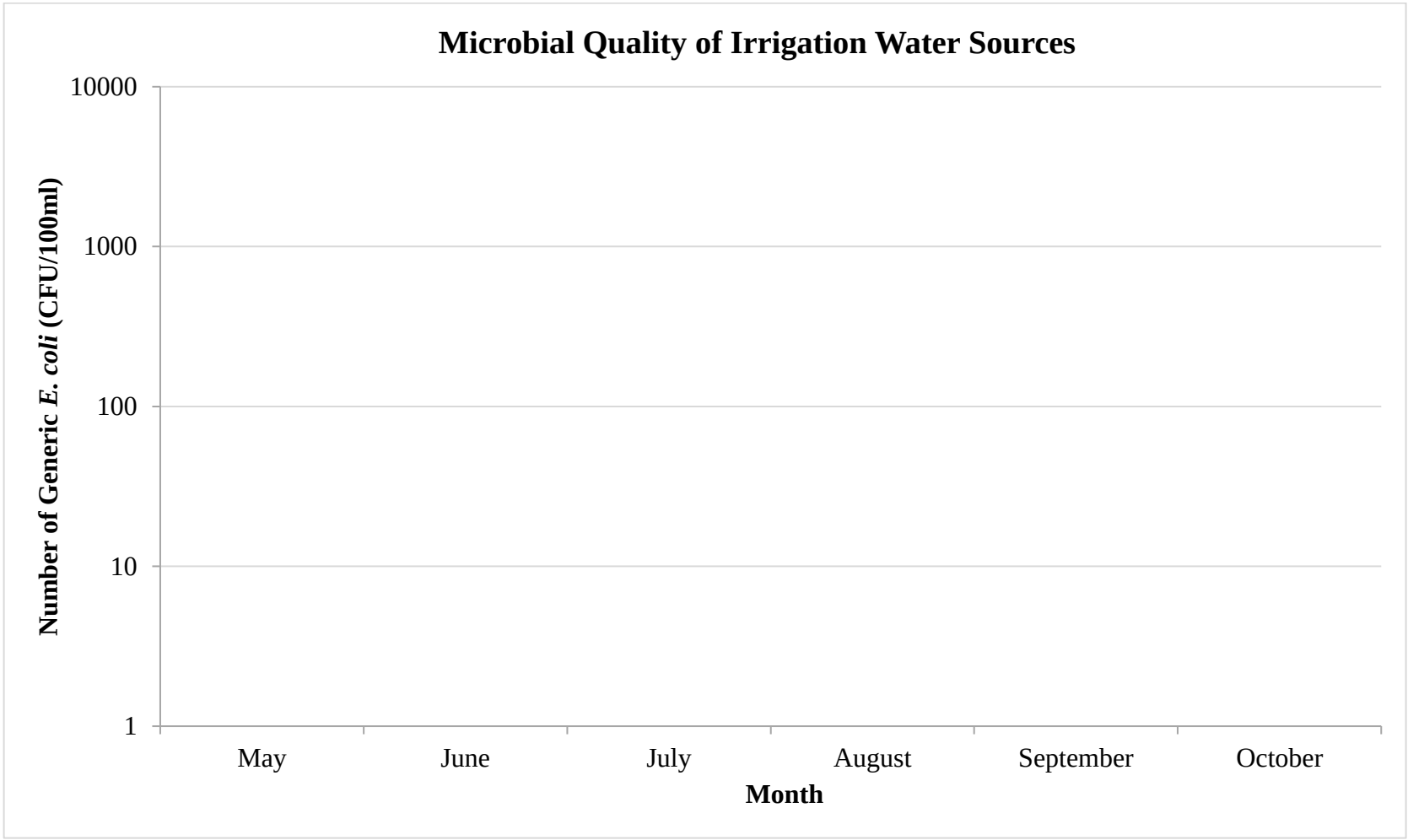
		Generic *E. coli* (CFU/100ml) (nonpathogenic bacterium used as indicator of potential fecal contamination)					
Sample Reference Number	**Water Source**	**May**	**June**	**July**	**August**	**September**	**October**
1	River	310	42	50	10	145	290
2	Pond	11	1	20	1130	57	5
3	Recycled	47	3000	27	120	10	160

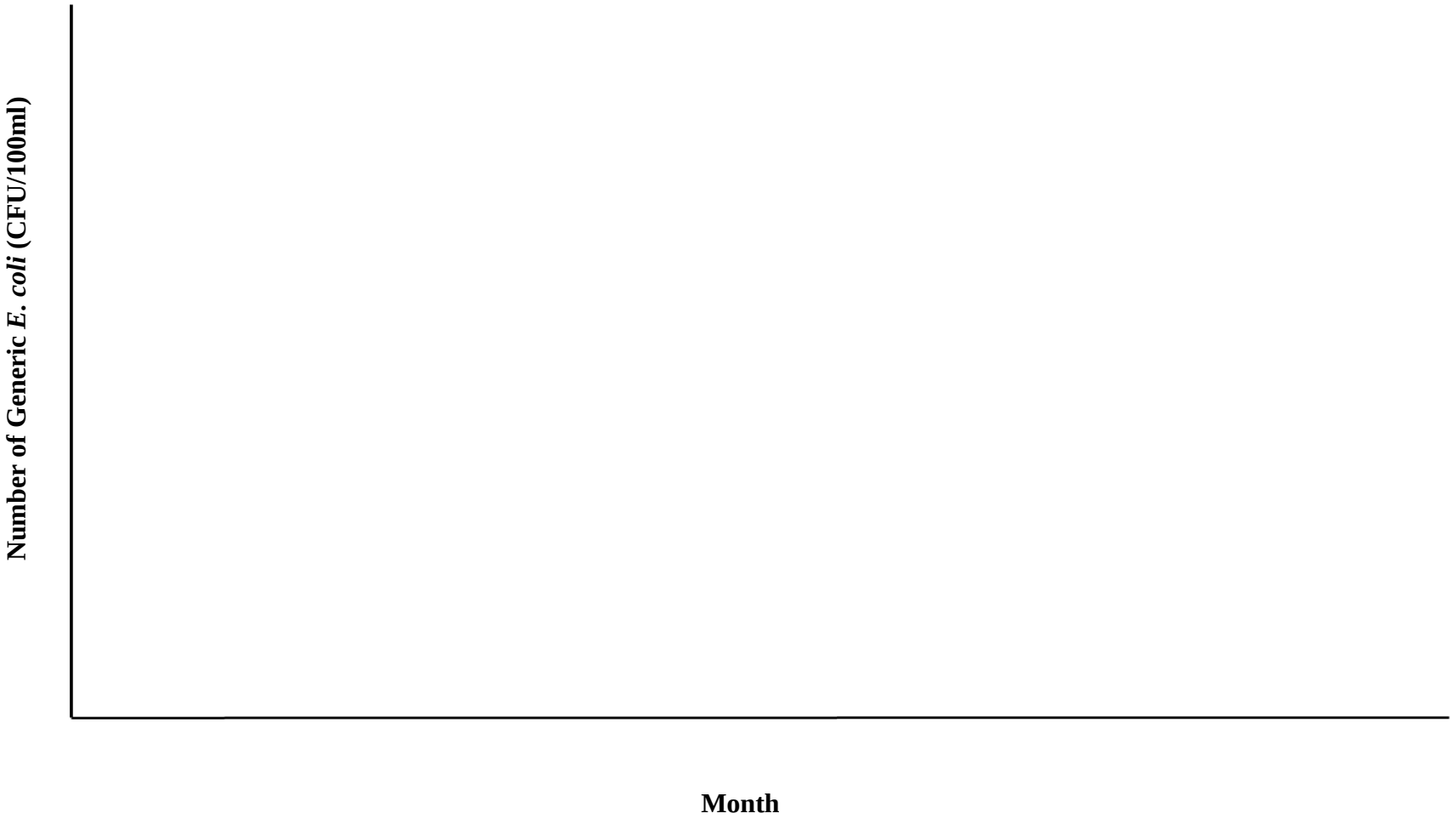
CFU, colony forming units (bacterial growth on agar growth medium; each colony represents outgrowth from one bacterium)

