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Laboratory of Molecular Microbiology and Immunology

#### **PhD THESIS**

Molecular Epidemiology and Antimicrobial Resistance Spread of Environmental *Escherichia coli* Isolates «A One Health Approach»

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#### PhD THESIS

Molecular Epidemiology and Antimicrobial Resistance Spread of Environmental *Escherichia coli* Isolates «A One Health Approach»

#### Chrysoula E. Dioli

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#### **Author's Declaration for Doctoral Thesis**

I, the undersigned, Chryssoula Dioli, PhD candidate in the Department of Biomedical Sciences, School of Health and Care Sciences, University of West Attica, hereby declare that:

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Furthermore, I certify that this work has been exclusively written by me and constitutes intellectual property both of myself and the University of West Attica. Any breach of this academic responsibility constitutes a substantial reason for the revocation of my doctoral degree.

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#### **DISSEMINATION OF RESULTS - PUBLICATION**

During the course of my doctoral research, the findings from both my dissertation and the additional projects I participated in were published in internationally peer-reviewed scientific journals and presented at national and international conferences.

### Publications in international scientific journals

Dioli Chrysoula, Pappa Olga, Siatravani Eirini, Bratakou Spiridoula, Tatsiopoulos Apostolos, Giakkoupi Panagiota, Miriagou Vivi & Beloukas Apostolos (2023). Molecular Characterization and Prevalence of Antimicrobial-Resistant *Escherichia coli* Isolates Derived from Clinical Specimens and Environmental Habitats, *microorganisms*, 11 (6), 1399

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### Conferences

- Participation in the 1st Conference of the Hellenic Scientific Society of Aesthetics, as a speaker in the Round Table titled "What an Aesthetic Professional Should Know," with the presentation topic: "Analysis of the Microbiome of Recreational Waters," Athens, Aigaleo, December 2, 2023.
- Participation in the 13th Panhellenic Conference of Panhellenic Union of Bioscientists, "A New Era for Biology: Opportunities and Challenges in the Post-COVID Era," Thessaloniki, December 9-12, 2022, where the presentation titled "Study of Resistant Environmental and Clinical Strains of *Escherichia coli*" was given as an oral presentation.
- Participation in the 13th Panhellenic Public Health Conference 2022, "Eudaimonia: The Eternal Goal of Public Health," Athens, February 28 - March 2, 2022, where the presentation titled "Study of Resistance Profiles of *E. coli* Strains Isolated from Dairy Farms" was given as an oral presentation.
- 4. Participation in the 12th Panhellenic Conference "Bioscientists and One Health: Humans, Animals, Environment," Athens, November 27-29, 2020, where the study titled "Study of Resistance Profiles of Environmental *Escherichia coli* Strains from Livadeia" was presented as a poster.
- 5. Participation in the 6th Panhellenic Conference of Medical Laboratory Technologists titled "Biomedical Practices and Technological Challenges in Clinical and Research Laboratories," Athens, March 29-31, 2019, where the presentation titled "Study of Resistance Profiles of *E. coli* Strains Isolated from Two Central Swimming Pools in Athens" was given as an oral presentation.
- Participation in the 8th International Conference on Swimming Pools and Spa, Marseille, France, March 18-22, 2019, where the presentation titled "Resistance Profiles of *E. coli* Isolates Deriving from Two Central Swimming Pools of Athens, Greece" was given as an oral presentation.

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#### Abstract

Antibiotic resistant bacteria are present in wastewaters as their elimination during treatment in wastewater treatment plants is often impossible. Water plays an important role in the spread of these microorganisms among humans, animals and the environment. Unfortunately, in Greece knowledge on prevalence and diversity of antibiotic resistance bacteria in environmental habitats is very limited.

Therefore, this doctoral dissertation was designed to study antimicrobial resistance under the One Health approach and aimed to a) assess the antibiotic resistance patterns and detect the antibiotic resistance genes related to resistant phenotypes, b) identify molecular genotypes, c) compare resistance patterns and genotypes between clinical and environmental E. coli isolates and d) identify molecular mechanism contributing to antimicrobial resistance spread both in clinical settings and in environment (aquatic and wastewater). For this reason, during the thesis, a total of 139 clinical and 502 environmental E. coli isolates were collected. Environmental isolates were obtained from semi-treated hospital wastewater, treated wastewater, and river water samples. All these isolates (clinical and environmental) are spatially and temporally related. In order to examine the circulated phylogenies in the clinical settings and in different environmental habitats all isolates were subjected to the molecular typing technique of phylogrouping. This method shown that the phylogenetic group B2 was predominant in clinical settings (60%; 84/139) and the second most frequent among wastewaters, whereas group A was dominant in all environmental isolates (48%, 242/502). To determine the prevalent resistance patterns, all isolates (both clinical and environmental) were evaluated for their susceptibility to 18 commonly used antibiotics. Based on the results, the vast majority of both environmental and clinical isolates were resistant, particularly to penicillins. In addition, 84 isolates (73 environmental and 11 clinical) exhibiting resistant or multidrug-resistant profiles associated with  $\beta$ -lactamases were identified and analyzed for  $\beta$ lactamase genes. The blaCTX-M-group 1 gene was found in 52 isolates (62%; 52/84), making it the most frequently encountered β-lactamase gene among both clinical and environmental isolates. Other β-lactamase genes detected included blaCTX-M-group 9 (8.4%; 7/84), blaTEM (14.3%; 12/84), blaSHV (20.2%; 17/84), blaOXA-244 (1.2%; 1/84), blaCMY-2 (2.4%; 2/84), blaDHA-1 (1.2%; 1/84), and blaFOX-17 (1.2%; 1/84). Finally, plasmid analysis, conjugation assay and plasmid sequencing were implemented in certain  $\beta$ - lactamase producing isolates to investigate the molecular environment of resistance genes and others molecular mechanisms which probable contributing to resistance dissemination. Out of the 33 isolates initially selected for the conjugation assay, only thirteen (39.4%; 13/33) appeared to contain conjugative plasmids and consequently the ability to transmit resistance  $\tau o \beta$ -lactamases. Sequencing analysis was applied in three plasmids

which were isolated from one clinical and two environmental *E. coli* and carried  $\beta$ -lactamase genes. Specifically, the three plasmids were ptrc203cli, ptrc618, and ptrc297, which respectively carried the  $\beta$ -lactamase genes blaDHA-1, blaCTX-M-14, and blaSHV-12. The first two plasmids belong to the compatibility group IncFII, while the last one belongs to the IncX3 group. Additionally, these conjugative plasmids not only carried the aforementioned  $\beta$ -lactamase genes but also additional resistance genes related to resistance to other categories of antibiotics. Specifically, ptrc203cli also co- carried resistance genes for sulfonamides (sul1), trimethoprim (drfA17), and fluoroquinolones (qnrB4); the plasmid ptrc618 harbored resistance genes for aminoglycosides (aac6'-Ib3), macrolides (mphA), and chloramphenicol (cmlA1); and ptrc297 carried a resistance gene for quinolones (IS elements and integrons), which contribute to the further spread of multidrug resistance.

In conclusion, this doctoral thesis reports confirming data that river water and wastewater serve as reservoirs of antibiotic resistant bacteria and as vehicles for the transmission of resistance genes to various bacterial species.

#### Keywords: E. coli; environment; antibiotic resistance

## Chapter 1

## **Theoretical Part**

#### Introduction

The rise of antimicrobial resistance (AMR) to nearly all clinically significant antibiotics represents an urgent global health threat that could undermine a century of medical advancements [1, 2]. AMR reduces the effectiveness of antimicrobials, resulting in increased morbidity and mortality rates [1, 2]. Antibiotic-resistant bacteria (ARB) are not limited to clinical environments but are disseminated through various ecological pathways [3, 4, 5, 6, 7]. This phenomenon is largely driven by the selective pressure exerted by the use of antimicrobials in human and veterinary medicine, agriculture, and aquaculture [8, 9, 10]. Substantial quantities of antimicrobial residues are released into the environment through several channels, including effluents from wastewater treatment plants (WWTPs), disrupting the equilibrium between sensitive and resistant bacterial populations [11, 12, 13, 14].

WWTPs process large volumes of municipal and industrial waste daily, including hospital wastewater (HWW), which contains ARB and antibiotic resistance genes (ARGs) [1, 14, 15, 16]. Both ARB and ARGs can evade treatment, and WWTP effluents (a) provide conducive conditions for ARB proliferation and horizontal gene transfer of ARGs, (b) are frequently discharged into aquatic environments such as rivers, seas, and lakes, and (c) are reclaimed for industrial or irrigation purposes in many countries, thereby facilitating the further dissemination of AMR in the ecosystem [3, 17, 18]. Systematic monitoring of wastewater is critical for detecting the presence and release of ARB into the environment, which is essential for the safe reuse of treated wastewater [2, 7]. Additionally, wastewater surveillance offers insights into the ARB and ARGs circulating within the community.

Although the resistance of *E. coli* to last-resort antibiotics, commonly used in clinical settings, livestock farming, and aquaculture, has been extensively studied in hospital settings, there is limited data available on its presence in community and environmental contexts. *E. coli* is capable of causing serious infections in both humans and animals and is also a member of the indigenous microbiota. Furthermore, *E. coli* serves as a significant reservoir of resistance genes, which can lead to therapeutic failures in human medicine. Numerous resistance genes have been identified in *E. coli*, many of which are transferable through horizontal gene transfer [**3**, **4**, **6**]. *E. coli* can function as both a donor and recipient of resistance genes. The transmission of virulent and resistant *E. coli* strains between aquatic environments and humans is a major concern, and this can occur through direct contact or via the food chain. Therefore, the genetic background of resistance genes and the circulating phylogenetic groups of antibiotic-resistant *E. coli* isolates in environmental settings are of increasing importance and warrant close monitoring and investigation [**3**, **4**, **6**, **19**]. The following section delves into the fundamental properties and classifications of antibiotic agents.

#### 1.1 Antibiotic agents

Antibiotics (or antibacterials) are chemical substances that kill or inhibit the growth of bacteria without harming the host. They are used to prevent or treat infections caused by bacteria in humans, animals and plants. Antibiotics are produced in nature by fungi, actinomycetes and bacteria, which contribute to the diversity of natural antibiotic compounds. The antibacterial agents derived from natural sources (e.g. benzylpenicillin and gentamicin) are usually chemically modified to improve their antibacterial or pharmacological properties and referred as semi-synthetic (ampicillin and amikacin). Some other agents are totally synthetic (e.g. moxifloxacin and norfloxacin) [**20**]. Antibacterial agents can be classified based on various criteria:

- Mechanism of action: bactericidal vs. bacteriostatic: Bactericidal agents eliminate bacteria, whereas bacteriostatic agents merely inhibit bacterial growth. Therefore, bactericidal action results in irreversible bacterial death, while bacteriostasis is a reversible process [20].
- Target site of action: Antibacterial agents can be categorized based on their primary target within bacterial cells. The five main targets are (a) cell wall synthesis, (b) protein synthesis, (c) nucleic acid synthesis, (d) metabolic pathways, and (e) cell membrane function [21] (Table 1.1, Figure 1.1).
- **Spectrum of activity**: Antibiotics are classified as broad-spectrum or narrow-spectrum. Broad-spectrum antibiotics are effective against a wide range of bacteria, including both Gram-positive and Gram-negative species, whereas narrow-spectrum antibiotics target either Gram-positive or Gram-negative bacteria specifically [20].
- Chemical structure: Antibiotics are also grouped by their chemical structure, which is directly linked to their unique therapeutic properties. Based on this criterion, antibiotics are classified into several categories, including β-lactams, macrolides, tetracyclines, aminoglycosides, quinolones, glycopeptides, macrolides, and miscellaneous agents (e.g., sulfonamide-trimethoprim) [20].

Mechanism of Action		Antimicrobial Groups
Cell Wall Synthesis Inhibition		<ul> <li>β-Lactams:</li> <li>Carbapenems</li> <li>Cephalosporins</li> <li>Monobactams</li> <li>Penicillins</li> <li>Glycopeptides</li> </ul>
Cell Membrane Depolarization		Lipopeptides
Metabolic Pathways Inhibition		Sulfonamides Trimethoprim
Protein Synthesis Inhibition	Bind to 30S Ribosomal Subunit	Aminoglycosides Tetracyclines
	Bind to 50S Ribosomal Subunit	Chloramphenicol Lincosamides Macrolides Oxazolidinones Streptogramins
Nucleic Acid Synthesis Inhibition		Quinolones
Outer Membrane Disruption		Colistin (Polymyxin E)

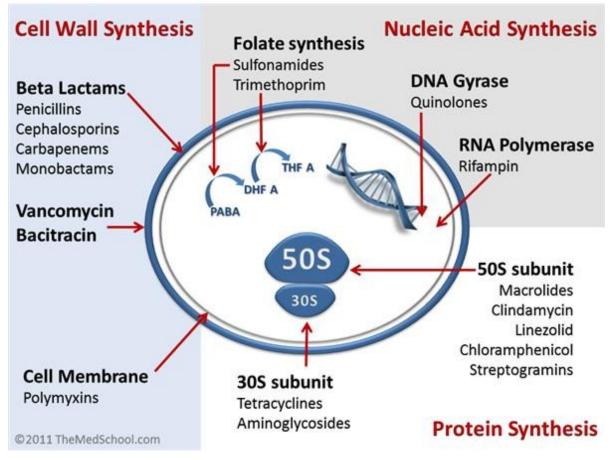


Figure 1.1 Target sites of different antibiotic categories [22]

#### 1.2 Antimicrobial resistance (AMR): definition

Antimicrobial resistance (AMR) is the ability of a microorganism to survive and resist exposure to antimicrobial drug. In the medical setting, the term 'resistant microorganism' is defined as one that will not be inhibited or killed by an antibacterial agent at concentrations of the drug achievable in the body after normal dosage [2, 20, 21, 23].

Before discussing the various aspects of antimicrobial resistance, the distinction between natural and acquired resistance should be mentioned. Not all antibiotics are active against all bacterial species. Some species have endogenous/intrinsic resistance to certain antibiotic categories [20, 21, 23]. These intrinsic resistance traits are known and predetermined. In other cases, some bacterial strains become resistant to antibiotics in their spectrum. This type of resistance call acquired and it is what the public health is concerned about [20, 21, 23].

#### **1.3 Factors contributing to the AMR spread**

AMR is a natural phenomenon that is primarily triggered by the selective pressure of antimicrobial use in human and veterinary medicine, agriculture and aquaculture [8, 9, 10]. Constantly, significant amounts of antimicrobial residues are released into the environment, and in particular into the aquatic environment, via various routes. As a result, susceptible bacteria are killed, while bacteria that are intrinsically resistant or that have acquired antibiotic-resistant traits have a greater chance to survive and multiply [11, 12, 13, 14]. Furthermore, under unfavorable conditions, such as high antibiotic concentration, microorganisms possessing defense strategies endure and proliferate [23, 24, 25, 26]. Their strategies for protecting against antibiotics are called resistance mechanisms and are briefly described in Table 1.2. Figure 1.2 illustrates the main mechanisms of bacterial resistance to antibiotics [23]. Advantageous chromosomal mutations or exogenous genetic elements acquisition can lead to antibiotic tolerance [20-26]. These resistance traits can be inherited generation to generation (vertical transfer) as well as pass directly from bacterium to bacterium (horizontal gene transfer, HGT) via conjugation, transduction, or transformation mode (Figure 1.3) [20-26, 28]. Horizontal gene transfer (HGT) and mobile genetic elements (MGEs) play a crucial role in the spread of antibiotic resistance genes (ARGs) within and between species [20-26, 28]. MGEs such as plasmids, transposons, insertion sequences and integrons contribute to the dissemination of various ARGs due to their ability to move from one location to another within the cell or be transferred from cell to cell horizontally [28]. Very often, MGEs harbor multiple resistance genes that confer a multidrug resistance (MDR) phenotype to their hosts [20-26, 28].

For the reasons above, the microbiota and microbiome of many environmental habitats have undergone excessive changes due to the increase of ARB and the subsequent accumulation of ARGs, which are present in both extracellular and intracellular forms in the environment. In these settings antibiotics, ARBs, ARGs, and the environmental bacterial flora can interact [21-28].

Soil, aquatic environments and wastewaters are identified as reservoir of ARB and ARGs and as ideal settings for development of new ARB via horizontal ARGs tranfer. Specifically, water and wastewaters are regarding a major ways of dissemination of ARB between different environmental compartments [21-28].

Wastewater treatment plants (WWTPs) receive vast quantities of municipal and industrial waste daily, including hospital wastewater (HWW) that contains ARB and ARGs [1, 14, 15, 16]. ARB and ARGs can evade treatment, and WWTP effluents (a) are often discharged into water bodies such as rivers, seas and lakes and (b) are reclaimed for industrial or irrigation purposes, in many countries, thus contributing to the further spread of AMR in the ecosystem [3, 17, 18].

Table 1.2 The main mechanisms of antimicrobial resistance [24]		
Antibiotic Resistance Mechanism	Description	
Restrict assess of an antimicrobial agent due to changes in membrane permeability	The LPS layer in gram-negative bacteria provides innate resistance to certain antimicrobial groups of antimicrobials Porin-mediated antibiotic resistance: Porins are transmembrane proteins which form channels and normally exists found within the outer membrane of gram-negative bacteria. The porin channel allows the exchange of nutrients and other substances (including antibiotics such as $\beta$ -lactams and fluoquinolones) between the extracellular environments. The loss or reduced number of porins present in the outer membrane or mutations that change the selectivity of the porin channel prevents the absorption of external substances such as antibacterial compounds [25]	
Rapid efflux of antimicrobial agents due to over-expression of efflux pumps	Efflux pumps are proteins that are imbedded in the cytoplasmatic membrane of the bacterium. The primary efflux pump function is to remove harmful substances from a bacterial cell. Many of these pumps will transport a large variety of compounds, including antibiotics. Over-expression of efflux pumps resulting in a more efficient antibiotic extrusion. Efflux systems may be responsible for resistance to several chemically distinct antibiotics such as fluoroquinolones, $\beta$ -lactams, chloramphenicol, and trimethoprim [21, 26]	
Modification of bacterial molecules that are antimicrobial targets due to mutational events	Structural alterations in an enzyme, primarily caused by mutations located within or near its active site, can inhibit the binding of antibiotics to the target enzyme. Example: Antibiotic resistance in agents targeting enzymes involved in nucleic acid synthesis, such as fluoroquinolones, may arise due to mutations in the genes encoding DNA gyrase or topoisomerase IV. These mutations cause changes in the structure of gyrase and topoisomerase which decrease or eliminate the ability of the antibiotic factor to bind to these components [20, 21, 24, 27].	
Antibiotic inactivation	Bacteria synthesize enzymes that hydrolyze antibiotics, rendering them ineffective. Example: $\beta$ -lactamases are enzymes that inactivate $\beta$ -lactam antibiotics by hydrolyzing a specific bond in the $\beta$ -lactam ring structure. This structural modification prevents the altered $\beta$ -lactam antibiotics from binding to their target penicillin-binding proteins (PBPs). The genes encoding $\beta$ -lactamases can be either inherently located on the bacterial chromosome or acquired through plasmids. The production of $\beta$ -lactamases is the most prevalent resistance mechanism employed by Gram-negative bacteria against $\beta$ -lactam antibiotics [21, 26]. *PBP: penicillin-binding proteins	

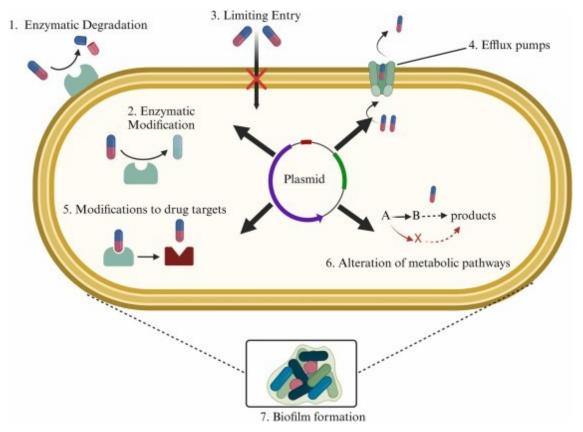


Figure 1.2 The main mechanisms of antibiotic resistance in Gram-negative bacteria [23]

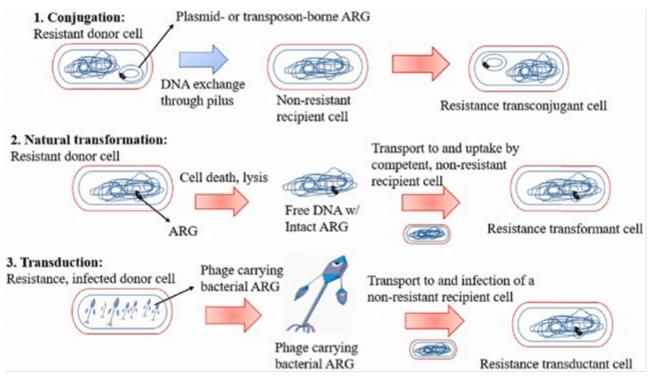


Figure 1.3 Schematic representations of the three mechanisms of HGT [28]

#### 1.4 Mechanisms of resistance to major antimicrobial agents

#### 1.4.1 Resistance to $\beta$ - lactams: inactivation by $\beta$ - lactamase enzymes

Extensive use of  $\beta$ -lactams, like other antimicrobial classes, has resulted in the development and spread of resistance. This resistance can arise through various mechanisms, such as changes to the antibiotic's target (through mutation or the expression of alternative penicillin-binding proteins, PBPs), reduced cell permeability due to decreased porin expression needed for  $\beta$ -lactam entry, overproduction of efflux pumps, and the production of enzymes that modify or degrade the antibiotic [**20**, **29**, **30**]. For  $\beta$ -lactams, resistance often involves enzyme-mediated hydrolysis by  $\beta$ -lactamases, enzymes produced by both Gram-positive and Gram-negative bacteria that hydrolyze the  $\beta$ - lactam ring. In Gram-negative bacteria,  $\beta$ -lactamases remain in the periplasmic space and the genes encoding these enzymes are located either on chromosomes or on plasmids [**20**].

To date, hundreds of different  $\beta$ -lactamase enzymes have been described. While these enzymes share a common function, their amino acid sequences vary, which influences their substrate specificity and inhibitor susceptibility. [20, 29, 30]. The identification of an increasing number of  $\beta$ -lactamases, along with the availability of protein and corresponding nucleotide sequence data, has revealed that these enzymes do not form a single homogeneous group but can be categorized into

multiple distinct classes [30, 31]. B-lactamase enzymes can generally be divided into four types based on their substrate specificity:

Penicillinases: These enzymes specifically target and inactivate penicillin antibiotics.

Narrow spectrum cephalosporinases: These enzymes are more effective against first and secondgeneration cephalosporins.

Extended-Spectrum  $\beta$ -Lactamases (ESBLs): These enzymes can hydrolyze a broad range of  $\beta$ -lactams, including penicillins, third and fourth-generation cephalosporins, and monobactams.

Carbapenemases: These are the most potent  $\beta$ -lactamases, capable of inactivating even carbapenems.

To achieve a more precise classification of these enzymes, several schemes have been developed. However, the most widely recognized systems for categorizing  $\beta$ -lactamases are those proposed by Ambler and Bush–Jacoby. According to the Ambler classification,  $\beta$ -lactamases are divided into four distinct classes: A, B, C, and D, based on amino acid sequence homology and hydrolytic mechanism. Classes A, C, and D are referred to as serine  $\beta$ -lactamases (SBLs) due to their serine active sites, while class B is known as metallo- $\beta$ -lactamases (MBLs) or zinc metalloenzymes because of the presence of metal (zinc) ions at their catalytic site [**30**].

In contrast, the Bush–Jacoby system classifies  $\beta$ -lactamases into groups 1 through 4 according to their substrate hydrolysis profiles and their inhibitor profiles, particularly inhibition by  $\beta$ -lactamase inhibitors (such as clavulanic acid and tazobactam) [**32**, **33**].

#### 1.4.1a Enzymes that hydrolyze extended-spectrum β-lactams

There are two major families of enzymes that can hydrolyze extended-spectrum  $\beta$ -lactams: extended- spectrum  $\beta$ - lactamases (ESBLs) and AmpC  $\beta$ -lactamases. Enzymes from both families possess the ability to hydrolyze third and fourth-generation cephalosporins, as well as aztreonam. These are potent antibiotics, often used in the treatment of severe, primarily hospital-acquired infections [**31**, **32**, **33**].

#### Extended-Spectrum β-Lactamases (ESBL)

ESBL are enzymes that inactivate of broad-spectrum cephalosporins (third- and fourth-generation) and monobactams (aztreonam) but not cephamycins (cefoxitin) or carbapenems (meropenem, imipenem, ertapenem, and doripenem) [**33**, **34**, **35**] Also, ESBLs are often neutralized by  $\beta$ -lactamase inhibitors (such as clavulanic acid, and tazobactam) [**33**, **34**, **35**]. ESBLs are produced by diverse range of Gram-negative bacterial species from various families such as *E. coli*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* spp. Among them E. coli is the most common host of ESBLs, followed by *K. pneumoniae* [**36**].

ESBLs are classified under Ambler's classes A and D, where serine functions as the active site of the enzyme. According to the Bush-Jacoby-Medeiros classification system, ESBLs in Ambler's classes A and D are categorized in group 2, specifically in subgroup 2be [33]. The most prevalent enzyme families within Ambler class A include TEM-, SHV-, and CTX-M- ESBLs [34, 37, 38, 39]. ESBLs have evolved from narrow- spectrum (non- ESBLs, with a more limited range of antibiotic activity) β- lactamases. TEM- type ESBLs are derived from the plasmid- mediated β- lactamase, TEM-1, which was first identified in the early 1960s. TEM-3 was the initial variant to exhibit the ESBL phenotype. Since then, 243 distinct TEM variants have been identified. SHV- type ESBLs, originating from chromosomally encoded enzymes in K. pneumoniae, include 228 variants, with SHV-5 and SHV-12 being the most common ESBL enzymes. CTX-M- type β- lactamases were first reported in the late 1980s and were initially named after their ability to hydrolyze cefotaxime. Since the early 2000s, CTX-M- type enzymes have become the most common ESBL group [37, 38, 39]. CTX-M enzymes are prevalent in hospital and community settings, as well as in animals, the environment, food products, and livestock. CTX-M enzymes are clustered into five groups: CTX-M-1, CTX-M-2, CTX-M-8, CTX-M-9, and CTX-M-25 [38, 39, 40]. Among the CTX-M- group- 1, the most common enzyme is CTX-M-15, followed by CTX-M-3 and CTX-M-1, while in the CTX-M-9 group, CTX-M-9 and CTX-M-14 are dominant. CTX-M variants efficiently hydrolyze cefotaxime and ceftriaxone (hence the name cefotaximase) and exhibit limited activity against ceftazidime [37-40]. However, variants such as CTX-M-27 and CTX-M-15, which have enhanced ceftazidime hydrolytic activity, have been described.

The global spread of ESBL genes is primarily driven by horizontal gene transfer. Most ESBLencoding genes are plasmid- borne and are associated with various insertion sequences (ISs), including ISEcp1, ISCR1, IS26, and IS10, as well as transposons such as Tn2, and integrons transposons. The plasmids carrying ESBLs are typically conjugative and self-transferred [27, 37, 38, 39].

Genes encoding TEM-1, TEM-2, and their ESBL derivatives are usually carried by Tn1-, Tn2-, or Tn3-like transposons, which are embedded in plasmids. The replicon types of conjugative plasmids harboring TEM-type ESBL genes primarily belong to the IncA/C type [**37**, **38**, **39**].

Genes encoding SHV-type ESBLs can be found either on plasmids or within the chromosome and are often flanked by intact copies of the mobilizing element IS26. Seven plasmid replicon types have been identified that predominantly carry blaSHV-encoding ESBL enzymes, including IncA/C, IncF, IncHI2, IncI1, IncL/M, IncN, and IncX3. Various blaSHV variants have been detected in these plasmid types, with the exception of IncX3, which has only been detected carrying blaSHV-12 [**37**, **38**, **39**].

Several blaCTX-M types are located adjacent to the mobile element ISEcp1. Elements harboring blaCTX-M are usually carried by conjugative plasmids. For example, blaCTX-M-15 is often embedded in narrow host range plasmids that belong to the IncF replicon type, such as IncFII alone or in association with IncFIA or IncFIB. The dissemination of blaCTX-M group 9 genes appears to be associated with IncHI2-type plasmids, although there have also been reports of IncFII-type plasmids [27, 37, 38, 39].

#### β- Lactamases of class C (AmpC- type lactamases)

Class C  $\beta$ - lactamases, also known as AmpC- type enzymes, can be expressed either from chromosomal or plalasmid- borne genes. Both chromosomal and plasmid- mediated AmpC enzymes confer high-level resistance to cephalosporins, cephamycins (such as cefoxitin), aztreonam, and typically to  $\beta$ -lactamase inhibitors like clavulanic acid. AmpC-type  $\beta$ -lactamases are classified as molecular class C according to the Ambler classification and fall under group 1 in the Bush-Jacoby scheme [**33**].

AmpC- type enzymes are encoded on the chromosomes of many Enterobacteriaceae and other Gram-negative species [27, 41]. In several bacterial species, including *Citrobacter freundii*, *Serratia marcescens*, and *P. aeruginosa*, AmpC expression is typically low but can be induced upon exposure to certain  $\beta$ -lactams, mainly to cefoxitin and imipenem. However, derepression of these enzymes - either due to mutation or induced by specific  $\beta$ -lactams - can result in high-level expression, leading to increased resistance to carbapenems, particularly ertapenem. In other organisms, such as *Acinetobacter baumannii* and *E. coli*, one or more components of the induction system are absent [27, 33, 41].

Regarding to plasmid-mediated enzymes are also exist in both Enterobacteriaceae and nonfermenting species like *P. aeruginosa*. Plasmid-borne genes encoding certain AmpC family members, such as CMY, ACT, DHA, FOX, and MIR, have been identified. The primary plasmidencoded AmpC  $\beta$ -lactamases include CMY, DHA, and ACC types, with CMY-type enzymes being the most prevalent worldwide [27, 40].

Plasmids carrying AmpC  $\beta$ - lactamase genes commonly belong to incompatibility group IncA/C. These conjugative plasmids often carry additional resistance genes for aminoglycosides, chloramphenicol, quinolones, sulfonamides, tetracycline, and trimethoprim, as well as other  $\beta$ -lactamase genes. Various genetic elements are involved in the mobilization of AmpC genes onto plasmids. For instance, the insertion sequence ISEcp1 is associated with many CMY alleles and is known to facilitate the transposition of adjacent genes, including mobilizing chromosomal  $\beta$ -lactamase genes onto plasmids [27, 41].

#### 1.4.1b Carbapenemases

Carbapenemases are  $\beta$ -lactamases that belong to various Ambler classes (A, B, D) and can be encoded by either chromosomal or plasmid-mediated genes. These enzymes are among the most potent  $\beta$ -lactamases, capable of hydrolyzing a wide range of  $\beta$ -lactams, including penicillins, 3rd and 4th generation cephalosporins, aztreonam, and even carbapenems [**33**, **42**]. The ability of these enzymes to break down carbapenems, the most potent last-resort antibiotics used in the treatment of very serious infections caused by multidrug-resistant bacteria, is particularly concerning [**36**, **38**, **40**, **42**]. So the clinical significance of carbapenemase production lies in its ability to compromise the efficacy of last-resort antibiotics used for treating severe infections [**36**, 40]. Epidemiologically, these enzymes pose a major challenge due to their widespread dissemination across various bacterial species and geographical regions [**27**, **42**, **43**]. Initially, carbapenemase- producing Enterobacteriaceae garnered significant attention following their first report in the early 1990s. More recently, there has been growing concern over the impact of non-fermenting bacteria, such as *A. baumannii* and *P. aeruginosa*, as well as other Gram-negative organisms that produce carbapenemases [**42**, **43**].

According to the Bush–Jacoby classification, carbapenemases are categorized into groups 2d, 2f, and 3. Based on the Ambler classification, they are divided into classes A, B, and D. Classes A and D include  $\beta$ -lactamases with serine at their active sites, while class B comprises metalloenzymes that require zinc for their catalytic activity [**33**].

#### Ambler class A carbapenemases:

Some of these enzymes are encoded on the bacterial chromosome, while others, such as IMI (imipenemase), KPC, and certain variants of GES (Guiana extended spectrum), are plasmidencoded. Plasmid-encoded enzymes are frequently associated with mobile genetic elements that promote their horizontal transfer between bacteria. Among Ambler class A carbapenemases, KPC (*K. pneumoniae* carbapenemase) is of particular concern due to its presence on self-conjugative plasmids and its frequent association with *K. pneumoniae*, a bacterium known for its capacity to acquire and disseminate resistance genes. The first KPC enzyme, KPC-1, was identified in a *K. pneumoniae* isolate in North Carolina in 1996. Within a few years, KPC-producing strains had spread worldwide, with reports from North and South America, the Middle East, Greece, Italy, and China, where they are now considered endemic [42, 43].

Although more than 20 different KPC variants have been identified, KPC-2 and KPC-3 remain the most common. The global dissemination of blaKPC genes in *K. pneumoniae* is associated with the major clone (sequence type ST-258), which serves as a successful transporter. Despite the genetic diversity among KPC variants, blaKPC genes are typically associated to a single transposon, Tn4401. This is a 10-kb Tn3-based transposon, flanked by two 39-bp imperfect inverted repeat

sequences, that harbors not only the KPC gene but also a transposase gene, a resolvase gene, and two novel insertion sequences known as ISKpn6 and ISKpn7. The gene blaKPC, except for K. *pneumoniae*, it has also been detected in other Enterobacteriaceae, such as *E. coli*, as well as in *P. aeruginosa* isolates [27, 42, 43].

#### **Class B carbapenemases:**

These enzymes, known as metallo- $\beta$ -lactamases (MBLs), require a heavy metal such as zinc for catalysis. MBLs have an extensive substrate spectrum and can hydrolyse virtually all  $\beta$ -lactam antibiotics, including carbapenems, with the exception of monobactams (like aztreonam). Since MBLs are metalloenzymes, they are resistant to commercially available  $\beta$ -lactamase inhibitors (such as clavulanic acid) but are susceptible to inhibition by metal ion chelators like ethylenediaminetetraacetic acid (EDTA) [33, 27, 42, 43].

Initially, MBLs were identified as chromosomal enzymes over 50 years ago in environmental and opportunistic pathogenic bacteria, including *Bacillus cereus, Aeromonas spp., Legionella gormanii, Pseudomonas stutzeri, Shewanella spp.,* and *Stenotrophomonas maltophilia*. At present, the most prevalent MBL families, including IMP, VIM, NDM, GIM, and SIM enzymes, are often found within various integrons, where they have been incorporated as gene cassettes. These integrons are embedded in plasmids, allowing them to transfer between bacteria. MBLs are now detected in various Gram-negative bacterial species, where their presence is frequently linked to resistance against multiple antibiotic classes, leading to multidrug resistance and limiting treatment options [27, 42, 43].

The VIM (Verona integron-encoded metallo- $\beta$ -lactamase) family represents one of the most prevalent groups of MBLs. The VIM  $\beta$ -lactamase gene is carried on a gene cassette within a class 1 integron, conferring resistance to a wide range of  $\beta$ -lactam antibiotics, including ampicillin, carbenicillin, piperacillin, mezlocillin, cefotaxime, cefoxitin, ceftazidime, cefoperazone, cefepime, and carbapenems [27, 42, 43]. Although blaVIM genes have been detected in various enterobacterial species, *P. aeruginosa* remains the primary reservoir for these enzymes. To date, over 40 allelic variants of VIM enzymes have been identified, categorized into three major phylogenetic clusters: VIM-1-like, VIM-2-like, and VIM-7-like enzymes. VIM-2-like enzymes are predominantly associated with *P. aeruginosa*, while VIM-1-like enzymes, particularly VIM-4, have been reported in Enterobacteriaceae [42, 43].

Another significant MBL gene is NDM (New Delhi Metallo- $\beta$ -lactamase), which has become a major global concern due to its rapid and widespread dissemination. The first NDM enzyme, NDM-1, was initially identified in a carbapenem- resistant *K. pneumoniae* strain isolated from a urine sample. NDM-1, exhibits only 32.4% similarity to other MBLs such as VIM-1/VIM-2, and can hydrolyze all  $\beta$ -lactams except aztreonam [**33**, **27**, **42**, **43**]. NDM genes are predominantly found in

*K. pneumoniae* and *E. coli*, but variants have also been identified in *A. baumannii* and *P. aeruginosa*. As of 2020, 24 NDM variants have been identified in over 60 species across 11 bacterial families, with several variants demonstrating enhanced carbapenemase activity. Most blaNDM- carrying plasmids are associated with a few replicon types, including IncX3, IncFII, and IncC [42, 43].

#### Ambler Class D Carbapenemases (Oxacillinases):

Among the earliest detected  $\beta$ - lactamases, class D  $\beta$ -lactamases were relatively uncommon in Enterobacteriae and were always plasmid- mediated [42, 43, 44]. These enzymes, often referred to as oxacillinases, are distinguished by their ability to hydrolyze isoxazolylpenicillins such as oxacillin, methicillin, and cloxacillin much more efficiently than classical penicillins like benzylpenicillin, and they show relatively lower activity against first-generation cephalosporins [33, 42-46]. The term "OXA" reflects their preference for oxacillin as a substrate [42]. The active sites of these enzymes feature a highly conserved serine-based structure, although the rest of the enzyme exhibits variability in amino acid sequences. Notably, OXA enzymes are not inhibited by  $\beta$ lactamase inhibitors such as clavulanate, sulbactam, or tazobactam, or by metal chelators like EDTA

#### [33, 42, 44, 45].

Currently, OXA enzymes with carbapenemase activity include groups such as OXA-23-like, OXA-24/40-like, OXA-48-like, OXA-58-like, OXA-143-like, and OXA-235-like [42, 43, 44]. The first carbapenem-resistant OXA-type enzyme identified was OXA-23, found on a large plasmid in a multidrug-resistant *A. baumannii* strain [42, 43]. OXA-48-like enzymes are notably prevalent in Enterobacteriaceae and represent a significant concern in carbapenem resistance, with a rising global prevalence over the past decade [42, 45, 46]. OXA-48 exhibits low-level hydrolytic activity against carbapenems, with greater activity against imipenem compared to meropenem, and only modest hydrolysis of expanded-spectrum cephalosporins such as ceftazidime and cefepime [42, 45, 46]. Despite this, combined with poor permeability, it can result in high-level carbapenem resistance. OXA-48 primarily hydrolyzes penicillins and narrow-spectrum cephalosporins [33, 42, 45]. However, Enterobacteriaceae harboring blaOXA-48-like genes may also carry genes encoding ESBLs (blaCTX-M, blaSHV, blaTEM) or AmpC enzymes, which contributes to resistance to aztreonam, extended-spectrum cephalosporins, and carbapenems [42, 45, 46]. The detection of OXA-48-like producers can be challenging, as the level of acquired carbapenem resistance may be low, leading to underreporting of these strains.

OXA-48 is now widespread not only in *K. pneumoniae* but also in other Enterobacteriaceae. Reports of OXA-48 producers have been sporadic across various European countries, including France, Germany, the Netherlands, Italy, Belgium, the UK, Ireland, Slovenia, Switzerland, and Spain [42, 45]. The primary vector for the blaOXA-48 gene is the 62.3 kb plasmid pOXA-48a, which belongs to the IncL/M type. This plasmid has integrated the gene via the Tn1999 composite transposon, which includes IS1999 insertion sequences that promote blaOXA-48 gene expression [42, 43, 45, 46]. The current spread of OXA-48 producers is thus linked to this highly conjugative plasmid. Nevertheless, chromosomal integration of OXA-48 has been documented in *E. coli* strains from the UK and Egypt [42]. Variants of OXA-48 include OXA-48, OXA-181, OXA-232, OXA-204, OXA-162, OXA-163, and OXA-244, with these being the most common among the group [42, 43, 45, 46].