Group E – Task 3

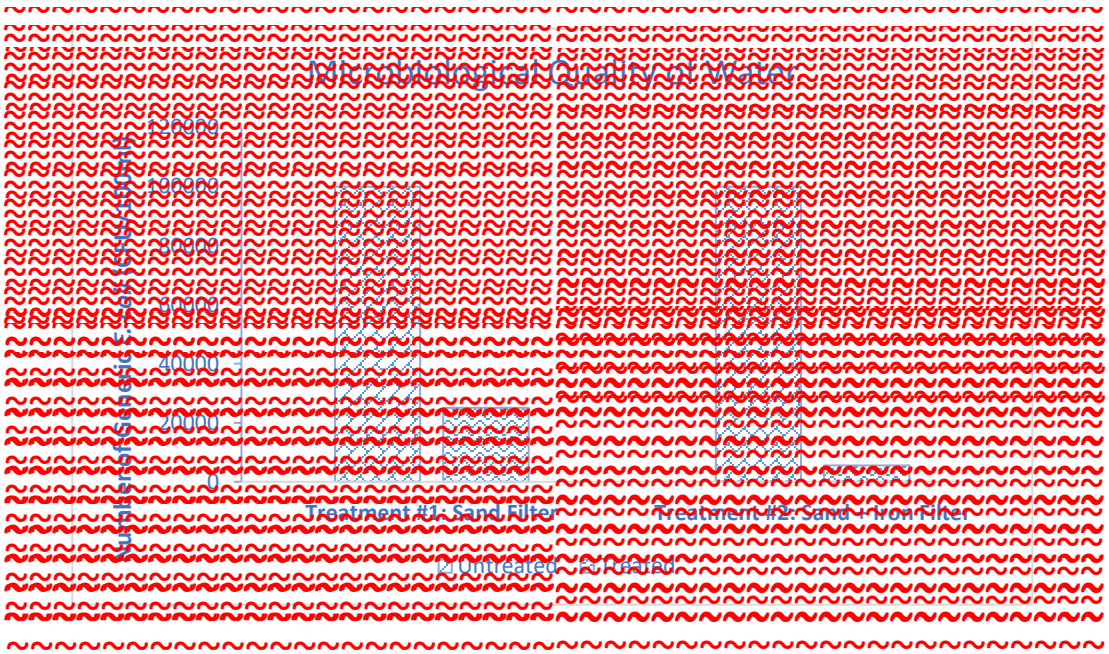
	Generic *E. coli* (CFU/100ml)	
Inoculated Water Sample	**Treatment #1 Sand Filter**	**Treatment #2 Sand + Iron Filter**
Untreated	100,000	25,000
Treated	100,000	5,500

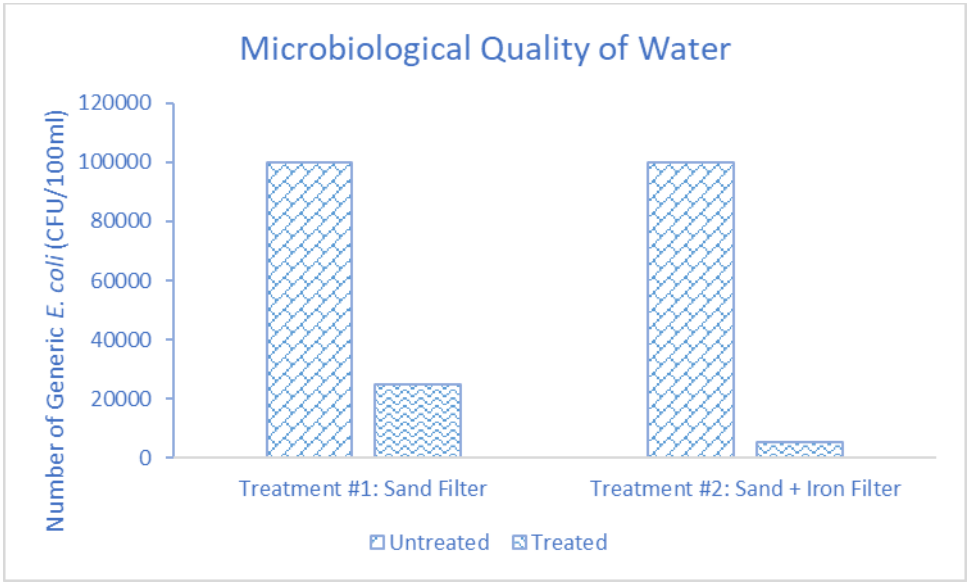
Group E – Task 1




Number of Generic E. coli (CFU/100ml)
Month

Group E – Task 3





Group E

Code Solution: 302

CONSERVE EXERCISE – Interactive Outbreak Investigation

GROUP F – Contributing Factors

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is indirect to this specific case but critical to understanding various issues expected to exacerbate illness events and to explore potential solutions. Your job is to investigate some underlying issues that affect water availability and safety. An understanding of these concepts is essential to the establishment of appropriate policies affecting water availability, use, and reuse. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

<u>Tasks</u>

1. Review the provided data on water use, changes in groundwater reserves, population change, and reclaimed water use for the United States. Use the data to complete the crossword puzzle.