#### 1.4.2 Resistance to quinolones

Quinolones and fluoroquinolones (next- generation quinolones) are critical antimicrobial agents used to treat a wide range of infections in humans and animals [20, 27]. These agents are effective in killing almost all types of bacteria. Resistance to quinolones and fluoroquinolones generally arises from mutations in the genes encoding DNA gyrase and topoisomerase IV, which are the primary drug targets [20, 27]. Additionally, other resistance mechanisms, such as decreased outer membrane permeability, protection of target structures, or increased activity of efflux pumps, may also contribute to reduced drug efficacy [20, 27].

#### 1.4.2a Chromosomal resistance to quinolones: drug-target modification

The main target of (fluoro)quinolones is DNA gyrase, which is composed of two GyrA and two GyrB subunits. Additionally, topoisomerase IV serves as a secondary target in Gram-negative bacteria, consisting of two ParC and two ParE subunits [20, 27]. Mutations related to quinolone resistance are predominantly found in the quinolone resistance- determining region (QRDR) of the GyrA subunit, specifically between Ala67 and Gln107, with the most frequent mutations occurring at codons 83 and 87 [27]. While single mutations in gyrA can lead to resistance to quinolones, fluoroquinolone resistance typically requires additional mutations in gyrA and/ or parC. Most mutations in parC are found at codons 80 and 84 [27].

# **1.4.2b** Plasmid-mediated resistance to quinolone: target protection, enzymatic modification, and efflux pumps

Since the discovery of the first plasmid-mediated quinolone resistance (PMQR) gene, qnrA1, in 1997, there has been growing concern about the global spread of PMQR genes [20, 27]. Various plasmid-encoded mechanisms of resistance have been identified, including: i) Qnr-like proteins (QnrA, QnrB, QnrC, QnrD, and QnrS), which shield DNA from the effects of quinolones; ii) the AAC(6')-Ib-cr acetyltransferase, which modifies specific fluoroquinolones (such as ciprofloxacin); and iii) active efflux pumps such as QepA and OqxAB [20, 27]. These resistance factors typically

do not induce high- level resistance to quinolones or fluoroquinolones, but they confer reduced susceptibility to these drugs. Additionally, they may facilitate the emergence of strains with higher resistance levels through the interaction with other chromosomally encoded resistance mechanisms [20, 27].

Plasmid-mediated quinolone resistance (PMQR) genes have been widely identified in both human and animal isolates. In Europe, the most commonly detected genes in *E. coli* isolates are qnrS1 and qnrB19, as well as qnrB1, qnrB4, and qnrB10 [**20**, **27**]. The PMQR genes qnrS1 and qnrB19 are often associated with plasmids belonging to the IncN and IncX replicon types, among others. The aac(6')Ib-cr gene was found on plasmids belonging to the IncF family, frequently alongside a blaCTX-M ESBL gene [**27**].

#### 1.4.3 Resistance to sulfonamides and trimethoprim

Sulfonamides and trimethoprim are synthetic antimicrobial drugs that target different stages in the folic acid synthesis pathway [20, 27]. Each of these agents works by inhibiting bacterial growth (bacteriostatic effect), but when combined, they produce a synergistic bactericidal effect on susceptible bacteria [20]. These drugs have been widely used in both animals and humans for decades. Acquired resistance mechanisms have been frequently identified, mainly due to: i) mutations in the genes encoding the target enzymes, such as dihydropteroate synthase for sulfonamides or dihydrofolate reductase for trimethoprim or ii) the acquisition of sul genes which encode dihydropteorate synthetases that are insensitive to sulfonamides or dfr genes which encode dihydrofolate reductases that are insensitive to trimethoprim [20, 27].

Regarding sul genes, resistance to sulfonamides can be conferred by any of the three sul genes: sul1, sul2, or sul3 [27]. The sul1 gene is especially widespread as it is part of the 3'-conserved segment of class 1 integrons (Figure 1.4), which are often found on plasmids that also carry additional resistance genes [27].

As for the dfr genes that provide resistance to trimethoprim, they have been identified in Enterobacteriaceae and other Gram-negative bacteria [27]. Based on their size and structure, these genes are categorized into two main groups, dfrA and dfrB. Most dfrA and dfrB genes are found on gene cassettes that are inserted into class 1 (Figure 1.4) or class 2 integrons [27].

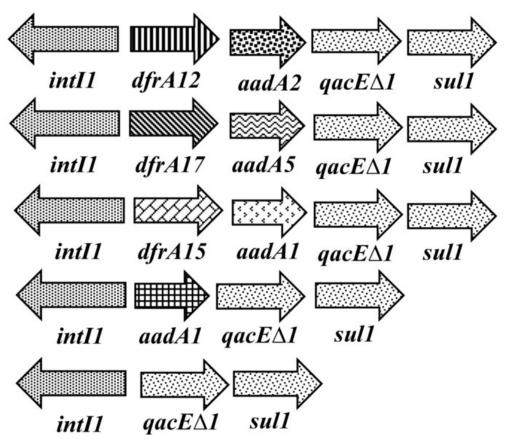


Figure 1.4 Schematic diagrams showing a gene cassette with multiple resistance genes

#### 1.4.4 Colistin resistance mechanisms

Colistin resistance has become a significant concern in recent years, particularly because this antibiotic is often considered a last- resort treatment for infections caused by multidrug- resistant gram-negative bacteria [20, 27]. The mechanisms involved in colistin resistance are both chromosomal and plasmid- mediated [27, 47]. However, the plasmid-mediated mechanisms are of greater concern because they can be easily transferred, spreading resistance among bacterial populations [20, 27, 47].

#### 1.4.4a Plasmid-mediated colistin resistance

The most common mechanism of colistin resistance in Enterobacteriaceae involves the presence of mobilized colistin resistance (mcr) genes [27, 49]. Since the discovery of mcr-1 in 2015, several variants have been identified, including mcr-2, mcr-3, mcr-4, mcr-5, mcr-6, and more [48, 49, 50, 51, 52]. These genes are typically located on conjugative plasmids and encode enzymes that modify the bacterial cell membrane by adding phosphoethanolamine to the lipid-A component of lipopolysaccharides (LPS) [27, 47]. This modification reduces the binding affinity of colistin to the

bacterial membrane, rendering the antibiotic less effective [27]. The first mcr genes were detected in Salmonella spp and *E. coli* strains isolated from animal samples, primarily poultry and pigs [48-52]. Now, there are also reports of mcr in Enterobacteriaceae from human samples, as well as from environmental samples such as river water [27, 48-52]. The spread of these plasmid-mediated genes in clinical settings poses significant challenges for infection control

#### 1.4.4b Colistin resistance due to chromosomal gene mutations

Chromosomal Mutations: Resistance can also arise from mutations in chromosomal genes, such as those encoding the two-component regulatory systems (e.g., pmrA/pmrB), which alter the lipid A component of the bacterial outer membrane [20, 27, 49].

#### 1.5 Current state of AMR and impacts

The emergence of AMR to nearly all clinically relevant antibiotics is a pressing health risk issue that could reverse a century of medical progress [53, 54, 55]. AMR exists everywhere and threatens not only human health but also animal health, the environment, food and nutrition security and safety, as well as economic development [56, 57, 58, 59]. For the above reasons, the World Health Organization (WHO) lists AMR among the top 10 threats for global health. [53, 54, 55, 56, 57, 58, 59]

AMR hampers the effectiveness of antibiotic treatments, making previously manageable infections increasingly difficult to treat [53, 54, 55, 57]. This growing challenge is leading to higher rates of illness and death worldwide [2, 23, 56, 57]. As first- line antimicrobials lose their effectiveness; there is an increasing reliance on second- and third-line therapies. In severe cases, last-resort antibiotics like carbapenems are required to combat multidrug- resistant infections. [23, 56, 57] AMR has far-reaching consequences, not only for individual patients but also for public health. For patients, the absence of effective antibiotics often means longer recovery times, or in some cases, no treatment options at all, potentially resulting in death [23, 56, 57, 58]. At the community level, this situation increases the risk of infection outbreaks, epidemics, and even pandemics. Furthermore, routine medical procedures such as surgeries, organ transplants, chemotherapy, and neonatal care are becoming increasingly hazardous due to the diminished ability to control infections [23, 56, 59]. It was estimated that bacterial AMR contributed to approximately 4.95 million (3.62–6.57 million) deaths in 2019, with 1.27 million (95% UI 0.911-1.71 million) of those deaths directly attributed to bacterial AMR [60]. Regionally, western sub-Saharan Africa had the highest death rate due to resistance, with 27.3 deaths per 100,000 people (20.9-35.3), while Australasia had the lowest at 6.5 deaths per 100,000 people (4.3-9.4). Lower respiratory infections were the leading cause,

responsible for over 1.5 million deaths linked to resistance in 2019, making them the most burdensome infection type (Figure 1.5) [60].

Resistant strains of the six major pathogens - *E. coli*, methicillin- resistant *Staphylococcus aureus* (MRSA), *K. pneumoniae*, *Streptococcus pneumoniae*, *A. baumannii*, and *P. aeruginosa* - were responsible for 929,000 (660,000–1,270,000) deaths attributable to AMR (**Figure 1.6**) and 3.57 million (2.62–4.78 million) deaths associated with AMR in 2019 [**23**, **36**, **56**, **60**]. Among these, MRSA alone caused over 100,000 deaths attributable to AMR, while six additional pathogen-drug combinations, including multidrug-resistant tuberculosis (excluding extensively drug-resistant forms), third-generation cephalosporin-resistant *E. coli* (**Figure 1.7**), carbapenem-resistant *A. baumannii*, fluoroquinolone-resistant *E. coli*, carbapenem-resistant *K. pneumoniae*, and third-generation cephalosporin-resistant *K. pneumoniae*, each caused between 50,000 and 100,000 deaths [**23**, **55**, **56**, **58**, **60**]

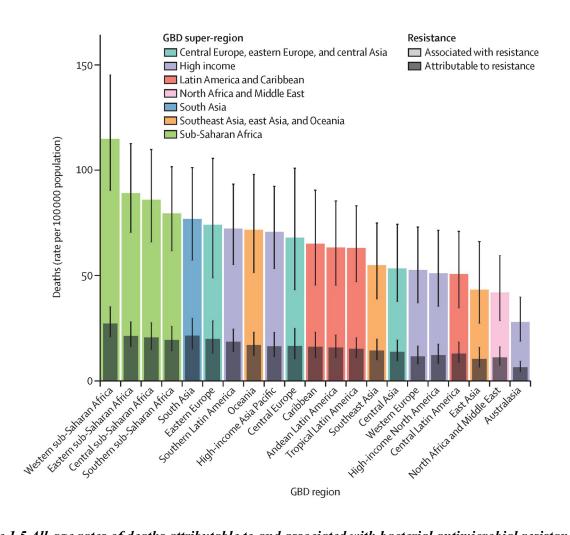


Figure 1.5 All-age rates of deaths attributable to and associated with bacterial antimicrobial resistance by GBD region, 2019 [60]

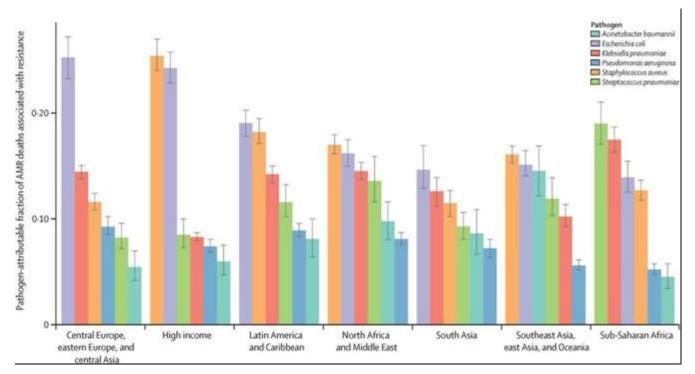


Figure 1.6 Pathogen-attributable fractions of deaths attributable to bacterial AMR for the six leading pathogens by GBD super-region, 2019 [60]

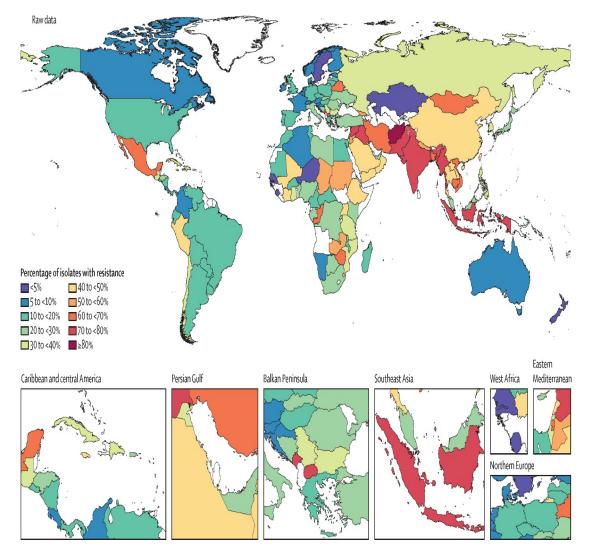
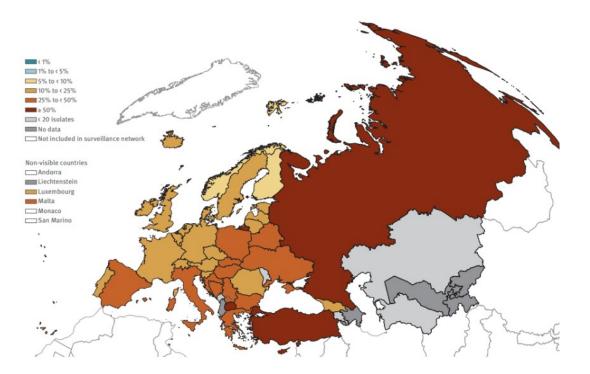


Figure 1.7 The raw data for third-generation cephalosporin-resistant E. coli by country and territory in 2019 [60]

### 1.5.1 Current state of AMR and impacts in Europe

In Europe, the situation is particularly concerning, with reports indicating alarmingly high AMR rates, especially in southern and eastern regions. According to the 2021 data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) [61], several countries reported resistance rates reaching or exceeding 25%, and in some cases, over 50% for last-resort antibiotics like carbapenems in pathogens such as *K. pneumoniae*, *P. aeruginosa*, and Acinetobacter spp [61]. Specifically, for *E. coli* - the most common cause of urinary tract and bloodstream infections- the highest European union (EU) population- weighted mean resistance was reported for aminopenicillins (53.1%), followed by fluoroquinolones (21.9%), and third-generation cephalosporins (13.8%), as shown in the maps in Figures 1.8a and b [61]. Although carbapenem-resistant *E. coli* isolates remain rare, a small but significant increase was noted between 2017 and 2021[61].

a)



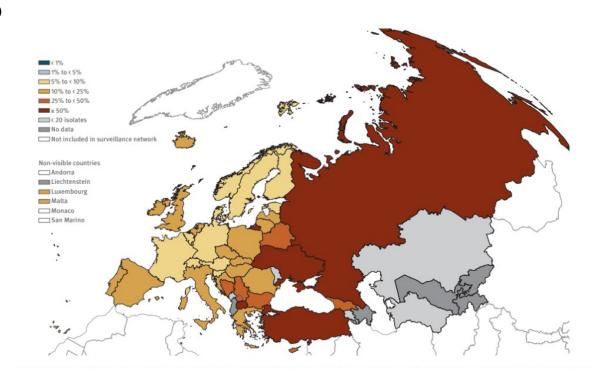


Figure 1.8 Maps showing the percentages of invasive E. coli strains resistant to (a) fluoroquinolones and (b) third-generation cephalosporins, by country, in Europe in 2021 [61].

The European Centre for Disease Prevention and Control (ECDC) conducted a study on the health burden of AMR in the EU/EEA from 2016 to 2020 [62]. The study found that the greatest disease burden came from infections with third-generation cephalosporin- resistant *E. coli*, followed by MRSA and third-generation cephalosporin-resistant *K. pneumoniae* (Figure 1.9) [62]. In 2020, carbapenem- resistant *K. pneumoniae* was estimated to have caused 4,076 deaths. These findings highlight the urgent need for ongoing monitoring and enhanced efforts to effectively address this public health threat [61, 62].

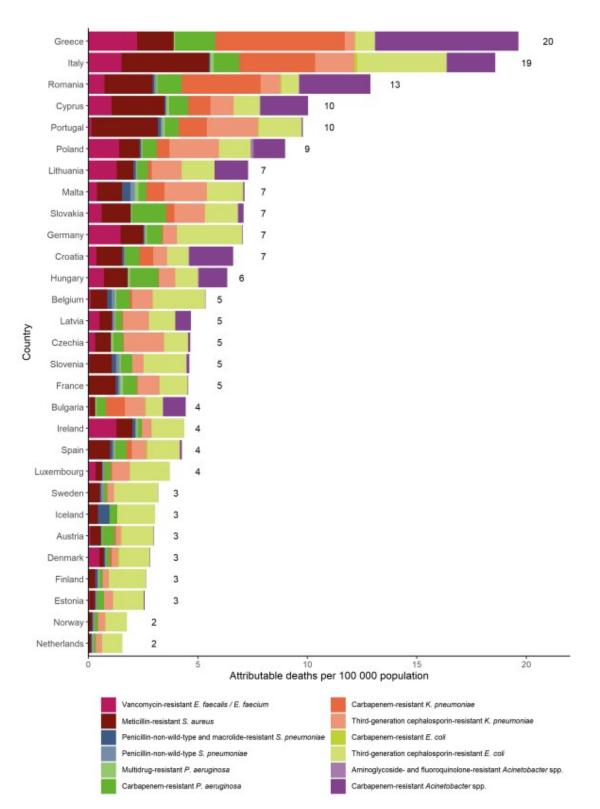


Figure 1.9 Estimations of the burden of infections with antibiotic-resistant bacteria presented as attributable deaths per 100 000 population by country, EU/EEA, 2020 [62]

AMR to critical antibiotics in zoonotic bacteria is an escalating threat, particularly with pathogens like *E. coli*, Salmonella spp., and Campylobacter spp. This resistance facilitates transmission to humans, whether through the food chain or direct contact, and significantly endangers public health. The European Food Safety Authority (EFSA) report for 2021-2022 provides valuable insights into the resistance patterns of these zoonotic bacteria [63]. Notably, resistance to fluoroquinolones, particularly ciprofloxacin, is alarmingly high among Campylobacter isolates from poultry [63]. This is concerning given the role of these bacteria in foodborne illnesses. In addition, the report highlights the prevalence of ESBL-/AmpC-producing isolates in broilers, with resistance rates ranging from 24.6% in Latvia to 97.7% in Germany. In cattle, these rates ranged from 16.7% in Denmark to 98.5% in Germany [63, 64, 65] (Figures 1.10a, b). These findings underscore the widespread nature of AMR in food-producing animals across Europe.

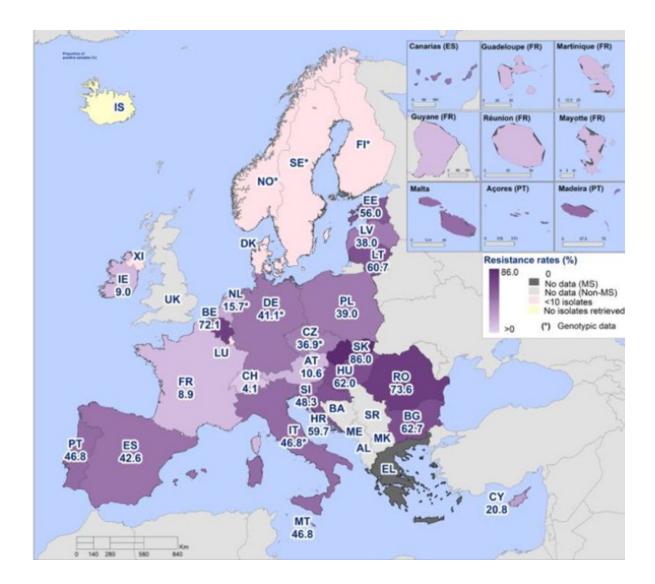
Resistance to last-resort antibiotics, such as colistin and tigecycline, is particularly worrisome [63]. While colistin resistance in *E. coli* from food-producing animals remains relatively low, its presence is still a concern given its critical role in treating multidrug-resistant infections [63]. Furthermore, some countries have reported very high levels of resistance to tigecycline—another last-resort antibiotic used to treat serious infections caused by MDR bacteria—in Salmonella isolates from broilers [63].

The increasing resistance to fluoroquinolones in *Salmonella Enteritidis* and *Campylobacter jejuni* isolates, both commonly associated with poultry, is a significant public health concern [63]. In severe cases of infection, fluoroquinolones are among the key antimicrobials used for treatment, making this trend particularly alarming [63].

Beyond food-producing animals, AMR has also been observed in companion animals. Studies [64, 65] have identified enterobacterial strains resistant to carbapenems in pets (Figure 1.11).

The restricted treatment options due to AMR in livestock not only pose a threat to animal health but also increase the risk of outbreaks among cattle, poultry, and sheep [**58**, **59**]. This often necessitates culling, leading to significant economic losses and threatening food security. It is estimated that AMR could impose a \$3–4 billion financial burden on the livestock sector alone in the coming decades [**58**, **59**].

The economic impact of AMR is difficult to quantify due to the various factors involved. Increased resistance leads to higher costs associated with more expensive antibiotics, specialized equipment, prolonged hospitalization, and isolation procedures for patients [**58**, **59**]. In Europe, the overall economic burden of antibiotic resistance is estimated to be at least 1.5 billion euros, with over 900 million euros attributed to hospital costs [**23**, **58**, **59**, **62**]



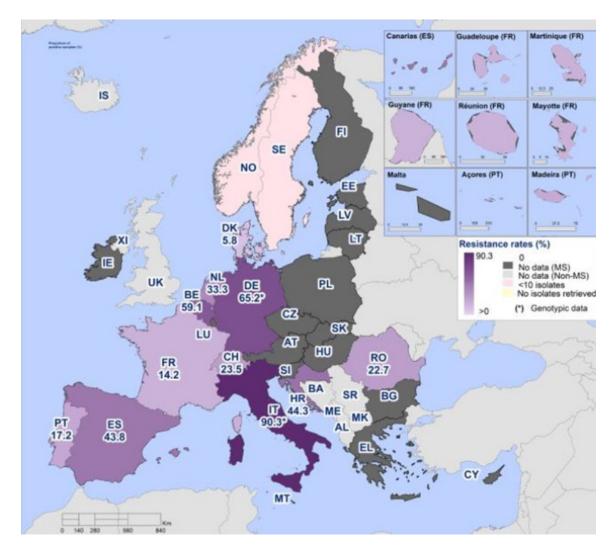


Figure 1.10 Spatial distribution of the prevalence of presumptive ESBL- and/or AmpC- producing Escherichia coli from (a) cattle under 1 year of age, (b) broilers, EU MSs and non-MSs, 2021/2022 [63].

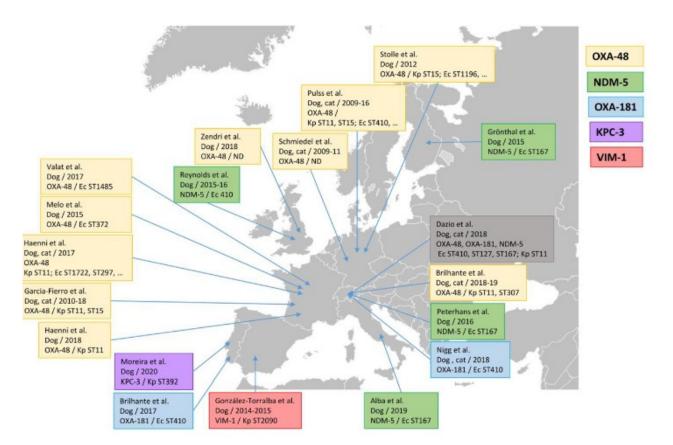


Figure 1.11 Reported carbapenem- resistant Enterobacterales in companion animals [63]

### 1.5.1a Current state of AMR in Greece

Greece is one of the most affected by the AMR countries in Europe. The high prevalence of resistant bacteria, particularly in hospital settings, poses a significant challenge to public health and healthcare systems. Greece's situation reflects broader trends in the Mediterranean region, where antibiotic overuse and misuse have contributed to the rapid emergence and spread of resistant pathogens [61, 62].

Greece consistently reports some of the highest rates of AMR in Europe. Our country faces significant challenges with resistance to several critical classes of antibiotics, particularly in hospital-acquired infections (HAIs) [61, 62]. In 2021, according to surveillance report published by the European Centre for Disease Prevention and Control (ECDC), Greece is among the countries with the highest rates of invasive Gram-negative bacteria such as *K. pneumoniae* and Acinetobacter spp, with resistance to carbapenems [61]. Figure 1.12 shows a significant increase in nosocomial infections caused by carbapenem- resistant isolates of *K. pneumoniae* and *Acinetobacter* spp in 2020, as well as an increase in infections caused by third- generation cephalosporin- resistant isolates

of *E. coli* and *K. pneumoniae* [61]. Additionally, Greece recorded the highest death rate attribuable to AMR, with 20 deaths per 100 000 people in 2020 [62, 66] (see Figure 1.9).

Furthermore, based on annual epidemiological report for the year 2022 issued by the European Surveillance of Antimicrobial Consumption Network (ESAC-Net), Greece also ranks first in antibiotic consumption, both in hospital settings and in community [67]. Specifically, the community antibiotic consumption rate is 32.1% (Figure 1.13) [67]. As for hospital sector, Greece is among the countries that have seen statistically significant increases in the consumption of carbapenems and polymyxins over the past 10 years (Figure 1.14) [66, 67].

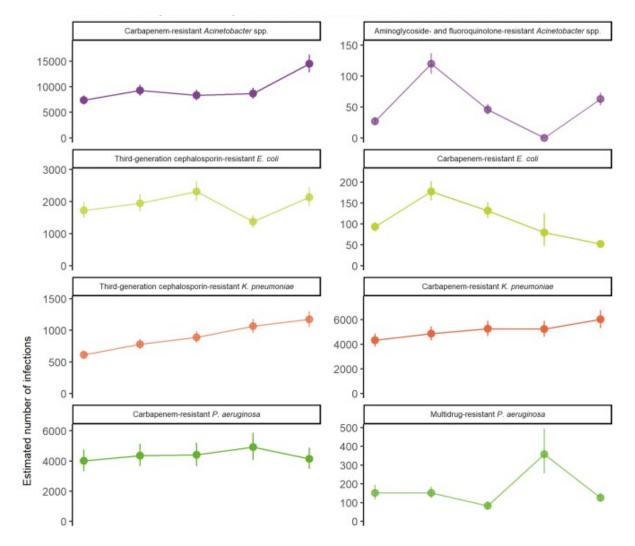


Figure 1.12 Greece: Estimated number of infections (bloodstream and other infections) with 95% uncertainty intervals, by bacterium- antibiotic resistance combination, 2016 – 2020 [66]

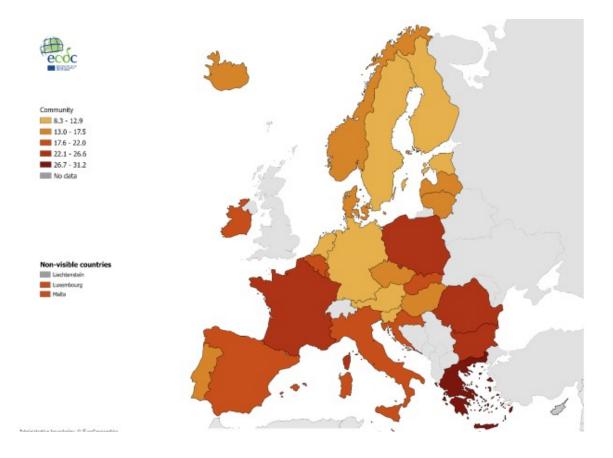


Figure 1.13 Community consumption of antibacterials for systemic use (ATC group J01), EU/EEA countries, 2022 (expressed as DDD per 1 000 inhabitants per day [67]

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Time series 2013–2022	Trend	Compoun annual growth rate (CAGR)
Austria						1	34.0	34.8	36.5	35.3	£	N/A	N/A
Belgium	31.3	31.5	31.7	31.0	30.9	30.2	29.8	31.4	31.2	30.1			-0.5%
Bulgaria	52.7	57.5	55.2	59.8	58.1	57.5	58.5	62.6	71.1	67.5		î	2.8%
Croatia	27.8	31.0	31.7	30.9	32.2	32.2	33.5	36.8	39.4	38.9		Ť	3.8%
Cyprus												N/A	N/A
Czechia									23.5	15.9		N/A	N/A
Denmark	22.8	22.7	20.6	23.7	21.4	22.9	23.9	24.7	24.3	22.6			-0.1%
Estonia	19.3	20.0	20.0	20.6	23.2	19.8	21.8	24.6	24.8	23.2		Ť	2.1%
Finland (a)	22.2	22.7	21.9	22.9	23.2	19.4	18.1	21.4	19.5	18.6		1	-1.9%
France	31.3	32.3	32.2	31.3	31.6	32.6	30.1	32.4	33.4	36.3		-	1.7%
Germany												N/A	N/A
Greece	35.9	35.7	38.6	35.8	36.9	49.1	50.8	50.8	59.8	57.9		Ť	5.4%
Hungary	37.8	37.4	38.8	39.4	40.1	40.6	36.3	40.8	42.4	39.7		-	0.6%
Iceland					16.4	18.1	17.0	18.7	21.3	29.3		N/A	N/A
Ireland	32.3	36.9	29.5	30.1	29.4	28.7	28.1	30.3	31.1	30.3		-	-0.7%
Italy	49.1	48.4	42.8	37.0	48.6	48.5	44.5	42.8	44.4	46.2			-0.7%
Latvia	40.1	39.9	40.1	39.9	38.4	38.1	40.8	36.9	41.9	40.2			0.0%
Lithuania	20.2	21.2	26.2	25.3	23.5	21.5	23.4	24.8	22.0	17.6			-1.5%
Luxembourg	31.1	31.8	33.3	36.0	34.0	35.7	35.1	37.9	37.5	35.1		N/A	1.4%
Maita	30.2	34.8	33.4	27.5	27.4	37.9	37.0	38.6	41.2	39.2		Ť	2.9%
Netherlands	25.2	25.2	25.1	25.2	24.6	25.1	24.3	26.8	28.7	27.4		1	0.9%
Norway	21.8	22.1	22.1	22.3	19.8	20.7	19.4	19.5	21.6	21.8		-	0.0%
Poland		23.6	24.1	34.2	24.3	31.8	29.2	34.3	44.1	37.9		N/A	6.1%
Portugal	42.6	43.8	43.6	43.5	42.2	42.8	42.6	43.3	44.2	42.6		-	0.0%
Romania							55.4	55.1	64.8	61.5		N/A	N/A
Slovakia	27.4	28.0	30.5	30.8	35.1	32.6	32.3	35.1	38.6	33.7		Ť	2.3%
Slovenia	31.5	32.1	32.8	32.1	31.2	31.4	30.7	31.3	32.2	31.2		-	-0.1%
Spain				47.8	45.4	44.6	45.7	47.9	50.3	50.2		N/A	N/A
Sweden	25.2	27.1	26.5	27.4	26.9	24.5	27.9	28.6	30.4	30.0		Ť	1.9%
EU/EEA*	35.8	36.4	35.0	33.4	36.2	36.8	35.0	36.1	37.8	37.6	~~~	-	0.6%
United Kingdom	15.8	16.8	17.4	17.6	16.6	16.7	16.6					N/A	N/A
Reported EU/EEA**	31.6	31.3	30.5	32.5	32.8	33.8	33.7	38.4	41.0	40.2		N/A	N/A

Figure 1.14 Proportion (%) of glycopeptides, third- and fourth-generation cephalosporins, monobactams, carbapenems, fluoroquinolones, polymyxins, piperacillin and enzyme inhibitor, linezolid, tedizolid and daptomycin out of total hospital consumption (DDD per 1 000 inhabitants per day) of antibacterials for systemic use, EU/EEA and UK, 2013–2022 [67]

#### **1.6 One Health approach on AMR surveillance**

AMR is a global, multidimensional phenomenon occurring in humans, animals, and environmental ecosystems. The increasing emergence of AMR compromises our ability to treat infections and to manage AMR- associated economic impacts across all sectors [53]. Globalization, international travels and trade are some of the reasons which facilitate the rapid spread of AMR across borders and around the globe [53, 54, 55]. Therefore, it has become evident that tackling AMR effectively requires transnational and intercontinental partnerships [53, 54, 55, 56].

A unilateral approach to controlling AMR is insufficient. Preventing this silent pandemic requires multi-sectoral and transdisciplinary approach which is known as "One Health". One Health is a global strategy that recognizes the direct connection between human health and the health of animals and our shared environment. According to One Health approach, addressing severe public health issues can be achieved through cooperation, communication, and coordinated actions among professionals in human health (e.g., doctors, nurses, epidemiologists), animal health (e.g., veterinarians, agricultural workers), and environmental fields (e.g., ecologists, wildlife experts). [53, 54, 55].

The WHO recognizes the urgent need for coordinated global action to combat AMR and alongside the Food and Agriculture Organization (FAO) and the World Organisation for Animal Health (WOAH), coordinates global efforts, providing guidance, technical support, and monitoring progress [53, 54, 57].

Furthermore, in 2015 the WHO launched the Global Action Plan (GAP) which serves as a comprehensive framework for guiding efforts to address AMR issue. The GAP adopts the One Health approach and encourages countries to develop and implement National Action Plans (NAPs), and emphasizes the importance of multisectoral collaboration. Specifically, the GAP outlines five strategic objectives to address AMR at multiple levels [53, 54, 55, 56]:

A) Raise awareness and promote education among the general public, and healthcare professionals about the risks of AMR and on the appropriate use of antibiotics [**53-57**].

B) Develop and maintain robust AMR surveillance systems to track the spread of resistance. These surveillance systems include the environmental monitoring, such as tracking antibiotic residues and resistance gene prevalence and interventions to reduce contamination from agricultural runoff, healthcare waste, and industrial processes [53, 54, 55].

C) Implement effective infection prevention and control measures in healthcare settings, communities, and farms [53, 54, 55].

D) Enhance antimicrobial stewardship programs in order to regulate and monitor the use of antimicrobials in human medicine, veterinary medicine, and agriculture [53, 54, 55].

E) Encourage investments in new antimicrobials, diagnostics, and other tools to combat AMR [53, 54, 55].

# **1.7 AMR surveillance in Europe**

The European strategy for combating AMR is firmly based One Health approach. The ECDC plays a central role in coordinating AMR surveillance across Europe. It manages several networks that collect and analyze data on resistant pathogens from clinical, veterinary, and environmental surveillance systems [68, 69].

The clinical surveillance of AMR is primarily concerned with monitoring resistance patterns in pathogens that infect humans and involves mandatory reporting of resistance data to databases, including:

1. The European Antimicrobial Resistance Surveillance Network (EARS-Net). EARS-Net is the largest AMR surveillance network in Europe, covering 30 countries [68, 69]. It monitors AMR in invasive bacterial pathogens from human clinical isolates, focusing on the ESKAPE pathogens (*E. faecium, Staph. aureus, K. pneumoniae, A. baumannii, P. aeruginosa*, and *Enterobacter species*), and especially on Carbapenem-resistant Enterobacteriaceae (CRE), Methicillin-resistant *Staph. aureus* (MRSA), Vancomycin- resistant *Enterococci* (VRE) and Extended-spectrum  $\beta$ -lactamases (ESBL)- producing *E. coli* [68, 69, 70].

2. Healthcare-Associated Infections Surveillance Network (HAI-Net): tracks infections acquired in healthcare settings, with a particular focus on those caused by resistant bacteria [70].

3. European Surveillance of Antimicrobial Consumption Network (ESAC-Net): monitors antibiotic consumption across Europe, providing data assist to assess the relationship between antibiotic use and the emergence of resistance [71].

Furthermore, Europe recognizing the importance of monitoring AMR in the environment (particularly in water bodies, soil, and wildlife) has developed:

1. NORMAN Network: a European initiative that monitors emerging environmental contaminants, including antibiotics and AMR genes. This network conducts joint monitoring campaigns, develops standardized methods for detecting AMR in the environment (such as water, soil and wastewater), and facilitates data sharing among European countries [72].

2. European Environment Agency (EEA): this supports the monitoring of environmental factors that contribute to AMR, such as antibiotic residues in water bodies and agricultural runoff [73].

3. Projects such as

Rethinking Antimicrobial Decision-systems in the Management of Animal Production (ROADMAP), which aims to optimize antimicrobial decision-making in animal production [74].

Joint Programming Initiative on Antimicrobial Resistance (JPIAMR), which funds research projects across Europe to explore AMR in the environment, including the impact of waste management practices and the role of wildlife in spreading resistance [75].

#### 1.7.1 AMR surveillance in Greece

Greece's AMR surveillance system is coordinated by the National Public Health Organization (NPHO)and is supported by the WHOHET- Greece network and participates in both the EARS- Net (ECDC) and the Global Antimicrobial Surveillance System (GLASS- WHO) [54, 68, 69].

The Greek system places special emphasis on high-risk pathogens, including carbapenem- resistant gram negative bacteria, MRSA and VRE which are associated with high morbidity and mortality rates, particularly in hospitals settings. Given the critical situation of AMR, Greece has implemented the 'Procrustes' Action Plan since 2011, primarily targeting the control of CRE in hospitals. [76]

Now, Greece is actively working to enhance its surveillance systems and harmonize with international efforts to mitigate this threat. A National Action Plan on AMR "National Action Plan for Combating Antimicrobial Resistance within the One Health Framework 2019-2023" [77], which aligns with the WHO's Global Action Plan, has been developed [54]. This plan includes measures to improve antibiotic stewardship, to enhance surveillance and to strengthen infection prevention and control [54, 61, 68, 69, 77].

#### 1.8 Characteristics of E. coli

*E. coli* is a Gram-negative, non- sporulating, rod- shaped, facultatively anaerobic coliform bacterium, which belongs to the Enterobacteriaceae family. It is motile due to peritrichous flagellar arrangement, and very few strains are non-motile. The optimal growth of *E. coli* occurs at 37°C, and under favorable conditions, it reproduces every 20 minutes [**20**, **27**].

*E. coli* can live on a wide variety of environments. In general, it cycles between two major habitats: a) the gastrointestinal tract of humans and other warm-blooded animals where it is a part of the microbiota. It synthesizes K and B complex vitamins protecting the host against colonization with pathogenics microbes [**20**].

b) environmental niches including water, wastewater, sediment, and soil, where it can live for long periods of time.

*E. coli* is used the most accurate indicator of fecal contamination, and in the domains of biotechnology and microbiology, it is the most widely studied prokaryotic model organism [20, 27, 40].

Although, more *E. coli* strains are harmless, certain strains are pathogenic causing intestinal or extraintestinal infections, depending on the array of virulence factors that they harbor. Various virulence factors, such as fimbrial and afimbrial adhesins, capsules, toxins (including exotoxins, hemolysins, and enterotoxins), and iron uptake systems, contribute to the pathogenicity of certain strains. [20].

The intestinal pathogenic *E. coli* (IPEC) strains are also linked to a number of extra-intestinal diseases and are the most prevalent cause of cholecystitis, bacteremia, cholangitis, urinary tract infections (UTIs), traveler's diarrhea, and septicemia as well as neonatal meningitis [**20**].

## 1.9 E. coli as an indicator of AMR in the environment

*E. coli* serves as a valuable indicator of AMR in the environment, given its ubiquitous widespread presence across various ecosystems, including the intestinal microbiota of mammals and birds [20, 27, 40]. Its ability to adapt genetically and its frequent exposure to antimicrobial agents make it a reliable marker for tracking AMR trends [40, 78]. Monitoring *E. coli* in environmental samples enables the assessment of resistance spread and dynamics, providing insights into the impact of antimicrobial use in both human and animal populations. This insight is instrumental in developing and refining policies to curb AMR spread [40, 78].

# 1.10 The One Health paradigm for AMR: extended-spectrum cephalosporin and carbapenem - resistant *E. coli*

While *E. coli* is intrinsically susceptible to nearly all clinically important antimicrobial agents, multidrug- resistant strains are frequently detected in both clinical and environmental samples. This is due to its remarkable ability to acquire resistance genes, primarily through horizontal gene transfer [27, 40]

The rise of multidrug resistance in *E. coli* has become a significant concern in both human and veterinary medicine globally. The most concerning resistance mechanisms in *E. coli* involve the acquisition of plasmid- borne genes that produce [27, 40]:

- Extended-spectrum β-lactamases (ESBLs) and AmpC enzymes confer resistance to a wide range of β-lactam antibiotics, including penicillins, broad spectrum cephalosporins, and aztreonam
- Carbapenemases causing resistance to carbapenems,
- Plasmid-mediated quinolone resistance (PMQR) genes, leading to resistance to quinolones (including fluoroquinolones)
- Plasmid- mediated genes that confer resistance to colistin.

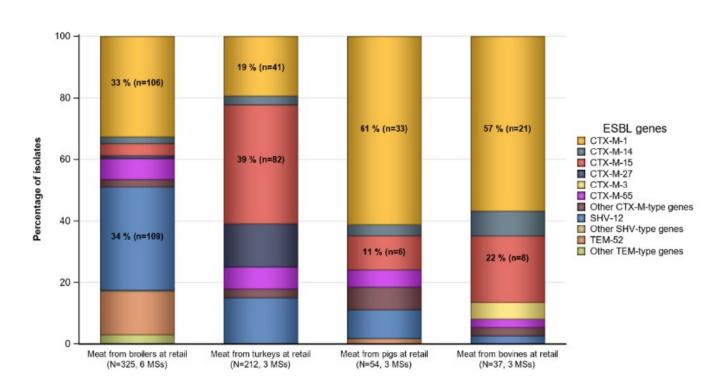
As mentioned before, infections caused by *E. coli* isolates producing ESBL and AmpC (referred to as extended-spectrum cephalosporin- resistant or ESC-EC) present a significant burden on healthcare systems. Furthermore, intestinal colonization by ESC-EC and its association with community-acquired multidrug- resistant (MDR) infections is a significant concern [40, 78]. Also, an increasing prevalence of ESBLs and AmpC genes has been observed in the human gut microbiota, affecting both healthy individuals and those with infections. Alongside this rising incidence in humans, ESC-EC are increasingly reported in livestock (Figures 1.10a, b and 1.15a, c), food products (Figures 1.15b, d), aquatic environments (Figure 1.16), and even wildlife (Figure 1.17) [40, 78, 79]. The most widely reported cephalosporinases in *E. coli* from humans are CTX-M-1, followed by CTX-M-15, CTX-M-14, and CMY-2 [27, 40, 78, 79]. According to epidemiological data from EFSA and other studies, blaCTX-M-1 and blaCTX-M-15 are the most prevalent ESBL genes found in both livestock and wild animals, while the most widespread AmpC-encoding gene is blaCMY-2. Additionally, blaCTX-M-15 is also predominant in aquatic ecosystems [78, 79].

In addition to extended-spectrum cephalosporin- resistant *E. coli* (ESC-EC), the rising prevalence of carbapenemase- producing *E. coli* (CP-EC) strains poses a significant concern. Research has confirmed the presence of CP-EC in food- producing animals, animal- derived food products, companion animals, and aquatic environments [40, 61, 63, 78, 79]. Among CP-EC, the blaOXA-181 gene is the most frequently identified carbapenemase gene, followed by blaNDM-5 [63, 80, 81]. While blaOXA-181 is predominantly associated with human infections, it has also been detected in various environmental sources such as seawater and hospital sewage. Additionally, blaOXA-48-like variants, including blaOXA-204 and blaOXA-244, have been found in river water, estuaries, and alarmingly, in drinking water [63, 80, 81].

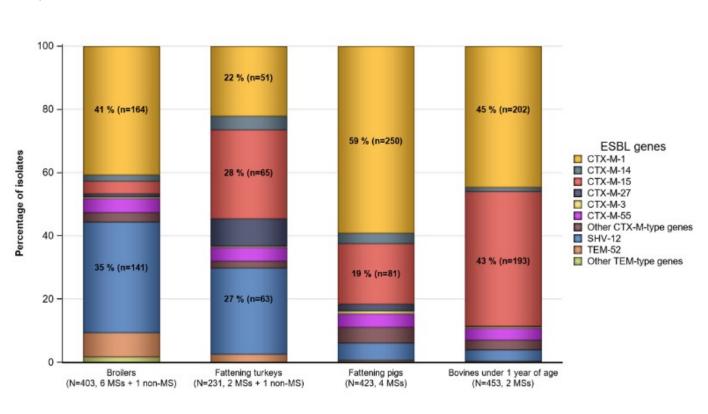
The blaNDM-5 gene, the second most common carbapenemase gene in CP-EC, has been isolated from companion and food-producing animals [63, 80, 81]. Notably, blaNDM-5 is the most frequently reported carbapenemase gene in CP-EC among humans in Europe [61, 82]. Also,

blaNDM genes have been detected in *E. coli* isolated from municipal and hospital sewage, rivers, and, more worryingly, drinking water [80, 81]

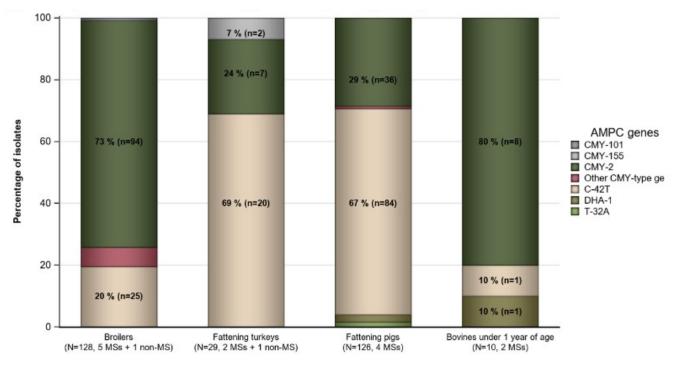
CP-producing Enterobacterales have been identified not only in EU monitoring programs [61, 82, 83, 84, 85] but also in companion animals [81], food-producing animals, and their derived products such as meat, seafood, and vegetables [80, 81, 83, 86, 87, 88, 89]. The amplification of carbapenemase- producing *E. coli* in foods, which are considered a significant reservoir of these bacteria for humans, is highly undesirable. The global spread of ESC-EC and CP-EC underscores the urgent need for comprehensive surveillance and targeted intervention strategies to mitigate this escalating public health threat [83, 84, 86, 88, 89]. The increasing prevalence of these resistant bacteria across diverse environments and hosts highlights the complexity of controlling their dissemination [88, 89, 90]. Ongoing efforts to develop scientifically-based intervention measures are crucial to addressing this growing public health issue [40, 62, 80, 86, 90].



a)







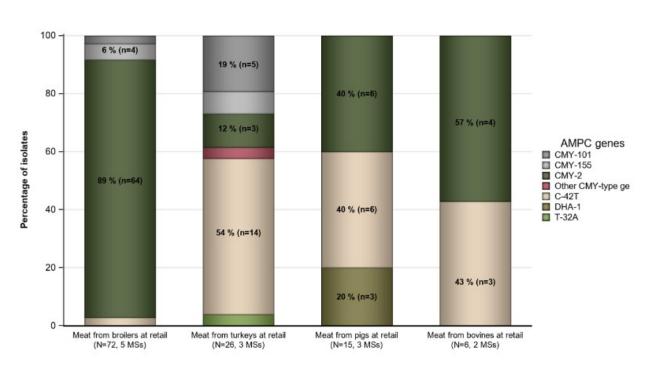


Figure 1.15 E. coli isolates harboring (a) ESBL- encoding genes in animals, (b) ESBL- encoding genes in retail meat, (c) AmpC- encoding genes and AmpC- chromosomal point mutations in animals and (d) AmpC- encoding genes and AmpC- chromosomal point mutations in retail meat. EFSA 2024 [63]

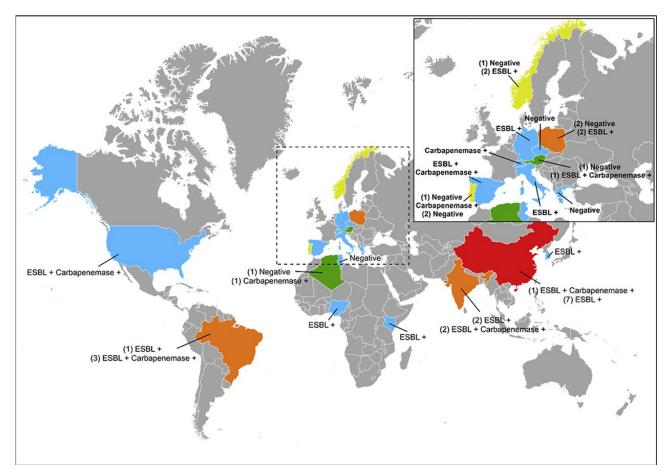


Figure 1.16 Global distribution of positive detection of ESBL and/or carbapenemase genes in aquatic environments such as rivers, lakes and ground water [89].

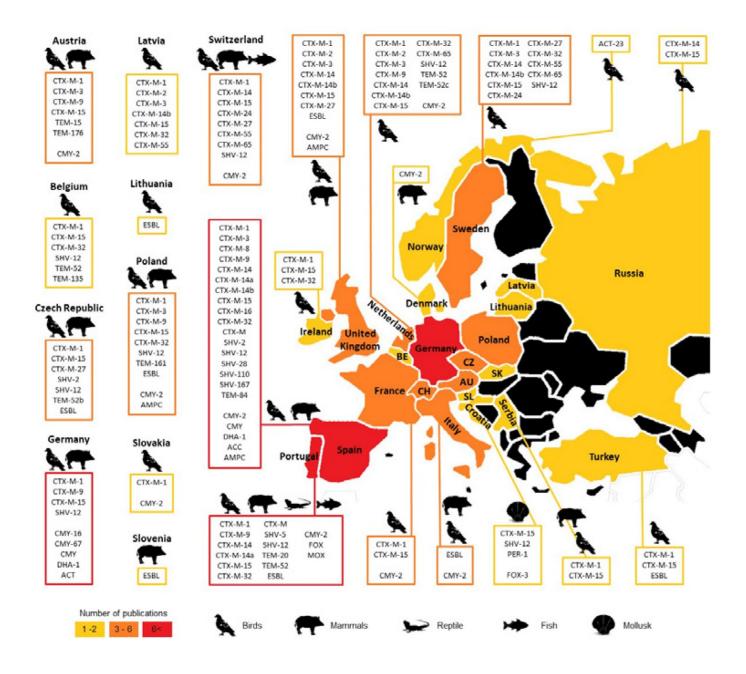


Figure 1.17 Map of Europe showing the animal host and cephalosporinases subtypes [90]

# Chapter 2

# **Experimental Part**

# **Material & Methods**

# Objective

This doctoral dissertation was conducted as part of the One Health approach. Specifically, the primary purpose of this dissertation was to assess the antimicrobial resistance patterns, the genes related to specific resistant phenotypes, and molecular genotypes by means of phylogenetic groups of *E. coli* isolates circulating both in environmental habitats (including sewage and receiving water bodies) and clinical settings.

Another key objective of this dissertation was the epidemiological correlation of genotypes circulating in different environmental settings with those predominant in hospitals, as well as the correlation between genotypes and resistance profiles.

Finally, a subset of the isolated strains that met specific criteria underwent plasmid sequencing using modern sequencing techniques to reveal molecular mechanisms, such as the presence of mobile elements (integrons, transposons), related to the spread of antimicrobial resistance in these environments.

# **Ethics Statement**

This study has received approval from the Bioethics and Research Ethics Committee of the University of West Attica (Reference Number: 33114/13-04-2021).

## 2.1 Sampling locations and collected samples

Sampling locations and collection procedures were strategically chosen to capture the distribution of environmental AMR in Livadeia city (the capital of the regional unit) of the Boeotia regional district, Greece. This region was chosen due to its intensive agricultural and farming activities, and it is crossed by two rivers: the Erkyna River on the northern side of the city and the Boeotian River on the southeast side of the city. The area also hosts a WWTP and a general prefectural hospital which performs a semi-treatment on the HWW. The hospital provides a wide range of services to approximately 60,000 people annually, including emergency and outpatient care, and has clinics for nephrology, pathology, cardiology, surgery, orthopedics and obstetrics-gynecology. After preliminary sedimentation, the hospital sewage is discharged into the regional WWTP. The WWTP receives urban and HWW, with an average daily volume of 5500 m3/day at the entrance and an average hourly flow of 400 m3/h. It performs primary treatment, including screening, grit collection, grease trap, oxidation ditch and primary sedimentation, as well as biological treatment that includes nitrogen and phosphorus removal, secondary sedimentation, chlorination, sludge thickening and dewatering [15]. The secondary treated effluents are disposed of in the Erkyna river, and are used for the restricted irrigation of cropland during the irrigation season. The Erkyna river is directly influenced by the WWTP discharges and indirectly by the hospital sewage. The Erkyna river flows into the Boeotian Kifissos river at a point approximately 6 km away from the WWTP. Both rivers are used for irrigation purposes, with one irrigation project covering 16,000 acres of the studied area [91].

During the period of summer 2019 to spring 2021, six sequential sampling events were conducted in Livadeia city, Boeotia regional district. A total of four samples per sampling period were collected, including (a) semi-treated HWW from a septic tank outside the hospital, (b) wastewater at the outlet of the regional WWTP, (c) river water samples from the Erkyna river adjacent to the WWTP (RWS1) and (d) river water samples from the Boeotian Kifissos river at the junction with the Erkyna river (RWS2), located 6 km downstream from the WWTP (**Figure 2.1**). A total of twelve river water samples (six from RWS1 and six from RWS2), six wastewater samples and six HWW samples were collected and analyzed. All of the samples were collected in sterile dark bottles (500 mL volume), were placed on ice and analyzed within 12 h post-collection. In addition, clinical isolates were collected from clinical specimens such as urine, blood and tissue from the microbiological laboratory of the hospital during the whole study period.



Figure 2.1 The map depicts the sampling locations and their relationships.

[The abbreviations used in the map are as follows: HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1 (located 100m downstream from the WWTP discharge site); RWS2, river water site 2 (located 6 km downstream from the WWTP discharge site].

# 2.2 Isolation of environmental E. coli strains

### Materials and equipment

- Culture Media: Chromogenic Coliform Agar, CCA (CHROMagar™ CCA, EF342)
- Cellulose ester membrane (Whatman® ME 25/21 ST)
- Antibiotics: Ampicillin Sodium for Injection 1 Gram (AUROMEDICS, NDC 55150-0113-10)
- Multiple vacuum filtration device (Whatman®, AS310/3, WHA10445835)

### Method

*E. coli* isolation and identification were conducted using a standard membrane filtration technique [*ISO 9308.01-1: 2017, 92*] for all river and wastewater samples. The procedure involved filtering multiple volumes (river water: 100 mL, 10 mL, 1 mL, wastewater: 10 mL, 1 mL, 0.1 mL) of each sample using a vacuum filtration device and a mixed cellulose ester membrane with a diameter of 47 mm and pore size of 0.45  $\mu$ m (Whatman® ME 25/21 ST). The membrane filters were then placed sterile petri dishes with Chromogenic Coliform medium (CCA) with and without an antibiotic (CCA with 100  $\mu$ g/mL ampicillin, CCA/AMP). In both culture media with and without AMP, all colonies showing positive  $\beta$ -d-galactosidase and  $\beta$ -d-glucuronidase reactions (dark blue to violet) were counted as *E. coli*. The CCA/AMP was used for the estimation and collection of the  $\beta$ -lactam-resistant isolates, while CCA without AMP was used for the enumeration and isolation of all *E. coli* isolates (e.g., sensitive and resistant to all antibiotics).

All suspected *E. coli* (dark blue to violet) colonies which were isolated from CCA and CCA/AMP were subcultured on Mac Conkey No3 agar, a selective and differential culture medium. Mac Conkey No3 is designed to selectively isolate only Gram-negative bacteria and differentiate them based on lactose fermentation. The pink /red metallic sheen appearance of *E. coli* colonies on MacConkey agar No3 agar was used to identify their features [**92**].

In cases of doubt concerning the *E. coli* colonies, additional biochemical and molecular identification tests were applied. For biochemical testing, all isolated colonies were maintained on a nutrient agar [92].

# 2.3 Biochemical identification of environmental E. coli strains

### Materials

- MacConkey Agar No.3 (Neogen® Culture Media, NCM0174B)
- Nutrient Agar (Neogen® Culture Media, NCM0033A)
- Peptone Water/ Tryptone Water (Condalab, Cat. 1403)
- Kovac's Reagent (Liofilchem, 80271)
- Simmons Citrate Agar (Neogen® Culture Media, NCM0168A)

#### Methods

*E. coli* colonies on MacConkey agar No3 agar with pink /red metallic sheen appearance subcultered on Nutrient agar and after overnight incubation at 37oC, they were subjected to indole and Simmons citrate biochemical tests.

#### 2.3.1 Indole biochemical test

The indole test screens for the ability of a bacterium to degrade the amino acid tryptophan and produce indole. It is used as a classic test to distinguish indole-positive *E. coli* from indole negative Enterobacteriaceae such as Klebsiella [92, 93]. For this test, a single colony of a pure culture was inoculated in a tube with tryptone/peptone broth and after overnight incubation at 37°C, five drops of Kovács reagent were added directly to the tube in order to test indole production [92, 93]. A positive indole test is indicated by the formation of a red color ("cherry-red ring") in the reagent layer on top of the medium within few seconds [92, 93].

#### 2.3.1 Simmons citrate biochemical test

The citrate test screens a bacterial isolate for the ability to utilize citrate as its carbon and energy source. This test is employed in combination with the indole test to distinguish between members of the Enterobacteriaceae [92, 94]. To carry out the test, a single colony of a pure culture was inoculated on Simmons media followed by incubation at  $37^{\circ}$ C for 18 to 48 hours. Only bacteria that can utilize citrate as the sole carbon will be able to grow on the Simmons citrate medium and the generation of alkaline by-products of citrate metabolism raise the pH of the medium causing the bromothymol blue to change from the original green color to blue. In cases of bacteria such as *E. coli* that give negative citrate test, no growth and no color change will be visible in the media [94].

# 2.4 Isolation and identification of clinical E. coli strains

As for the clinical strains, they were obtained from biological fluids of hospitalized or emergency room patients, such as blood, urine and tissue, and were identified as *E. coli* in the microbiological laboratory of the hospital. Specifically, the clinical samples were cultivated on blood and MacConkey agar No3 at 37 °C for 24 h. Following this, the isolates were identified via a Micro Scan automated system according to standard biochemical tests. The isolates were stored in cryovials with Brain Heart Infusion+20% glycerol solution and transported to the Molecular Microbiology and Immunology Laboratory with proper packaging and transfer conditions [**95**].

# 2.5 Molecular identification of E. coli isolates

## Material and equipment for DNA extraction and PCR

- Nutrient Agar (Neogen® Culture Media, NCM0033A)
- Water for injection
- DreamTaq DNA Polymerase, 5 U/µL (Thermo Scientific<sup>™</sup>, EP0702)
- 10X DreamTaq Buffer (includes 20 mM MgCl2) (Thermo Scientific<sup>™</sup>, EP0702)
- Primers of 100 μM stock solution, for housekeeping uidA gene (Invitrogen- Thermo Fisher Scientific)
- Deoxynucleotide triphosphates (dNTPs) Bundle, 4x 100 mM (dATP, dCTP, dGTP, dTTP), (JENA BIOSCIENCE, NU-1005S)
- *Escherichia coli* ATCC 25922 (positive control isolate)
- Mini Centrifuge (MiniSpin ® Eppendorf, 22331)
- PCR Thermocycler 2720 (Applied Biosyststems, Thermo Fisher Scientific)

### Materials and equipment for electrophoresis

- FastGene Agaroze (Nippon Genetics, Cat.:AG02)
- Midori Green Advance gel stain (Nippon Genetics Cat. No.: MG04)
- 10X Tris Borate EDTA (TBE) stock solution: 900 mM Tris base, 900mM Boric acid and 20mM EDTA pH 8.0
- BlueJuice<sup>™</sup> Gel Loading Buffer 10x (Invitrogen<sup>™</sup> by Thermo Fisher Scientific, Cat. No: 10816015)
- DNA ladder (FastGene 100 bp DNA Marker, Nippon Genetics Cat. No. MWD100)
- Horizontal electrophoresis tank ClearSub L10 (Kisker Biotech)
- Gel imaging system FastGene FAS-DIGI PRO (Nippon Genetics)

#### Method

The final confirmation of isolates identity was achieved using the molecular method of polymerase chain reaction (PCR) targeting the housekeeping  $\beta$ -d-glucuronidase gene uidA [95]. Genomic DNA extracted by the boiling method as follow: few colonies of fresh pure cultures grown on Nutrient agar were resuspended in 250 µL water for injection, lysed by heating at 100 oC for 25 min and then were immediately put on ice for 10 min. The supernatant, which contains the whole bacterial genome, was harvested by centrifugation at 11.000 rpm for 10 min. Then, the bacterial genomic DNA was amplified by PCR using a specific set of primer targeted at uidA gene. The pair of primer used for uidA PCR amplification is shown in (Table 2.1). Each reaction was carried out by using a 25 µl mixture containing 2.5µl of 10× DreamTaq buffer (includes 20mM MgCL2), 0.5 µM of each primer (initial concentration 10 µM), 0.2 mM of each dNTP (initial concentration of dNTPS mix 10 mM), 1 U of DreamTaq polymerase, and 3 µl of genomic DNA. The PCR was performed under the following conditions: denaturation for 6 min at 94°C; 35 cycles of 1 min at 94°C, 1 min at 56°C and 1.5 min at 72°C; and a final extension step of 10 min at 72°C [96]. Negative control (reaction lacking the template DNA) and a positive control (Escherichia coli ATCC 25922) were included in all performed amplifications. Six-microliter aliquots of PCR products were analyzed by gel electrophoresis with 1.5 % agarose in 1X TBE. Gels were stained with Midori Green stain and visualized in Gel imaging system FastGene FAS-DIGI PRO. A 100-bp DNA ladder was used as a marker.

Table 2.1	Fable 2.1 The pair of primer used for uidA PCR amplification [96]						
Target gene	Sequences $5' \rightarrow 3'$	Melting temperature- Tm (oC)	Product size (bp)				
uidA	F_GTTTTCCCAGTCACGACGTTGTACATTACGGCAAA GTGTGGGTCAAT R_TTGTGAGCGGATAACAATTTCCCATCAGCACGTTA TCGAATCCTT	56	740				

# 2.6 Storage of isolates

# Materials

- Nutrient Agar (Neogen® Culture Media, NCM0033A)
- Brain Heart Infusion Broth (Thermo Scientific<sup>™</sup> CM1135B)
- glycerol
- cryovials

# Method

All isolates that exhibited positive and negative result in indole production and citrate test, respectively and simultaneously indicated positive result in uidA pcr, were presumed to be *E. coli* and were stored as stock at -80 °C in cryovials with Brain Heart Infusion and 20% glycerol solution, for further experiments.

# 2.7 Antimicrobial susceptibility testing and phenotypic methods for detecting antibacterial resistance mechanisms

# Materials

- Petri dishes 120x120 mm
- Muller Hinton Agar I ((Neogen® Culture Media, NCM2016A)
- 0,9% NaCl
- Antibiotic disks (LIOFILCHEM ®, ITALY and BIOPROM BD, Greece)
- *Escherichia coli* ATCC 25922 (reference strain for antimicrobial susceptibility testing and other phenotypic tests)

# Methods

# 2.7.1 Antimicrobial susceptibility testing

All isolates (environmental and clinical) were tested for their antimicrobial susceptibility via disk diffusion assays (Kirby–Bauer method) in 18 antibiotics, commonly used in clinical practice, distributed in 9 different categories: penicillins (ampicillin (AMP; 10  $\mu$ g), piperacillin (PIP; 30  $\mu$ g)), penicillin/inhibitor combinations (amoxicillin/clavulanic acid (AMC; 20  $\mu$ g/10  $\mu$ g), piperacillin/tazobactam (TZP; 30  $\mu$ g/6  $\mu$ g)), cephalosporins (ceftriaxone (CRO; 30  $\mu$ g), cefuroxime (CXM; 30  $\mu$ g), ceftazidime (CAZ; 10  $\mu$ g), cefotaxime (CTX; 5  $\mu$ g), cefepime (FEP; 30  $\mu$ g)), cephamycins (cefoxitin (FOX; 30  $\mu$ g)), monobactams (aztreonam (ATM; 30  $\mu$ g)), carbapenems

(imipenem (IMP; 10 µg), meropenem (MEM; 10 µg)), aminoglycosides (amikacin (AN; 30 µg), gentamicin (GM; 10 µg)), quinolones (ciprofloxacin (CIP; 5 µg), nalidixic acid (NAL; 30 µg)) and miscellaneous agents (sulfamethoxazole-trimethoprim (SXT; 23.75 µg/1.25 µg)). The test was performed by inoculating a bacterial suspension (of turbidity equal to 0.5 of the McFarland scale) onto Muller Hinton agar followed by placing antibiotic-impregnated paper disks on the surface. Antibiotic disks were positioned at a distance of 30 mm (centre to centre). The interpretation of the susceptibility results for the environmental and clinical isolates was performed according to EUCAST ECOFFs (epidemiological cut-off values) and clinical breakpoint criteria, respectively [97]. All isolates were characterized as sensitive/wild-type (S/WT: susceptible to all antibiotics), as non-wild-type (N-WT: resistant to only one antibiotic factor), as resistant (R: resistant to more than one antimicrobial agent; maximum of three different categories) or as multi-drug-resistant (MDR: resistant to at least one antimicrobial agent in more than three categories) [97, 98, 99].

#### 2.7.2 Phenotypic methods for detecting antibacterial resistance mechanisms

# 2.7.2a: Double-disk synergy test for the detection of extended spectrum β-lactamases (ESBL) production

Clavulanic acid synergy test (double-disk synergy test, DDST) is recommended for the detection of extended spectrum  $\beta$ -lactamases (ESBL) production in isolates with resistance to third and/or four - generation cephalosporins (such as cefotaxime, ceftazidime, cefepime) [100]. The test was performed by inoculating a bacterial suspension (of turbidity equal to 0.5 of the McFarland scale) onto Muller Hinton agar followed by placing disks containing cephalosporins (cefotaxime, ceftazidime, cefepime) next to a disk with clavulanic acid (amoxicillin-clavulanic acid, AMC). The test was considered positive when the inhibition zones around any of the cephalosporin disks were augmented in the direction of the disk containing clavulanic acid [100].

#### 2.7.2b Carbapenem inactivation method for detection of carbapenemase production

The phenotypic test carbapenem inactivation method (CIM) were implemented in isolates which exhibited decreased susceptibility to carbapenems (meropenem, imipenem) in order to detect carbapenemase production such as KPC, NDM, OXA-48, VIM, IMP and OXA-23 [100, 101]. The CIM test detects carbapenemase production by incubating a bacterial suspension with a carbapenem disk (e.g meropenem). If carbapenemase is present, it hydrolyzes and inactivates the drug. After incubation (typically around 2 hours), the disk is placed on Muller Hinton agar inoculated with susceptible *E. coli* strain (commonly ATCC 25922). A reduced or absent inhibition zone around the disk indicates carbapenemase production, while a clear inhibition zone suggests no enzyme activity

[101]. Well-characterized carbapenem- producing bacterial strains, provided by the Laboratory of Antimicrobial Resistance and Hospital Infections, National Reference Center for Infectious Diseases, Hellenic National Public Health Organization, were used as positive controls for the CIM test.

# 2.8 PCR amplification of resistance genes

# Materials and Equipment for DNA extraction and PCR

- Nutrient Agar (Neogen® Culture Media, NCM0033A)
- Water for injection
- Mini Centrifuge (MiniSpin ® Eppendorf, 22331)
- PurelinkTM Genomic DNA mini kit (Invitrogen, Waltham, MA, USA)
- DreamTaq DNA Polymerase, 5 U/μL (Thermo Scientific<sup>TM</sup>, EP0702)
- 10X DreamTaq Buffer (includes 20 mM MgCl2) (Thermo Scientific™, EP0702)
- Primers of 100 μM stock solution, for housekeeping uidA gene (Invitrogen- Thermo Fisher Scientific)
- Deoxynucleotide triphosphates (dNTPs) Bundle, 4x 100 mM (dATP, dCTP, dGTP, dTTP), (JENA BIOSCIENCE, NU-1005S)
- PCR Thermocycler 2720 (Applied Biosyststems, Thermo Fisher Scientific)
- Positive controls- well characterised strains positive for the tested resistance genes.
- NucleoSpin, Gel and PCR clean-up (MACHEREY-NAGEL)

# Materials and equipment for electrophoresis

- FastGene Agaroze (Nippon Genetics, Cat.:AG02) for gel electrophoresis
- Midori Green Advance gels stain (Nippon Genetics Cat. No.: MG04)
- 10X Tris Borate EDTA (TBE) stock solution: 900 mM Tris base, 900mM Boric acid and 20mM EDTA pH 8.0
- BlueJuice<sup>™</sup> Gel Loading Buffer 10x (Invitrogen<sup>™</sup> by Thermo Fisher Scientific, Cat. No: 10816015)
- DNA ladder (FastGene 100 bp DNA Marker, Nippon Genetics Cat. No. MWD100)
- Horizontal electrophoresis tank ClearSub L10 (Kisker Biotech)
- Gel imaging system FastGene FAS-DIGI PRO (Nippon Genetics)

# Method

All DDST-positive isolates underwent PCR to detect three different types of ESBL genes: blaTEM, blaSHV and blaCTX-M-group 1-, 2-, 9- types [102, 103]. CIM-positive isolates were tested for the presence of carbapenemase genes (blaKPC, blaVIM, blaNDM, blaIMP, blaOXA-48 and blaOXA-23) [100, 102, 104]. Isolates resistant to penicillin/inhibitor combinations and cephamycins were

tested for AmpC-type  $\beta$ -lactamases genes (blaCMY, blaDHA, blaACC, blaMIR and blaFOX) [100, 105], while MDR isolates exhibiting resistance to SXT were screened for the dihydropteroate synthase gene (sul1) demonstrating resistance to sulphonamides [106]. PCR protocols and conditions were performed according to EUCAST guidelines and other published studies [99, 100-105].

The total bacterial genome of all the above isolates was extracted using the Purelink<sup>™</sup> Genomic DNA Mini Kit according to the manufacturer's instructions. Each reaction was carried out by using a 25 µl mixture containing 2.5 µl of 10× Dream Taq Buffer (+MgCl2), 0.5 µM of each primer (initial concentration 10 µM), 0.2 mM of each dNTP (initial concentration of dNTPS mix 10 mM), 1 U of DreamTaq polymerase, and 100 ng of bacterial genomic DNA. PCR conditions for the amplification of ESBL genes are displayed in Table 2.2, of AmpC genes in Table 2.3, carbapenemase genes in Table 2.4 and sull gene in Table 2.5. All primer sets used for resistance genes detection are listed in Table 2.6. Negative control (reaction lacking the template DNA) and positive controls were included in all performed amplifications. All bacterial strains used as positive controls were kindly provided by the Laboratory of Antimicrobial Resistance and Hospital Infections, National Reference Center for Infectious Diseases, and Hellenic National Public Health Organization. These strains either originate from inter-laboratory schemes in which the laboratory participates or are well-characterized. Six-microliter aliquots of PCR products were analyzed by gel electrophoresis with 1.5 % agarose in 1X TBE. Gels were stained with Midori Green stain and visualized in Gel imaging system FastGene FAS-DIGI PRO. A 100-bp DNA ladder was used as a marker. The PCR amplicons were purified using the kit NucleoSpin Gel and PCR clean-up. Subsequently, their concentration and DNA quality were determined by checking OD and running the samples on an agarose gel, respectively, and then were subjected to Sanger sequence analysis by CeMIA SA (http://cemia.eu/sangersequencing.html, accessed on 12 September 2022) [99, 107]. The set of primers used for sequencing were the same as those used in PCR. The sequences and chromatographs were interpreted using MEGA software (https://www.megasoftware.net/, accessed on 19 September 2022), and the BLAST algorithm (https://blast.ncbi.nlm.nih.gov/Blast.cgi, accessed on 18 September 2022) was used to identify antimicrobial resistance genes. DNA sequences were compared with reference antibiotic resistance genes from NCBI (https://www.ncbi.nlm.nih.gov/pathogens/refgene, accessed on 19 September 2022) and phylogenetic trees were constructed using the maximum likelihood method to investigate any possible correlations.

Cycle step	Temperature (°C)	Time	Number of cycles	
Initial denaturation	94	5 min	1	
Denaturation	94	25sec		
Annealing	Melting Temparature (Tm)*	40sec	30	
Extension	72	50 sec		
Final elongation	72	6 min	1	
*See Tm of specific gene				
Fable 2.3 AmpC genes P	CR amplification program [105]			
Cycle step	Temperature (°C)	Time	Number of cycles	
-, <b>F</b>		<u> </u>		
	94	3 min	1	
Initial denaturation	94 94	3 min 30 sec	1	
Initial denaturation Denaturation	-		25	
Initial denaturation Denaturation Annealing Extension	94	30 sec		

Cycle step	Temperature (°C)	Time	Number of cycles	
Initial denaturation	94	5 min	1	
Denaturation	94	30 sec		
Annealing	Melting Temparature (Tm)*	30 sec	30	
Extension	72	1 min		
Final elongation	72	10 min	1	

Cycle step	Temperature (°C)	Time	Number of cycles	
Initial denaturation	94	3 min	1	
Denaturation	94	45 sec		
Annealing	60	30 sec	30	
Extension	72	1.5 min		
Final elongation	72	2 min	1	

		Target gene	Sequences 5'→ 3'	Melting temperature- Tm (oC)	Product size (bp)	Reference
		BlaCTX-M-group 1-	F_AAAAATCACTGCGCCAGTTC		415	
		type	R_AGCTTATTCATCGCCACGTT		415	
		BlaCTX-M-group 2-	F_CGACGCTACCCCTGCTATT		553	[102]
	Sa	type	R_CCAGCGTCAGATTTTTCAGG	55	552	[103]
	gene	BlaCTX-M-group 9-	F_CAAAGAGAGTGCAACGGATG		205	-
	ESBL genes	type	R_ATTGGAAAGCGTTCATCACC		205	
	Ē	DISCHW	F_AAGATCCACTATCGCCAGCAG		200	
		BlaSHV	R_ATTCAGTTCCGTTTCCCAGCGG	58	300	[102]
		BlaTEM	F_GAGTATTCAACATTTCCGTGTC		850	[102]
			R_TAATCAGTGAGGCACCTATCTC		030	
		BlaCMY-type	F_TGGCCAGAACTGACAGGCAAA		462	
		DiaCivi 1-type	R_TTTCTCCTGAACGTGGCTGGC		402	
es	ý	BlaFOX-type	F_AACATGGGGTATCAGGGAGATG	•	190	
gen	gene	Diar OX-type	R_CAAAGCGCGTAACCGGATTGG		150	
ß-lactamase genes	type genes	BlaDHA-type	F_AACTTTCACAGGTGTGCTGGGT	64	405	[105]
ctan	Cty		R_CCGTACGCATACTGGCTTTGC	•••		
3-lae	AmpC	BlaACC-type	F_AACAGCCTCAGCAGCCGGTTA		346	
_	V		R_TTCGCCGCAATCATCCCTAGC			
		BlaMIR-type	F_TCGGTAAAGCCGATGTTGCGG		302	
			R_CTTCCACTGCGGCTGCCAGTT			
		BlaOXA-48-type	F_TTGGTGGCATCGATTATCGG	58	744	[102, 104
			R_GAGCACTTCTTTTGTGATGGC			
	genes	BlaVIM-type	F_AGTGGTGAGTATCCGACAG	52	212	[104]
	se ge		R_TCAATCTCCGCGAGAAG			
	Carbapenemase	BlaNDM-type	F_TGGCAGCACACTTCCTATC	58	488	[104]
	pene		R_AGATTGCCGAGCGACTTG			
	rba]	BlaIMP-type	F_GGAATAGAGTGGCTTAACTC	56	232	[102]
	Ca		R_TCGGTTTAATAAAAACAACCACC			
		BlaKPC-type	F_CTGTCTTGTCTCTCATGGCC	60	796	[104]
16	<u> </u>		R_CCTCGCTGTRCTTGTCATCC			
sulfona		sul-1	F_GATTTTTCTTGAGCCCCGC	58	200	[106]
esistance	e gene		R_TGGACCCAGATCCTTTACAGG			

## 2.9 Molecular typing

## 2.9.1 Phylogrouping typing method

### Materials/ reagents and equipment for triplex PCR

- Water for injection
- DreamTaq DNA Polymerase, 5 U/μL (Thermo Scientific<sup>TM</sup>, EP0702)
- 10X DreamTaq Buffer (includes 20 mM MgCl2) (Thermo Scientific<sup>™</sup>, EP0702)
- Deoxynucleotide triphosphates (dNTPs) Bundle, 4x 100 mM (dATP, dCTP, dGTP, dTTP), (JENA BIOSCIENCE, NU-1005S)
- Primers of 100 µM stock solution (Invitrogen)
- Escherichia coli ATCC 25922 (Positive control)
- PCR Thermocycler 2720 (Applied Biosyststems, Thermo Fisher Scientific)
- Mini Centrifuge (MiniSpin ® Eppendorf, 22331)

#### Materials/ reagents and Equipement for PCR-product electrophoresis

- FastGene Agaroze (Nippon Genetics, Cat.:AG02)
- Midori Green Advance gels stain (Nippon Genetics Cat. No.: MG04)
- 10X Tris Borate EDTA (TBE) stock solution: 900 mM Tris base, 900mM Boric acid and 20mM EDTA pH 8.0
- BlueJuice<sup>™</sup> Gel Loading Buffer 10x (Invitrogen<sup>™</sup> by Thermo Fisher Scientific, Cat. No: 10816015)
- DNA ladder (FastGene 100 bp DNA Marker, Nippon Genetics Cat. No. MWD100)
- Horizontal electrophoresis tank ClearSub L10 (Kisker Biotech)
- Gel imaging system FastGene FAS-DIGI PRO (Nippon Genetics)

#### Method

The Triplex PCR phylogrouping method utilizes the detection of chuA and yjaA genes and the DNA fragment TSPE4.C2 to classify *E. coli* isolates into four phylogenetic groups, A, B1, B2 and D, as per Clermont's schema [108].

The genomic DNA of *E. coli* bacterial isolates was amplified by triplex PCR using three pairs of primers simultaneously, targeted at three markers chuA, yjaA and TspE4.C2.

The DNA lysates the boiling method were performed as follow: a full loop of fresh pure cultures grown on Nutrient agar were resuspended in 250  $\mu$ L water for injection, lysed by heating at 100 oC for 25 min and then were immediately put on ice for 10 min. The supernatant, which contains the whole bacterial genome, was harvested by centrifugation at 11.000 rpm for 10 min.