2. Complete the cryptogram. Identify clues from the completed crossword puzzle in Task 1 to identify the first two digits of the numeric lock code.

3. Search the puzzle for hidden terms important to climate change and predicted impacts for agriculture. Unused letters provide a clue to the third digit of the numeric lock code.

Group F

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. Share data from Task 1 on:

    a. The main uses of water in Western and Eastern states of the United States. Propose reasons for the differences in primary water use.

    b. The projected global human population in 2050 and corresponding predicted increase in agricultural water needs.

    c. The volume of municipal effluent produced in the United States, the percentage of effluent reclaimed, and the major use of reclaimed water.

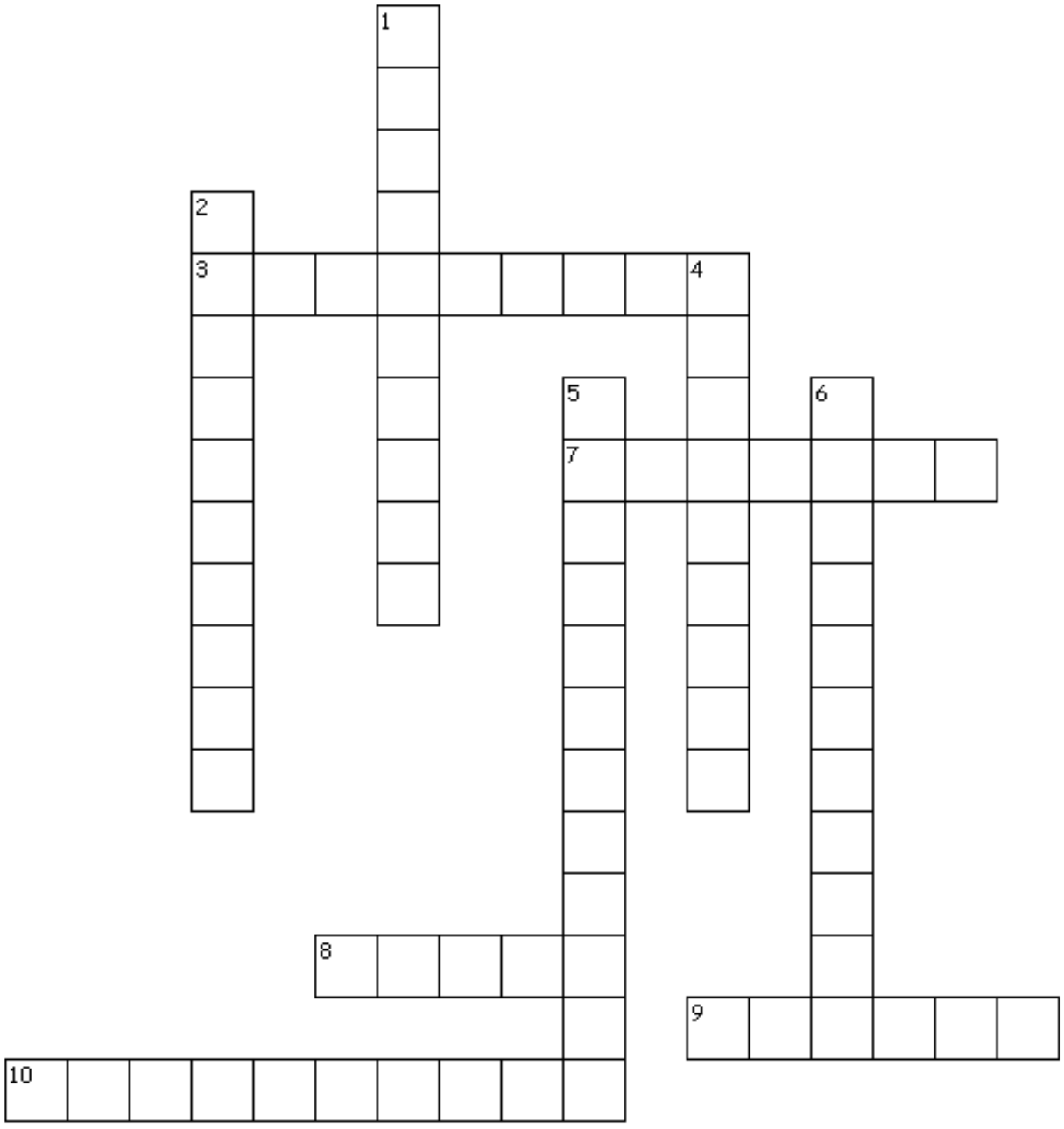
2. Climate change is predicted to increase global temperatures leading to both worsening droughts and more flooding.

    a. How do you think rising temperatures could contribute to each of what appear to be opposite effects?

    b. How do you think drought and flooding could impact food production and food safety?

Group F – Task 1

CONSERVE Water for Food



CONSERVE Water for Food
Crossword Puzzle Clues

Across

3. EPA data indicate the U.S. produces approximately 32 billion gallons of municipal effluent, of which less than 10% is _____. (Figure 7)

7. In 2010 in the U.S., irrigation accounted for 49,500 million _____ per day of groundwater withdrawal. (Figure2)

8. The greatest proportion of water use in the Eastern United States is for thermoelectric _____. (Figure 1)

9. The water source most likely to contaminate produce with pathogens is surface water unprotected from _____. (Figure 6)

10. In 2010 in the U.S., irrigation accounted for sixty-five percent of total freshwater _____.

Down

1. Freshwater use has increased as the human _____ has increased. (Figure 3)

2. The greatest proportion of water use in the Western United States is for _____. (Figure 1)

4. Total groundwater _____ in the U.S. increased during the period of 1950 to 2008. (Figure 4)

5. EPA data indicate the most common use of reclaimed water is for _____ irrigation. (Figure 7)

6. Producing enough food to support the projected 2050 world population of 9 billion people will require approximately a 19% increase in _____ of agricultural water. (Figure 5)

Group F – Task 1 - Crossword Puzzle Clues and Answers

Water Use and Reuse, Groundwater Reserves, Population Change and Water Needs

Puzzlemaker.com

Word	Clue	Figure	Crossword Puzzle Clue
Irrigation	The greatest proportion of water use in the Western United States is for _____.	1	2 Down
Power	The greatest proportion of water use in the Eastern United States is for thermoelectric _____.	1	8 Down
Gallons	In 2010 in the U.S., irrigation accounted for 49,500 million _____ per day of groundwater withdrawal.	2	7 Across
Withdrawal	In 2010 in the U.S., irrigation accounted for sixty-five percent of total freshwater _____.	2	10 Across
Population	Freshwater use has increased as the human _____ has increased.	3	1 Down
Consumption	Producing enough food to support the projected 2050 world population of 9 billion people will require approximately a 19% increase in _____ of agricultural water.	5	6 Down
Depletion	Total groundwater _____ in the U.S. increased during the period of 1950 to 2008.	4	4 Down
Runoff	The water source most likely to contaminate produce with pathogens is surface water unprotected from _____.	6	9 Across
Reclaimed	EPA data indicate the U.S. produces approximately 32 billion gallons of municipal effluent, of which less than 10% is _____.	7	3 Across
Agricultural	EPA data indicate the most common use of reclaimed water is for _____ irrigation.	7	5 Down

Group F – Task 2

1. Fill in the missing numbers and letters in the cryptogram below according to the established patterns.

2. Using the completed crossword puzzle from Task 1, identify the fourth letter of the answer to *1 Down*. Find the corresponding number in the cryptogram below.

   Task 1 puzzle: *1 Down*, fourth letter _____ Corresponding Task 2 cryptogram number _____

3. Using the completed crossword puzzle from Task 1, identify the letter at the intersection of *3 Across* and *4 Down*. Find the corresponding number in the cryptogram below.

   Task 1 puzzle: letter at intersection of *3 Across* and *4 Down* _____ Corresponding Task 2 cryptogram number _____

4. The difference between the two numbers identified in steps 2 and 3 of Task 2 comprise the first two digits of the numeric lock code.

Cryptogram

A		**C**			**F**		**H**	**I**			**L**		**N**			**Q**		**S**	**T**		**V**		**X**	**Y**	
0	**3**	**6**		**12**	**15**		**21**		**27**	**30**			**39**		**45**		**51**		**57**			**66**			**75**

Group F – Task 2 – Solution

1. Fill in the missing numbers and letters in the cryptogram below according to the established patterns.

2. Using the completed crossword puzzle from Task 1, identify the fourth letter of the answer to *1 Down*. Find the corresponding number in the cryptogram below.

   Task 1 puzzle: *1 Down*, fourth letter _____ Corresponding Task 2 cryptogram number _____
   Solution: Letter U and corresponding number 60

3. Using the completed crossword puzzle from Task 1, identify the letter at the intersection of *3 Across* and *4 Down*. Find the corresponding number in the cryptogram below.

   Task 1 puzzle: letter at intersection of *3 Across* and *4 Down* _____ Corresponding Task 2 cryptogram number _____
   Solution: Letter D and corresponding number 9

4. The difference between the two numbers identified in steps 2 and 3 of Task 2 comprise the first two digits of the numeric lock code.
   Solution: 51

Cryptogram

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**
0	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30**	**33**	**36**	**39**	**42**	**45**	**48**	**51**	**54**	**57**	**60**	**63**	**66**	**69**	**72**	**75**

Group F – Task 3

Find the words in the puzzle from the list below. Unused letters reveal a hidden clue to the code.

T D E R U N O F F P

H R S R E T A W O E

E O A L A S T P C N

G U E O F D U E D E

N G R E C L A I M G

A H C I A G O I T O

H T N T I S F O I H

C L I M A T E V D T

E O Y T I R A C S A

N O I T C I D E R P

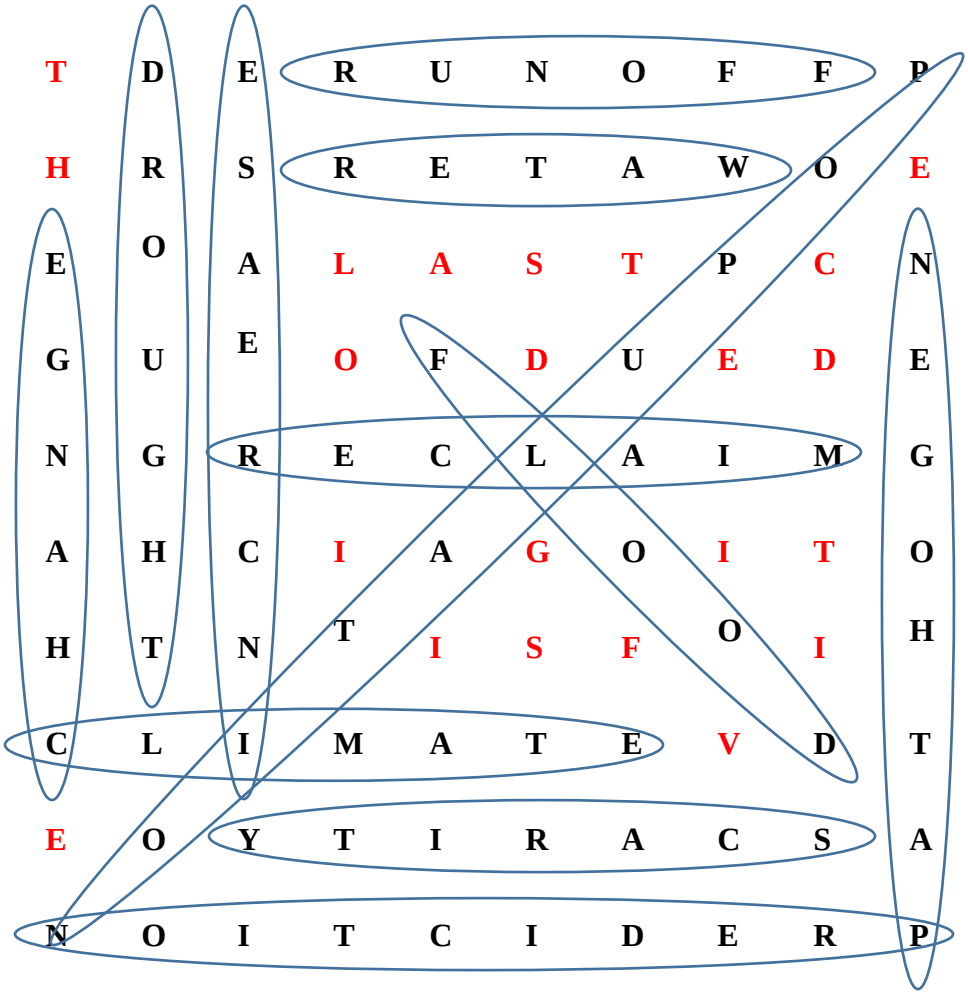
CLIMATE	CHANGE	PREDICTION
INCREASE	FLOOD	DROUGHT
PATHOGEN	POPULATION	RUNOFF
WATER	SCARCITY	RECLAIM