The PCR was performed with a standard protocol. Each reaction was carried out by using a 25  $\mu$ l mixture containing 2.5 $\mu$ l of 10× DreamTaq buffer (includes 20mM MgCL2), 0.8  $\mu$ M of each primer (initial concentration 20  $\mu$ M), 0.2 mM of each deoxynucleoside triphosphate (initial concentration 10 mM), 1.5 U of DreamTaq polymerase, and 3 $\mu$ l of genomic DNA. The sequences and the other characteristics of primer pairs used are presented in **Table 2.7**. Negative controls (reaction lacking the template DNA) and a positive control (*Escherichia coli* ATCC 25922) were included in all performed amplifications. The PCR was performed under the following conditions: denaturation for 5 min at 94°C; 30 cycles of 30 s at 94°C, 30 s at 55°C, and 30 s at 72°C; and a final extension step of 7 min at 72°C [**108**]. Six-microliter aliquots of PCR products were analyzed by gel electrophoresis with 2% agarose in 1X TBE. Gels were stained with Midori Green stain and visualized in Gel imaging system FastGene FAS-DIGI PRO. A 100-bp DNA ladder was used as a marker.

This method was employed to investigate the correlation between the origin of the sample (clinical specimens, HWW, WWTP effluents, RWS1 and RWS2) and the phylogenetic groups, and to assess the possible association between groups and specific resistance profiles.

Target gene or locus	Sequences 5'- $\rightarrow$ 3'	Melting temperature- Tm (oC)	Product size (bp)
chuA	F_GACGAACCAACGGTCAGGAT R_TGCCGCCAGTACCAAAGACA		279
YjaA	F_TGAAGTGTCAGGAGACGCTG R_ATGGAGAATGCGTTCCTCAAC	55	211
TspE4.C2	F_GAGTAATGTCGGGGGCATTCA R_CGCGCCAACAAAGTATTACG		152

## 2.9.2. Pulsed field gel electrophoresis (PFGE)

#### Material and equipment

- Water for injection
- Ethylenediaminetetraacetic acid (EDTA) 0.5M pH 8.0
- EDTA 0.5M pH 9.0
- Tris-HCl 1M pH 7.4
- N-Lauroylsarcosine Sodium Salt (Sarcosyl) 10%
- Sodium Chloride (NaCl) Solution 5.0 M
- TE (Tris-EDTA): 10mM Tris-HCl, 1mM EDTA pH 8.0
- EC buffer: 6mM Tris-HCl, 1M NaCl, 100mM EDTA pH 9.0, 0.5% Brij 58, 0.2% sodium deoxycholate, 0.5% sarkosyl
- ESP: 0.5M EDTA, 1% sarkosyl, pH 9.0
- Lysozyme 25mg/ml (Apollo Scientific, Cat. No BIL1028-10)
- Proteinase K 20 mg/ml (Invitrogen<sup>TM</sup>, Cat No AM2544)
- Restriction endonuclease XbaI, 3000 U (Takara Bio, Cat. No 1093AH)
- Seakem Gold agarose (Lonza Bioscience, Cat. No 50150)
- TBE (Tris Borate EDTA) 5X: 0.9M Tris-HCl:0.9M Boric Acid: 0.02M EDTA pH 8.0
- Gel Red nucleic acid gels stain 10,000x in water (BIOTIUM, Cat. No 41003)
- Salmonella Braenderup H9812 (universal standard of DNA size in PFGE)
- Pulsed Field Gel Electrophoresis (PFGE) Systems (BIORAD)
- DOLPHIN DOC imaging system (Wealter Bioscience, Cat. No 1141004)

#### Method

The PFGE typing method is based on the comparison of profiles (PFGE patterns) generated following restriction digestion of bacterial DNA. This method was applied to 51 representative MDR isolates derived from different environments (6 clinical isolates, 17 from HWW, 13 from WWTP effluents, 8 from RSW1, and 7 from RSW2), which belong to different phylogenetic groups, in order to reveal their phylogenetic relationship based on the their PFGE patterns. PFGE was performed according to the pulse net protocol [109]. The isolates were cultured in nutrient agar overnight at 37 °C, and treated with lysozyme at 37 °C for 1 h and then with proteinase K at 56 °C for overnight incubation. After four washing steps, the DNA was digested using rare-cutting restriction endonuclease XbaI (30 units/reaction) at 37 °C overnight. The produced fragments of the digested genomic DNA were resolved on 1% agarose gels by electrophoretic current 'pulsed' in different directions for different lengths of time (PFGE system). The conditions for electrophoresis were as follows: 6 V/cm, 120°, Initial duration: 5 sec, Final duration: 55 sec, Total duration: 20h. In this method the strain Salmonella Braenderup H9812 was utilized as both a DNA size marker and a quality control. Following electrophoresis, genomic profiles were visualized by staining with GelRed under UV light using a DOLPHIN - DOC imaging system. The final step involved evaluating the similarity of the strains through visual examination of the molecular fingerprints, based on the criteria established by Tenover et al [110].

## 2.9.3 Plasmid pattern- based typing

## Materials and equipment

- EDTA 0.5 M EDTA pH 8.0
- Tris-HCl 1M pH 8.0
- TE Buffer: (50mM Tris-HCl, 10mM EDTA) pH 8.0
- Lysis Buffer: TE Buffer, 0.4% sodium dodecyl sulfate (SDS), pH 12.39-12.42
- Tris-HCl 2M pH 7.0
- NaCl 5M
- CH3COONa 3M pH 5.2
- Phenol equilibrated, stabilized (PanReac AppliChem ITW Reagents, A1153)
- Water for injection
- 10X Tris Borate EDTA (TBE) stock solution: 900 mM Tris base, 900mM Boric acid and 20mM EDTA pH 8.0 (TBE Buffer 0.5X)
- E. coli 39R861 (control strain)
- Refrigerated centrifuge (Mikro 22R, Hettich)

- FastGene Agaroze (Nippon Genetics, Cat.:AG02)
- Midori Green Advance gels stain (Nippon Genetics Cat. No.: MG04)
- BlueJuice<sup>™</sup> Gel Loading Buffer 10x (Invitrogen<sup>™</sup> by Thermo Fisher Scientific, Cat. No: 10816015)
- DNA ladder (FastGene 100 bp DNA Marker, Nippon Genetics Cat. No. MWD100)
- Horizontal electrophoresis tank ClearSub L10 (Kisker Biotech)
- Gel imaging system FastGene FAS-DIGI PRO (Nippon Genetics)

#### Method

Plasmid pattern- based typing was employed to the eighty-four (73 environmental and 11 clinical) isolates that were confirmed to be  $\beta$ -lactamase producers and were distributed in all phylogenetic groups. The application of this method aimed at: a) estimating the size of the plasmids they might harbor, and b) grouping the isolates according to their plasmid profiles and the resistance genes they carry. Furthermore, by comparing the generated plasmid profiles, it can be determined whether the bacterial isolates share common plasmids, indicating potential transmission or relatedness.

This method was carried out according to the protocol described by Portnoy et al [111, 112]. Initially, a full loop of fresh pure cultures grown on Nutrient agar was harvested and resuspended in 60  $\mu$ l of TE buffer (pH 8). This suspension was then mixed with 600  $\mu$ l of Lysis buffer [0.4% sodium dodecyl sulfate (SDS), pH 12.42]. The alkaline environment and SDS disrupted the cell membranes and denatured chromosomal DNA, while the plasmid DNA remained intact. Subsequently, 45  $\mu$ l of 2 M Tris-HCl (pH 7) was added for neutralization, followed by 160  $\mu$ l of 5M NaCl to precipitate the single- stranded chromosomal DNA. For further purification and to concentrate the plasmid DNA, phenol extraction was performed, followed by ethanol precipitation. After these steps, the sediment was dried, resuspended in 25  $\mu$ l of TE buffer, and subjected to electrophoresis on a 0.72% agarose gel in 0.5X TBE buffer. The gels were stained with Midori Green and visualized using the FastGene FAS-DIGI PRO gel imaging system. The molecular weight of the purified plasmids (in Mega Daltons, MDa) was estimated by comparing them to known plasmids from the control strain *E. coli* 39R861, which contains plasmids of 98.0, 42.0, 23.9, 4.2 Mda and resulting plasmid profiles were compared across different isolates.

#### 2.10 Statistical analysis

Pearson's chi-square test (or Fisher's exact test in case the expected values of any of the cells were below 5) was performed to examine the relationship between the phylogenetic groups and origin of the sample, and additionally between the phylogenetic groups and resistance profiles. The SPSS v.29 package was used for statistical analysis.

## 2.11 Transfer of resistance: conjugation assay

#### Materials

- LB Broth (Miller) (Neogen®, NCM0088A)
- 0.9% NaCl
- MacConkey Agar No.3 (Neogen® Culture Media, NCM0174B)
- Cefotaxime Sodium for injection 1 gram (SteriMax, ST-BQ212)
- Streptomycin injectable 25% (Neocell Pharmaceuticals)
- Escherichia coli 1R716 (recipient strain).

#### Method

The purpose of the conjugation assay was to investigate the potential transfer of resistance genes and to assess the frequency of plasmid transmission in selected isolates. Specifically, this method was applied to thirty three (27 environmental and 6 clinical) representative  $\beta$ -lactamase producing *E. coli* isolates from all geographical study sites with different plasmid profiles.

Conjugation experiments in broth as previously described [113] were performed to estimate the plasmid transfer frequency (also called conjugation rate) which parametrizes the horizontal spread of the studied plasmids carrying  $\beta$ -lactamases genes. *E. coli* 1R716 (lac-, ampicillin sensitive, streptomycin resistant) was used as recipient strain and the studied  $\beta$ -lactamase producing *E. coli* isolates (lac+, ampicillin resistant, streptomycin sensitive) as donors.

Briefly, both donor and recipient strains were inoculated in 10 mL of LB broth. After 24h incubation at 37 °C, donor and recipient suspensions were mixed in the same tube (co-culture) at a ratio of 1:1 and incubated at 37 °C for 18 h. Co-cultures were underwent on ten-fold serial dilutions (10-1 up to 10-6) and 100 $\mu$ l of each dilution were spread on selection MacConkey No3 agar plates containing a combination of streptomycin (STR, 1500  $\mu$ g/mL) and cefotaxime (CTX, 0.4  $\mu$ g/mL). This necessitated that all donor strains were pre-tested for susceptibility to streptomycin and recipient strain for susceptibility to cefotaxime. For the controls, 100 $\mu$ l of 10-6 diluted co-culture

were inoculated on MacConkey No3 agar plates which contain no antibiotic (non-selection plates), in which both strains (donor and recipient) could grow on. Those non-selective plates were used to determine the conjugation efficiency by comparing growth to the selective plates.

The lac- colonies on selection plates were the potential transconjugants clones and the lac+ colonies on the non-selection plate provide the denominator for calculating the transfer frequency. Conjugation frequencies (CF) were calculated as follows:

 $CF = \frac{Number of \ lac - colonies(transconjugants) \ on \ selective \ plates \ x \ dilution \ factor}{Number of \ lac + colonies(donors) \ on \ non \ selective \ plates}$ 

The lac- colonies that grew on the selective media were collected and tested for:

a) Their antibiotic suspectibility in  $\beta$ -lactams, aminoglycosides (including streptomycin), SXT and fluoroquinoles and

b) For the presence of  $\beta$ -lactamase genes via PCR on various transconjugant colonies per conjugation experiment.

Furthemore, transconjugants clones were submitted to plasmid analysis (according to the protocol described by Portnoy et al; **111**, **112**], in order to determine the size of the transferred plasmids.

## 2.12 Plasmid sequencing, assembly, and annotation and bioinformatics analysis

#### Materials

- LB Broth (Miller) (Neogen®, NCM0088A)
- Cefotaxime Sodium for injection 1 gram (SteriMax, ST-BQ212)
- Streptomycin injectable 25% (Neocell Pharmaceuticals)
- Refrigerated Centrifuge (Kubota Model S700TR)
- Nucleobond Kit BAC 100/ 10 cart. (MACHEREY -NAGEL, Cat. No 740579)

#### Method

Initially, for the plasmid DNA extraction from the transconjugants, the following procedures were employed: a) high-density 500 ml liquid cultures in LB broth supplemented with streptomycin (1000  $\mu$ g/ ml) and cefotaxime (0.4  $\mu$ g/ ml), and b) the bacterial pellet obtained after centrifugation (at 3,200 rpm for 25 min) was processed using the NucleoBond BAC 100 kit for large construct plasmid DNA, following the manufacturer's instructions. This kit utilizes an optimized alkaline lysis procedure followed by anion-exchange chromatography to ensure high yields and purity of the plasmid DNA. The resulting DNA is suitable for downstream applications, including sequencing.

Sequencing of  $\beta$ -lactamase gene-carrying plasmids was conducted by Eurofins, using Oxford Nanopore Technology (ONT). Sequencing and the resulting reads are then subjected to quality filtering, assembly, and annotation using the Nanopore data analysis pipeline. The draft sequence of these plasmids was used for the characterisation of the  $\beta$ -lactamase genetic environment.

Acquired ARGs and other features in the plasmid DNA of each isolate were identified using the websever ResFinder 4.1 with a minimum coverage of 80% and a minimum identity of 95% as well as Proksee software. The PlasmidFinder bioinformatic tool was used for the identification of plasmid replicon types (incompatibility groups). Sequence similarity search was performed using BLAST (https://blast.ncbi.nlm.nih.gov/Blast.cgi, accessed on 15 July 2024) scans against the GenBank database. BLAST Ring Image Generator (BRIG) 0.9534 was used for plasmid comparisons and while Proksee for map construction.

Chapter 3

# **Experimental Part**

## Results

#### 3.1 E. coli collection

The total number of *E. coli* colonies was determined by counting the number of characteristic colonies on the membrane filter according to ISO 9308.01-1:2017. A total of 610 colonies presumptive of *E. coli* (identified by their blue-violet color in CCA) were initially collected. Out of the 610 colonies, 502 (171 from WWTP, 105 from semi-treated HWW, 163 from RWS1 and 63 from RWS2 samples) were finally confirmed as being *E. coli* using the gold standard procedures [**ISO 9308.01-1:2017**] and molecular uidA confirmatory test [**91**]. In more detail, of the 502 confirmed E. coli isolates, 296 (92 from WWTP, 73 from HWW, 91 from RWS1 and 40 from RWS2 samples) were collected from CCA culture media without AMP and 206 (79 from WWTP, 32 from HWW, 72 from RWS1 and 23 from RWS2 samples) were collected from CCA/AMP. Regarding the clinical collection, a total of 139 *E. coli* isolates were identified and confirmed, with 104 derived from urine, 30 from blood and 5 from patients' tissue.

# **3.2.** Antimicrobial susceptibility profiles and assessment of resistance mechanisms

Considering that *E. coli* has no intrinsic resistance mechanisms, all of the isolates (environmental and clinical) were classified into specific sub-categories. Regarding the environmental isolates, 40.4% (203/502) were characterized as WT, 2.8% (14/502) were characterized as N-WT, 36.5% (183/502) were characterized as R and 20.3% (102/502) were characterized as MDR. Regarding the clinical isolates, 40% (56/139) were characterized as S, 46% (64/139) were characterized as R and 14% (19/139) were characterized as MDR. The results of the antimicrobial susceptibility tests (antibiograms) and the characteristics of all isolates are presented in **Table 3.1** while the data for the characterization of the resistance profiles of the environmental and clinical samples are summarized in **Table 3.2**.

The resistance frequencies of the 502 environmental and 139 clinical isolates in all of the tested antibiotics are presented in **Figure 3.1**. Resistance to penicillins (AMP and PIP) was the most frequent among all of the environmental and clinical isolates, followed by resistance to AMC.

In more detail, 55% (275/502) of the environmental isolates exhibited resistance to AMP, 53% (267/502) exhibited resistance to PIP and 33% (164/502) exhibited resistance to AMC. A high resistance rate to quinolones (24.9%; 125/502) was also observed and the majority of the resistant isolates were derived from HWW (33.6%; 42/125) (**Figure 3.1**).

Regarding the 139 clinical isolates, 40% (55/139) presented resistance to AMP, 33% (46/139) presented resistance to PIP and 25% (35/139) presented resistance to AMC. The number of different antibiotic categories in which environmental and clinical MDR isolates presented resistance is shown in **Table 3.3**.

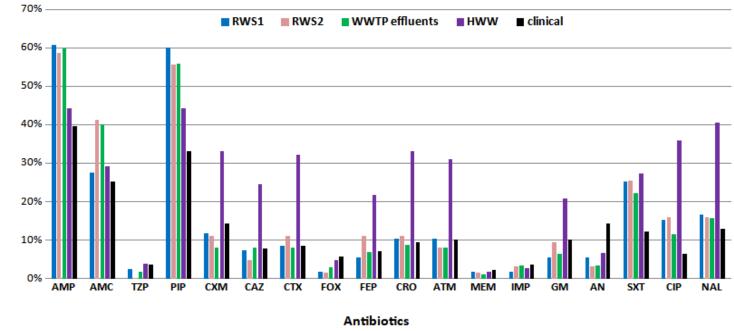


Figure 3.1 The frequency rate of resistance to each antibiotic per origin of sample.

[Abbreviations: AMP, ampicillin; AMC, amoxicillin/clavulanic acid; TZP, piperacillin/ tazobactam; PIP, piperacillin; CXM, cefuroxime; CAZ, ceftazidime; CTX, cefotaxime; FOX, cefoxitin; FEP, cefepime; CRO, ceftriaxone; ATM, aztreonam; MEM, meropenem; IMP, imipenem; GM, gentamicin; AN, amikacin; SXT, sulfamethoxazole-trimethoprim; CIP, ciprofloxacin; NAL, nalidixic acid. HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1; RWS2, river water site 2]

# Table 3.1 All environmental and clinical *E.coli* isolates and their characteristics (sampling season, type of sample, sampling site, resistance pattern and profile and phylogenetic group)

	p.e, su		10010001000				
la olatea	Sampling Scaron	Type of Sample	Sampling Site	Phylogenetic group	Resistance Pattern	Renintance Profile	DOST
293	Summer 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC	R	
294	Summer 2019	Treated Wastewater	WWTP outlet	A		WT	
29/5	Summer 2019	Treated Wastewater	WWTP outlet	A		WT	
296	Summer 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, CIP, NAL	R	
297	Summer 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, TCC, CAZ, CTX, CRO, ATM, AN	MDR	+
298	Summer 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, TCC	R	
299	Summer 2019	Treated Wastewater	WWTP outlet	Bl	AMP, AMC, PIP, TCC, NAL	R	
300	Summer 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, TZP, PIP, TCC	R	
301	Summer 2019	Treated Wastewater	WWTP outlet	B2	AMP, AMC	R	
302	Summer 2019	Treated Wastewater	WWTP outlet WWTP outlet	Bl	AMP, AMC, PIP, TCC	R	<u> </u>
303	Summer 2019 Summer 2019	Treated Wastewater Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, TCC, SXT	R WT	
304 305	Summer 2019	River water	RW S2	A		WT	<u> </u>
306	Summer 2019	River water	RW S2	BI	AMP, AMC, PIP, TCC	R	
307	Summer 2019	River water	R/W S2	A	And And In the	WT	
308	Summer 2019	River water	R/W S2	A		WT	
309	Summer 2019	River water	R/W S2	Bl	AMP, AMC	R	
310	Summer 2019	River water	R/W S2	A	AMP, AMC	R	
311	Summer 2019	River water	RWS1	D	AMP, AMC, PIP, TCC	R	
312	Summer 2019	River water	R/W SL	A		WT	
313	Summer 2019	River water	RW S1	A	AMP, AMC, PIP, TCC	R	
314	Summer 2019	River water	R/W S1	A		WT	
315	Summer 2019	River water	R/W SL	A	7.5.0F	WT	<b> </b>
316	Summer 2019	River water	RW S2	B2	SXT	N-WT	<b>—</b>
317	Auturn 2019	Treated Wastewater	WWTP outlet WWTP outlet	A	AMP, AMC, PIP, NAL	R	
318 319	Auturn 2019 Auturn 2019	Treated Wastewater Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, CIP, NAL AMP, AMC, PIP, SXT	R R	
319	Auturn 2019 Auturn 2019	Treated Wastewater	WWTP outlet	A	AMP, ANC, PIP, SX1 AMP, PIP	R	
320	Auturn 2019	Treated Wastewater	WWTP outlet	A	AMP, PP	R	
322	Auturn 2019	Treated Wastewater	WWTP outlet	BI	AMP, PIP	R	
323	Auturn 2019	Treated Wastewater	WWTP outlet	Bl	AMP, AMC, PIP	R	
324	Auturn 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, TCC	R	
325	Auturn 2019	Treated Wastewater	WWTP outlet	B2	AMP, PIP	R	
326	Auturn 2019	Treated Wastewater	WWTP outlet	B2	AMP, PIP, MEM, IMP	R	-
327	Auturn 2019	Treated Wastewater	WWTP outlet	B2		WΤ	
328	Auturn 2019	Treated Wastewater	WWTP outlet	B2	AMP, AMC, FOX, AN, NAL	MDR	
329	Auturn 2019	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP, TCC	R	
330	Auturn 2019	Treated Wastewater	WWTP outlet	A		WΤ	
331	Auturn 2019	Treated Wastewater	WWTP outlet WWTP outlet	B2		WT	<u> </u>
332 333	Auturn 2019	Treated Wastewater Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP , GM, AN, SXT, CIP, NAL	MDR WT	<u> </u>
333	Auturn 2019		WWTP outlet	A Bl		WT	<u> </u>
334	Auturn 2019 Auturn 2019	Treated Wastewater Treated Wastewater	WWTP outlet	A		WT	
337	Auturn 2019	Treated Wastewater	WWTP outlet	A	CIP, NAL	R	
338	Auturn 2019	Treated Wastewater	WWTP outlet	A		WT	
339	Auturn 2019	Treated Wastewater	WWTP outlet	D		WT	
340	Auturn 2019	Treated Wastewater	WWTP outlet	B2	AMP, AMC, TCC, FOX, NAL	MDR	
341	Auturn 2019	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, GM	R	
344	Auturn 2019	HWW	Septic tank	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL	MDR	+
345	Auturn 2019	HWW	Septic tank	A	AMP, PIP, CAZ, CTX, CRO, ATM, NAL	MDR	+
347	Auturn 2019	HWW	Septic tank	A	AMP, AMC, SXT	R	
348	Auturn 2019	HWW	Septic tank	A		WT	
349	Auturn 2019	HWW	Septic tank	A	SXT	N-WT	
350	Auturn 2019	HWW	Septic tank	A	AMD ANAC DID TOO AN OVE NAL	WT	l
352	Auturn 2019 Auturn 2019	HWW	Septic tank	B2	AMP, AMC, PIP, TCC, AN, SXT, NAL	MDR	
355	Auturn 2019 Auturn 2019	River water River water	RWS1 RWS1	A D	AMP, AMC, PIP, TCC, NAL AMP, AMC, PIP, COM, CAZ, CTX, FEP, CRO, ATM	R MDR	+
356	Auturn 2019 Auturn 2019	River water	RWSI RWSI	B2	AMP, AMC, PIP	R	
358	Auturn 2019	River water	RWSI	A	AMP, AMC, PIP, NAL	R	
359	Auturn 2019	River water	RWSI	A	AMP, AMC, PIP, NAL	R	
361	Auturn 2019	River water	R/W SL	BI		WT	
362	Auturn 2019	River water	R/W SL	A		WT	
363	Auturn 2019	River water	R/W SL	A	AMP, AMC, PIP	R	
364	Auturn 2019	River water	RW S1	Bl		WT	
365	Auturn 2019	River water	R/W SL	A		WT	
367	Auturn 2019	River water	R/W SL	A	AMP, AMC, PIP, CXM, CAZ, FOX, CRO, ATM	MDR	-
368	Auturn 2019	River water	RWS1	A		WT	
369	Auturn 2019	River water	R/W S2	A	AMP, PIP, NAL	R	I
370	Auturn 2019	River water	RW S2	A	AMP, AMC, PIP, NAL	R	<u> </u>
371	4	Biver water	RW S2	A	AMP, AMC, PIP, SXT, NAL	R	
-	Auturn 2019		T1431 (C17)				
372	Auturn 2019	River water	R/W S2 R/W S2	D	AMP, AMC, PIP	R	<u> </u>
372 373	Auturn 2019 Auturn 2019	River water River water	R'W S2	A	AMP, AMC, PIP, SXT	R	
372 373 374	Autumn 2019 Autumn 2019 Autumn 2019	River water River water River water	RW S2 RW S2	A A	AMP, AMC, PIP, SXT AMP, AMC, PIP	R R	
372 373 374 375	Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019	River water River water River water River water	R'W S2	A A A	AMP, AMC, PIP, SXT AMP, AMC, PIP AMP, AMC, PIP, SXT, CIP, NAL	R R MDR	
372 373 374	Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019	River water River water River water River water River water	R/W S2 R/W S2 R/W S2 R/W S2	A A A A	AMP, AMC, PIP, SXT AMP, AMC, PIP AMP, AMC, PIP, SXT, CIP, NAL AMP, AMC, PIP, SXT	R R	
372 373 374 375 376	Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019	River water River water River water River water	RW S2 RW S2 RW S2	A A A	AMP, AMC, PIP, SXT AMP, AMC, PIP AMP, AMC, PIP, SXT, CIP, NAL	R R MDR R	
372 373 374 375 376 377	Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019 Auturn 2019	River water River water River water River water River water River water	RW S2 RW S2 RW S2 RW S2 RW S2	A A A B2	AMP, AMC, PIP, SXT AMP, AMC, PIP AMP, AMC, PIP, SXT, CIP, NAL AMP, AMC, PIP, SXT AMP, AMC, PIP SXT	R R MDR R R	

					1		
383	Winter 2020	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, TOC	R	I
384	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
385	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
386	Winter 2020	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP, TOC, AN, SXT	MDR	
387	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
388	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
389	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
391	Winter 2020	Treated Wastewater	WWTP outlet	A	Chillen (Chilling Line) Lines	WT	
			WWTP outlet			-	<b> </b>
392	Winter 2020	Treated Wastewater		A		WT	
398	Winter 2020	Treated Wastewater	WWTP outlet	A	1 5 MB	WT	
394	Winter 2020	Treated Wastewater	WWTP outlet	A	AMP	N-WT	<b>—</b>
396	Winter 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, TOC	R	
397	Winter 2020	River water	RWS2	B2		WT	
398	Winter 2020	River water	RWS2	A		WT	
399	Winter 2020	River water	RWS2	B2		WT	
400	Winter 2020	River water	RWS2	A		WT	
401	Winter 2020	River water	RWS2	A		WT	
402	Winter 2020	River water	RWS1	B2	AMP, PIP, NAL	R	
403	Winter 2020		RWSI	B2	AMP, AMC, PIP, AN	R	
		River water					<u> </u>
404	Winter 2020	River water	RWSI	A	AMP, AMC, PIP, TZP, TCC, SXT, CIP, NAL	MDR	<u> </u>
404.1	Winter 2020	River water	RWS1	A	AMP, AMC, PIP, AN, SXT, CIP, NAL	MDR	L
405	Winter 2020	River water	RWS1	D	AMP, AMC, PIP, CXM, CTX, CRO, ATM, CIP, NAL	MDR	+
406	Winter 2020	River water	RWS1	D	AMP, AMC, PIP, SXT, NAL	R	
407	Winter 2020	River water	RWS1	A	AMP, PIP, SXT	R	
408	Winter 2020	River water	RWS1	D	AMP, AMC, TZP, PIP, TCC, CXM, CAZ, CTX, FEP, CRO, ATM, MEM, IMP, SXT	MDR	+
409	Winter 2020	River water	RWS2	A	AMP, AMC, PIP, SXT, CIP, NAL	MDR	
410	Winter 2020	River water	RWS1	D	AMP, PIP	R	
412	Winter 2020	River water	RWSI	A	AMP, AMC, PIP	R	
413	Winter 2020		RWSI			R	
		River water		A	AMP, AMC, PP	-	
414	Winter 2020	River water	RWSI	A	AMP, AMC, PIP	R	
415	Winter 2020	River water	RWSI	B2	AMP, PIP, SXT	R	<b>—</b>
416	Winter 2020	River water	RWS2	Bl	AMP, PIP, SXT	R	
417	Winter 2020	River water	RWS2	BL		WT	
418	Winter 2020	River water	RWS2	Bl		WT	
419	Winter 2020	River water	RWS1	A	AMP, AMC, PIP, SXT	R	
420	Winter 2020	River water	RWS2	BL		WT	
421	Winter 2020	River water	RWS2	D		WT	
422	Winter 2020	River water	RWS2	BL		WT	
426	Winter 2020	HWW	Septic tank	D	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	+
420	Winter 2020 Winter 2020	HWW	*	B2		MDR	-
			Septie tank		AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	_	- T
431	Winter 2020	HWW	Septic tank	B2	AMP, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	MDR	+
434	Winter 2020	HWW	Septic tank	B2	AMP, AMC, PIP, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	+
436	Winter 2020	HWW	Septic tank	B2	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	MDR	+
439	Winter 2020	HWW	Septic tank	B2		WT	
442	Winter 2020	HWW	Septic tank	A	AMP, AMC, NAL	R	
445	Winter 2020	HWW	Septic tank	Bl		WΤ	
446	Winter 2020	HWW	Septic tank	BL		WT	
447	Winter 2020	HWW	Septic tank	B2	AMP, AMC, COM, NAL	R	
448	Winter 2020	HWW	Septic tank	BL		WT	
450	Summer 2020	River water	RWSI	A		WT	
451	Summer 2020	River water	RWSI	A		WT	
451						WT	
	Summer 2020	River water	RWS1	A			
453	Summer 2020	River water	RWS1	A	AMP, AMC, PIP	R	<b>I</b>
454	Summer 2020	River water	RWS1	B2		WT	<b> </b>
455	Summer 2020	River water	RWSI	B2	AMP, AMC, PIP	R	
456	Summer 2020	River water	RWS1	A	AMP, PIP,	R	
457	Summer 2020	River water	RWS1	A		WT	
458	Summer 2020	River water	RWS1	A	AMP, PIP, SXT, CIP, NAL	R	
499	Summer 2020	River water	RWS1	A		WT	
460	Summer 2020	River water	RWSI	B2	1	WT	
461	Summer 2020	River water	RWSI	A	1	WT	
462	Summer 2020	River water	RWSI	A	l	WT	
462							
-	Summer 2020	River water	RWSI	B2		WT	
464	Summer 2020	River water	RWS1	BL		WT	<b>—</b>
465	Summer 2020	River water	RWS1	A		WT	
466	Summer 2020	River water	RWS1	A	AMP, AMC, PIP, SXT, CIP, NAL	MDR	
467	Summer 2020	River water	RWS1	D	AMP, PIP, SXT, CIP, NAL	R	
468		River water	RWSI	B2	AMP, PIP, AN	R	
469	Summer 2020	TANKS WARDING				1	
	Summer 2020 Summer 2020	River water	RWS1	B2	AMP, AMC, PIP	R	
470				B2 A	AMP, AMC, PIP AMP, PIP, CIP, NAL	R R	
	Summer 2020 Summer 2020	River water River water	RWS1 RWS1	A		R	
470 471	Sammer 2020 Sammer 2020 Sammer 2020	River water River water River water	RWS1 RWS1 RWS1	A Bl	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT	R MDR	+
470 471 472	Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water	RWSI RWSI RWSI RWSI	A Bl A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL	R MDR MDR	+
470 471 472 473	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL AMP, AMC, PIP	R MDR MDR R	+
470 471 472 473 474	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP	R MDR MDR R R	+
470 471 472 473 474 474	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, COM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, CIP, NAL	R MDR MDR R R R	+
470 471 472 473 474 475 476	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, SXT, CIP, NAL	R MDR R R R R R	+
470 471 472 473 474 474	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, COM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, CIP, NAL	R MDR MDR R R R	+
470 471 472 473 474 475 476	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A A	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, SXT, CIP, NAL	R MDR R R R R R	+
470 471 472 473 474 475 476 476 477	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water River water River water River water River water River water River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A Bl	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CXM, CTX, GRO, ATM, NAL AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, SXT, CIP, NAL AMP, PIP, COM, CAZ, GRO, ATM, CIP, NAL	R MDR R R R R R MDR	+
470 471 472 473 473 474 475 476 477 478	Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020 Summer 2020	River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A Bl A	AMP, PIP, CIP, NAL AMP, AMC, PIP, CM, SXT AMP, AMC, PIP, CXM, CTX, CBO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, SXT, CIP, NAL AMP, PIP, SXT, CIP, NAL AMP, PIP, CXM, CAZ, CBO, ATM, CIP, NAL AMP, PIP, CXM, CAZ, CBO, ATM, CIP, NAL	R MDR R R R R MDR MDR	+
470 471 472 473 474 475 476 477 478 479 481	Summer 2020 Summer 2020	River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A Bl A Bl Bl Bl	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, CNA, CAZ, CRO, ATM, CIP, NAL AMP, PIP, CNA, CAZ, CRO, ATM, CIP, NAL AMP, AMC, PIP AMP, AMC, PIP	R MDR R R R R MDR MDR R R R	+
470 471 472 473 474 475 475 475 475 475 475 475 475 475	Summer 2020 Summer 2020	River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A Bl A Bl A Bl A	AMP, PIP, CIP, NAL AMP, AMC, PIP, CM, SXT AMP, AMC, PIP, CM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, COA, CAZ, CRO, ATM, CIP, NAL AMP, PIP, COA, CAZ, CRO, ATM, CIP, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, AMC, PIP AMP, AMC, PIP	R MDR R R R R MDR MDR R R R R	+
470 471 472 473 474 475 476 477 478 479 481	Summer 2020 Summer 2020	River water River water	RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1 RWS1	A Bl A A A A Bl A Bl Bl Bl	AMP, PIP, CIP, NAL AMP, AMC, PIP, GM, SXT AMP, AMC, PIP, CM, CTX, CRO, ATM, NAL AMP, AMC, PIP AMP, AMC, PIP AMP, PIP, CIP, NAL AMP, PIP, CNA, CAZ, CRO, ATM, CIP, NAL AMP, PIP, CNA, CAZ, CRO, ATM, CIP, NAL AMP, AMC, PIP AMP, AMC, PIP	R MDR R R R R MDR MDR R R R	+