Hidden Message

__ __

Group F – Task 3 - Solution

Find the words in the puzzle from the list below. Unused letters reveal a hidden clue to the code.



CLIMATE	CHANGE	PREDICTION
INCREASE	FLOOD	DROUGHT
PATHOGEN	POPULATION	RUNOFF
WATER	SCARCITY	RECLAIM

Hidden Message: THE LAST CODE DIGIT IS FIVE

Group F – Task 1 – Figure 1

United States' Water Use Data

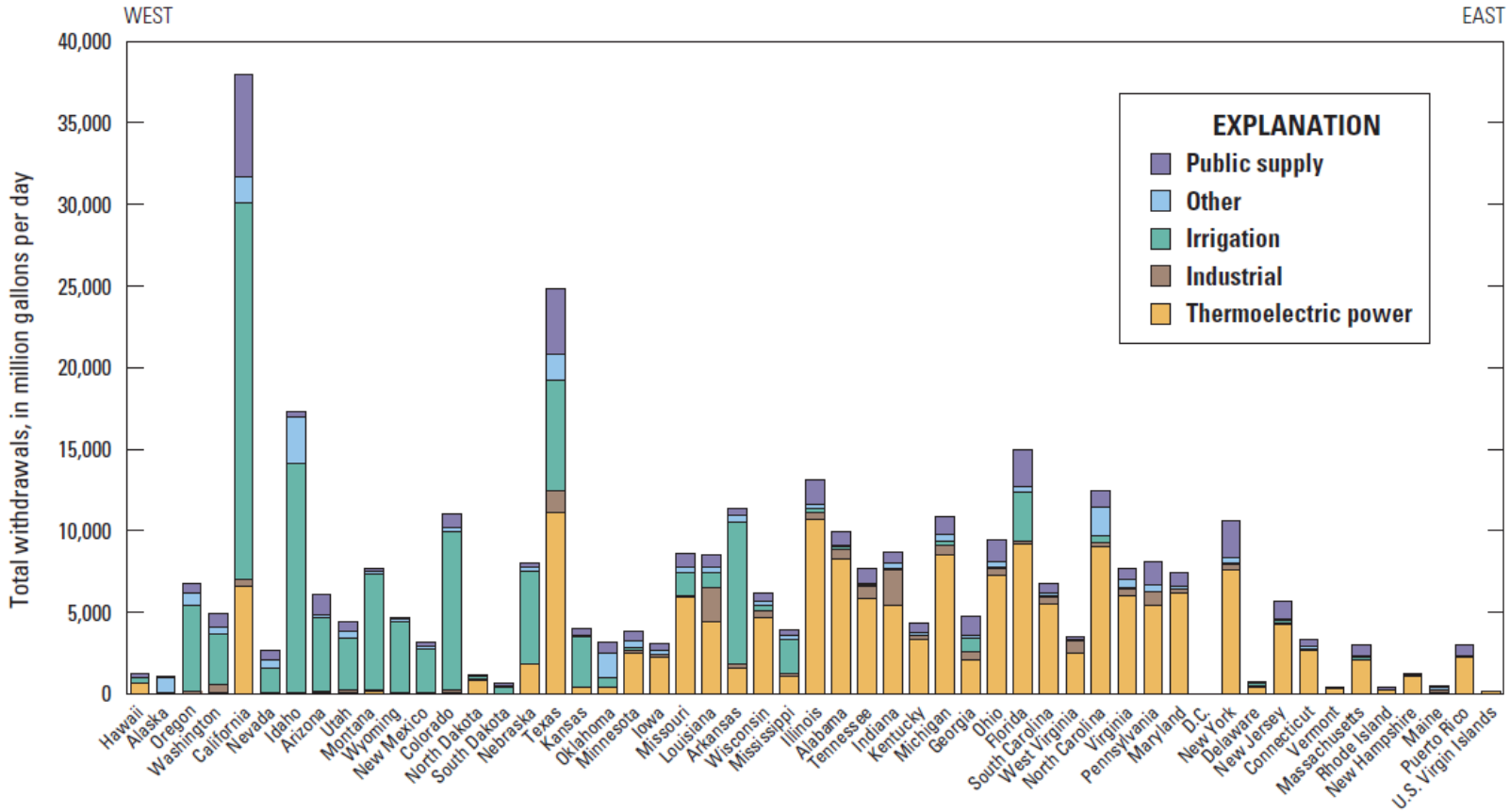


Figure 2. Total water withdrawals by State and barchart showing categories by State from west to east, 2010.

Maupin, M. A., Kenny, J. F., Hutson, S. S., Lovelace, J. K., Barber, N. L., and Linsey, K. S. 2014. Estimated use of water in the United States in 2010. *U. S. Geological Survey Circular 1405*, 56 p., http://dx.doi.org/10.3133/cir1405.

Group F – Task 1 – Figure 2

United States' Groundwater Use Data

Table 4A. Groundwater withdrawals by water-use category, 2010, in million gallons per day.

[Values may not sum to totals because of independent rounding]

State	Public supply	Self-supplied domestic	Irrigation	Live-stock	Aqua-culture	Self-supplied industrial		Mining		Thermoelectric power		Total		
						Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total
Alabama	280	38.0	84.9	11.7	32.4	34.0	0	12.7	0	0	0	494	0	494
Alaska	27.2	14.1	1.57	0.10	429	3.38	0	0.01	144	2.19	0	478	144	622
Arizona	585	27.2	1,690	27.0	39.5	12.9	0	86.6	0	77.3	0	2,550	0	2,550
Arkansas	134	12.8	7,380	15.6	181	56.1	5.05	0.18	0	4.26	0	7,780	5.05	7,790
California	2,830	142	8,690	84.4	171	399	0	24.1	236	33.1	48.4	12,300	369	12,700
Colorado	130	37.9	1,300	25.1	23.0	3.45	0	5.46	19.4	16.8	0	1,540	19.4	1,560
Connecticut	135	65.4	0.85	1.01	6.67	6.28	0	0.92	0	0	0	216	0	216
Delaware	44.8	14.8	86.1	1.31	0.06	8.43	0	0.44	0	0.37	0	156	0	156
District of Columbia	0	0	0.05	0	0	0	0	0	0	0	0	0.05	0	0.05
Florida	2,010	214	1,580	19.1	1.86	165	0	78.8	0	43.5	6.54	3,970	154	4,120
Georgia	243	115	636	2.38	3.92	206	0	19.3	0	2.92	0	1,230	0	1,230
Hawaii	258	1.85	101	0.63	2.14	4.63	0	1.40	0	53.2	50.8	423	50.8	474
Idaho	212	79.0	3,820	38.5	65.6	32.6	0	1.28	0	0.88	0	4,250	0	4,250
Illinois	367	92.4	208	36.0	4.78	124	0	15.5	25.5	5.65	0	853	25.5	879
Indiana	351	126	98.4	26.2	6.60	82.2	0	4.52	0	24.6	0	720	0	720
Iowa	309	38.4	41.6	102	14.4	123	0	1.53	0	21.2	0	650	0	650
Kansas	160	14.9	2,880	91.0	4.37	33.5	0	9.34	0	11.2	0	3,200	0	3,200
Kentucky	71.0	19.7	1.65	2.21	0.53	81.4	0	7.80	0	15.3	0	199	0	199
Louisiana	378	47.0	670	4.15	197	231	0	5.32	0	41.1	0	1,570	0	1,570
Maine	27.7	33.0	2.51	1.71	25.8	6.54	0	1.14	0	0.96	0	99.4	0	99.4
Maryland	89.2	85.6	53.4	6.02	5.06	11.3	0	7.25	0	2.25	0	260	0	260
Massachusetts	191	37.9	118	0.90	7.23	4.28	0	1.82	0	0.21	0	361	0	361
Michigan	204	231	147	17.7	4.21	75.0	0	10.1	0.57	4.12	0	693	0.57	694
Minnesota	353	79.0	171	59.3	1.69	61.8	0	8.32	0	2.34	0	736	0	736
Mississippi	349	44.6	1,960	7.35	113	77.8	0	8.23	12.6	50.0	7.05	2,610	19.6	2,630
Missouri	293	61.8	1,350	18.4	10.5	34.3	0	24.4	0	19.9	0	1,810	0	1,810
Montana	65.6	21.2	127	12.4	2.45	36.9	0	1.73	18.6	0.85	0	268	18.6	286
Nebraska	234	44.0	4,300	93.0	6.07	28.8	0	0.09	0.13	5.25	0	4,710	0.13	4,710
Nevada	133	29.8	653	5.06	10.6	0.70	0	341	0.95	17.9	11.0	1,190	11.9	1,200
New Hampshire	34.7	33.3	1.25	0.67	8.09	10.6	0	0.01	0	1.02	0	89.7	0	89.7
New Jersey	398	98.3	67.6	0.98	9.16	34.8	0	1.73	0	1.57	0	612	0	612
New Mexico	211	25.8	1,240	32.8	15.8	10.3	0	27.4	0	9.59	0	1,570	0	1,570
New York	457	152	30.2	14.6	3.36	35.9	0	8.34	0	2.39	0	704	0	704
North Carolina	194	231	88.3	56.9	11.5	83.8	0	27.8	0	0.37	0	694	0	694
North Dakota	30.5	3.68	77.5	12.9	0	5.77	0	8.73	13.6	0	0	139	13.6	153
Ohio	455	134	17.2	7.70	15.4	197	0	79.0	0	23.0	0	929	0	929
Oklahoma	130	26.8	429	32.5	3.25	6.46	0	4.75	1,400	1.26	0	635	1,400	2,030
Oregon	114	60.0	1,910	3.00	33.4	2.62	0	7.47	0	1.48	0	2,130	0	2,130
Pennsylvania	226	201	7.39	45.6	47.9	73.8	0	51.4	0	4.49	0	657	0	657
Rhode Island	15.8	8.02	2.30	0.17	5.60	4.17	0	0.43	0	0	0	36.5	0	36.5
South Carolina	114	115	67.7	5.23	2.00	22.7	0	6.69	0	4.86	0	339	0	339
South Dakota	74.3	5.37	198	19.1	24.8	6.85	0	7.22	0	3.34	0	339	0	339
Tennessee	301	38.7	44.3	14.0	15.4	47.6	0	6.89	0	1.78	0	470	0	470
Texas	1,130	259	5,100	131	9.13	108	2.04	122	810	38.8	0	6,830	884	7,710
Utah	364	8.44	494	7.77	97.1	31.2	37.5	2.59	41.6	24.0	10.5	1,030	92.6	1,120
Vermont	14.0	13.6	0.77	4.22	5.97	2.00	0	0.32	0	0.74	0	41.6	0	41.6
Virginia	71.0	124	16.0	6.52	9.39	74.2	0.02	6.56	0	1.55	0	299	9.97	309
Washington	471	113	798	19.2	86.4	99.4	0	13.4	0	1.57	0	1,600	0	1,600
West Virginia	34.2	30.9	0.05	1.66	11.7	35.1	3.80	5.53	1.02	1.40	0	121	4.82	125
Wisconsin	261	78.4	256	65.8	25.5	54.3	0	10.9	0	2.78	0	754	0	754
Wyoming	51.5	8.55	437	6.14	2.10	4.92	0	37.1	67.1	2.29	0	550	67.1	617
Puerto Rico	87.3	2.41	22.4	5.57	0.01	4.30	0	1.43	0.32	1.17	0	125	0.32	125
U.S. Virgin Islands	0.91	0	0	0.01	0	0.22	0	0	0	0	0	1.14	0	1.14
TOTAL	15,700	3,540	49,500	1,200	1,820	2,900	48.4	1,120	2,790	587	134	76,000	3,290	79,300

Maupin, M. A., Kenny, J. F., Hutson, S. S., Lovelace, J. K., Barber, N. L., and Linsey, K. S. 2014. Estimated use of water in the United States in 2010. *U. S. Geological Survey Circular 1405*, 56 p., http://dx.doi.org/10.3133/cir1405.