44         Seven 200         Next Monday         WTT Park         10         NAD AUL, PA         10           45         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         11           46         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         11           47         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         NAD AUL, PA         11           48         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         NAD AUL, PA         11           47         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         NAD AUL, PA         NAD AUL, PA         11           47         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         NAD AUL, PA         11           48         Seven 200         Inald Vaccoux         WTT Park         10         NAD AUL, PA         NAD AU						1		
eff         Surent 200         Food Number 2000         NUT Parts         D         DAY AUC, PE YAL         A           60         Surent 200         Food Number 2000         NUT Parts         A         AUX AUX, PE YAL         A           61         Surent 200         Food Number 2000         NUT Parts         A         AUX AUX, PE YAL         A           62         Surent 200         Food Number 2000         AUX AUX, PE YAL         A         AUX AUX, PE YAL         A           63         Surent 200         Food Number 2000         AUX AUX, PE YAL         A         AUX AUX, PE YAL         A           64         Surent 200         Food Number 2000         NUT Parts         A         AUX AUX, PE YAL         A           64         Surent 200         Food Number 2000         NUT Parts         A         AUX AUX, PE YAL         AUX         AUX AUX, PE YAL         AUX         AUX         AUX         AUX         AUX AUX, PE YAL         AUX         A	485	Summer 2020	Treated Wastewater		D	AMP, AMC, PIP,	R	
Heat         Summary 200         Food Survayors         NUT Process         A         AUX AUX, PP         A           46         Summary 200         Food Survayors         NUT Process         A         AUX AUX, PP         A           47         Summary 200         Food Survayors         NUT Process         A         AUX AUX, PP         AUX         AUX           48         Summary 200         Food Survayors         NUT Process         A         AUX AUX, PP SY         A         A           49         Summary 200         Food Survayors         NUT Process         A         AUX AUX, PP SY         AUX         AUX           47         Summary 200         Food Survayors         NUT Process         AUX         AUX AUX, PP SY         AUX         AUX           47         Summary 200         Food Survayors         NUT Process         AUX         AUX AUX, PP SY CP AUX	486	Summer 2020	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP	R	
140Sumar 30Total WaxnessWATP andAAUP, VAC, PPAUP, VAC, PPAA44Sumar 20Facil WaxnessWATP andAAAUP, VAC, PP ATNAA45Sumar 20Facil WaxnessWATP andAAAUP, VAC, PP ATNAA46Sumar 20Facil WaxnessWATP andAAAUP, VAC, PP ATNAA47Sumar 20Facil WaxnessWATP andAAAUP, VAC, PP ATNAA48Sumar 20Facil WaxnessWATP andAAUP, VAC, PP ATN, CUA ATNAAUP48Sumar 20Facil WaxnessWATP andAAUP, VAC, PP CUA CUA CUA TRANALAUR48Sumar 20Facil WaxnessWATP andAAUP, VAC, PP ATN, PC AU, AUP, AUP, CUA TRANALAUR49Sumar 20Facil WaxnessWATP andAAUP, PC AU, CUA TRANALAUR40Sumar 20Facil WaxnessWATP andAAUP, PC AU, CUA TRANAL AUP, AUP, AUP, AUP, AUP, AUP, AUP, AUP,	487	Summer 2020	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP, NAL	R	
E40         Survey 200         Total Number 200         WTT reads         A.M. MAR, NEP, PC, MAR, TAURANAL         MER         +           461         Survey 200         Total Number 200         WTT reads         A.M. MAR, MAR, PC, MAR, TAURANAL         MER         -           471         Survey 200         Total Number 200         WTT reads         A.M. MAR, PC, PC MATT, TAURANAL         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MAR, PC PC MATT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MAR, PC PC MATT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MP, PC MATT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MP, PC MATT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MP, PC MATT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MP, NC PT OAT, CAD NT         ME           471         Survey 200         Total Number 200         WTT reads         A.M. MP, NC PT OAT, CAD NT         ME           471         Survey 200	488	Summer 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP, CIP, NAL	R	1
464         Surenz 20         Total Number 20         WTP and Number 20         Auto 20, Auto 20, PC AUTO 20, AUTO 20, PC AUTO	489	Summer 2020	Treated Wastewater	WWTP outlet	A		R	
Hear 200         Total Number 2007	400			WWTP outlet			P	<u> </u>
Hear 20         Tool Warrows         WTP own         A         AVE ALC, PAST         I           H         Sware 20         Tool Warrows         WTP own         B         AVE ALC, PAST         B           H         Sware 20         Tool Warrows         WTP own         B         AVE ALC, PAST         MB         MB           H         Sware 20         Tool Warrows         WTP own         B         AVE ALC, PAST, CAS, PAST, PASH         MB           Sware 20         Tool Warrows         WTP own         D         AVE ALC, PAST, CAS, PAST, PASH, AND ALC, PAST, PASH, P							-	+
Heat         Survey 200         Total Number 200         WTP rock         ALP         ALP, PACP, PCATY, TCAY, TCAY         ME         -           44         Survey 200         Total Number 200         WTP rock         ALP         ALP, PCATY, TCAY, TCA		t					+	· ·
Heat         Survey 200         Total Nurssan         WTP ands         A.M. AUP TOTAL CR. (20. XIT)         M.M.           Heat         Survey 200         Total Nurssan         WTP ands         A.M.         AUP TOTAL CR. (20. XIT)         M.M.           Heat         Survey 200         Total Nurssan         WTP ands         A.M.         AUP TOTAL CR. (20. C.C.)         M.M.         AUP TOTAL CR. (20. M.M.)         M.M.         AUP TOTAL CR. (20. M.M.)         M.M.         AUP TOTAL CR. (20. M.M.)         M.M.         <							-	<u> </u>
8446         Surang 200         Total Nutsiand         WETP solid         A. M.P. PALKPP COM LAG CITY PP. CR. ATM. AND.         M.R.         -           845         Surang 200         Total Nutsiand         WETP solid         D. M.D. PALKPP COM LAG CITY PP. CR. ATM. AND.         M.R.         -           846         Surang 200         Total Nutsiand         WETP solid         D. M.D. PALKPP COM LAG CITY PP. CR. ATM. AND.         M.R.         -           847         Surang 200         Total Nutsiand         WETP solid         D. M.D. PCP NAL.         M.R.         -           848         Surang 200         Total Nutsiand         WETP solid         D. M.D. PCP NAL.         M.R.         -           848         Surang 200         Total Nutsiand         WETP solid         G.G.         -		-	Treated Wastewater					L
Here         Server 201         Tender Nurversett         WTP marks         A.M.P. ALE, P.Y.ALE, P.Y.ALE, P.Y.ALE, M.Y.ALE,	494	Summer 2020	Treated Wastewater	WWTP outlet	BL	AMP, AMC, PIP, CXM, CTX, CRO, SXT	MDR	+
190         Suma 20         Tended Number 20         WT Prodet A         ALP ALE POST (P AL         Mate         Mate         Mate           56         Suma 23         Tended Number 20         WT Prodet A         ALP ALE POST (P ALA SET ALL)         I           56         Suma 23         Tended Number 20         WT Prodet A         ALP POT (P ALA SET ALL)         I           56         Suma 23         Tended Number 20         WT Prodet A         ALP POT (P ALA SET ALL)         I         I           51         Suma 23         Tended Number 20         WT Prodet A         ALP POT (P ALA SET ALL)         I         I           51         Suma 23         Tended Number 20         WT Prodet A         A         I	495	Summer 2020	Treated Wastewater	WWTP outlet	A	AMP, PIP	R	
Sec.         Sec.         Teal Network         WTP make         A         AUX ALCE PD AXIC (P) AXIC         MDE           Sec.         Learn 230         Teal Warrange         WTP make         A         AUX ALCE PD AXIC         Image         Image<	497	Summer 2020	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	+
Store         Store         Total Structure         WTF marks         A         AUP. AUX. PTP         A         AUP. PR           56         Stores 203         Total Structure         WTF marks         D         AUP. PTP	500	Summer 2020	Treated Wastewater	WWTP outlet	D		MDR	
9000         Instant Numeral         WTP model         A         AUP PP         AUP PP         AUP PP           900         Searce 200         Tackal Numeral         WTP model         D         AUP PP CNA CA, CE PP ATM NUTNAL         B           900         Searce 200         Tackal Numeral         WTP model         D         AUP PP CNA CA, CE PP ATM NUTNAL         B           901         Searce 200         Tackal Numeral         WTP model         D         AUP PP CNA CA, CE PP ATM NUTNAL         D           901         Searce 200         Tackal Numeral         WTP model         D         AUP CNA CA, CE PP ATM NUTNAL         VT           901         Searce 200         Tackal Numeral         WTP model         A         P         AUP CNA CA, CE PP ATM NUTNAL         VT           901         Searce 200         Tackal Numeral         WTP model         A         Z//         CA         Numeral         VT           901         Searce 200         Tackal Numeral         WTP model         A         Z//         Numeral	501	Summer 2020	Treated Wastewater	WWTP outlet	A		MDR	1
Source 200         Lond Numeral WT Pack         O         AUP PP (CM, CAC, CTA, PP, ATM, SML)         MB         -           56         Sueaz 201         Taski Numeral WT Pack         R         AUP PP (CM, CRA, CTA, PP, CM, ML)         MD         -           56         Sueaz 201         Taski Numeral WT Pack         R         AUP PP (CM, CRA, CRA, CRA, CRA, CRA, CRA, CRA, CRA							-	<u> </u>
Sec.         Sec. <th< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td><b>.</b></td></th<>								<b>.</b>
10         Summer 2001         Frank Ware-same         WPT Parks         RC         Add P. PP. CNAL CTX, CRU NAL.         MUT         WT           10         Summer 2001         Trank Ware-same         WPT Parks         A         WT         WT           10         Summer 2001         Trank Ware-same         WPT Parks         A         WT         WT           10         Summer 2001         Trank Ware-same         WPT Parks         A         Parks         WT         WT           10         Summer 2001         Trank Ware-same         WPT Parks         A         Parks         WT         WT           10         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT Parks         A         CA         Parks         Summer 2001         Trank Ware-same         WPT P		-					-	+
Sum 200         Fund Watersam         WYT Parks         BC         Sum 200         Fund Watersam         WYT Parks         BC           51         Sum 200         Fund Watersam         WYT Parks         BC         WYT Parks         A         YYT Parks         A								
101         Lamary 200         Frank Watersam         WYTP molth         A.         Image 200         Frank Watersam         WYTP molth         BC           154         Gamery 200         Frank Watersam         WYTP molth         BC         WYT         WYT           154         Gamery 200         Frank Watersam         WYTP molth         A         WYT         WYT           154         Gamery 200         Frank Watersam         WYTP molth         A         VZ         WYT         WYT           156         Gamery 200         Frank Watersam         WYTP molth         A         VZ         WYT         WYT           157         Gamery 200         Frank Watersam         WYTP molth         A         QZ         WYT         WYT           158         Gamery 200         Frank Watersam         WYTP molth         A         QZ         WYT         WYT           159         Gamery 200         Frank Watersam         WYTP molth         A         P         P         WYT         WYT           150         Gamery 200         Frank Watersam         WYTP molth         A         P         P         P           150         Gamery 200         Frank Watersam         WYTP molth         A	500	Summer 2020	Treated Wastewater	WWTP outlet	B2	AMP, PIP, CXM, CTX, CRO, SXT, CIP, NAL	MDR	+
10.         Unsers 200         Family Number of With Parkin         RC         Image Park Parkin         WT parkin         Park           15.         Guere 2001         Teaded Watersame         WT Parkin         A         WT         WT           15.         Guere 2001         Teaded Watersame         WT Parkin         A         Park         WT         WT           16.         Guere 2001         Teaded Watersame         WTT Parkin         A         Park Parkin         WT         WT           17.         Guere 2001         Teaded Watersame         WTT Parkin         A         Park Parkin         NT           17.         Guere 2001         Teaded Watersame         WTT Parkin         A         Park Parkin         NT           17.         Guere 2001         Teaded Watersame         WTT Parkin         A         Parkin         WTT           17.         Guere 2001         Teaded Watersame         WTT Parkin         A         Parkin         WTT         WTT           17.         Guere 2001         Teaded Watersame         WTT Parkin         B         Parkin         WTT         WTT           17.         Guere 2001         Teaded Watersame         WTT Parkin         B         Parkin         Parkin	511	Summer 2020	Treated Wastewater	WWTP outlet	B2		WT	
544         Summer 200         Trainit Wurstwatt         WTP only         A           554         Summer 200         Trainit Wurstwatt         WTP only         A           575         Summer 200         Trainit Wurstwatt         WTP only         A           576         Summer 200         Trainit Wurstwatt         WTP only         A           577         Summer 200         Trainit Wurstwatt         WTP only         A           578         Summer 200         Trainit Wurstwatt         WTP only         A           588         Summer 200         Trainit Wurstwatt         WTP only         A           598         Summer 200         Trainit Wurstwatt         WTP only         A           598         Summer 200         Trainit Wurstwatt         WTP only         B           598         Summer 200         Trainit Wurstwatt         WTP only         B           598         Summer 200         Trainit Wurstwatt         WTP only	512	Summer 2020	Treated Wastewater	WWTP outlet	A		WT	
Summ         Summ         Summ         Summ         Summ         Summ         Summ         Summ           54         Summ	513	Summer 2020	Treated Wastewater	WWTP outlet	B2		WT	
Sume         Sume         Sume         Sume         Yes         Ver           513         Sume         Sume         Sume         WTP ends         A.         A.           514         Sume         Sume         Sume         Num         Num         Num           515         Sume         Sume         Sume         Num         Num         Num           516         Sume         Sume         Sume         Num         Num         Num           517         Sume         Sume         Sume         Num         Num         Num           518         Sume         Sume         Sume         Num         Num         Num         Num           518         Sume         Sume         Sume         Sume         Num         Num         Num         Num           528         Sume         Sume         Sume         Num         Num         Num         Num         Num           529         Sume         Sume         Sume         Num		•				1		
117         Summer 200         Transit Wurstwatt         WTP market         A.         Corr         Numer         Numer         Numer         Numer           151         Summer 200         Transit Wurstwatt         WTP market         A.         Corr         Numer						1	-	1
Summ. 200         Total Wurstand         WTTP ands         A.         CAZ         Summ. 2010         Total Wurstand         WTTP ands         D.           10         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           10         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           11         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           12         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           13         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           14         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           15         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           16         Summ. 2010         Total Wurstand         WTTP ands         A.         CP.         P.           17         Summ. 2010         Total Wurstand         WTTP ands         B.         CP.         P.           16         Summ. 2010         Total Wurstand         WTTP an								<u> </u>
190         Summer 200         Transit Watersame         WPTP market         A         APP, PRN, CP, PALL         R           190         Summer 200         Transit Watersame         WPTP market         A         Vert         Vert           191         Summer 200         Transit Watersame         WPTP market         A         Vert         Vert           191         Summer 200         Transit Watersame         WPTP market         A         Vert         Vert           191         Summer 200         Transit Watersame         WPTP market         A         Vert         WPT           191         Summer 200         Transit Watersame         WPTP market         A         Vert         WPT           192         Summer 200         Transit Watersame         WPTP market         A         Vert         WPT           193         Summer 200         Transit Watersame         WPTP market         Bit         Vert         WPT           193         Summer 200         Transit Watersame         WPTP market         Bit         Vert         WPT           194         Summer 200         Transit Watersame         WPTP market         Bit         Vert         WPT           195         Summer 200         Transit Water						017	+	H
Summe 2001         Factor Materian         WT Prouble         A         CD Nat.         R           221         Summe 2001         Teatal Watersam         WT Prouble         N         N           231         Summe 2001         Teatal Watersam         WT Prouble         N         N           231         Summe 2001         Teatal Watersam         WT Prouble         N         N           235         Summe 2001         Teatal Watersam         WT Prouble         N         N           235         Summe 2001         Teatal Watersam         WT Prouble         N         N           236         Summe 2001         Teatal Watersam         WT Prouble         A         N         N           236         Summe 2001         Teatal Watersam         WT Prouble         N         N         N         N           231         Summe 2001         Teatal Watersam         WT Prouble         N         N         N         N         N           231         Summe 2001         Teatal Watersam         WT Prouble         N         N         N         N           233         Summe 2001         Teatal Watersam         WT Prouble         N         N         N         N		-					-	<b>I</b>
Same 200         Same 200         Teach Watersam         WT Prouble         A         Normality           201         Same 200         Teach Watersam         WT Prouble         A         WT         WT           203         Same 200         Teach Watersam         WT Prouble         A         WT         WT           204         Same 200         Teach Watersam         WT Prouble         A         WT         WT           205         Same 200         Teach Watersam         WT Prouble         A         WT         WT           207         Same 200         Teach Watersam         WT Prouble         A         WT         WT           208         Same 200         Teach Watersam         WT Prouble         A         WT         WT           208         Same 200         Teach Watersam         WT Prouble         A         WT         WT           208         Same 200         Teach Watersam         WT Prouble         D         WT         WT           208         Same 200         Teach Watersam         WT Prouble         D         WT         WT           208         Same 200         Teach Watersam         WT Prouble         D         A         AVP, AMC, PP         R			Treated Wastewater					
Summe 2001         Summe 2001         Totak Watersam         WPT Pools         H         WPT Pools         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         WPT         WPT           Siss         Summe 2007         Testak Watersam         WPT Pools         A         A         A         A         A           Siss         Summe 2007         Testak Watersam         WPT Pools         R2         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A         A <td></td> <td>Summer 2020</td> <td>Treated Wastewater</td> <td>WWTP outlet</td> <td>A</td> <td>CIP, NAL</td> <td></td> <td></td>		Summer 2020	Treated Wastewater	WWTP outlet	A	CIP, NAL		
Summ 2001         Tread Watersam         WTT Product         A           255         Summer 2001         Tread Watersam         WTT Product         WT           257         Summer 2001         Tread Watersam         WTT Product         No           257         Summer 2001         Tread Watersam         WTT Product         A           258         Summer 2001         Tread Watersam         WTT Product         A           250         Summer 2001         Tread Watersam         WTT Product         A           250         Summer 2001         Tread Watersam         WTT Product         A           251         Summer 2001         Tread Watersam         WTT Product         A           253         Summer 2001         Tread Watersam         WTT Product         A           254         Summer 2001         Tread Watersam         WTT Product         D           254         Summer 2001         Tread Watersam         WTT Product         B1           256         Summer 2001         Tread Watersam         WTT Product         B1           256         Summer 2001         Tread Watersam         WTT Product         B1           256         Summer 2001         Tread Watersam         WTT Product	522	Summer 2020	Treated Wastewater	WWTP outlet	A		WT	
Sore 2001         Fund Wateredue         WWT Poolst         A           217         Sore 2001         Faced Wateredue         WWT Poolst         A           218         Sore 2001         Faced Wateredue         WWT Poolst         A           218         Sore 2001         Faced Wateredue         WWT Poolst         A           219         Sore 2001         Faced Wateredue         WWT Poolst         A           210         Sore 2001         Faced Wateredue         WWT Poolst         A           210         Sore 2001         Faced Wateredue         WWT Poolst         A           211         Sore 2001         Faced Wateredue         WWT Poolst         A           213         Sore 2001         Faced Wateredue         WWT Poolst         A           214         Sore 2001         Faced Wateredue         WWT Poolst         B           215         Sore 2001         Faced Wateredue         WWT Poolst         A           216         Sore 2001         Faced Wateredue         WWT Poolst         A           216         Sore 2001         Faced Wateredue         WWT Poolst         A           216         Sore 2001         Faced Wateredue         WWT Poolst         A	\$23	Summer 2020	Treated Wastewater	WWTP outlet	BL		WT	
Some 200         Tondo Wateratto         WWT Poolst         A           27         Some 200         Tondo Wateratto         WWT Poolst         NA           28         Some 200         Tondo Wateratto         WWT Poolst         A           28         Some 200         Tondo Wateratto         WWT Poolst         A           29         Some 200         Tondo Wateratto         WWT Poolst         A           200         Some 200         Tondo Wateratto         WWT Poolst         B           201         Some 200         Tondo Wateratto         WWT Poolst         A           301	\$25			WWTP outlet			WT	
Steres 200         Found Waterstate         WWT Poolst         A           23         Same 200         Testald Waterstate         WWT Poolst         A           29         Same 200         Testald Waterstate         WWT Poolst         A           201         Same 200         Testald Waterstate         WWT Poolst         A           201         Same 200         Testald Waterstate         WWT Poolst         A           201         Same 200         Testald Waterstate         WWT Poolst         Bit           201         Same 200         Testald Waterstate         WWT Poolst         Bit           201         Same 200         Testald Waterstate         WWT Poolst         B2           301         Same 200         Testald Waterstate         WWT Poolst         B2           301         Same 200         Testald Waterstate         WWT Poolst         B2           301         Same 200         Testald Waterstate         WWT Poolst         A           402         Same 200         How Waterstate         WWT Poolst         A           403         Same 200         How Waterstate         WWT Poolst         A           404         Same 200         How Waterstate         WWT Poolst         A </td <td>\$26</td> <td>Summer 2020</td> <td></td> <td>WWTP outlet</td> <td></td> <td></td> <td>WT</td> <td>1</td>	\$26	Summer 2020		WWTP outlet			WT	1
Same 2001         Found Wate-state         WWT Poskt         A           90         Same 2001         Found Wate-state         WWT Poskt         N           91         Same 2001         Found Wate-state         WWT Poskt         N           91         Same 2001         Found Wate-state         WWT Poskt         N           911         Same 2001         Found Wate-state         WWT Poskt         N           912         Same 2001         Found Wate-state         WWT Poskt         N           913         Same 2001         Found Wate-state         WWT Poskt         N           914         Same 2001         Found Wate-state         WWT Poskt         N           915         Same 2001         Found Wate-state         WWT Poskt         N           916         Same 2001         Found Wate-state         WWT Poskt         N           916         Same 2001         Found Wate-state         WWT Poskt         N         N           916         Same 2001         Found Wate-state         WWT Poskt         N         N         N           916         Same 2001         Found Wate-state         WWT Poskt         N         N         N           916         Same 2001						NAT	-	
Sores 200         Fund Wateratio         WWT Poolst         A           90         Sores 200         Fund Wateratio         WWT Poolst         Bit           91         Sores 200         Fund Wateratio         WWT Poolst         Bit           91         Sores 200         Fund Wateratio         WWT Poolst         A           921         Sores 200         Fund Wateratio         WWT Poolst         A           921         Sores 200         Fund Wateratio         WWT Poolst         A           923         Sores 200         Fund Wateratio         WWT Poolst         A           924         Sores 200         Fund Wateratio         WWT Poolst         B2           925         Sores 200         Fund Wateratio         WWT Poolst         B2           926         Sores 200         How Wateratio         WWT Poolst         A           927         Sores 200         How Wateratio         WWT Poolst         A           928         Sores 200         How Wateratio         WWT Poolst         A           929         Sores 200         How Wateratio         WWT Poolst         A           929         Sores 200         How Wateratio         WHT Poolst         A           92						13/58		t
Senerg 200         Tortical Watersatz         WWTP marks         Bit         Performance         WT           511         Senerg 200         Tortical Watersatz         WWTP marks         A         WT           512         Senerg 200         Tortical Watersatz         WWTP marks         A         WT           513         Senerg 200         Tortical Watersatz         WWTP marks         D         WT           514         Senerg 200         Tortical Watersatz         WWTP marks         D         WT           515         Senerg 200         Tortical Watersatz         WWTP marks         D         WT           516         Senerg 200         Tortical Watersatz         WWTP marks         B2         WT         WT           516         Senerg 200         Tortical Watersatz         WWTP marks         B2         WT         WT           526         Senerg 200         Tortical Watersatz         WWTP marks         B2         WT         WT           541         Senerg 200         Tortical Watersatz         WWTP marks         A         AMP, AMC, PP, COM, CW, CW, CW, CW, CW, SU, CM, ALL         MDR           542         Senerg 200         Thread Watersatz         WWTP marks         A         AMP, AMC, PP, COM, CW, CW, CW, CW, SU, CM								-
Summer 200         Tended Watersam         WWTP model         HI         Performance         WT           512         Summer 200         Tended Watersam         WWTP model         A         WT         WT           513         Summer 200         Tended Watersam         WWTP model         B2         WT         WT           514         Summer 200         Tended Watersam         WWTP model         B2         WT         WT           515         Summer 200         Tended Watersam         WWTP model         B2         WT         WT           516         Summer 200         Tended Watersam         WWTP model         B2         WT         WT           517         Summer 200         Tended Watersam         WWTP model         A         AMP, AMC, PP, CXML CAZ, CTX, CPB, CALL         MTR         WT           518         Summer 200         Tended Watersam         WWTP model         A         AMP, AMC, PP, CXML CAZ, CTX, CPB, CALL         MTR         A           540         Summer 200         Tended Watersam         WWTP model         A         AMP, AMC, PP, CXML CAZ, CTX, CPB, CAL, CAZ, CTX, CPB, ALL         MTR         A           541         Summer 200         TRVW         Septe task         A         AMP, AMC, PP, CXML CAZ, CTX, CPD							-	<b>—</b>
Summer 200         Tentod Watersam         WWTP model         A         Performance         WT           513         Summer 200         Tentod Watersam         WWTP model         BC         WT           514         Summer 200         Tentod Watersam         WWTP model         BC         WT           515         Summer 200         Tentod Watersam         WWTP model         BC         WT           516         Summer 200         Tentod Watersam         WWTP model         BC         WT           517         Summer 200         Tentod Watersam         WWTP model         BC         WT           518         Summer 200         Tentod Watersam         WWTP model         BC         WT           519         Summer 200         Tentod Watersam         WWTP model         A         AdP, AMC, PP COM, CAZ, CTX, PPP, 20A, CTM, CM, SXT, CPP, NAL         MTR           540         Summer 200         THW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, PPP, 20A, CTX, CM, ATM, CM, SXT, CP, NAL         MTR           541         Summer 200         THW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, CPP, CMA, CM, SXT, CP, NAL         MTR           542         Summer 200         THW         Septe tank         A		Summer 2020					-	
Samer 2001         Tested Waterstar         WTP oxidit         B2           544         Samer 2001         Tested Waterstar         WTP oxidit         D         WT           545         Samer 2001         Tested Waterstar         WTP oxidit         R2         WT           545         Samer 2001         Tested Waterstar         WTP oxidit         R2         WT           547         Samer 2001         Tested Waterstar         WTP oxidit         A         AMP, AMC, PP, CMA, CAZ, CTC, PP, CMA, ATA, CA, STC, CPA, ATA, STC, CPA, ATA, STC, CPA, ATA, CA, STC, CPA, ATA, CA, STC, CPA, ATA, STC,		Summer 2020	Treated Wastewater	WWTP outlet	BL		-	
Starter 200         Teatif Vaurestin         WTT markt         D           515         Samer 200         Teatif Vaurestin         WTT markt         R2           516         Samer 200         Teatif Vaurestin         WTT markt         R2           517         Samer 200         Teatif Vaurestin         WTT markt         R2           518         Samer 200         Teatif Vaurestin         WTT markt         R4           519         Samer 200         Teatif Vaurestin         WTT markt         R1           540         Samer 200         Teatif Vaurestin         WTT markt         R4           541         Samer 200         Teatif Vaurestin         WTT markt         A           542         Samer 200         THW         Sight tank         A         AMP, AMC, PP, CML CAZ, CTX, CP, DAL         MTR           543         Samer 200         THW         Sight tank         A         AMP, AMC, PP, CML CAZ, CTX, CP, DAL         MTR           544         Samer 200         THW         Sight tank         A         AMP, AMC, PP, CML CAZ, CTX, CP, DAL         MTR           545         Samer 200         THW         Sight tank         A         AMP, AMC, PP, CML CAZ, CTX, CP, DAL, AL, MS, MTR           545         Samer 200 </td <td>532</td> <td>Summer 2020</td> <td>Treated Wastewater</td> <td>WWTP outlet</td> <td>A</td> <td></td> <td>WT</td> <td></td>	532	Summer 2020	Treated Wastewater	WWTP outlet	A		WT	
Stander 2001         Testad Wartsstart         WTP adds         R2         WT           966         Stander 2001         Testad Wartsstart         WWTP adds         R2         WT           971         Stander 2001         Testad Wartsstart         WWTP adds         R4         AMP, AMC, PP         P           971         Stander 2001         Testad Wartsstart         WWTP adds         R4         AMP, AMC, PP, CMA, CAZ, CTX, PP, CPA, ATA, CM, STT, CP, NL         SUBR         +           978         Stander 2001         Testad Wartsstart         WWTP adds         A         AMP, AMC, PP, CMA, CAZ, CTX, PP, CPA, ATA, CM, STT, CP, NL         SUBR         +           974         Stander 2001         HWW         Sepic tank         A         AMP, AMC, PP, CMA, CAZ, CTX, PP, CMA, CM, STT, CP, NL         SUBR         +           974         Stander 2001         HWW         Sepic tank         A         AMP, AMC, PP, CMA, CAZ, CTX, CPA, CM, NL         SUBR         -           975         Stander 2001         HWW         Sepic tank         A         AMP, AMC, PP, CMA, CAZ, CTX, CPA, NL         SUBR         -           976         Stander 2001         HWW         Sepic tank         A         AMP, AMC, PP, CMA, CAZ, CTX, CPA, NL, CM, SNT, CP, NL         SUBR         -	533	Summer 2020	Treated Wastewater	WWTP outlet	B2		WT	
Sterey 200         Heard Watersatt         WW IP midst         A         MP_AMC, PP         P           531         Samery 200         Tested Watersatt         WW IP midst         A         MP_AMC, PP         R         P           538         Samery 200         Tested Watersatt         WW IP midst         A         P         P         P         P           549         Samery 200         Heave         WW IP midst         A         AMP_AMC, PP, COM, CAZ, CDX, PP, COM, ATM, GM, SXT, CIP, NAL.         MDR         +           544         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, DP, ATM, GM, SXT, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, CIP, NAL.         MDR         +           546         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, PA, CM, ST, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP, AMC, PP, COM, CAZ, CDX, PP, COM, CAL, CLN, CAL, CLN, ALL, MDR </td <td>534</td> <td>Summer 2020</td> <td>Treated Wastewater</td> <td>WWTP outlet</td> <td>D</td> <td></td> <td>WT</td> <td>1</td>	534	Summer 2020	Treated Wastewater	WWTP outlet	D		WT	1
Sterey 200         Heard Watersatt         WW IP midst         A         MP_AMC, PP         P           531         Samery 200         Tested Watersatt         WW IP midst         A         MP_AMC, PP         R         P           538         Samery 200         Tested Watersatt         WW IP midst         A         P         P         P         P           549         Samery 200         Heave         WW IP midst         A         AMP_AMC, PP, COM, CAZ, CDX, PP, COM, ATM, GM, SXT, CIP, NAL.         MDR         +           544         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, DP, ATM, GM, SXT, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, CIP, NAL.         MDR         +           546         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP_AMC, PP, COM, CAZ, CDX, PA, CM, ST, CIP, NAL.         MDR         +           545         Samery 200         Heave         Septe tank         A         AMP, AMC, PP, COM, CAZ, CDX, PP, COM, CAL, CLN, CAL, CLN, ALL, MDR </td <td>535</td> <td>Summer 2020</td> <td>Treated Wastewater</td> <td>WWTP outlet</td> <td>B2</td> <td></td> <td>WT</td> <td>1</td>	535	Summer 2020	Treated Wastewater	WWTP outlet	B2		WT	1
Storew 2000         Firsted Watersattr         WWTP midst         A         AMP, AMC, PP         P         P           538         Sameer 2001         Teaded Watersattr         WWTP midst         A         P         P           549         Sameer 2001         Teaded Watersattr         WWTP midst         A         P         P         P           540         Sameer 2001         Teaded Watersattr         WWTP midst         A         AMP, AMC, PP, CXAL, CAZ, CTX, CPA, CAJ, CJP, CIA, ALL         MDR         +           541         Sameer 2001         HWW         Septic tank         A         AMP, AMC, PP, CXAL, CTX, COX, DY, PAL, CMA, CX, CTX, CDX, PAL         MDR         +           543         Sameer 2001         HWW         Septic tank         A         AMP, AMC, PP, CXAL, CTX, CDX, DX, PP, CMA, CXT, CTX, DXAL         MDR         +           544         Sameer 2001         HWW         Septic tank         A         AMP, AMC, PP, CXAL, CTX, CTX, CDX, ATM, ALL         MDR         +           555         Sameer 2001         HWW         Septic tank         A         AMP, AMC, PP, CXAL, CTX, CTX, CDX, ATM, CM, ATM, CMAL         MDR         +           555         Sameer 2001         HWW         Septic tank         A         AMP, AMC, PP, CXAL, CTX, CPR, ATM, CMA, CMA, CTX								
Summer 2000         Tested Waterstam         WWT Poulds         Bit         WT           599         Summer 2000         Tested Waterstam         WWT Poulds         A         NMP. AMC, PP, CNA, CAZ, CTX, PP, CNA, TAU, CP, NAL.         MUB         +           540         Summer 2000         HFWW         Septe tools         A         AMP. AMC, PP, CNA, CAZ, CTX, CP, CP, ATL, CP, NAL.         MUB         +           541         Summer 2001         HFWW         Septe tools         A         AMP. AMC, PP, CCM, CAZ, CTX, CPD, CPA, ATL, CP, NAL.         MUB         +           545         Summer 2001         HFWW         Septe tools         A         AMP. AMC, PP, CCM, CAZ, CTX, CPD, CPA, ATL, NAL.         MDB         +           546         Summer 2001         HFWW         Septe tools         A         AMP. AMC, PP, CCM, CAZ, CTX, CPD, CAL, CML, MM, CAT, CDP, NAL.         MDB         +           550         Summer 2001         HFWW         Septe tools         A         AMP. AMP, PP, CCM, CAZ, CTX, PP, CM, SUT, CP, NAL.         MDB         +           551         Summer 2001         HFWW         Septe tools         A         AMP. AMP, PP, CCM, CAZ, CTX, PP, CM, SUT, CP, NAL.         MDB         +           555         Summer 2001         HFWW         Septe tools         A <td< td=""><td></td><td>•</td><td></td><td></td><td></td><td>AND ANC DD</td><td></td><td>1</td></td<>		•				AND ANC DD		1
99.         Summer 2000         Treated Wattream         WWT I Provided         WT         Provided           940         Summer 2000         HPW         Septe tank         A         AMP AMC, PP, COM, CAZ, CTX, PP, CBO, ATM, OM, SXT, CP, NAL         MDB         +           940         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, PP, ATM, ON, SXT, CP, NAL         MDB         +           941         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, CPD, CPA, ALL         MDB         +           945         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, CPD, CAL, CAU, CPA, CPA, ALL         MDB         +           954         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, CPD, CAL         MDB         +           953         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, CPD, CAL         MDB         +           953         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM, CAZ, CTX, PP, CAU, ATM, CD, NAL         MDB         +           955         Summer 2001         HPWW         Septe tank         A         AMP, AMC, PP, COM						raming carding E.B.	-	t
940         Summer 2000         1PWW         Septe tunk         A         AMP. AMC, PP, COM, CAY, CIP, NAL         MDB         +           541         Summer 2001         1PWW         Septe tunk         A         AMP. AMC, PP, COM, CIX, CID, OP, NAL         MDB         +           543         Summer 2001         1PWW         Septe tunk         A         AMP. AMC, PP, COM, CIX, CID, OP, NAL         MDB         +           544         Summer 2001         1PWW         Septe tunk         D         AMP. AMC, PP, COM, CAZ, CIX, CID, O, AML, NAL         MDB         +           545         Summer 2001         1PWW         Septe tunk         A         AMP. AMC, PP, COM, CAZ, CIX, CID, ATM, ANL         MDB         +           550         Summer 2001         1PWW         Septe tunk         A         AMP. AMC, PP, COM, CAZ, CIX, PP, COM, ATM, CIX, SIX, CP, NAL         MDB         +           551         Summer 2001         1PWW         Septe tunk         A         AMP, AMC, PP, COM, CAZ, CIX, PP, COM, ATM, GNX, CIT, CP, NAL         MDB         +           553         Summer 2001         1PWW         Septe tunk         A         AMP, AMC, PP, COM, CAZ, CIX, PP, COM, ATM, GNX, CIT, CP, NAL         MDB         +           554         Summer 2001         1PWW         Septe tunk </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td><b>I</b></td>							-	<b>I</b>
Semar 200         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, CHP. NAL.         MDR         +           941         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, CHP. NAL.         MDR         +           945         Summer 2001         HWW         Septie tank         B2         AMP. AMC. PP. CXM. CTX. CBO, ATM, NAL.         MDR         +           946         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, ATM, CM, STT, CP. NAL.         MDR         +           955         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, ATM, CM, STT, CP. NAL.         MDR         +           951         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, ATM, CM, STT, CP. NAL.         MDR         +           955         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. CBO, ATM, CM, STT, CP. NAL.         MDR         +           955         Summer 2001         HWW         Septie tank         A         AMP. AMC. PP. CXM. CTX. FP. CBO, ATM, CM, STT, CP. NAL.         MDR         +           956         Summer 2001         HWW         Septie tank         A <td></td> <td>•</td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td><b>I</b></td>		•					-	<b>I</b>
941         Summar 2001         HWW         Septis tank         A         AMP. AMC. PP. CXM. CTX. DD, FPF. ATM. (Pk. SXT, CP, NAL.         MDR         +           945         Summar 2001         HWW         Septis tank         B2         AMP. AMC. PP. SXT         E         -           946         Summar 2001         HWW         Septis tank         B2         AMP. AMC. PP. CXM. CAZ, CTX. CRO, ATM. (MS. STT, CP, NAL.         MDR         +           950         Summar 2001         HWW         Septis tank         A         AMP. AMC, PP. CXM. CAZ, CTX. CRO, ATM. (MS. STT, CP, NAL.         MDR         -           951         Summar 2001         HWW         Septis tank         A         AMP. AMC, PP. CXM. CAZ, CTX. PP. OXAL ALL, CP, NAL.         MDR         +           953         Summar 2001         HWW         Septis tank         A         AMP. AMC, PP. CXM. CAZ, CTX, PP. OXAL ALL, CP, NAL.         MDR         +           955         Summar 2001         HWW         Septis tank         A         AMP. AMC, PP. CXM. CAZ, CTX, PP. OXAL ALL, NST, CP, NAL.         MDR         +           956         Summar 2001         HWW         Septis tank         A         AMP. AMC, PP. CXM. CAZ, CTX, PP. CSD, ATM, GN, STT, CP, NAL.         MDR         +           956         Summar 2001				*			-	
945         Samer 200         HWW         Septi tank         D         AMP, AMC, FP, SXT         C, BD, CAL, C, CH, CAL, C, CH, CAL, CL, CL, CH, CAL, CL, CL, CL, CH, CAL, CL, CL, CL, CL, CL, CL, CL, CL, CL, C	542	Summer 2020	HWW	Septic tank	A	AMP, AMC, PIP, CXM, CTX, CRO, CIP, NAL	MDR	+
946         Samer 200         HWW         Septis tank         PL         AMP, AMC, TP, PM, CAC, TC, CEO, ATM, NAL.         MDR         +           550         Samers 200         HWW         Septis tank         A         AMP, AMC, T2P, PP, CAM, CAZ, CTX, CEO, ATM, AL, CH, NAL.         MDR         +           551         Samers 200         HWW         Septis tank         A         AMP, AMC, T2P, PP, CAM, CAZ, CTX, FPP, CBO, ATM, GM, SAT, CP, NAL.         MDR         +           553         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GM, SAT, CP, NAL.         MDR         +           555         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SAT, CP, NAL.         MDR         +           555         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SAT, CP, NAL.         MDR         +           556         Samers 200         HWW         Septis tank         A         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SMT, CP, NAL         MDR         +           560         Samers 200         HWW         Septis tank         A         CMP, CAM, CTX, FPP, CBO, ATM, GN, SMT, CP, NAL         MT	543	Summer 2020	HW W	Septic tank	A	AMP, AMC, PIP, CXM, CTX, CRO, FEP, ATM, GN, SXT, CIP, NAL	MDR	+
946         Samer 200         HWW         Septis tank         PL         AMP, AMC, TP, PM, CAC, TC, CEO, ATM, NAL.         MDR         +           550         Samers 200         HWW         Septis tank         A         AMP, AMC, T2P, PP, CAM, CAZ, CTX, CEO, ATM, AL, CH, NAL.         MDR         +           551         Samers 200         HWW         Septis tank         A         AMP, AMC, T2P, PP, CAM, CAZ, CTX, FPP, CBO, ATM, GM, SAT, CP, NAL.         MDR         +           553         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GM, SAT, CP, NAL.         MDR         +           555         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SAT, CP, NAL.         MDR         +           555         Samers 200         HWW         Septis tank         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SAT, CP, NAL.         MDR         +           556         Samers 200         HWW         Septis tank         A         A         AMP, AMC, PP, CMA, CAZ, CTX, FPP, CBO, ATM, GN, SMT, CP, NAL         MDR         +           560         Samers 200         HWW         Septis tank         A         CMP, CAM, CTX, FPP, CBO, ATM, GN, SMT, CP, NAL         MT		Summer 2020	HWW	*			R	
150         Samer 200         HWW         Septe tank         A         AMP, AMC, TP, PP, CMA, EXT, CP, NAL         MDR            521         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, EXT, CTX, NAL         MDR         +           535         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, CTX, CDX, ATM, STX, CP, NAL         MDR         +           555         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, CTX, CP, NAL         MDR         +           565         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, CTX, CP, NAL         MDR         +           575         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, CTX, FP, CDA, ATM, CM, STT, CP, NAL         MDR         +           580         Samer 2000         HWW         Septe tank         A         AMP, AMC, TP, CMA, CTX, FP, CDA, ATM, CN, STT, CP, NAL         MDR         +           561         Samer 2000         HWW         Septe tank         A         A         AMP, AMC, TP, CMA, CTX, FP, CDA, ATM, CN, STT, CP, NAL         MDR         +           562         Samer 2000         HWW         Septe tank         A         <	_	+	HWW	*			-	+
152         Samer 200         HWW         Septic tank         A         AMP, AMC, PP, CMACAZ, CTX, FPP, CDA, ATM, GM, SXT, CIP, NAL.         MDR         +           533         Sammer 2000         HWW         Septic tank         A         AMP, AMC, PP, CMACAZ, CTX, FPP, CDA, ATM, GM, SXT, CIP, NAL.         MDR         +           555         Sammer 2000         HWW         Septic tank         A         AMP, AMC, PP, CMACAZ, CTX, FPP, CDA, ATM, GM, SXT, CIP, NAL.         MDR         +           556         Sammer 2000         HWW         Septic tank         A         AMP, PM, CDA, CAZ, CTX, FPP, CDA, ATM, CM, SXT, CIP, NAL.         MDR         +           557         Sammer 2000         HWW         Septic tank         A         AMP, AMC, PP, CCM, CAZ, CTX, FPP, CDA, ATM, CN, SXT, CIP, NAL.         MDR         +           569         Sammer 2000         HWW         Septic tank         A         A         A         MP, AMC, PP, CCM, CTX, FPP, CDA, ATM, CN, SXT, CIP, NAL.         MDR         +           561         Sammer 2000         HWW         Septic tank         A         A         A         MP, AMC, PP, CCM, CTX, FPP, CDA, ATM, CN, SXT, CIP, NAL.         MDR         +           563         Sammer 2000         HWW         Septic tank         A         A         A         MPT							-	
S31         Sammer 2000         HWW         Septie tank         A         AMP, AMC, MP, COXI, CTX, CRO, ATM, SXT, CIP, NAL.         MDR         +           555         Sammer 2000         HWW         Septie tank         A         AMP, AMC, MP, COXI, CTX, CRO, ATM, SXT, CIP, NAL.         MDR         +           556         Sammer 2000         HWW         Septie tank         A         AMP, PLCXM, CAZ, CTX, FEP, CBO, ATM, CR, NAL.         MDR         +           557         Sammer 2000         HWW         Septie tank         A         AMP, AMC, PP, CXM, CTX, FEP, CBO, ATM, CR, NAL.         MDR         +           560         Sammer 2001         HWW         Septie tank         A         AMP, AMC, PP, CXM, CTX, FEP, CBO, ATM, CR, SXT, CP, NAL.         MDR         +           560         Sammer 2001         HWW         Septie tank         A         A         MP, AMC, PP, CXM, CTX, FEP, CBO, ATM, CR, SXT, CP, NAL.         MDR         +           561         Sammer 2001         HWW         Septie tank         A         A         MP, AMC, PP, CXM, CTX, FEP, CBO, ATM, CR, SXT, CP, NAL.         WT         -           563         Sammer 2001         HWW         Septie tank         A         A         MPT         -         -         -         -         -         - <td></td> <td>-</td> <td></td> <td>1</td> <td></td> <td></td> <td>-</td> <td></td>		-		1			-	
555         Summer 2020         HWW         Sprik tank         A         AMP, APP, CM, CAZ, CTX, FEP, CBO, ATM, (M, SXT, CIP, NAL.         MDR         +           556         Summer 2020         HWW         Septik tank         A         AMP, PIP, CM, CAZ, CTX, FEP, CBO, ATM, (M, SXT, CIP, NAL.         MDR         +           557         Summer 2020         HWW         Septik tank         A         AMP, AMC, FIP, CMA, CAZ, CTX, FEP, CBO, ATM, (GN, SXT, CIP, NAL.         MDR         +           560         Summer 2020         HWW         Septik tank         A         AMP, AMC, FIP, CMA, CAZ, CTX, FEP, CBO, ATM, (GN, SXT, CIP, NAL.         MDR         +           561         Summer 2020         HWW         Septik tank         A         A         MP, AMC, FIP, CMA, CAZ, CTX, FEP, CBO, ATM, (GN, SXT, CIP, NAL.         MDR         +           562         Summer 2020         HWW         Septik tank         A         A         MP, AMC, FIP, CMA, CAZ, CTX, FEP, CBO, ATM, (GN, SXT, CIP, NAL.         MDR         +           563         Summer 2020         HWW         Septik tank         A         A         MPT         -         5           564         Summer 2020         HWW         Septik tank         A         A         -         -         5         -         -				*			-	- · · ·
S56         Summer 2020         FWW         Sepic tank         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.         MDR         +           557         Sammer 2020         HWW         Sepic tank         A         AMP, AMC, PIP, COM, CTX, FEP, CRO, ATM, CR, SXT, CIP, NAL.         MDR         +           558         Sammer 2020         HWW         Sepic tank         A         AMP, AMC, PIP, COM, CTX, FEP, CRO, ATM, CR, SXT, CIP, NAL.         MDR         +           560         Sammer 2020         HWW         Sepic tank         A         A         AP, AMC, PIP, COM, CTX, FEP, CRO, ATM, CR, SXT, CIP, NAL.         MDR         +           561         Sammer 2020         HWW         Sepic tank         A         A         AP, AMC, PIP, COM, CTX, CTX, FEP, CRO, ATM, CR, SXT, CIP, NAL.         WT           562         Sammer 2020         HWW         Sepic tank         A         A         AP, AMC, PIP, COM, CTX, CTX, FEP, CRO, ATM, CR, SXT, CIP, NAL.         WT           563         Sammer 2020         HWW         Sepic tank         A         A         AP         WT         Sammer 2020         HWW         Sepic tank         A         APCX         WT         Sammer 2020         HWW         Sepic tank         A         APCX         WT         Sammer 2020         HWW <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td>							-	
Str         Summer 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CTX, FBP, CBO, ATM, GN, SXT, CIP, NAL         MDR         +           581         Summer 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CTX, FBP, CBO, ATM, GN, SXT, CIP, NAL         MDR         +           560         Summer 2020         HWW         Septic tank         A          WT            581         Summer 2020         HWW         Septic tank         A          WT            582         Summer 2020         HWW         Septic tank         A          WT            583         Summer 2020         HWW         Septic tank         A          WT            584         Summer 2020         HWW         Septic tank         A          WT            585         Summer 2020         HWW         Septic tank         A          WT            586         Summer 2020         HWW         Septic tank         A          FOX         WT            587         Summer 2020         HWW         Septic tank         A         NAL							-	
S38         Summer 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CTX, FEP, CBO, ATM, GN, SXT, CIP, NAL         MDR         +           560         Summer 2020         HWW         Septic tank         A         WT         WT           581         Summer 2020         HWW         Septic tank         A         WT         WT           582         Summer 2020         HWW         Septic tank         A         WT         WT           583         Summer 2020         HWW         Septic tank         A         WT         WT           584         Summer 2020         HWW         Septic tank         A         WT         WT           586         Summer 2020         HWW         Septic tank         A         WT         WT           587         Summer 2020         HWW         Septic tank         A         PCX         WT           588         Summer 2020         HWW         Septic tank         A         PCX         WT           589         Summer 2020         HWW         Septic tank         A         PCX         WT           570         Summer 2020         HWW         Septic tank         B2         WT         Signific anne		-		*				<u> </u>
S80         Summer 2020         HWW         Septie tank         A         WT           581         Summer 2020         HWW         Septie tank         A         WT           582         Summer 2020         HWW         Septie tank         A         WT           583         Summer 2020         HWW         Septie tank         A         WT           583         Summer 2020         HWW         Septie tank         A         WT           586         Summer 2020         HWW         Septie tank         A         WT           586         Summer 2020         HWW         Septie tank         A         WT           587         Summer 2020         HWW         Septie tank         A         WT           588         Summer 2020         HWW         Septie tank         A         FOX         WT           590         Summer 2020         HWW         Septie tank         B2         WT         WT           571         Summer 2020         HWW         Septie tank         B2         WT         WT           573         Summer 2020         HWW         Septie tank         B2         WT         WT           574         Summer 2020	557	Summer 2020	HWW	Septic tank	A	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL	MDR	+
Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         FOX         WT         WT           Sell         Summer 2020         HWW         Septic tank         A         FOX         WT         MT           Sell         Summer 2020         HWW         Septic tank         A         FOX         WT         MT           Sell         Summer 2020         HWW         Septic tank         A         NAL         WT         MT           Sell         Summer 2020         HWW         Septic tank         R         NAL         WT	822	Summer 2020	HW W	Septic tank	A	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL	MDR	+
Sel         Samer 200         HWW         Septic tank         A         Provide tank         WT           Sel         Summer 200         HWW         Septic tank         A         WT         WT           Sel         Summer 200         HWW         Septic tank         A         WT         WT           Sel         Summer 200         HWW         Septic tank         A         WT         WT           Sel         Summer 200         HWW         Septic tank         A         WT         WT           Sel         Summer 200         HWW         Septic tank         A         WT         WT           Sel         Summer 200         HWW         Septic tank         A         POX         WT           Sel         Summer 200         HWW         Septic tank         A         POX         WT           Sel         Summer 200         HWW         Septic tank         A         POX         WT           Sel         Summer 200         HWW         Septic tank         A         NAL         WT           Sel         Summer 200         HWW         Septic tank         B         WT         MT           Si         Summer 200         HWW	560	Summer 2020	HWW	Septic tank	A		WT	
Sel         Summer 2020         HWW         Septic tank         A         WT           563         Summer 2020         HWW         Septic tank         A         WT           566         Summer 2020         HWW         Septic tank         B1         WT           567         Summer 2020         HWW         Septic tank         A         WT           568         Summer 2020         HWW         Septic tank         A         WT           568         Summer 2020         HWW         Septic tank         A         WT           569         Summer 2020         HWW         Septic tank         D         WT           570         Summer 2020         HWW         Septic tank         D         WT           571         Summer 2020         HWW         Septic tank         A         NAL         WT           572         Summer 2020         HWW         Septic tank         A         NAL         WT           573         Summer 2020         HWW         Septic tank         A         NAL         WT           574         Summer 2020         HWW         Septic tank         B1         WT         WT           575         Summer 2020	561	Summer 2020	HWW		A		WT	
563         Summer 2020         HWW         Septic tank         A         MT           566         Summer 2020         HWW         Septic tank         B1         WT           567         Summer 2020         HWW         Septic tank         A         WT           568         Summer 2020         HWW         Septic tank         A         WT           569         Summer 2020         HWW         Septic tank         A         FOX         N-WT           570         Summer 2020         HWW         Septic tank         A         FOX         N-WT           571         Summer 2020         HWW         Septic tank         R2         WT         WT           572         Summer 2020         HWW         Septic tank         R2         WT         WT           573         Summer 2020         HWW         Septic tank         R2         WT         WT           574         Summer 2020         HWW         Septic tank         R2         WT         WT           574         Summer 2020         HWW         Septic tank         R1         WT         WT           575         Summer 2020         HWW         Septic tank         R1         WT	562						_	
566         Summer 2020         HWW         Septic tank         Bl         WT           567         Summer 2020         HWW         Septic tank         A         WT         WT           568         Summer 2020         HWW         Septic tank         A         WT         WT           569         Summer 2020         HWW         Septic tank         A         FOX         NeWT           570         Summer 2020         HWW         Septic tank         D         WT         WT           571         Summer 2020         HWW         Septic tank         D         WT         WT           571         Summer 2020         HWW         Septic tank         A         NAL         WT           572         Summer 2020         HWW         Septic tank         A         NAL         WT           573         Summer 2020         HWW         Septic tank         B2         WT         WT           574         Summer 2020         HWW         Septic tank         B2         WT         WT           575         Summer 2020         HWW         Septic tank         B2         AMP, AMC, PP, SXT         R           577         Summer 2020         HWW			-				-	
567         Summer 2020         HWW         Septie tank         A         WT           568         Summer 2020         HWW         Septie tank         A         POX         WT           569         Summer 2020         HWW         Septie tank         A         POX         WT           570         Summer 2020         HWW         Septie tank         D         WT         WT           571         Summer 2020         HWW         Septie tank         B2         WT         WT           572         Summer 2020         HWW         Septie tank         A         MT         WT           573         Summer 2020         HWW         Septie tank         A         NAL         WT           573         Summer 2020         HWW         Septie tank         A         NAL         WT           574         Summer 2020         HWW         Septie tank         B2         WT         WT           575         Summer 2020         HWW         Septie tank         B1         WT         WT           576         Summer 2020         HWW         Septie tank         B1         WT         WT           577         Summer 2020         HWW         Septie		-		*		1		1
588Summer 2020HWWSeptic tankAFOXWT599Summer 2020HWWSeptic tankAFOXN-WT570Summer 2020HWWSeptic tankDWT571Summer 2020HWWSeptic tankB2WT572Summer 2020HWWSeptic tankANAL573Summer 2020HWWSeptic tankANAL574Summer 2020HWWSeptic tankANAL575Summer 2020HWWSeptic tankB2WT576Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT579Summer 2020HWWSeptic tankDWT580Summer 2020HWWSeptic tankDWT581Summer 2020HWWSeptic tankDWT584Autum 2020HWWSeptic tankDA589Autum 2020River waterRWS1DAMP, PIP590Autum 2020River waterRWS1B2AMP, PIP591Autum 2020River waterRWS1B2AMP, PIP594Autum 2020River waterRWS1AAMP, PIP, CXM, CAZ, CT								
\$60Summer 2020HWWSeptie tankAFOXN-WT570Summer 2020HWWSeptie tankDWT571Summer 2020HWWSeptie tankR2WT572Summer 2020HWWSeptie tankAN-MT573Summer 2020HWWSeptie tankAN-MT574Summer 2020HWWSeptie tankRN-WT574Summer 2020HWWSeptie tankR2WT575Summer 2020HWWSeptie tankB1WT576Summer 2020HWWSeptie tankB1WT577Summer 2020HWWSeptie tankB1WT578Summer 2020HWWSeptie tankB1WT579Summer 2020HWWSeptie tankAWT579Summer 2020HWWSeptie tankDWT580Summer 2020HWWSeptie tankDWT591Summer 2020HWWSeptie tankDWT593Summer 2020HWWSeptie tankAA594Autum 2020River waterRWS1DAMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL598Autum 2020River waterRWS1DAMP, PIPR599Autum 2020River waterRWS1B2AMP, PIP, SXTR591Autum 2020River waterRWS1B2AMP, PIP, SXTR591Aut				+			-	l
570Sammer 2020HWWSeptic tankDWT571Sammer 2020HWWSeptic tankB2WT572Sammer 2020HWWSeptic tankAWT573Sammer 2020HWWSeptic tankANAL574Sammer 2020HWWSeptic tankANAL575Sammer 2020HWWSeptic tankB2WT576Sammer 2020HWWSeptic tankB1WT577Sammer 2020HWWSeptic tankB1WT578Sammer 2020HWWSeptic tankB1WT578Sammer 2020HWWSeptic tankB1WT578Sammer 2020HWWSeptic tankB1WT578Sammer 2020HWWSeptic tankB1WT578Sammer 2020HWWSeptic tankB1WT579Sammer 2020HWWSeptic tankAWT580Sammer 2020HWWSeptic tankDWT581Sammer 2020HWWSeptic tankDWT583Sammer 2020HWWSeptic tankAAMP, AMC, TZP, PP, CXM, FOX, FEP, GM, SXT, CIP, NALMDR584Autum 2020River waterRWS1DAMP, PIPR589Autum 2020River waterRWS1B2AMP, PIP, SXTR591Autum 2020River waterRWS1B2AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NALMDR <td></td> <td></td> <td></td> <td>*</td> <td></td> <td>t oar</td> <td>-</td> <td><b>I</b></td>				*		t oar	-	<b>I</b>
571Summer 2020HWWSeptic tankB2WT572Summer 2020HWWSeptic tankAWT573Summer 2020HWWSeptic tankANAL574Summer 2020HWWSeptic tankB2WT575Summer 2020HWWSeptic tankB1WT576Summer 2020HWWSeptic tankB1WT577Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankDWT580Summer 2020HWWSeptic tankDWT581Summer 2020HWWSeptic tankDWT583Summer 2020HWWSeptic tankDWT584Autum 2020River waterRWS1DAMP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NALMDR589Autum 2020River waterRWS1B2AMP, PIP, SXTR590Autum 2020River waterRWS1B2AMP, PIP, SXTR591Autum 2020River waterRWS1AAMP, PIP, SXTR594Autum 2020River waterRWS1AAMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NALMDR594Autum 2020River waterRWS1A						KUX		L
572Summer 2020HWWSeptic tankANALWT573Summer 2020HWWSeptic tankANALN-WT574Summer 2020HWWSeptic tankB2WT575Summer 2020HWWSeptic tankB1WT576Summer 2020HWWSeptic tankB1WT577Summer 2020HWWSeptic tankB1WT578Summer 2020HWWSeptic tankB1WT579Summer 2020HWWSeptic tankAMP579Summer 2020HWWSeptic tankDWT580Summer 2020HWWSeptic tankDWT581Summer 2020HWWSeptic tankDWT588Autum 2020River waterRWS1DAMP, PIP589Autum 2020River waterRWS1B2AMP, PIP590Autum 2020River waterRWS1B2AMP, PIP, SXT591Autum 2020River waterRWS1B2AMP, PIP, SXT594Autum 2020River waterRWS1AAMP, PIP, SXT594Autum 2020		Summer 2020	HWW				WT	
573     Summer 2020     HWW     Septic tank     A     NAI.       574     Summer 2020     HWW     Septic tank     B2     WT       575     Summer 2020     HWW     Septic tank     B1     WT       576     Summer 2020     HWW     Septic tank     B1     WT       578     Summer 2020     HWW     Septic tank     B2     AMP, AMC, PIP, SXT     R       578     Summer 2020     HWW     Septic tank     B1     WT       578     Summer 2020     HWW     Septic tank     B1     WT       578     Summer 2020     HWW     Septic tank     B1     WT       579     Summer 2020     HWW     Septic tank     D     WT       579     Summer 2020     HWW     Septic tank     D     WT       581     Summer 2020     HWW     Septic tank     D     WT       583     Summer 2020     HWW     Septic tank     A     AMP, AMC, TZP, PIP, COM, FOX, FEP, GM, SXT, CIP, NAL     MDR       588     Autum 2020     River water     RWS1     D     AMP, PIP       599     Autum 2020     River water     RWS1     B2     AMP, PIP, SXT       591     Autum 2020     River water     RWS1			HWW	Septic tank	B2		WT	
574         Summer 2020         HWW         Septic tank         B2         WT           575         Summer 2020         HWW         Septic tank         B1         WT           576         Summer 2020         HWW         Septic tank         B2         AMP, AMC, PIP, SXT         R           576         Summer 2020         HWW         Septic tank         B2         AMP, AMC, PIP, SXT         WT           577         Summer 2020         HWW         Septic tank         B1         WT         WT           578         Summer 2020         HWW         Septic tank         A         WT         WT           578         Summer 2020         HWW         Septic tank         D         WT         WT           579         Summer 2020         HWW         Septic tank         D         WT         WT           580         Summer 2020         HWW         Septic tank         D         WT         MT           581         Summer 2020         HWW         Septic tank         D         AMP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL         MDR           588         Autum 2020         River water         RWS1         D         AMP, PIP, SXT         R           590         <	\$72	Summer 2020	HW W	Septic tank	A		WT	
574         Summer 2020         HWW         Septic tank         B2         WT           575         Summer 2020         HWW         Septic tank         B1         WT           576         Summer 2020         HWW         Septic tank         B2         AMP, AMC, PIP, SXT         R           576         Summer 2020         HWW         Septic tank         B2         AMP, AMC, PIP, SXT         WT           577         Summer 2020         HWW         Septic tank         B1         WT         WT           578         Summer 2020         HWW         Septic tank         A         WT         WT           578         Summer 2020         HWW         Septic tank         D         WT         WT           579         Summer 2020         HWW         Septic tank         D         WT         WT           580         Summer 2020         HWW         Septic tank         D         WT         MT           581         Summer 2020         HWW         Septic tank         D         AMP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL         MDR           588         Autum 2020         River water         RWS1         D         AMP, PIP, SXT         R           590         <	\$73	Summer 2020	HWW	Septic tank	A	NAL	N-WT	
575         Sammer 2020         HWW         Septic tank         B1         WT           576         Sammer 2020         HWW         Septic tank         B2         AMP, AMC, PIP, SXT         R           577         Sammer 2020         HWW         Septic tank         B1         WT           578         Sammer 2020         HWW         Septic tank         B1         WT           578         Sammer 2020         HWW         Septic tank         A         WT           579         Sammer 2020         HWW         Septic tank         D         WT           580         Sammer 2020         HWW         Septic tank         D         WT           580         Sammer 2020         HWW         Septic tank         D         WT           580         Sammer 2020         HWW         Septic tank         D         WT           581         Sammer 2020         HWW         Septic tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL         MDR         -           588         Autum 2020         River water         RWS1         D         AMP, PIP         R           590         Autum 2020         River water         RWS1         B2         AMP, PIP <td></td> <td></td> <td></td> <td>+</td> <td>•</td> <td></td> <td>-</td> <td></td>				+	•		-	
S76     Summer 2020     HWW     Septie tank     B2     AMP, AMC, PIP, SXT     R       577     Summer 2020     HWW     Septie tank     B1     WT       578     Summer 2020     HWW     Septie tank     A       579     Stammer 2020     HWW     Septie tank     A       579     Summer 2020     HWW     Septie tank     D     WT       580     Summer 2020     HWW     Septie tank     D     WT       581     Summer 2020     HWW     Septie tank     D     WT       581     Summer 2020     HWW     Septie tank     D     WT       581     Summer 2020     HWW     Septie tank     A     AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL     MDR       581     Summer 2020     HWW     Septie tank     A     AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL     MDR       583     Autumn 2020     River water     RWS1     D     AMP, PIP       584     Autumn 2020     River water     RWS1     B2     AMP, PIP       590     Autumn 2020     River water     RWS1     B2     AMP, PIP, SXT       591     Autumn 2020     River water     RWS1     A     AMP, PIP, SXT       594     Autumn 2020				+		1	-	
577         Summer 2020         HWW         Septic tank         B1         WT           578         Summer 2020         HWW         Septic tank         A         WT           579         Summer 2020         HWW         Septic tank         D         WT           579         Summer 2020         HWW         Septic tank         D         WT           580         Summer 2020         HWW         Septic tank         D         WT           581         Summer 2020         HWW         Septic tank         D         WT           581         Summer 2020         HWW         Septic tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL.         MDR           583         Autumn 2020         River water         RWS1         D         AMP, PIP         R           589         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           590         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           591         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           594         Autumn 2020         River water         RWS1				1		AMP AMC PP SXT	_	
578         Sammer 2020         HWW         Septic tank         A         WT           579         Sammer 2020         HWW         Septic tank         D         WT           580         Stammer 2020         HWW         Septic tank         D         WT           581         Stammer 2020         HWW         Septic tank         D         WT           581         Stammer 2020         HWW         Septic tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL         MDR           588         Autuen 2020         River water         RWS1         D         AMP, PIP         R           589         Autuen 2020         River water         RWS1         B2         AMP, PIP         R           590         Autuen 2020         River water         RWS1         B2         AMP, PIP, SXT         R           591         Autuen 2020         River water         RWS1         B2         AMP, PIP, SXT         R           591         Autuen 2020         River water         RWS1         A         AMP, PIP, SXT         R           592         Autuen 2020         River water         RWS1         A         AMP, PIP, SXT         R           594         Autuen 2020		-		+		energy control and the and the and	+	1
579         Summer 2020         HWW         Septie tank         D         WT           580         Summer 2020         HWW         Septie tank         D         WT           581         Summer 2020         HWW         Septie tank         D         WT           581         Summer 2020         HWW         Septie tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL.         MDR           588         Autumn 2020         River water         RWS1         D         AMP, PIP         R           589         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           590         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           591         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           591         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           592         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           594         Autumn 2020         River water         RWS1         A         AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR <td< td=""><td></td><td>-</td><td></td><td></td><td></td><td>1</td><td>-</td><td>l</td></td<>		-				1	-	l
S80         Summer 2020         HWW         Septie tank         D         WT           S81         Summer 2020         HWW         Septie tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL         MDR         -           S88         Autumn 2020         River water         RWS1         D         AMP, PIP         R           S89         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           S90         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           S90         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           S91         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           S91         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           S92         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           S94         Autumn 2020         River water         RWS1         A         AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +							-	<b>—</b>
S81         Summer 2020         HWW         Septie tank         A         AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL.         MDR         -           S88         Autumn 2020         River water         RWS1         D         AMP, PIP         R         R           S89         Autumn 2020         River water         RWS1         D         AMP, PIP         R         R           S90         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R         R           S91         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R         R           S91         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R         R           S91         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R         R           S92         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R         R           S94         Autumn 2020         River water         RWS1         A         AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +				+			-	I
S88         Autumn 2020         River water         RWS1         D         AMP, PIP         R           S89         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           900         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           901         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           902         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           903         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           904         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           904         Autumn 2020         River water         RWS1         A         AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR		Summer 2020	HWW	Septic tank	D		WT	L
S89         Autum 2020         River water         RWS1         B2         AMP, PIP         R           900         Autum 2020         River water         RWS1         B2         AMP, PIP, SXT         R           901         Autum 2020         River water         RWS1         B2         AMP, PIP, SXT         R           902         Autum 2020         River water         RWS1         B2         AMP, PIP, SXT         R           904         Autum 2020         River water         RWS1         A         AMP, PIP, SXT         R           904         Autum 2020         River water         RWS1         A         AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +	581	Summer 2020	HWW	Septic tank	A	AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL	MDR	-
990         Autum 2020         River water         RWS1         B2         AMP, PIP, SXT         R           991         Autum 2020         River water         RWS1         B2         AMP, PIP         R           992         Autum 2020         River water         RWS1         A         AMP, PIP, SXT         R           994         Autum 2020         River water         RWS1         A         AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +	588	Auturn 2020	River water	RWSI	D	AMP, PIP	R	
990         Autumn 2020         River water         RWS1         B2         AMP, PIP, SXT         R           991         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           992         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           994         Autumn 2020         River water         RWS1         A         AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +	589	Autumn 2020	River water	RWS1	B2	AMP, PIP	R	
S91         Autumn 2020         River water         RWS1         B2         AMP, PIP         R           S92         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           S94         Autumn 2020         River water         RWS1         B1         AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL         MDR         +	990	Autumn 2020	River water	RWSI	B2	AMP, PIP, SXT	R	
992         Autumn 2020         River water         RWS1         A         AMP, PIP, SXT         R           994         Autumn 2020         River water         RWS1         B1         AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL.         MDR         +							-	
994 Autumn 2020 River water RWS1 B1 AMP, PIP, COM, CAZ, CTX, CRO, ATM, CIP, NAL MDR +								1
		Autumn 2020						
202 AURURAL 2020 REVET RV S1 B2 AMP, PP, CAM, CAZ, CL3, PP, COU, ATM MDR +	.992			protect	101	AMP PIP CYM CAZ CTX CRO ATM CIP NAL	MDP	+
	992 994	Autumn 2020	River water					· · ·

Box         Auron 20         Box and Dec Auron 200								
19.         Augue 20         Normal         PRN 1         0         No.P.P.C.M.C.A.C.T.NP.CO.M.M.C.M.T.T.NL.         1.8           10.         Augue 20.         Normal         PRN 1         0.         No.P.P.C.M.C.A.C.T.NP.CO.M.C.M.T.T.NL.         1.8           10.         Augue 20.         Normal         PRN 1         0.         No.P.P.C.M.C.A.C.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M.C.M.T.T.NP.CO.M	.996	Auturn 2020	River water	RWSI	B2	AMP, AMC, PIP, SXT	R	
19.1     Augue 20     Instant     IPEN     A.     NOP PRANCIPAL     IPEN     IPEN       10.1     Augue 20.1     Review 20	997	Auturn 2020	River water	RWSI	Bl	AMP, PIP, SXT	R	
1000     Aller 200     Bits     FR31     Aller 200     Aller 200     Aller 200     Aller 200       101     Aller 200     Bits and 200       101     Aller 200     Bits and 200     Bits and 200     Bits and 200     Bits and 200       102     Aller 200     Bits and 200     Bits and 200     Bits and 200       103     Aller 200     Bits and 200     Bits and 200     Bits and 200       103     Aller 200     Bits and 200     Bits and 200     Bits and 200       104     Aller 200     Bits and 200     Bits and 200     Bits and 200       105     Aller 200     Bits and 200     Bits and 200     Bits and 200       105     Aller 200     Bits and 200     Bits and 200     Bits and 200       106     Aller 200     Bits and 200     Bits and 200     Bits and 200       106     Aller 200     Bits and 200     Bits and 200     Bits and 200       107     Aller 200     Bits and 200     Bits and 200     Bits and 200       108     Aller 200     Bits and 200     Bits and 200     Bits and 200       109     Bits and 200     Bits and 200     Bits and 200     Bits and 200       101     Aller 200	.998	Auturn 2020	River water	RWS1	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	+
etc.         Auran 200         Inter and Part 1         Auran 200         Auran 200         Part 200	999	Autumn 2020	River water	RWSI	A	AMP, PIP, AN, CIP, NAL	R	
Set B         Auran 200         Inter war         BPN         A         MP PP CNU CAU STA ANAINE         Set B           84         Auran 200         Bort war         BPN         A         MP PP CNU CAU STA         A           84         Auran 200         Bort war         BPN         A         MP PP CNU CAU STA         A           84         Auran 200         Bort war         BPN         A         MP AUC PP CAU STATE         A           84         Auran 200         Bort war         BPN         A         MP AUC PP CAU STATE         AD           84         Auran 200         Brot war         BPN         A         MP AUC PP CAU STATE         AD           84         Auran 200         Brot war         BPN         A         ADP PC CAU STATE         ADD           84         Auran 200         Brot war         BPN         A         ADP PC CAU STATE         ADD         ADD<	600	Autumn 2020	River water	RWSI	B2	AMP, PIP	R	
161         Ausam 200         Jin man         Jin	601	Autumn 2020	River water	RWSI	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO	R	+
161         Auran 200         160 mode         181         182         187 Auran 200         187 auran 200 <td>602</td> <td>Autumn 2020</td> <td>River water</td> <td>RWSI</td> <td></td> <td></td> <td>MDR</td> <td>+</td>	602	Autumn 2020	River water	RWSI			MDR	+
Hole         Astama 200         First and 1931         A A         MP P(N) TOTAL (P) NA1         A I         MP P(N) TOTAL (P) NA1         A III         A IIII         A IIIII         A IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	-		River water					
1961         A. Jame 200         Jin Mark 200							-	
1960         Auran 200         Ibox war         1971         A         Ale ALP, PD AL, CAT, PD AL,         1971         1971           101         Auran 200         Box war         BOX         BOX War         BOX	H H							<u> </u>
eff         Auran 200         Bro variat         PPS1         FI         AUR AUC PP AUC ON ANST CP NAL         MTB           60         Auran 20         Bro variat         PPS1         D         AUR PP ST         E         E         AUR PP ST         E							-	<b> </b>
BB         Auson 200         For varial         FPS1         FG         Auson 200         For varial         FPS1         C         Auson 200         C         Auson 200         C         Auson 200         For varial         FPS1         D         Auson 200         C         Auson 200         For varial         FPS1         D         Auson 200         C         Auson 200         For varial         FPS1         D         Auson 200         D         Auson 200         For varial         FPS1         Au         Auson 200         Auson 200         For varial         For varial         FPS1         Au         Auson 200         Auson 200         For varial         F			River water					
980         Ausen 200         Proceeding         PS1         D         AUP PP         AUP PP        AUP PP         AUP PP	607	Autumn 2020	River water	RWSI	BL	AMP, AMC, PIP, GM, AN, SXT, CIP, NAL	MDR	
bit         Autom 200         Bro variat         BPS1         P         Autom 200         Autom 200         Bro variat         BPS1         A         AUP PCOM CAL OT PLOD         B         I           621         Autom 200         Bro variat         BPS2         O         AUP AUC PT NAL         B         I           621         Autom 200         Bro variat         BPS2         O         AUP AUC PT NAL         B           621         Autom 200         Bro variat         BPS2         A         AUP PC AUC PT PC DO         B         I           621         Autom 200         Bro variat         BPS2         A         AUP PC AUC PT PC DO         B         I           621         Autom 200         Bro variat         BPS2         A         AUP PC AUC PT PC DO         AU         B         I           623         Autom 200         Bro variat         BPS2         A         AUP PC AUC PT PC DO         AU         B         I	608	Autumn 2020	River water	RWSI	B2	AMP, PIP, SXT	R	
International         Job State         Add PP CONCON PP CON         R         I           121         Anterna 202         Box vacuum         BVS CONCON PP CONCON         B           121         Anterna 202         Box vacuum         BVS CONCON PP CONCON         B           121         Anterna 202         Box vacuum         BVS CONCONCONCONTRACTON AND         B           121         Anterna 202         Box vacuum         BVS CONCONCONTRACTON AND         B           121         Anterna 202         Box vacuum         BVS CONCONTRACTON AND AND         B           121         Anterna 202         Box vacuum         BVS CONCONTRACTON AND AND AND         B           122         Anterna 202         Box vacuum         BVS CONCONTRACTON AND AND AND         B           123         Anterna 202         Box vacuum         BVS CONCONTRACTON AND AND AND AND AND AND AND AND AND AN	609	Autumn 2020	River water	RWSI	D	AMP, PIP	R	
Status         Assam 200         Box vanc.         BPS (A)         A         AUP (P) COL (T) (P) CD         BD         I           Status         Assam 200         Box vanc.         BPS (A)         D         AUP AUC, P) AUL         B         I           Status         Assam 200         Box vanc.         BPS (A)         AUP AUC, PP AUL         B         I           Status         Box vanc.         BPS (A)         AUP AUC, PP AUL         B         I           Status         Box vanc.         BPS (A)         AUP AUC, PP COL (T), PP CD         B         I           Status         Box vanc.         BPS (A)         A         AUP AUC, PP COL (T), PP CDA (T), PP CDA (T)         Market AU           Status         Box vanc.         BPS (A)         A         AUP AUC, PP COL (T), PP CDA (T), PP CD	600	Autumn 2020	River water	RWSI	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, NAL	MDR	+
1513         Autam 203         Box watch         BPSC         D         AMP_AME_PP_NAL         R           644         Autam 203         Box watch         BPSC         D         AMP_AME_PP_CON_CATA PP_CON         R           644         Autam 203         Box watch         BPSC         A         AMP PP_CON_CATA PP_CON         R         -           645         Autam 203         Box watch         BPSC         A         AMP PP_CON_CATA PP_CON         R         -           646         Autam 203         Box watch         BPSC         A         AMP_AME_PP_CON_CATA PP_CON         R         -           647         Autam 203         Box watch         BPSC         A         AMP_AME_PP_CON_CATA PP_CON ATA AND         R         -           648         Autam 203         Box watch         BPSC         A         AMAE_PP_CON_CATA PP_CON ATA AND         R         -           649         Autam 203         Box watch         BPSC         A         CA         AMAE_PP_CON CATA PP_CON ATA AND         N <t< td="">         -           658         Autam 203         Box watch         BPSC         A         AP         AP         AND         AND         AND         AND         AND         AND         AND         A</t<>	611	Autumn 2020	River water	RWSI	A		R	+
61         Auter 300         Flore ware Flore w	-						+	<u> </u>
616         Autom 200         Buy war         PR-2         A         AUP PP CMA CTX PP CBA         R         I           636         Autom 200         Buy war         FRV3         A         AUP PP CMA CTX PP CBA         R           64         Autom 200         Buy war         FRV3         A         AUP PP CMA CTX PP CBA         R           61         Autom 200         Buy war         FRV3         A         AUP PP CMA CTX PP CBA TA         MUR           61         Autom 200         Buy war         FRV3         A         AUP AUP CMA CTX PP CBA TA         MUR           62         Autom 200         Buy war         FRV3         A         AUP AUP CCA CTX PP CBA TA         MUR         T           63         Autom 200         Buy war         FRV3         A         AUP AUP CCA CTX PP CBA TA         MUR         T           64         Autom 200         Buy war         FRV3         A         AUP AUP CCA CTX PP CBA TA         MUR         T           65         Autom 200         Buy war         FRV3         A         AUP AUP CCA CTX PP CBA TA         MUR         T           64         Autom 200         Buy war         FRV3         A         AUP AUP CCA CTX PP CBA TA         MUR         T <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
610         Arasm 200         Byr war         FNS2         A         AMP PP OM         FN         N           64         Autam 200         Byr war         FNS2         A         AMP, PR CM, CTR PD (20)         B         -           65         Autam 200         Byr war         FNS2         A         AMP, PR CM, CTR PD (20)         B         B           66         Autam 200         Byr war         FNS2         A         AMP, AMP, CAC, CAZ LTR PP, CHA, ATM         MDB         -           67         Autam 200         Byr war         FNS2         B         Common 200         Byr war         FNS2         A         AMP, AMP, CTR PD, CHA, ATM         MDB         -           63         Autam 200         Byr war         FNS2         B         Common 200         Byr war         FNS2         A         Common 200         NUT         NUT         -           63         Autam 200         Byr war         FNS2         A         Common 200         NUT         NUT         -         -         NUT         NUT         -         -         NUT         -         -         NUT         NUT         -         NUT         -         NUT         -         NUT         -         NUT	-						+	
616         Attem 200         Bur war         PRS2         A         AUP PPC CNL CX TY PPC CND         FI         I           61         Attem 200         Bur war         PRS2         A         AUP, AUE, PPC CNL CA 2, TX PPC, ED, ATM         MDE           61         Attem 200         Bur war         FRS2         A         AUP, AUE, PPC CNL CA 2, TX PPC, ED, ATM         MDE           61         Attem 200         Bur war         FRS2         A         AUP, AUE, PPC CNL CA 2, TX PPC, ED, ATM         N           62         Attem 200         Bur war         FRS2         A         AUP, PCC, PCL CA, TX PPC, ED, ATM         N           63         Attem 200         Bur war         FRS2         A         FL         FL         AU           64         Attem 200         Bur war         FRS2         A         FL         FL         AU         FL         AU         FL							+ +	+
eff         Attem 200         Bits ware         PR-S2         A         AUP AUC PP         Display         Bit           64         Attem 200         Bits ware         FR-S2         A         AUP AUC PP         Bit         Bits         Attem 200         Bits ware         Bits         Attem 200         Bits         <	615	Autumn 2020	River water		A	AMP, PIP, GM	R	
610         Junne 200         Roy van         FWS         A         ANP, MAC, PP, CNA, CAZ, CTA, PP, CRA, ATM, AN         MIR         I           620         Auture 200         Roy van         FWS         A         ANP, MAC, PP, CNA, CTA, PP, CRA, ATM, AN         MIR         I           630         Auture 200         Roy van         FWS         A         SUP, CNA, CTA, PP, CTA, CTA, PP, CNA, CTA, PP, CTA, CTA,	616	Autumn 2020	River water	RWS2	A	AMP, PIP, CXM, CTX, FEP, CRO	R	+
610         Name	617	Auturn 2020	River water	RWS2	A	AMP, AMC, PIP	R	
610         Name	618	Autumn 2020	River water	RWS2		AMP, AMC, PIP, CXM, CAZ ,CTX, FEP, CRO, ATM	MDR	+
Solution 200         Rev state         FWS         A         AUP, PECCAL CTX, PEP, CEU, ATMA AN         MDE         I           GA         Mattern 200         Rev state         FWS         A         XCP, CP, NAL         Re           GA         Mattern 200         Rev state         FWS         A         XCP, CP, NAL         WT           GA         Mattern 200         Rev state         FWS         A         XCP, CP, NAL         WT           GA         Mattern 200         Rev state         FWS         A         XCP, CPL, CPL, CPL, CPL, CPL, CPL, CPL, C								<u> </u>
420.         Augen 200         Rev same         FWS         A         NT (P NA).         FI           53.         Augen 200         Rev same         FWS         RC         NT         NT           53.         Augen 200         Rev same         FWS         A         NT         NT           54.         Augen 200         Rev same         FWS         A         NT         NT           50.         Augen 200         Rev same         FWS         A         NT         NT           50.         Augen 200         Rev same         FWS         A         NT         NT         NT           50.         Augen 200         Rev same         FWS         A         NT         NT         NT         NT           60.         Augen 200         Total Watersam         WTP rev Nt         A         ANP PAC, PP, NA         R         R           61.         Augen 200         Total Watersam         WTP rev Nt         D         ANP, MC, PP, NA         R         R           62.         Augen 200         Total Watersam         WTP rev Nt         D         ANP, PAC, PP, SA         NT         MT           63.         Augen 200         Total Watersam         WTP rev	-						-	+
GAL         Autume 200         Berr warer         RPS 2         R2           GS         Autume 200         Berr warer         RPS 2         A         (M         WT           GS         Autume 200         Berr warer         RPS 2         A         (M         WT           GS         Autume 200         Berr warer         RPS 2         A         (M         WT           GS         Autume 200         Berr warer         RPS 2         A         (M, P, COL, CTX, FP, COL, ATM, AN         MD           GS         Autume 200         Teact Warener         RPS 1         A         (M, AUP, PC, CNL, CTX, FP, CNL, ATM, AND         R           GS         Autume 200         Teact Warener         WT Proubt         R         AUP, AUC, FP         R           GS         Autume 200         Teact Warener         WT Proubt         R         AUP, AUC, FP         R         R           GS         Autume 200         Teact Warener         WT Proubt         R         AUP, AUC, FP, CNL, GAL, CTX, FP, CNL, ALL, MSR         R           GS         Autume 200         Teact Warener         WT Proubt         R         AUP, AUC, FP, CNL, GAL, CTX, FP, CNL, ALL, MSR         R           GS         Autume 200         Teact Warener	-						+ +	· ·
Ode         Autem 200         Roy merr         RVS ()         A           631         Autem 200         Roy warr         RVS ()         A         (A)           642         Autem 200         Roy warr         RVS ()         A         (A)           643         Autem 200         Roy warr         RVS ()         A         APP, CDA, ALC, PP, CDA, ALC, PP, CDA, ALL         NUE         -           643         Autem 200         Roy warr         RVS ()         A         APP, CDA, ALC, PP, CDA, ALC, CDA, CDA, CDA, CDA, CDA, CDA, CDA, CD						SAL, CIP, POAL		<b>I</b>
Gal         Augers 200         Brow server         IPS 2         A         Chi         NetT           620         Augers 200         Brow server         IPS 2         A         AAP, PR, CNL, CTX, FPR, CSA, LTX, FPR, CSA, ATM, AAN         MIR         -           630         Augers 200         Brow seer         IPS 2         A         AAP, PR, CNL, CTX, FPR, CSA, ATM, AAN         B           641         Augers 200         Testal Watersaare         WTP reads         A         AAP, PR, CP, CNL, CTX, FPR, CSA, ATM, AAN         B           643         Augers 200         Testal Watersaare         WTP reads         D         AAP, AAC, FP, CAL         B           644         Augers 200         Testal Watersaare         WTP reads         D         AAP, AAC, FP, CAL         B         A           645         Augers 200         Testal Watersaare         WTP reads         A         AAP, FAC, FP, CAL         B         A           646         Augers 200         Testal Watersaare         WTP reads         A         AAP, FAC, FP, CAL         B         A           646         Augers 200         Testal Watersaare         WTP reads         A         AAP, FAC, FP, CAL         B         A           646         Augers 200         Testal Watersa							-	
400         Autime 200         Browmer         RP32         A         Amp ALC LTX FP COL CTX FP COL ATA AND         MP8         -           610         Auter 200         Browmer         RP32         A         AMP ALC LTX FP COL CTX FP COL ATA AND         MP8         -           611         Auter 200         Testal Water and WNT Praids         A         AMP, PP, CN         R         R           613         Auter 200         Testal Water and WNT Praids         R2         AMP, PP, CN         R         R         R           614         Auter 200         Testal Water and WNT Praids         R2         AMP, AUC, PP, NAL         R		Auturn 2020	River water		A		+ +	L
600         Auran 200         For ward         FW32         A         AMP, PAC, CP, 200, CTX, PP, CBA, ATM, AN         MDE         *           611         Auran 200         Total Waterato         WWTP ooks         A         AMP, PP, CDN, AL, CTX, PP, CBA, ATM, AN         R         -           611         Auran 200         Total Waterato         WWTP ooks         A         AMP, PR, CDN, AL, CTX, PP, CBA, ATM, ANK, CP, PN, NAL.         R         -           616         Auran 200         Total Waterato         WWTP ooks         D         AMP, AMC, PP, SNAL.         R         -           617         Auran 200         Total Waterato         WWTP ooks         D         AMP, AMC, PP, SNL         R         R         -         R         -         R         -         R         -         R         -         R         -         R         R         -         R         -         R         -         R         -         R         -         R         -         R         R         -         R         -         R         -         R         -         R         -         R         -         R         -         R         -         R         -         R         -         R         - </td <td>628</td> <td>Auturn 2020</td> <td>River water</td> <td>RWS2</td> <td>A</td> <td>GM</td> <td>N-WT</td> <td></td>	628	Auturn 2020	River water	RWS2	A	GM	N-WT	
ftt         Auran 200         Form ward         Will         A         AMP, PP, CDN NAL.         R         Image: Constraint of the constheter	629	Autumn 2020	River water	RWS2	A		WT	
ftt         Auran 200         Form ward         Will         A         AMP, PP, CDN NAL.         R         Image: Constraint of the constheter	630	Auturn 2020		RWS2	A	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, AN	MDR	+
610         Aurum 200         Frand Waterster         WWT Poold         A         AMP, PK, CM         R         Image: Constraint of the consthetin the constraint of the constraint of the consthet	632	Auturn 2020	River water	RWSI			R	
644         Auron 200         Frank Waterstor, WWTP outst         92         AMP, AMC, PP, NL.         R           65         Auron 200         Frank Waterstor, WWTP outst         D         AMP, AMC, PP         R           66         Auron 200         Frank Waterstor, WWTP outst         D         AMP, AMC, PP         R         R           67         Auron 200         Frank Waterstor, WWTP outst         D         AMP, AMC, PP         R         R           68         Auron 200         Frank Waterstor, WWTP outst         D         AMP, AMC, PP, STA, CP, CD, CAZ, CTX, PP, CDA, AMS, ST, NAL.         ME           64         Auron 200         Frank Waterstor, WWTP outst         D         AMP, PMC, PP, STA         R         R           64         Auron 200         Frank Waterstor, WWTP outst         A         AMP, AMC, PP, STA         R         R           64         Auron 200         Frank Waterstor, WWTP outst         B         AMP, AMC, PP, STA         R         R           64         Auron 200         Frank Waterstor, WWTP outst         B         AMP, AMC, PP, CML         R         R           64         Auron 200         Frank Waterstor, WWTP outst         D         AMP, AMC, PP, CML         R         R           64								
std         Aurers 202         Tested Watersarr         WWTP weldt         D         AAP, AAC, PP         B           666         Aurers 202         Tested Watersarr         WWTP weldt         B         AAP, AAC, PP         B           617         Aurers 202         Tested Watersarr         WWTP weldt         B         AAP, AAC, PP         B         B           618         Aurers 202         Tested Watersarr         WWTP weldt         A         AAP, AAC, PP, SCM, CAZ, CTE, PP, CBD, ATM, STM, L         MB           619         Aurers 202         Tested Watersarr         WWTP weldt         A         AAP, PAC, PP, SCM, CAZ, CTE, PP, CSM, AL         R           641         Aurers 202         Tested Watersarr         WWTP weldt         A         AAP, AAC, PP, STM, CP, NAL         R           642         Aurers 202         Tested Watersarr         WWTP weldt         BI         AAP, AAC, PP, CM         R           643         Aurers 202         Tested Watersarr         WWTP weldt         BI         AAP, AAC, PP, CM         R           644         Aurers 203         Tested Watersarr         WWTP weldt         D         AAP, AAC, PP, CM         R           644         Aurers 204         Tested Watersarr         WWTP weldt         A <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								
Set         Autem 202         Tractal Watersam         WWTP medit         D         AMP, AME, PP         B           617         Autem 202         Tractal Watersam         WWTP medit         D         AMP, PP, CM, CAZ, CTX, FPP, CID, ATM, SXT, NAL.         MER           618         Autem 202         Tractal Watersam         WWTP medit         A         AMP, ARC, FPS         R           640         Autem 202         Tractal Watersam         WWTP medit         A         AMP, ARC, FPS         NT           641         Autem 202         Tractal Watersam         WWTP medit         A         AMP, ARC, FPS         NT           642         Autem 202         Tractal Watersam         WWTP medit         BI         AMP, ARC, FPS         NT         MR           643         Autem 202         Tractal Watersam         WWTP medit         BI         AMP, ARC, FPS         NT         R           644         Autem 202         Tractal Watersam         WWTP medit         BI         AMP, ARC, FPS         R         R           644         Autem 202         Tractal Watersam         WWTP medit         D         AMP, ARC, FPS         R         R           644         Autem 202         Tractal Watersam         WWTP medit         BI								
617         Auture 320         Total Watersam         WWT Prackt         61         AAAP, AAC, PP         D         AAP           618         Auture 320         Total Watersam         WWT Prackt         D         AAAP, PC, CM, CAZ, CTS, PP, CBD, ATAL, SKT, NAL.         MBB           619         Auture 320         Total Watersam         WWT Prackt         A         AAP, PARC, PP, SYT, CP, NAL.         R           641         Auture 320         Total Watersam         WWT Prackt         A         AAP, PARC, TP, SYT, CP, NAL.         R           642         Auture 320         Total Watersam         WWT Prackt         A         AAP, PARC, TP, SYT, CP, NAL.         R           643         Auture 320         Total Watersam         WWT Prackt         B1         AAP, AAC, TP, SYT, CP, NAL.         R           644         Auture 320         Total Watersam         WWT Prackt         B1         AAP, AAC, TP, CA         R           645         Auture 320         Total Watersam         WWT Prackt         A         AAP, AAC, RP, CA         R           646         Auture 320         Total Watersam         WWT Prackt         A         AAP, AAC, RP         R           647         Auture 320         Total Watersam         WWT Prackt         A         <								
Auture 200         Load Watesatu         WYTP eakt         D         AMP, PP, CM, CAZ, CTX, PP, CMA, CM, SMT, NAL.         MTR         +           640         Auture 200         Testad Watesatu         WYTP eakt         A         AMP, ACC, PP, ST         R           640         Auture 200         Testad Watesatu         WYTP eakt         A         AMP, ACC, PP, ST         R           641         Auture 200         Testad Watesatu         WYTP eakt         A         AMP, ACC, PP, ST         R           642         Auture 200         Testad Watesatu         WYTP eakt         R         AMP, ACC, PP, ST         R           644         Auture 200         Testad Watesatu         WYTP eakt         D         AMP, ACC, PP, CM, CAZ, CTX, PP, CRO, ATM, NAL.         MTR         -           644         Auture 200         Testad Watesatu         WYTP eakt         D         AMP, AMC, PP, CM         R         -           645         Auture 200         Testad Watesatu         WYTP eakt         D         AMP, AMC, PP, CM         R         -           646         Auture 200         Testad Watesatu         WYTP eakt         D         AMP, AMC, PP, CM         R         -           647         Auture 200         Testad Watesatu         WYTP e	636	Autumn 2020	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP	R	
Autere 200         Autere 200         Easted Variestari         WATP easter         A         AMP, AMC, PP, SYT, CP, NAL.         R           640         Autere 200         Tested Variestari         WATP easter         A         AMP, PSYT, CP, NAL.         MR           641         Autere 200         Tested Variestari         WATP easter         A         AMP, PSYT, CP, NAL.         MR           642         Autere 200         Tested Variestari         WATP easter         BI         AMP, AMC, PP, OM         R           643         Autere 200         Tested Variestari         WATP easter         D         AMP, AMC, PP, OM         R           644         Autere 200         Tested Variestari         WATP easter         D         AMP, AMC, PP, CML CAZ, CTX, PP, CDC, ATM, NAL.         MR           644         Autere 200         Tested Variestari         WATP easter         D         AMP, AMC, PP         R         E           644         Autere 200         Tested Variestari         WATP easter         D         AMP, AMC, PP         R         E           644         Autere 200         Tested Variestari         WATP easter         D         AMP, AMC, PP, CP, NAL         R         E           645         Autere 200         Tested Variestari	637	Autumn 2020	Treated Wastewater	WWTP outlet	BL	AMP, AMC, PIP	R	
Set         Auture 200         Load Watesata         WYT eacht         A         AMP, PP, SXT, CP, NAL         R           641         Auture 200         Load Watesata         WYT eacht         A         AAP, AAC, TP, PN, CY, PN, NAL         MTR           642         Auture 200         Load Watesata         WYT eacht         Bi         AAP, AAC, TP, PP, SXT         B           644         Auture 200         Load Watesata         WYT eacht         D         AAP, AAC, TP, PP, SXT, CP, NAL         MTR           644         Auture 200         Load Watesata         WYT eacht         D         AAP, AAC, TP, PC, CA, CAZ, CTX, PP, CRO, ATM, NAL         MTR           646         Auture 200         Load Watesata         WYT eacht         R         AAP, AAC, TP, PC, TA, AAC, ATM, NAL         B           647         Auture 200         Tested Watesata         WYT eacht         R         AAP, AAC, TP, PC, TA, AC, TP, CH, NAL         B           648         Auture 200         Tested Watesata         WYT eacht         D         AAP, AAC, TP, CH, NAL         B           649         Auture 200         Tested Watesata         WYT eacht         D         AAP, AAC, TP, CH, NAL         B           640         Auture 200         Tested Watesata         WYT eacht <td< td=""><td>638</td><td>Auturn 2020</td><td>Treated Wastewater</td><td>WWTP outlet</td><td>D</td><td>AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT, NAL</td><td>MDR</td><td>+</td></td<>	638	Auturn 2020	Treated Wastewater	WWTP outlet	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT, NAL	MDR	+
640         Autum 200         Testad Wate-stat         WTP owkt         A         AMP, PP, SXI CP, NAL         NDR           641         Autum 200         Testad Wate-stat         WTP owkt         A         AMP, AUC, PP, SXI CP, NAL         MDR           642         Autum 200         Testad Wate-stat         WTP owkt         Bi         AMP, AUC, PP, SXI CP, NAL         MDR           644         Autum 200         Testad Wate-stat         WTP owkt         D         AMP, AUC, PP, SXI CP, NAL         MDR           644         Autum 200         Testad Wate-stat         WTP owkt         D         AMP, AUC, PP, CAC, CTX, PP, CDO, ATM, NAL         MDR         +           644         Autum 200         Testad Wate-stat         WTP owkt         D         AMP, AUC, PP, CDC, ATM, NAL         MDR         +           645         Autum 200         Testad Wate-stat         WTP owkt         R         AMP, AUC, PP, CDC, ATM, NAL         R         +           644         Autum 201         Testad Wate-stat         WTP owkt         R         AMP, AUC, PP, CDL, ALL         R         +           645         Autum 201         Testad Wate-stat         WTP owkt         R         AMP, AUC, PP, CDL, ALL         MT         +           646         Autum 201 <td>639</td> <td>Autumn 2020</td> <td>Treated Wastewater</td> <td>WWTP outlet</td> <td>A</td> <td>AMP, AMC, PIP, SXT</td> <td>R</td> <td></td>	639	Autumn 2020	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP, SXT	R	
541         Aumen 200         Tested Watersame         WWTP ondst         A         AMP, AMC, TPP, SXT.         MUTB           642         Aumen 200         Tested Wastersame         WWTP ondst         BI         AMP, AMC, TPP, SXT.         B           644         Aumen 200         Tested Wastersame         WWTP ondst         D         AMP, AMC, TPP, SXT.         B           644         Aumen 200         Tested Wastersame         WWTP ondst         D         AMP, AMC, TPP, SXT.         B           646         Aumen 200         Tested Wastersame         WWTP ondst         D         AMP, AMC, TPP, SXT.         B         A           646         Aumen 200         Tested Wastersame         WWTP ondst         D         AMP, AMC, TPP         R         R           646         Aumen 200         Tested Wastersame         WWTP ondst         R         AMP, AMC, TPP, CM         R         R           646         Aumen 205         Tested Wastersame         WWTP ondst         D         AMP, AMC, TP, CD, NAL         R         R           647         Aumen 205         Tested Wastersame         WWTP ondst         D         AMP, AMC, TP, CD, NAL         R         R           648         Aumen 205         Tested Wastersame         W				WWTP outlet				
542         Autrem 2005         France Wastersand         WWTP outdst         Bit         AMP, AMC, TPP, DM         Bit         AMP, AMC, TPP, TSXT         Bit         Bit           644         Autrem 2005         Treated Wastersand         WWTP outdst         D         AMP, AMC, TPP, CM         Bit         AMP, AMC, TPP, CM, CAT, CTX, TPP, CMO, ATM, NAL.         MDR         +           645         Autrem 205         Treated Wastersand         WWTP outdst         D         AMP, AMC, TPP, CMO, CAT, CTX, TPP, CMO, ATM, NAL.         MDR         +           646         Autrem 205         Treated Wastersand         WWTP outdst         A         AMP, AMC, TPP         R         R           647         Autrem 205         Treated Wastersand         WWTP outdst         A         AMP, AMC, TPP         R         R           648         Autrem 205         Treated Wastersand         WWTP outdst         D         AMP, AMC, TPP, CM, CM         R								
Add         August 200         France Wastessand         WWTP eacht         Bit         AMP, AMC, PP, OM         Bit           644         August 200         Teated Wastessand         WWTP eacht         D         AMP, AMC, PP, OM         B           646         August 200         Teated Wastessand         WWTP eacht         D         AMP, AMC, PP         R         MDR         +           646         August 200         Teated Wastessand         WWTP eacht         D         AMP, AMC, PP         R         R         A           646         August 200         Teated Wastessand         WWTP eacht         R         AMP, AMC, PP         R         R         R         R           646         August 200         Teated Wastessand         WWTP match         R         AMP, AMC, PP, CM         R			-				• •	
544         Auren 202         Testal Waterstein         WATP outh         D         AMP, AMC, PP, CMA, CAT, CTX, FPP, CBO, ATM, NAL.         MD         AME           645         Auren 202         Testal Waterstein         WATP outh         B2         AMP, AMC, PP, CMA, CAT, CTX, FPP, CBO, ATM, NAL.         MD         A           646         Auren 202         Testal Waterstein         WATP outh         B2         AMP, AMC, PP         R         R           647         Auren 203         Testal Waterstein         WATP outh         B2         AMP, AMC, PP         R         R           646         Auren 203         Testal Waterstein         WATP outh         D         AMP, AMC, PP         R         R           646         Auren 203         Testal Waterstein         WATP outh         D         AMP, AMC, PP, CM         R         R           646         Auren 203         Testal Waterstein         WATP outh         D         AMP, AMC, PP, CM         R         R           647         Auren 203         Testal Waterstein         WATP outh         D         AMP, PMC, CM, SXT, CP, NAL         MDR           648         Auren 203         Testal Waterstein         WATP outh         D         AMP, PMC, CM, SXT, CP, NAL         WT <td< td=""><td>H 1</td><td></td><td></td><td></td><td></td><td></td><td>+</td><td><u> </u></td></td<>	H 1						+	<u> </u>
446         Auren 2020         Tested W stream         WATP earlst         B2         AMP, AMC, PP, CXM, CAZ, CTX, FP, CBO, ATM, NAL.         MDR         +           646         Auren 2020         Tested W stream         WATP earlst         A2         AMP, AMC, PP         R         R           647         Auren 2020         Tested W stream         WATP earlst         A         AMP, AMC, PP         R         R           646         Auren 2020         Tested W stream         WATP earlst         D         AMP, AMC, PP, CP, NAL         R         R           646         Auren 2020         Tested W stream         WATP earlst         D         AMP, AMC, PP, CP, NAL         R         R           646         Auren 2020         Tested W stream         WATP earlst         D         AMP, AMC, PP, CP, NAL         R         R           647         Auren 2020         Tested W stream         WATP earlst         D         AMP, AMC, PP, CP, NAL         WT         R           648         Auren 2020         Tested W stream         WATP earlst         D         AMP, PM, CM, SXT, CP, NAL         WT           649         Auren 2020         Tested W stream         WATP earlst         B1         E         E           649         Auren 2							-	
646         Aurem 2020         Tested Wateward         WWTP oakt         R           647         Auram 2020         Tested Wateward         WWTP oakt         A         AMP, AMC, PP         R           648         Auram 2020         Tested Wateward         WWTP oakt         R         A           649         Auram 2020         Tested Wateward         WWTP oakt         R         A           640         Auram 2020         Tested Wateward         WWTP oakt         R         A           641         Auram 2020         Tested Wateward         WWTP oakt         D         AMP, AMC, PP, GM         R           652         Auram 2020         Tested Wateward         WWTP oakt         D         AMP, APC, CPP, CM         R         MCR           653         Auram 2020         Tested Wateward         WWTP oakt         D         AMP, PP, CM, SXT, CP, NAL         MCR           654         Auram 2020         Tested Wateward         WWTP oakt         D         AMP, PP         R         MCR           655         Auram 2020         Tested Wateward         WWTP oakt         D         ST         WT         MCR           664         Auram 2020         Tested Wateward         WWTP oakt         A         W		Autumn 2020						
967         Auren 2020         Tested Wateward         WWTP oukt         A.         AMP, AMC, FP         R           640         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, AMC, FP         R           640         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, AMC, FP, CP, NAL         R           640         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, AMC, FP, CM         R           641         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, AMC, FP, CM         R           642         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, AMC, PP, CM, SXT, CP, NAL         MUE           643         Auren 2020         Tested Wateward         WWTP oukt         A         AMP, APP, CM, SXT, CP, NAL         WT           645         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, APP, CM, SXT, CP, NAL         WT           646         Auren 2020         Tested Wateward         WWTP oukt         D         AMP, APP, CM, SXT, CP, NAL         WT           646         Auren 2020         Tested Wateward         WWTP oukt         A         MT         MT	645	Autumn 2020	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	+
640         Autrem 2020         Tested Watewate         WWTP made         92         AMP, AMC, PP, CP, NAL         9           640         Autrum 2020         Tested Watewate         WWTP made         D         AMP, AMC, PP, CP, NAL         R           641         Autrem 2020         Tested Watewate         WWTP made         BL         AMP, AMC, PP, CP, NAL         R           652         Autrem 2020         Tested Watewate         WWTP made         D         AMP, AMC, PP, CP, NAL         MDR           653         Autrem 2020         Tested Watewate         WWTP made         D         AMP, AMC, PP, CP, NAL         MDR           654         Autrem 2020         Tested Watewate         WWTP made         D         AMP, PP, CA, SXT, CP, NAL         WT           655         Autrem 2020         Tested Watewate         WWTP made         D         AMP, PP         R         WT           656         Autrem 2020         Tested Watewate         WWTP made         D         AMP, PP, CA, SXT, CP, NAL         WT           665         Autrem 2020         Tested Watewate         WWTP made         D         AMP, PP, CA, SXT, CP, NAL         WT           665         Autrem 2020         Tested Watewate         WWTP made         A         WT	646	Autumn 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP	R	
649         Auturn 200         Tested Wastewate         WWTP oulds         D         AMP, AMC, PP, CP, NAL         R           650         Auturn 200         Tested Wastewate         WWTP oulds         B1         AMP, AMC, PP, CM         R           651         Auturn 200         Tested Wastewate         WWTP oulds         D         AMP, AMC, PP, CM         R           652         Auturn 200         Tested Wastewate         WWTP oulds         D         AMP, AMC, PP, CP, NAL         MDR           653         Auturn 200         Tested Wastewate         WWTP oulds         B1         AMP, AMC, PP, CP, NAL         MDR           654         Auturn 200         Tested Wastewate         WWTP oulds         A         AMP, PP         CAL, SXT, CP, NAL         WT           655         Auturn 200         Tested Wastewate         WWTP oulds         D         SXT         N+WT         E           656         Auturn 200         Tested Wastewate         WWTP oulds         A         WT         WT         E           666         Auturn 200         Tested Wastewate         WWTP oulds         A         WT         E         E           661         Auturn 200         Tested Wastewate         WWTP oulds         A         WT	647	Autumn 2020	Treated Wastewater	WWTP outlet	A	AMP, AMC, PIP	R	
65         Autum 2020         Treated Wastewate         WWTP oukt         BI         AMP, AMC, PP, GM         P           651         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, AMC, PP, GM         R           652         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, AMC, PP, GM, SXT, CIP, NAL.         MDR           653         Autum 2020         Treated Wastewate         WWTP oukt         BI         WT           654         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, PP         R           655         Autum 2020         Treated Wastewate         WWTP oukt         D         ST         N-WT           656         Autum 2020         Treated Wastewate         WWTP oukt         D         ST         N-WT           657         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, PP, CM, SXT, CIP, NAL         MDR           668         Autum 2020         Treated Wastewate         WWTP oukt         A         WT         WT           661         Autum 2020         Treated Wastewate         WWTP oukt         A         WT         WT           662         Autum 2020         Treated Waste	648	Autumn 2020	Treated Wastewater	WWTP outlet	B2	AMP, AMC, PIP	R	
65         Autum 2020         Treated Wastewate         WWTP oukt         BI         AMP, AMC, PP, GM         P           651         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, AMC, PP, GM         R           652         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, AMC, PP, GM, SXT, CIP, NAL.         MDR           653         Autum 2020         Treated Wastewate         WWTP oukt         BI         WT           654         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, PP         R           655         Autum 2020         Treated Wastewate         WWTP oukt         D         ST         N-WT           656         Autum 2020         Treated Wastewate         WWTP oukt         D         ST         N-WT           657         Autum 2020         Treated Wastewate         WWTP oukt         D         AMP, PP, CM, SXT, CIP, NAL         MDR           668         Autum 2020         Treated Wastewate         WWTP oukt         A         WT         WT           661         Autum 2020         Treated Wastewate         WWTP oukt         A         WT         WT           662         Autum 2020         Treated Waste	649	Auturn 2020	Treated Wastewater	WWTP outlet	D	AMP, AMC, PIP, CIP, NAL	R	
65:         Autum 2020         Treated Watewater         WWTP order         D         AMP, PMC, PF         P           652:         Autum 2020         Treated Watewater         WWTP order         D         AMP, PMC, CM, SXT, CIP, NAL.         MDR           653:         Autum 2020         Treated Watewater         WWTP order         BI         WT         WT           654         Autum 2020         Treated Watewater         WWTP order         A         MP, PMC, CM, SXT, CIP, NAL.         WT           654         Autum 2020         Treated Watewater         WWTP order         D         AMP, PMP         R           655         Autum 2020         Treated Watewater         WWTP order         D         AMP, PMP         R           655         Autum 2020         Treated Watewater         WWTP order         D         AMP, PMP, CM, SXT, CIP, NAL.         MDR           655         Autum 2020         Treated Watewater         WWTP order         A         MP         WT           656         Autum 2020         Treated Watewater         WWTP order         A         MWT         WT           666         Autum 2020         Treated Watewater         WWTP order         B2         WT         WT           664 <td< td=""><td>650</td><td></td><td></td><td></td><td></td><td>AMP AMC PIP (M</td><td>R</td><td></td></td<>	650					AMP AMC PIP (M	R	
652         Autum 202         Tested Watewater         WWTP makt         D         AMP, PP, GM, SVT, CIP, NAL.         MDR           653         Autum 202         Tested Watewater         WWTP makt         BI         WT           654         Autum 202         Tested Watewater         WWTP makt         D         AMP, PP, GM, SVT, CIP, NAL.         WT           655         Autum 202         Tested Watewater         WWTP makt         D         AMP, PP         NWT           656         Autum 202         Tested Watewater         WWTP makt         D         SXT         NWT           657         Autum 202         Tested Watewater         WWTP makt         BI         WT         MT           658         Autum 202         Tested Watewater         WWTP makt         BI         WT         MT           663         Autum 202         Tested Watewater         WWTP makt         A         WT         MT           664         Autum 202         Tested Watewater         WWTP makt         B2         WT         MT           665         Autum 202         Tested Watewater         WWTP makt         D         WT         WT           664         Autum 202         Tested Watewater         WWTP makt         B								
653         Autum 205         Treated Wastewate         WWTP ould:         Bit         WT           654         Autum 205         Treated Wastewate         WWTP ould:         D         AMP, PIP         R           655         Autum 205         Treated Wastewate         WWTP ould:         D         AMP, PIP         R           656         Autum 205         Treated Wastewate         WWTP ould:         D         SXT         N-WT           658         Autum 205         Treated Wastewate         WWTP ould:         D         AMP, PIP, CM, SXT, CIP, NAL.         MUR           669         Autum 205         Treated Wastewate         WWTP ould:         A         MP, PIP, CM, SXT, CIP, NAL.         MUR           660         Autum 205         Treated Wastewate         WWTP ould:         A         WT            661         Autum 205         Treated Wastewate         WWTP ould:         B2         WT             662         Autum 205         Treated Wastewate         WWTP ould:         B2         WT             664         Autum 205         Treated Wastewate         WWTP ould:         B2         WT             665         Autum 205							-	<u> </u>
654     Autuen 200     Teated Wastewarz     WWTP oudet     A       655     Autuen 200     Teated Wastewarz     WWTP oudet     D     AMP, PIP       656     Autuen 200     Teated Wastewarz     WWTP oudet     D     SXT       658     Autuen 200     Teated Wastewarz     WWTP oudet     D     SXT       658     Autuen 200     Teated Wastewarz     WWTP oudet     D     AMP, PIP, GM, SXT, CIP, NAL     MT       659     Autuen 200     Teated Wastewarz     WWTP oudet     A     MT       660     Autuen 200     Teated Wastewarz     WWTP oudet     A       661     Autuen 200     Teated Wastewarz     WWTP oudet     A       662     Autuen 200     Teated Wastewarz     WWTP oudet     A       663     Autuen 200     Teated Wastewarz     WWTP oudet     B2       664     Autuen 200     Teated Wastewarz     WWTP oudet     A       665     Autuen 200     Teated Wastewarz     WWTP oudet     A       666     Autuen 202     Teated Wastewarz     WWTP oudet     A       666     Autuen 202     Teated Wastewarz     WWTP oudet     A       666     Autuen 202     Teated Wastewarz     WWTP oudet     A       675     Autuen						AMP, PIP, ON, SAT, CIP, NAL	-	
655     Autumn 2020     Teated Watewater     WWTP outlet     D     AMP, PIP     R       656     Autumn 2020     Teated Watewater     WWTP outlet     D     SXT     N:WT       658     Autumn 2020     Teated Watewater     WWTP outlet     D     AMP, PIP, GM, SXT, CIP, NAL.     MUR       659     Autumn 2020     Teated Watewater     WWTP outlet     A     MTP     WT       660     Autumn 2020     Teated Watewater     WWTP outlet     A     WT       661     Autumn 2020     Teated Watewater     WWTP outlet     A     WT       662     Autumn 2020     Teated Watewater     WWTP outlet     R2     WT       663     Autumn 2020     Teated Watewater     WWTP outlet     R2     WT       664     Autumn 2020     Teated Watewater     WWTP outlet     R2     WT       665     Autumn 2020     Teated Watewater     WWTP outlet     R2     WT       666     Autumn 2020     Teated Watewater     WWTP outlet     R1     WT       667     Autumn 2020     Teated Watewater     WWTP outlet     A     WT       668     Autumn 2020     Teated Watewater     WWTP outlet     B1     WT       669     Autumn 2020     Teated Watewater	-							I
656     Autum 2020     Treated Wasteware     WWTP outlet     B1     WT       658     Autum 2020     Treated Wasteware     WWTP outlet     B1     WT       659     Autum 2020     Treated Wasteware     WWTP outlet     D     AMP, PIP, GM, SXT, CIP, NAL.     MDR       660     Autum 2020     Treated Wasteware     WWTP outlet     A     WT     WT       661     Autum 2020     Treated Wasteware     WWTP outlet     A     WT       662     Autum 2020     Treated Wasteware     WWTP outlet     R2     WT       663     Autum 2020     Treated Wasteware     WWTP outlet     R2     WT       664     Autum 2020     Treated Wasteware     WWTP outlet     R2     WT       665     Autum 2020     Treated Wasteware     WWTP outlet     R2     WT       666     Autum 2020     Treated Wasteware     WWTP outlet     R2     WT       666     Autum 2020     Treated Wasteware     WWTP outlet     R1     WT       666     Autum 2020     Treated Wasteware     WWTP outlet     R1     WT       666     Autum 2020     Treated Wasteware     WWTP outlet     R1     WT       667     Autum 2020     Treated Wasteware     WWTP outlet     R1 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td>l</td> <td></td> <td>L</td>						l		L
653         Autum 2020         Treated Wastewater         WWTP ondet         Bl         WT           659         Autum 2020         Treated Wastewater         WWTP ondet         D         AMP, PIP, CM, SXT, CIP, NAL.         MDR           660         Autum 2020         Treated Wastewater         WWTP ondet         A         WT         WT           661         Autum 2020         Treated Wastewater         WWTP ondet         A         WT         WT           662         Autum 2020         Treated Wastewater         WWTP ondet         B2         WT         WT           663         Autum 2020         Treated Wastewater         WWTP ondet         B2         WT         WT           664         Autum 2020         Treated Wastewater         WWTP ondet         B2         WT         WT           665         Autum 2020         Treated Wastewater         WWTP ondet         A         WT         WT           666         Autum 2020         Treated Wastewater         WWTP ondet         B1         WT         WT           669         Autum 2020         Treated Wastewater         WWTP ondet         B1         WT         MT           670         Autum 2020         Treated Wastewater         WWTP ondet	655	Auturn 2020	Treated Wastewater	WWTP outlet	D	AMP, PIP	R	
657       Autum 2020       Tested Wastewater       WWTP oakt       D       AMP, PP, GM, SXT, CIP, NAL.       MDR         660       Autum 2020       Tested Wastewater       WWTP oakt       A         661       Autum 2020       Tested Wastewater       WWTP oakt       A         662       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         663       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         664       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         665       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         665       Autum 2020       Tested Wastewater       WWTP oakt       A       WT         666       Autum 2020       Tested Wastewater       WWTP oakt       A       WT       WT         667       Autum 2020       Tested Wastewater       WWTP oakt       B1       WT       WT       WT         668       Autum 2020       Tested Wastewater       WWTP oakt       B1       WT       WT       MT         669       Autum 2020       HWW       Septic tank       A       CIP, NA1.       R       KT         <	656	Autumn 2020	Treated Wastewater	WWTP outlet	D	SXT	N-WT	
657       Autum 2020       Tested Wastewater       WWTP oakt       D       AMP, PP, GM, SXT, CIP, NAL.       MDR         660       Autum 2020       Tested Wastewater       WWTP oakt       A         661       Autum 2020       Tested Wastewater       WWTP oakt       A         662       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         663       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         664       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         665       Autum 2020       Tested Wastewater       WWTP oakt       B2       WT         665       Autum 2020       Tested Wastewater       WWTP oakt       A       WT         666       Autum 2020       Tested Wastewater       WWTP oakt       A       WT       WT         667       Autum 2020       Tested Wastewater       WWTP oakt       B1       WT       WT       WT         668       Autum 2020       Tested Wastewater       WWTP oakt       B1       WT       WT       MT         669       Autum 2020       HWW       Septic tank       A       CIP, NA1.       R       KT         <	658	Auturn 2020	Treated Wastewater	WWTP outlet	BL		WT	
660     Auturn 2020     Tested Wastewater     WWTP ould:     A       661     Auturn 2020     Tested Wastewater     WWTP ould:     A       662     Auturn 2020     Tested Wastewater     WWTP ould:     B2       663     Auturn 2020     Tested Wastewater     WWTP ould:     D       664     Auturn 2020     Tested Wastewater     WWTP ould:     B2       665     Auturn 2020     Tested Wastewater     WWTP ould:     A       666     Auturn 2020     Tested Wastewater     WWTP ould:     A       667     Auturn 2020     Tested Wastewater     WWTP ould:     A       668     Auturn 2020     Tested Wastewater     WWTP ould:     B1       669     Auturn 2020     Tested Wastewater     WWTP ould:     B1       668     Auturn 2020     Tested Wastewater     WWTP ould:     B1       670     Auturn 2020     HWW     Septic tank     A       671     Auturn 2020     HWW     Septic tank     A       672     Auturn 2020     HWW     Septic tank     A       673     Auturn 2020     HWW     Septic tank     A       674     Auturn 2020     HWW     Septic tank     A       675     Auturn 2020     HWW <t< td=""><td></td><td></td><td></td><td>WWTP outlet</td><td></td><td>AMP, PIP, GM, SXT, CIP, NAL</td><td>-</td><td></td></t<>				WWTP outlet		AMP, PIP, GM, SXT, CIP, NAL	-	
661       Autuen 2020       Teated Wastewater       WWTP ondet       R2         662       Autuen 2020       Teated Wastewater       WWTP ondet       R2         663       Autuen 2020       Teated Wastewater       WWTP ondet       R2         664       Autuen 2020       Teated Wastewater       WWTP ondet       R2         665       Autuen 2020       Teated Wastewater       WWTP ondet       R2         666       Autuen 2020       Teated Wastewater       WWTP ondet       A         666       Autuen 2020       Teated Wastewater       WWTP ondet       A         667       Autuen 2020       Teated Wastewater       WWTP ondet       B1         668       Autuen 2020       Teated Wastewater       WWTP ondet       B1       WT         669       Autuen 2020       Teated Wastewater       WWTP ondet       B1       WT         669       Autuen 2020       Teated Wastewater       WWTP ondet       B1       WT         669       Autuen 2020       Teated Wastewater       WWTP ondet       B1       WT         670       Autuen 2020       HWW       Septic tank       A       CIP, NAL       R         671       Autuen 2020       HWW       Septic								
662       Autum 2020       Teated Wastewater       WWTP oakt       B2       WT         663       Autum 2020       Treated Wastewater       WWTP oakt       D       WT         664       Autum 2020       Treated Wastewater       WWTP oakt       B2       WT         665       Autum 2020       Treated Wastewater       WWTP oakt       A       WT         665       Autum 2020       Treated Wastewater       WWTP oakt       A       WT         666       Autum 2020       Treated Wastewater       WWTP oakt       A       WT         666       Autum 2020       Treated Wastewater       WWTP oakt       B1       WT       WT         667       Autum 2020       Treated Wastewater       WWTP oakt       B1       WT       WT         668       Autum 2020       Treated Wastewater       WWTP oakt       B1       WT       WT         669       Autum 2020       Treated Wastewater       WWTP oakt       B1       WT       WT         670       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT         671       Autum 2020       HWW       Septic tank       A       CIP, NAL       R         672       Au							-	
663       Auturn 2020       Treated Wastewater       WWTP ould:       D       WT         664       Auturn 2020       Treated Wastewater       WWTP ould:       R2       WT         665       Auturn 2020       Treated Wastewater       WWTP ould:       A       WT         666       Auturn 2020       Treated Wastewater       WWTP ould:       A       WT         667       Auturn 2020       Treated Wastewater       WWTP ould:       Bi       WT       WT         668       Auturn 2020       Treated Wastewater       WWTP ould:       Bi       WT       WT         669       Auturn 2020       Treated Wastewater       WWTP ould:       Bi       WT       WT         669       Auturn 2020       Treated Wastewater       WWTP ould:       Bi       WT       WT         670       Auturn 2020       HWW       Septic tank       A       CIP, NAL       R       R         671       Auturn 2020       HWW       Septic tank       R2       WT       MDR       +         673       Auturn 2020       HWW       Septic tank       A       CIP, NAL       R          674       Auturn 2020       HWW       Septic tank       A	-					1		l
664     Autum 202     Treated Wistewater     WWTP oadlet     B2     WT       665     Autum 2020     Treated Wistewater     WWTP oadlet     A     WT       666     Autum 2020     Treated Wistewater     WWTP oadlet     A     WT       666     Autum 2020     Treated Wistewater     WWTP oadlet     A     WT       667     Autum 2020     Treated Wistewater     WWTP oadlet     B1     WT       668     Autum 2020     Treated Wistewater     WWTP oadlet     B1     WT       669     Autum 2020     Treated Wistewater     WWTP oadlet     B1     WT       660     Autum 2020     Treated Wistewater     WWTP oadlet     B1     WT       671     Autum 2020     Treated Wistewater     WWTP oadlet     B1     WT       673     Autum 2020     HWW     Septie tank     A     CIP, NAL     WT       673     Autum 2020     HWW     Septie tank     A     AMP, PIP, CAZ, CRO, ATM, NAL     MDR     +       674     Autum 2020     HWW     Septie tank     A     CIP, NAL     R        675     Autum 2020     HWW     Septie tank     A     CIP, NAL     R        675     Autum 2020     HWW     Sept						l		<b>—</b>
665       Autum 2020       Treated Wastewater       WWTP oullet       A         666       Autum 2020       Treated Wastewater       WWTP oullet       A       WT         667       Autum 2020       Treated Wastewater       WWTP oullet       B1       WT         668       Autum 2020       Treated Wastewater       WWTP oullet       B1       WT         668       Autum 2020       Treated Wastewater       WWTP oullet       B1       WT         669       Autum 2020       Treated Wastewater       WWTP oullet       B1       WT         669       Autum 2020       Treated Wastewater       WWTP oullet       B1       WT         671       Autum 2020       HWW       Septic tank       A       CIP, NAL       R         672       Autum 2020       HWW       Septic tank       A       CIP, NAL       R         673       Autum 2020       HWW       Septic tank       A       AMP, PIP, CAZ, CRO, ATM, NAL       MDR       +         674       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT          675       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT	H H						+	
666Autuen 2020Treated WastewaterWWTP ould:AWTWT667Autuen 2020Treated WastewaterWWTP ould:B1WTWT668Autuen 2020Treated WastewaterWWTP ould:B1WTWT669Autuen 2020Treated WastewaterWWTP ould:B1WTWT670Autuen 2020HWWSeptic tankAWTWT671Autuen 2020HWWSeptic tankACIP, NALR672Autuen 2020HWWSeptic tankACIP, NALR673Autuen 2020HWWSeptic tankACIP, NALR674Autuen 2020HWWSeptic tankAAMP, PIP, CAZ, CRO, ATM, NALR675Autuen 2020HWWSeptic tankACIP, NALR674Autuen 2020HWWSeptic tankACIP, NALR675Autuen 2020HWWSeptic tankACIP, NALR676Autuen 2020HWWSeptic tankAMCP, PIP, CAZ, CTX, CPT, CPT, CPT, CPT, NALWT678Autuen 2020HWWSeptic tankAMCP, PIP, CXX, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NALMDR679Autuen 2020HWWSeptic tankACIP, NALR670Autuen 2020HWWSeptic tankACIP, NALMDR671Autuen 2020HWWSeptic tankACIP, NALMDR673Aut							-	l
667       Autum 2020       Traited Wasteware       WWTP outlet       B1       WT         668       Autum 2020       Traited Wasteware       WWTP outlet       B1       WT         669       Autum 2020       Traited Wasteware       WWTP outlet       B1       WT         669       Autum 2020       Traited Wasteware       WWTP outlet       B1       WT         670       Autum 2020       HWW       Septic tank       A       MT       MT         671       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT       MT         672       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT       MDR       +         673       Autum 2020       HWW       Septic tank       A       CIP, NAL       MDR       +         674       Autum 2020       HWW       Septic tank       A       CIP, NAL       R          675       Autum 2020       HWW       Septic tank       A       CIP, NAL       R          676       Autum 2020       HWW       Septic tank       A       CIP, NAL       WT          677       Autum 2020       HWW       Septic tank	665	Auturn 2020	Treated Wastewater		A			
668     Autum 2020     Treated Wastewater     WWTP outlet     B1     WT       669     Autum 2020     Treated Wastewater     WWTP outlet     B1     WT       670     Autum 2020     HWW     Sepic tank     A     PR       671     Autum 2020     HWW     Sepic tank     A     CP, NAL     R       672     Autum 2020     HWW     Sepic tank     A     CP, NAL     WT       673     Autum 2020     HWW     Sepic tank     B2     WT     WT       673     Autum 2020     HWW     Sepic tank     A     AMP, PIP, CAZ, CRO, ATM, NAL     MDR     +       674     Autum 2020     HWW     Sepic tank     A     CIP, NAL     R        675     Autum 2020     HWW     Sepic tank     A     CIP, NAL     R        675     Autum 2020     HWW     Sepic tank     A     CIP, NAL     WT        676     Autum 2020     HWW     Sepic tank     A     CIP, NAL     WT        677     Autum 2020     HWW     Sepic tank     A      WT        678     Autum 2020     HWW     Sepic tank     A      MP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL<	666	Auturn 2020	Treated Wastewater	WWTP outlet	A		WT	
669         Autuen 2020         Treated Wastewater         WWTP ould:         B1         WT           670         Autuen 2020         HWW         Septie tank         A         WT         WT           671         Autuen 2020         HWW         Septie tank         A         CP, NAL         R           672         Autuen 2020         HWW         Septie tank         R         WT         R           673         Autuen 2020         HWW         Septie tank         R         WT         R           673         Autuen 2020         HWW         Septie tank         A         AMP, PIP, CAZ, CRO, ATM, NAL         MDR         +           674         Autuen 2020         HWW         Septie tank         A         CIP, NAL         MDR         +           674         Autuen 2020         HWW         Septie tank         A         CIP, NAL         WT            675         Autuen 2020         HWW         Septie tank         A          WT             676         Autuen 2020         HWW         Septie tank         A           WT            677         Autuen 2020         HWW         Septie tank	667	Autumn 2020	Treated Wastewater	WWTP ontlet	BL		WT	
670         Autum 2020         HWW         Septic tank         A         WT           671         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           671         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           672         Autum 2020         HWW         Septic tank         R         WT            673         Autum 2020         HWW         Septic tank         R         WT            674         Autum 2020         HWW         Septic tank         A         AMP, PIP, CAZ, CRO, ATM, NAL         WT            674         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           675         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           675         Autum 2020         HWW         Septic tank         A         WT            676         Autum 2020         HWW         Septic tank         A          MP, CMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR           677         Autum 2020         HWW         Septic tank         A         CIP, NAL	668	Autumn 2020	Treated Wastewater	WWTP outlet	BL		WT	
670         Autum 2020         HWW         Septic tank         A         WT           671         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           671         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           672         Autum 2020         HWW         Septic tank         R         WT            673         Autum 2020         HWW         Septic tank         R         WT            674         Autum 2020         HWW         Septic tank         A         AMP, PIP, CAZ, CRO, ATM, NAL         WT            674         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           675         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           675         Autum 2020         HWW         Septic tank         A         WT            676         Autum 2020         HWW         Septic tank         A          MP, CMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR           677         Autum 2020         HWW         Septic tank         A         CIP, NAL	669	Autumn 2020	Treated Wastewater	WWTP outlet	BL		WT	
671         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           672         Autum 2020         HWW         Septic tank         B2         WT           673         Autum 2020         HWW         Septic tank         A         AMP, PIP, CAZ, CRO, ATM, NAL         MDR         +           674         Autum 2020         HWW         Septic tank         A         CIP, NAL         R            675         Autum 2020         HWW         Septic tank         A         CIP, NAL         R             676         Autum 2020         HWW         Septic tank         A         CIP, NAL         R             R              R            R               R						1		
672         Autuen 2020         HWW         Septie tank         B2         WT           673         Autuen 2020         HWW         Septie tank         A         AMP, PIP, CAZ, CRO, ATM, NAL.         MDR         +           674         Autuen 2020         HWW         Septie tank         A         CP, NAL.         R           675         Autuen 2020         HWW         Septie tank         A         CP, NAL.         R           676         Autuen 2020         HWW         Septie tank         A         WT         VT           676         Autuen 2020         HWW         Septie tank         A         WT         VT           677         Autuen 2020         HWW         Septie tank         A         WT         VT           678         Autuen 2020         HWW         Septie tank         A         MP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           677         Autuen 2020         HWW         Septie tank         A         CP, NAL         R            678         Autuen 2020         HWW         Septie tank         A         CP, NAL         RDR         +           679         Autuen 2020         HWW         Septie t				+		CIP. NAL	+	
673         Autum 2020         HWW         Septic tank         A         AMP, PIP, CAZ, CRO, ATM, NAL.         MDR         +           674         Autum 2020         HWW         Septic tank         A         CIP, NAL         R         R           675         Autum 2020         HWW         Septic tank         A         CIP, NAL         R         WT           676         Autum 2020         HWW         Septic tank         A         WT         WT           677         Autum 2020         HWW         Septic tank         A         WT         WT           678         Autum 2020         HWW         Septic tank         A         WT         WT           678         Autum 2020         HWW         Septic tank         A         MP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           678         Autum 2020         HWW         Septic tank         A         CIP, NAL.         MDR         +           679         Autum 2020         HWW         Septic tank         A         CIP, NAL.         R            680         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, CN, SXT, CIP, NAL.         MDR </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td> </td>								
674         Autuen 2020         HWW         Septic tank         A         CP, NAL         R           675         Autuen 2020         HWW         Septic tank         A         WT           676         Autuen 2020         HWW         Septic tank         A         WT           676         Autuen 2020         HWW         Septic tank         A         WT           677         Autuen 2020         HWW         Septic tank         A         WT           678         Autuen 2020         HWW         Septic tank         A         WT           678         Autuen 2020         HWW         Septic tank         A         WT           678         Autuen 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR           679         Autuen 2020         HWW         Septic tank         A         CIP, NAL         R           680         Autuen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autuen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR	-			-		AMP DID CAZ CDO ATM NAT	-	
675         Autum 2020         HWW         Septic tank         A         WT           676         Autum 2020         HWW         Septic tank         A         WT           676         Autum 2020         HWW         Septic tank         A         WT           677         Autum 2020         HWW         Septic tank         A         WT           678         Autum 2020         HWW         Septic tank         A         MDR         +           678         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR         +           679         Autum 2020         HWW         Septic tank         A         CIP, NAL         R            680         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR         +           681         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL         MDR         +							+	+
676         Autum 2020         HWW         Septic tank         A         WT           677         Autum 2020         HWW         Septic tank         A         WT           678         Autum 2020         HWW         Septic tank         A         WT           678         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR           679         Autum 2020         HWW         Septic tank         A         CIP, NAL         R           680         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autum 2020         HWW         Septic tank         A         AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A <td></td> <td></td> <td></td> <td></td> <td></td> <td>CIP, NAL</td> <td></td> <td></td>						CIP, NAL		
677         Auturen 2020         HWW         Septic tank         A         WT           678         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           679         Auturen 2020         HWW         Septic tank         A         CP, NAL.         R           680         Auturen 2020         HWW         Septic tank         A         CP, NAL.         R           681         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Auturen 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.								L
678         Autum 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           679         Autum 2020         HWW         Septic tank         A         CIP, NAL.         R            680         Autum 2020         HWW         Septic tank         A         CIP, NAL.         R            681         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +	676	Auturn 2020	HWW	Septic tank	A		WT	
678         Autum 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           679         Autum 2020         HWW         Septic tank         A         CIP, NAL.         R            680         Autum 2020         HWW         Septic tank         A         CIP, NAL.         R            681         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +	677	Auturn 2020	HWW	Septic tank	A		WT	
679         Autuen 2020         HWW         Septie tank         A         CIP, NAL         R           680         Autuen 2020         HWW         Septie tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autuen 2020         HWW         Septie tank         A         AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autuen 2020         HWW         Septie tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autuen 2020         HWW         Septie tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autuen 2020         HWW         Septie tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +	678		HW W			AMP, AMC, PIP, CXM, CAZ ,CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL	MDR	+
680         Autum 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           681         Autum 2020         HWW         Septic tank         A         AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +	-			*			-	
681         Autum 2020         HWW         Septic tank         A         AMP, PIP, COM, CTX, FEP, CRO, ATM, CN, SXT, CIP, NAL.         MDR         +           682         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, COM, CTX, FEP, CRO, ATM, CN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, COM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +           683         Autum 2020         HWW         Septic tank         A         AMP, AMC, PIP, COM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL.         MDR         +							+	+
682         Autumn 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, ON, SXT, CIP, NAL.         MDR         +           683         Autumn 2020         HWW         Septic tank         A         AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, ON, SXT, CIP, NAL.         MDR         +	480						-	<u> </u>
683 Autumn 2020 HWW Septis tank A AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL. MDR. +		A reference months	CTW W	outlik: tarik	A		041.00	
	681			Course in some bu		AND AND DECIVALOAT OTVIDED ODO ATAL ON CAT OD ANAL	1.000	
684 Autuen 2020 HWW Septis tank A AMP, PIP, COM, CTX, ORO, ATM, GN, SXT, CIP, NAL MDR +	681 682	Auturn 2020	HWW	-			+	-
	681 682 683	Autumn 2020 Autumn 2020	HWW HWW	Septic tank	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL	MDR	+