Group F – Task 1 – Figure 3

United States Freshwater Withdrawals and Human Population

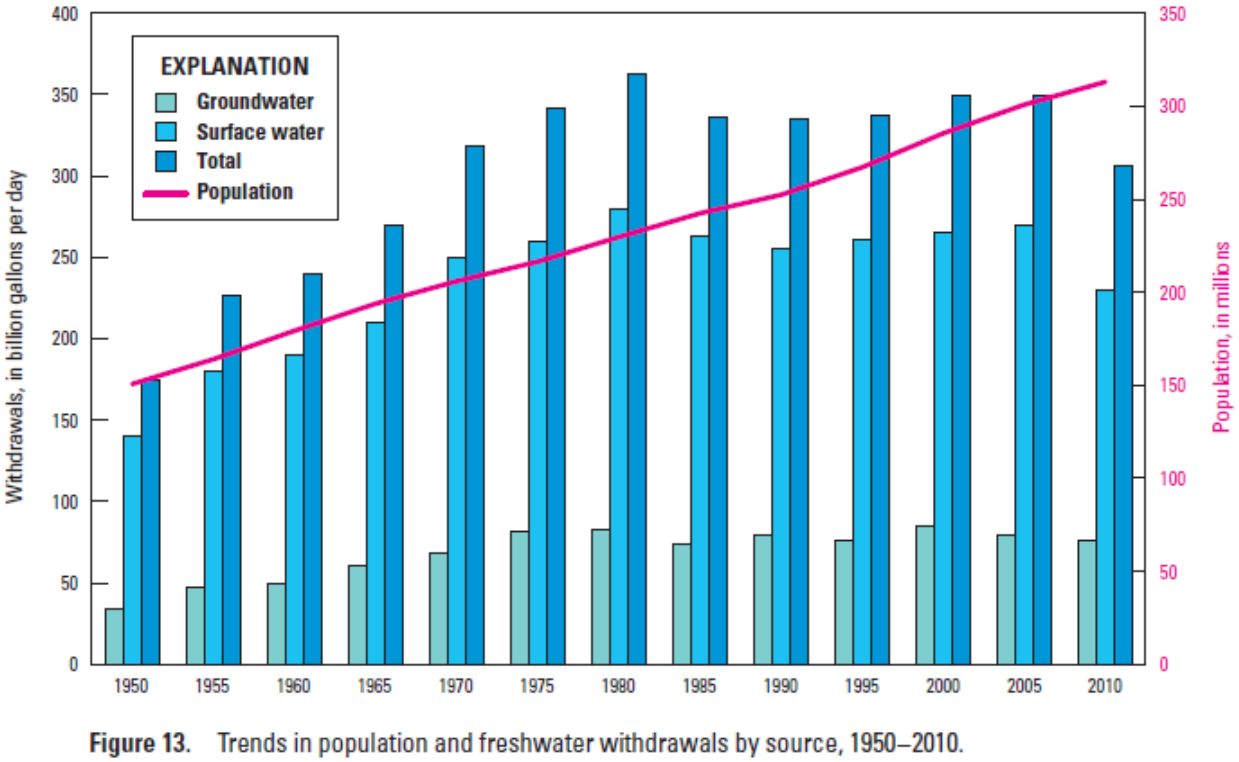


Figure 13. Trends in population and freshwater withdrawals by source, 1950–2010.

Maupin, M. A., Kenny, J. F., Hutson, S. S., Lovelace, J. K., Barber, N. L., and Linsey, K. S. 2014. Estimated use of water in the United States in 2010. *U. S. Geological Survey Circular 1405*, 56 p., http://dx.doi.org/10.3133/cir1405.