685 686	Auturn 2020	HW W					
	Auturn 2020	HWW	Septic tank Septic tank	A	AMP, PIP, CXM, CTX, CRO, ATM, GN, SXT, CIP, NAL AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GN, SXT, CIP, NAL	MDR MDR	+ +
690	Autum 2020	HWW	Septic tank	A	NAL	N-WT	<u> </u>
691	Autum 2020	River water	RWSI	A	1.0.54	WT	
692	Autumn 2020	River water	RWS1	A		WT	
693	Auturn 2020	River water	RWS1	A	AMP, AMC, PIP, SXT, CIP, NAL	MDR	
694	Autumn 2020	River water	RWS1	D		WT	
695	Autumn 2020	River water	RWS1	D		WT	
696	Autumn 2020	River water	RWS1	A	SXT, CIP, NAL	R	
697	Auturn 2020	River water	RWS1	B2	AMP, PIP, SXT	R	<u> </u>
698	Autumn 2020	River water	RWSI	D	AMP, PIP, SXT, CIP, NAL	R	
699	Autumn 2020	River water	RWSI	D	CAPE ALLE	WT	<b></b>
700	Autumn 2020 Autumn 2020	River water River water	RWS1 RWS1	BL	SXT, NAL	R WT	<u> </u>
702	Autum 2020		RWSI	A	SXT	N-WT	<b>├</b> ──
702	Autumn 2020	River water River water	RWSI	BL	571	WT	<del> </del>
204	Autum 2020	River water	RWSI	BL		WT	<u> </u>
705	Autumn 2020	River water	RWSI	A		WT	<u> </u>
706	Autumn 2020	River water	RWS1	D		WT	
707	Autumn 2020	River water	RWS1	D		WT	
708	Autumn 2020	River water	RWS1	D		WT	
709	Autumn 2020	River water	RWS1	Bl		WT	
710	Autumn 2020	River water	RWS1	A	AMP, PIP	R	
711	Autumn 2020	River water	RWS1	BL		WT	L
712	Autumn 2020	River water	RWS1	D		WT	<u> </u>
713	Autumn 2020	River water	RWSI	BL		WT	<u> </u>
714 715	Autumn 2020	River water	RWS1 RWS1	A Bl		WT WT	<del> </del>
715	Auturn 2020 Auturn 2020	River water				+	<u> </u>
716	Autumn 2020 Autumn 2020	River water River water	RWS1 RWS1	A B2	NAL	WT N-WT	<u> </u>
718	Autum 2020	River water	RWSI	D	AMP, PIP, GM, SXT, CIP, NAL	MDR	<u> </u>
719	Autum 2020	River water	RWSI	A	· · · · · · · · · · · · · · · · · · ·	WT	<u> </u>
720	Autumn 2020	River water	RWSI	A	AMP, PIP	R	
721	Autumn 2020	River water	RWS1	BL		WT	
722	Autumn 2020	River water	RWS1	BL		WT	
723	Autumn 2020	River water	RWS1	Bl		WT	
724	Autumn 2020	River water	RWS1	BL		WT	
725	Autumn 2020	River water	RWS1	D		WT	
726	Autumn 2020	River water	RWS1	BL		WT	L
727	Aufumn 2020	River water	RWSI	A		WT	<u> </u>
728	Autumn 2020	River water	RWS1 RWS1	D B2	AMP, AMC, PIP	WT R	
730	Spring 2021 Spring 2021	River water River water	RWSI	A	AMP, AMC, PP	R	
731	Spring 2021	River water	RWSI	A	AMP, PIP	R	<u> </u>
732	Spring 2021	River water	RWSI	A	AMP, AMC, PIP	R	
733	Spring 2021	River water	RWS1	D	AMP, AMC, PIP	R	
734	Spring 2021	River water	RWS1	A	AMP, PIP	R	
735	Spring 2021	River water	RWS1	B2	AMP, PIP	R	
736	Spring 2021	River water	RWS1	B2	AMP, AMC, PIP, SXT	R	
737	Spring 2021	River water	RWS1	B2	AMP, AMC, TZP, PIP, CXM, FOX, CAZ, GN, AN	MDR	-
738	Spring 2021	River water	RWS1	B2	AMP, AMC, TZP, PIP, CXM, CAZ, FOX, AN	MDR	-
739	Spring 2021	River water	RWSI	A	AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	+
740	Spring 2021	River water	RWSI	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	+
742	Spring 2021 Spring 2021	River water River water	RWS1 RWS1	B2 B2	AMP, AMC, PIP, SXT, NAL AMP, PIP	R	<del> </del>
743	Spring 2021 Spring 2021		RWSI	D B2	AMP, PIP AMP, PIP, SXT	R	<u> </u>
746	Spring 2021 Spring 2021	River water River water	RWSI	A	AMP, PIP, SXT	R	<u> </u>
747	Spring 2021	River water	RWSI	D	AMP, PIP	R	
748	Spring 2021	River water	RWSI	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	+
749	Spring 2021	River water	RWS1	B2	AMP, PIP	R	
750	Spring 2021	River water	RWS1	B2	AMP, PIP	R	
751	Spring 2021	River water	RWS1	B2	AMP, PIP	R	
752	Spring 2021	River water	RWSI	B2	AMP, AMC, PIP, GM, SXT	MDR	
753	Spring 2021	River water	RWS1	BL		WT	<u> </u>
754	Spring 2021	River water	RWS1	A		WT	<b>—</b>
755	Spring 2021	River water	RWSI	BL		WT	<b></b>
756	Spring 2021 Series 2021	River water	RWSI	BL	AMB DID OVE OD MAL	WT	<b> </b>
757	Spring 2021 Spring 2021	River water River water	RWS1 RWS1	BL	AMP, PIP, SXT, CIP, NAL	R WT	<del> </del>
758	Spring 2021 Spring 2021	River water	RWSI	A		WT	<u> </u>
760	Spring 2021 Spring 2021	River water	RWSI	BL	AMP, PIP, SXT, CIP, NAL	R	<u> </u>
761	Spring 2021	River water	RWSI	A	AMP, PIP, GM	R	
762	Spring 2021	River water	RWS1	BL	AMP, PIP, SXT, CIP, NAL	R	
763	Spring 2021	River water	RWS1	A		WT	
764	Spring 2021	River water	RWS1	A	AMP, PIP, SXT, CIP, NAL	R	
765	Spring 2021	River water	RWS1	A		WT	
766	Spring 2021	River water	RWSI	A		WΤ	
767	Spring 2021	River water	RWSI	BL		WT	
768	Spring 2021	River water	RWSI	A		WT	L
769	Spring 2021	River water	RWS1	D		WT	L
772	Spring 2021	River water	RWS2	A		WT	<b>—</b>
		River water	RWS2	A	AMP, PIP, CIP, NAL	R	L
773 774	Spring 2021 Spring 2021	River water	RWS2	BL		WT	