Group F – Task 1 – Figure 4

Groundwater Depletion in the United States

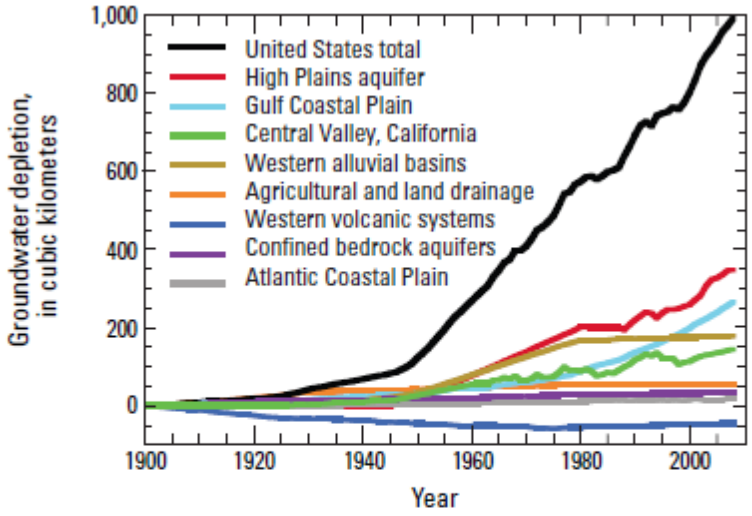
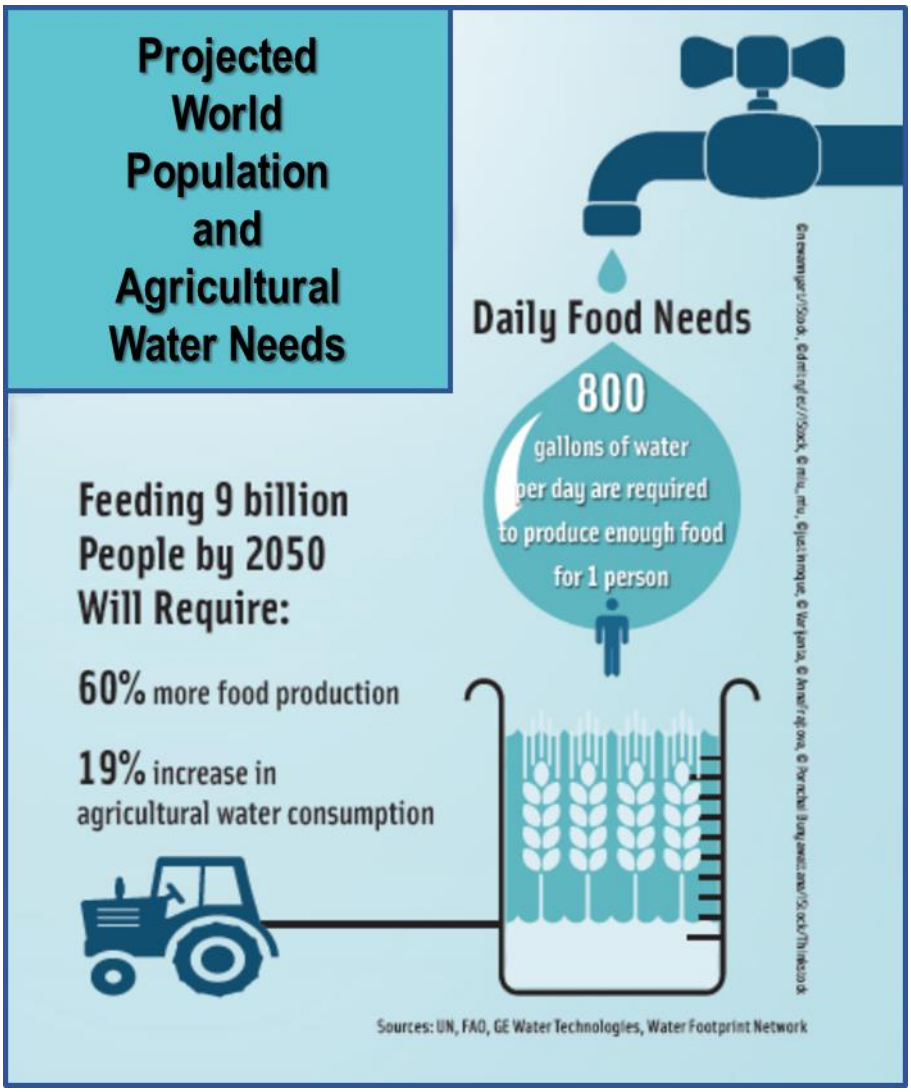


Figure 56. Cumulative groundwater depletion in the United States and major aquifer systems or categories, 1900 through 2008 (modified from Konikow, 2011).

Konikow, L.F. 2013. Groundwater depletion in the United States (1900-2008): U.S. Geological Survey Scientific Investigations Report 2013-5070, 63 p., http://pubs.usgs.gov/sir/2013/5079.

Group F – Task 1 – Figure 5

Projected World Human Population and Agriculture Water Needs



Institute of Food Technologists. June 2015. *Food Technology*

Group F – Task 1 – Figure 6

Produce Contamination Risk by Water Source

Table 7. Relative Likelihood of Produce Becoming Contaminated with Pathogens of Public Health Concern from Agricultural Water

	Least → Most			
Source	Public Drinking Water	Ground water	Surface water protected from runoff	Surface water unprotected from runoff
And where contamination is known to exist, the likelihood of contamination is a function of the following factors:				
Contact with commodity	Indirect contact		Direct contact	
Commodity effects	Unlikely infiltration		Susceptible to infiltration	
	Surface not conducive to adhesion		Surface conducive to adhesion	
Application timing	Early in crop growth	Late in crop growth	During harvest	Postharvest

US FDA. 2015. Final Qualitative Assessment of Risk to Public Health from On-Farm Contamination of Produce.

Group F – Task 1 – Figure 7

Reclaimed Water Use in the United States

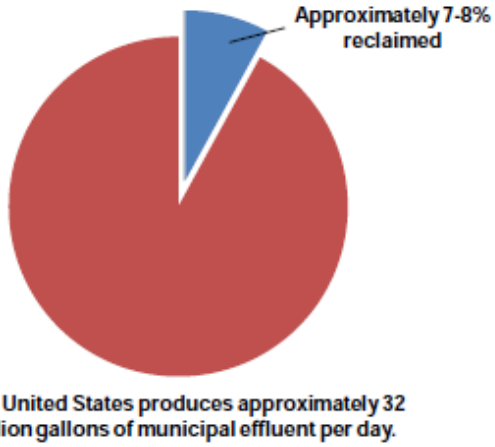


Figure 3-1
Reclaimed water use in the United States

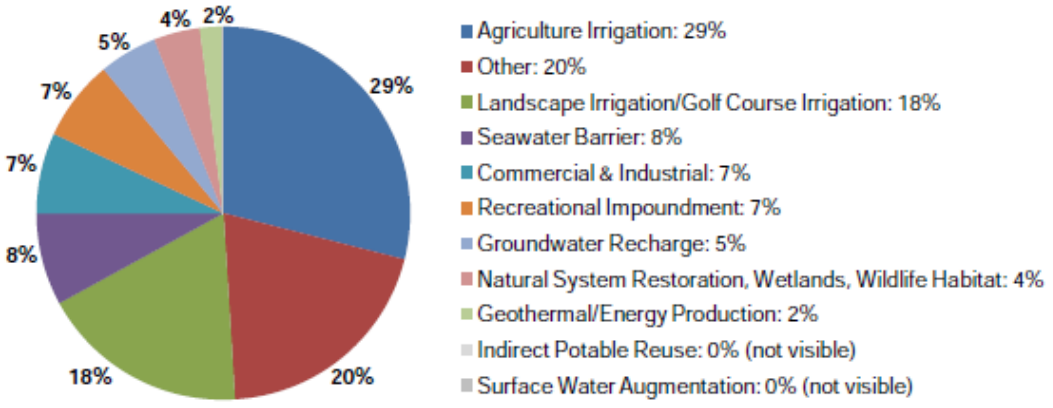


Figure 3-2
Nationwide reuse summaries of reclaimed water use in agricultural irrigation (adapted from Bryk, et al., 2011)

US EPA. 2012. *Guidelines for Water Reuse*. EPA/600/R-12/618 | September 2012

Group F

Code Solution: 515

CONGRATULATIONS GROUP F!

You cracked the code.

Please get ready to present to the class.

Acknowledgement:

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