Tris         Spring 2021         River water         RWS2         A           Tris         Spring 2021         River water         RWS2         B1            Tris         Spring 2021         River water         RWS2         D         AMP, AMC, PP, ON, SXT, CIP, NAL.            Tris         Spring 2021         River water         RWS2         D         AMP, AMC, PP, SXT, CIP, NAL.            Tris         Spring 2021         River water         RWS2         A         AMP, AMC, PP, SXT, CIP, NAL.            Tris         Spring 2021         River water         RWS2         A         AMP, AMC, PP, SXT            Tris         Spring 2021         River water         RWS2         A         AMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL.            Tris         Spring 2021         River water         RWS2         B1         AMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL.            Tris         Spring 2021         River water         RWS2         D         AMP, AMC, PP, SXT            Tris         Spring 2021         River water         RWS2         D         AMP, AMC, PP, SXT, CIP, NAL.            Tris         Spring 2021         River wa	WT WT WT MDR R R R R R R MDR MDR MDR R R R R R R	+ + + + + + + + + + + + + + + + + + + +
778         Spring 2021         Bixer water         RWS2         D           780         Spring 2021         Bixer water         RWS2         D         AMP, AMC, PP, SXT, CIP, NAL.           781         Spring 2021         Bixer water         RWS2         A         AMP, AMC, PP, SXT, CIP, NAL.           783         Spring 2021         Bixer water         RWS2         A         AMP, AMC, PP, SXT           784         Spring 2021         Bixer water         RWS2         A         AMP, AMC, PP, SXT           784         Spring 2021         Bixer water         RWS2         A         AMP, PM, C, PP, SXT           784         Spring 2021         Bixer water         RWS2         D         AMP, PM, C, PP, SXT           785         Spring 2021         Bixer water         RWS2         D         AMP, AMC, PP, CM, CAZ, CTX, FSP, CRO, ATM, IMP, SXT, NAL.           786         Spring 2021         Bixer water         RWS2         D         AMP, AMC, PP, CN, CAZ, CTX, FSP, CRO, ATM, IMP, SXT, NAL.           788         Spring 2021         Bixer water         RWS2         D         AMP, AMC, PP, CN, CAZ, CTX, FSP, CRO, ATM, CIP, NAL.           790         Spring 2021         Rixer water         RWS2         D         AMP, AMC, PP, CN, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.	WT MDR MDR R R MDR R R MDR MDR MDR R R R R	+ + + + + +
780Figure 201River waterRWS2DAMP, AMC, PP, GN, SXT, CIP, NAL.781Spring 2021River waterRWS2AAMP, PM, CMP, RXT, CIP, NAL.782Spring 2021River waterRWS2AAMP, PM, SXT783Spring 2021River waterRWS2AAMP, PM, CMP, RXT784Spring 2021River waterRWS2AAMP, AMC, PP, SXT784Spring 2021River waterRWS2DAMP, AMC, PP, CM, CAZ, CTX, FP, CBO, ATM, IMP, SXT, NAL.786Spring 2021River waterRWS2DAMP, AMC, PP, CM, CAZ, CTX, FP, CBO, ATM, IMP, SXT, NAL.788Spring 2021River waterRWS2DAMP, AMC, PP, CM, CAZ, CTX, FP, CBO, ATM, IMP, SXT, NAL.789Spring 2021River waterRWS2DAMP, AMC, PP, CN, SXT, CIP, NAL.790Spring 2021River waterRWS2DAMP, AMC, PP, CN, SXT, CIP, NAL.791Spring 2021River waterRWS2DAMP, AMC, PP, CN, CAZ, CTX, FP, CBO, ATM, SXT792Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PP, CNA, CAZ, CTX, FP, CBO, ATM, SXT793Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PP, SXT794Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PP, SXT795Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PP, CN, CAZ, CTX, FP, CBO, ATM, SXT796Spring 2021Treated WastewaterWWTP outlet </td <td>MDR MDR R R MDR R R MDR MDR MDR R R R R</td> <td>+ + + + + +</td>	MDR MDR R R MDR R R MDR MDR MDR R R R R	+ + + + + +
781       Spring 2021       River water       RW S2       A       AMP, AMC, PIP, SXT, CIP, NAL.         782       Spring 2021       River water       RW S2       A       AMP, AMC, PIP, SXT         783       Spring 2021       River water       RW S2       A       AMP, AMC, PIP, SXT         784       Spring 2021       River water       RW S2       B       AMP, PIP, CM         785       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL         786       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL         788       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CN, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL         790       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CN, CAZ, CTX, FEP, CRO, ATM, CTP, NAL         791       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CNA, CAZ, CTX, FEP, CRO, ATM, SXT         792       Spring 2021       River water       RW S2       D       AMP, AMC, PIP, CNA, CAZ, CTX, FEP, CRO, ATM, SXT         793       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, AMC, PIP, CNA, CAZ, CTX, FEP,	MDR R R R MDR R MDR MDR MDR R R R MDR R MDR MD	+ + + + + +
782Spring 2021River waterRWS2AAMP, PIP, SXT783Spring 2021River waterRWS2AAMP, PIP, SXT784Spring 2021River waterRWS2B1AMP, PIP, CM785Spring 2021River waterRWS2DAMP, PMP, CM786Spring 2021River waterRWS2DAMP, AMC, PIP, SXT787Spring 2021River waterRWS2AAMP, AMC, PIP, SXT788Spring 2021River waterRWS2AAMP, AMC, PIP, SXT789Spring 2021River waterRWS2AAMP, AMC, PIP, GN, SXT, CIP, NAL790Spring 2021River waterRWS2DAMP, AMC, PIP, GN, SXT, CIP, NAL791Spring 2021River waterRWS2DAMP, PMP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL792Spring 2021Treated WastewaterRWS2DAMP, PMP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL793Spring 2021Treated WastewaterWWTP outletAAMP, PMC, CM, CAZ, CTX, FEP, CRO, ATM, SXT794Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PIP, SXT795Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PIP, SXT796Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PIP, SXT797Spring 2021Treated WastewaterWWTP outletAAMP, AMC, PIP, SXT798Spring 2021Treated WastewaterWWTP outletA<	R R R R R MDR MDR MDR MDR R R R R MDR R MDR R MDR R R MDR R R MDR R R MDR R R MDR	+ + + + + +
Total         Total <th< td=""><td>R R MDR R R MDR MDR MDR R R R R R MDR MD</td><td>+ + + + + +</td></th<>	R R MDR R R MDR MDR MDR R R R R R MDR MD	+ + + + + +
784Spring 2021River waterRWS2B1AMP, PIP, CM785Spring 2021River waterRWS2DAMP, AMC, PIP, COM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL.786Spring 2021River waterRWS2B2AMP, PIP788Spring 2021River waterRWS2DAMP, AMC, PIP, SXT799Spring 2021River waterRWS2DAMP, AMC, PIP, ON, SXT, CIP, NAL.790Spring 2021River waterRWS2DAMP, AMC, PIP, CN, SXT, CIP, NAL.791Spring 2021River waterRWS2DAMP, AMC, PIP, CN, SXT, CIP, NAL.792Spring 2021Treated WastewaterWWTP outletAAMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.794Spring 2021Treated WastewaterWWTP outletAAMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT795Spring 2021Treated WastewaterWWTP outletAAMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT795Spring 2021Treated WastewaterWWTP outletAAMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, SXT798Spring 2021Treated WastewaterWWTP outletAAMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, SXT799Spring 2021Treated WastewaterWWTP outletDAMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, SXT800Spring 2021Treated WastewaterWWTP outletAAMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, SXT804Spring 2021Treated WastewaterWWTP outletAAMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, S	R MDR R MDR MDR MDR R R R R R MDR MDR MD	+ + + + + +
785         Speing 2021         River water         RW S2         D         AMP, AMC, PP, COM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL           786         Spring 2021         River water         RW S2         R2         AMP, PIP           788         Spring 2021         River water         RW S2         A         AMP, AMC, PIP, SXT           789         Spring 2021         River water         RW S2         D         AMP, AMC, PIP, ON, SXT, CIP, NAL           790         Spring 2021         River water         RW S2         D         AMP, AMC, PIP, ON, SXT, CIP, NAL           791         Spring 2021         River water         RW S2         D         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL           792         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           796         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           797         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           799         Spring 2021         Treated Wastewater         WWTP outlet<	MDR R R MDR MDR MDR R R R R MDR R MDR R MDR R R MDR R R MDR R R R	+ + + + + +
786         Spring 2021         River water         RWS2         B2         AMP, PIP           788         Spring 2021         River water         RWS2         A         AMP, AMC, PIP, SXT           789         Spring 2021         River water         RWS2         D         AMP, AMC, PIP, ON, SXT, CIP, NAL           790         Spring 2021         River water         RWS2         D         AMP, AMC, PIP, ON, SXT, CIP, NAL           791         Spring 2021         River water         RWS2         D         AMP, PIP, COM, CAZ, CTX, FIP, CBO, ATM, CIP, NAL           792         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FIP, CBO, ATM, SYT           796         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           797         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           799         Spring 2021         Treated Wastewater         WWTP outlet         A	R R MDR MDR MDR R R R R R MDR MDR R MDR R R MDR R R MDR R R MDR	+ + + + + +
788     Spring 2021     River water     RWS2     A     AMP, AMC, PP, SXT       799     Spring 2021     River water     RWS2     D     AMP, AMC, PP, SXT, CIP, NAL.       790     Spring 2021     River water     RWS2     D     AMP, AMC, PP, CN, SXT, CIP, NAL.       791     Spring 2021     River water     RWS2     D     AMP, AMC, PP, CN, SXT, CIP, NAL.       792     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, PIP, CNA, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.       792     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, AMC, PP, CNA, CAZ, CTX, FEP, CRO, ATM, SXT       796     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, AMC, PP, SXT       797     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, AMC, PP, SXT       798     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, AMC, PP, SXT       798     Spring 2021     Treated Wastewater     WWTP outlet     B1     AMP, AMC, PP, SXT       799     Spring 2021     Treated Wastewater     WWTP outlet     D     AMP, PMP, CNA, CAZ, CTX, FEP, CRO, ATM, SXT       800     Spring 2021     Treated Wastewater     WWTP outlet     A     AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT       801	R MDR MDR R R R R R MDR MDR MDR R R R MDR MD	+
789       Spring 2021       River water       RWS2       D       AMP, AMC, PIP, ON, SXT, CIP, NAL.         790       Spring 2021       River water       RWS2       D       AMP, AMC, PIP, ON, SXT, CIP, NAL.         791       Spring 2021       River water       RWS2       D       AMP, AMC, PIP, CN, SXT, CIP, NAL.         792       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, PIP, COM, CAZ, CTX, FIP, CRO, ATM, CIP, NAL.         796       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, AMC, PIP, SXT         797       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, AMC, PIP, SXT         798       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, AMC, PIP, SXT         799       Spring 2021       Treated Wastewater       WWTP outlet       BI       AMP, AMC, PIP, SXT         799       Spring 2021       Treated Wastewater       WWTP outlet       D       AMP, PIP, CNM, CAZ, CTX, FIP, CRO, ATM, SXT         800       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, PIP, CNM, CAZ, CTX, FIP, CRO, ATM, SXT         801       Spring 2021       Treated Wastewater       WWTP outlet       A       AMP, PIP, CNM, CAZ, CTX, FIP, CRO, A	MDR MDR MDR R R R MDR R MDR MDR R R MDR R R MDR	+
790         Spring 2021         River water         RWS2         D         AMP, AMC, PIP, CN, SXT, CIP, NAL.           791         Spring 2021         River water         RWS2         D         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.           792         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL.           796         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SAT           797         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           799         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           800         Spring 2021         Treated Wastewater         WWTP outlet         D         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           801         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           803         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT      <	MDR MDR R R MDR R MDR MDR MDR R R R R MDR R R MDR	+
791         Spring 2021         River vater         RWS2         D         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, CIP, NAL           792         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           796         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SAL           797         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP, SXT           798         Spring 2021         Treated Wastewater         WWTP outlet         BI         AMP, AMC, PIP, SXT           799         Spring 2021         Treated Wastewater         WWTP outlet         D         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           800         Spring 2021         Treated Wastewater         WWTP outlet         D         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           801         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           803         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT	MDR MDR R R MDR R MDR MDR R R R R MDR	+
792       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         796       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PIP, NAL.         797       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PIP, SXT         798       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PIP, SXT         798       Spring 2021       Treated Wastewater       WWTP oatlet       B1       AMP, AMC, PIP, CN, SXT         799       Spring 2021       Treated Wastewater       WWTP oatlet       B1       AMP, AMC, PIP, CN, SXT         800       Spring 2021       Treated Wastewater       WWTP oatlet       D       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         801       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         801       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         804       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP         805       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP </td <td>MDR R R MDR R MDR MDR R R R R MDR</td> <td>+</td>	MDR R R MDR R MDR MDR R R R R MDR	+
766       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PP, NAL         797       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PP, SXT         798       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PP, SXT         798       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, AMC, PP, SXT         799       Spring 2021       Treated Wastewater       WWTP oatlet       B1       AMP, AMC, PP, CN, SXT         800       Spring 2021       Treated Wastewater       WWTP oatlet       D       AMP, PP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         801       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         802       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         803       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT         804       Spring 2021       Treated Wastewater       WWTP oatlet       B2       AMP, PIP         805       Spring 2021       Treated Wastewater       WWTP oatlet       A       AMP, PIP <tr< td=""><td>R R MDR R MDR MDR R R R R MDR</td><td>+ +</td></tr<>	R R MDR R MDR MDR R R R R MDR	+ +
277     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PP, SXT       278     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PP, SXT       279     Spiring 2021     Treated Wastewater     WWTP oatlet     B1     AMP, AMC, PP, SXT       280     Spiring 2021     Treated Wastewater     WWTP oatlet     B1     AMP, AMC, PP, CN, SXT       800     Spiring 2021     Treated Wastewater     WWTP oatlet     D     AMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, SXT       801     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT       802     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT       803     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT       804     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP       805     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       805     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       806     Spiring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       806	R MDR R MDR MDR R R R MDR	-
798         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, AMC, PIP, SXT           799         Spring 2021         Treated Wastewater         WWTP oatlet         B1         AMP, AMC, PIP, ON, SXT           800         Spring 2021         Treated Wastewater         WWTP oatlet         D         AMP, PIP, NAL.           801         Spring 2021         Treated Wastewater         WWTP oatlet         D         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           802         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           803         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           805         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           806         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, STX           807         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CBO, ATM, STX           806         Spring	R MDR R MDR MDR MDR R R MDR	-
799         Spring 2021         Treated Wastewater         WWTP oatlet         B1         AMP, AMC, PIP, ON, SXT           800         Spring 2021         Treated Wastewater         WWTP oatlet         D         AMP, PIP, NAL.           801         Spring 2021         Treated Wastewater         WWTP oatlet         D         AMP, PIP, COA, CAZ, CTX, FEP, CRO, ATM, SXT           802         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           803         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, PIP           805         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           806         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           807         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           808         Spring 2021         Treated Wastewater <td>MDR R MDR MDR R R R MDR</td> <td>-</td>	MDR R MDR MDR R R R MDR	-
800         Spring 2021         Treated Wastewater         WWTP oatlet         D         AMP, PIP, NAL.           801         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           802         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           803         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           804         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           805         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           806         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           807         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, CM, CAZ, CTX, FEP, CRO, ATM, STX	R MDR MDR R R R MDR	-
801     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT       802     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT       803     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT       804     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT       804     Spring 2021     Treated Wastewater     WWTP oatlet     B2     AMP, PIP       805     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       806     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       806     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, AMC, PIP       807     Spring 2021     Treated Wastewater     WWTP oatlet     A     AMP, PIP       808     Spring 2021     Treated Wastewater     WWTP oatlet     B2     AMP, PIP       808     Spring 2021     Treated Wastewater     WWTP oatlet     B2     AMP, AMC, PIP, ON, SXT	MDR MDR MDR R R MDR	-
BQ         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           B03         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, SXT           B04         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, PIP           B05         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMC, PIP           B06         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, AMC, PIP           B07         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           B07         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           B08         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           B08         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMC, PIP           B08         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMC, PIP, ON, SXT	MDR MDR R R MDR	-
BB         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT           804         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, PIP           805         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMP, AMP, AMP, AMP, AMP, AMP, AMP,	MDR R R MDR	-
804         Spring 2021         Treated Wastewater         WWTP outlet         B2         AMP, PIP           805         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP           806         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP           806         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           807         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP           808         Spring 2021         Treated Wastewater         WWTP outlet         B2         AMP, AMC, PIP, ON, SXT	R R MDR	+
805         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, AMC, PIP           806         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           807         Spring 2021         Treated Wastewater         WWTP outlet         A         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, STX           808         Spring 2021         Treated Wastewater         WWTP outlet         B2         AMP, AMC, PIP, CN, SXT	R MDR	
866         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX           807         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           808         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMC, PIP, CN, SXT	MDR	
807         Spring 2021         Treated Wastewater         WWTP oatlet         A         AMP, PIP           808         Spring 2021         Treated Wastewater         WWTP oatlet         B2         AMP, AMC, PIP, ON, SXT		
808 Spring 2021 Treated Wastewater WWTP outlet B2 AMP, AMC, PIP, ON, SXT	P	+
809 Spring 2021 Treated Wastewater WWTP outlet B2 AMP, PIP, SXT	MDR	
	R	
800 Spring 2021 Treated Wastewater WWTP oatlet B2 AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX	MDR	+
811 Spring 2021 Treated Wastewater WWTP oatlet B2 AMP, PIP	R	
812 Spring 2021 Treated Wastewater WWTP outlet A AMP, PIP, SXT	R	
813 Spring 2021 Treated Wastewater WWTP onliket A AMP, PIP, CIP, NAL	R	
814 Spring 2021 Treated Wastewater WWTP outlet B2 AMP, AMC, PIP, GN, SXT	MDR	
815 Spring 2021 Treated Wastewater WWTP oxide: A AMP, PIP	R	
836 Spring 2021 Treated Wastewater WWTP ontlet B2 AMP, PIP	R	
817 Spring 2021 Treated Wastewater WWTP outlet D	WT	
818 Spring 2021 Treated Wastewater WWTP outlet D	WT	
839 Spring 2021 Treated Wastewater WWTP onder D AMP, PIP, SXT, CIP, NAL	R	
820 Spring 2021 Treated Wastewater WWTP oatlet B1	WT	
821 Spring 2021 Treated Wastewater WWTP ontlet B1	WT	
823 Spring 2021 Treated Wastewater WWTP outlet A	WT	
834 Spring 2021 Treated Wastewater WWTP outlet B2	WT	
825 Spring 2021 Treated Wastewater WWTP outlet D	WT	
826 Spring 2021 Treated Wastewater WWTP ontlet A	WT	
827 Spring 2021 Treated Wastewater WWTP outlet A	WT	
828 Spring 2021 Treated Wastewater WWTP outlet BI SXT	N-WT	
829 Spring 2021 Treated Wastewater WWTP outlet B2	WT	
830 Spring 2021 Treated Wastewater WWTP oatlet D	WT	
831 Spring 2021 Treated Wastewater WWTP outlet A	WT	
832 Spring 2021 Treated Wastewater WWTP outlet A	WT	
833 Spring 2021 Treated Wastewater WWTP outlet B2 SXT	N-WT	
834 Spring 2021 Treated Wastewater WWTP outlet B2	WT	
835 Spring 2021 Treated Wastewater WWTP oatlet A	WT	
836 Spring 2021 HWW Septie tank B2 AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, CIP, NAL	MDR	+
837 Spring 2021 HWW Septise tank B2 AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CM, AN, CIP, NAL	MDR	+
838 Spring 2021 HWW Septic tank A AMP, PIP, COM, CAZ, CTX, FEP, CRO, A TM, CM, SXT, CIP, NAL	MDR	+
839 Spring 2021 HWW Septie tank A AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	+
Hit         Spring 2021         HWW         Septic tank         B2         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, CM, AN, CIP, NAL	MDR	+
842 Spring 2021 HWW Septie tank A	WT	
843 Spring 2021 HWW Septic tank B2	WT	
844 Spring 2021 HWW Septic tank B1	WT	
84S Spring 2021 HWW Septie tank A	WT	
846 Spring 2021 HWW Septie tank B2	WT	
147 Spring 2021 HWW Septic tank A	WT	
848 Spring 2021 HWW Septic tank B1	WT	
840 Spring 2021 HWW Septie tank B2	WT	
850 Spring 2021 HWW Septie tank B2	WT	
R51 Spring 2021 HWW Septic tank B1	WT	
852         Spring 2021         HWW         Septic tank         B2         AMP, PIP, COM, CAZ, CTX, FEP, CRO, ATM, AN, CIP, NAL	MDR	+
853 Spring 2021 HWW Septie tank A	WT	
854 Spring 2021 HWW Septic tank B1	WT	
855 Spring 2021 HWW Septic tank B1	WT	
856 Spring 2021 HWW Septic tank B2	WT	
187 Spring 2021 HWW Septic tank B2	WT	
858 Spring 2021 HWW Septic tank A AMP, AMC, PIP, CXM, CAZ, CTX, FOX, CRO, ATM, IMP	MDR	-
859 Spring 2021 HWW Septic tank B2	WT	
860 Spring 2021 HWW Septic tank Bi	WT	
861 Spring 2021 HWW Septic tank B1	WT	
862 Spring 2021 HWW Septic tank B1	WT	
863 Spring 2021 HWW Septic tank B2	WT	
864 Spring 2021 HWW Septic tank B1	WT	
865 Spring 2021 HWW Septic tank A	WT	

Proc.     Symaph 20.	· · · · · ·						1	
How         Spir. Max         Hoy         Spir. Max         How         How         How         How           10         Schlass         HSW         Max Max         Har	866	Spring 2021	HWW	Septic tank	B1		WT	
HereJuneJuneJuneA10JuneJuneJuneJuneJuneJune11JuneJuneJuneJuneJuneJuneJune12JuneJuneJuneJuneJuneJuneJuneJune13JuneJuneJuneJuneJuneJuneJuneJuneJune14JuneJuneJuneJuneJuneJuneJuneJuneJuneJune14JuneJ	867	Spring 2021	HWW		B2		WT	
FN         Symp. 20:         Sym. 20:         Sym. 20:         Sym. 20	868	Spring 2021	HWW	Septic tank	B1		WT	
B10Spent B1Spent B1B10Spent B1Spent B1CSpent B1DVSMore B1AVAVDSpent B1DVSAVAVAVAVDSpent B1DVSAVAVAVAVDSpent B1DVSAVAVAVAVDSpent B1DVSAVAVAVAVDSpent B1DVSDVAVAVAVDSpent B1DVSDVAVAVAVDSpent B1DVSDVAVAVAVDSpent B1DVSDVSAVAVAVDSpent B1DVSDVSDVSAVAVDSpent B1DVSDVSDVSAVAVDSpent B1DVSDVSDVSDVSAVDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVSDVSDVSDSpent B1DVSDVSDVS	869	Spring 2021	HWW	Septic tank	А		WT	
HT         Upper 200         UPPE 200 <thuppe 200<="" th="">         UPPE 200         <thu< td=""><td>871</td><td></td><td>HWW</td><td>Septic tank</td><td></td><td></td><td>WT</td><td></td></thu<></thuppe>	871		HWW	Septic tank			WT	
ByteJeng, 201JUNYJordBICAutomationWeitAutomationAutomatio							-	
No.         Nyw.         Nyw.         Nyw.         Nyw.         Nyw.         Nyw.           1.         Sumer, 2019         (inclustory)         New.         A.         AVP.AAC.         A.         AVP.AAC.           2.         Sumer, 2019         (inclustory)         New.         A.         AVP.AAC.         AVP.AAC.         AVP.AAC.           4.         Sumer, 2019         (inclustory)         New.         A.         AVP.AAC.         AVP.AAC.         AVP.AAC.           4.         Sumer, 2019         (inclustory)         New.         A.         AVP.AAC.         AVP.AAC.         AVP.AAC.           5.         Sumer, 2019         (inclustory)         New.         A.         AVP.AAC.         AVP.AAC.         AVP.AAC.           7.         Sumer, 2019         (inclustory)         New.         AVP.AAC.         AVP.AAC.         AVP.AAC.         AVP.AAC.           7.         Sumer, 2019         (inclustory)         New.         AVP.AAC.         AVP.AAC.         AVP.AAC.         AVP.AAC.           7.         Sumer, 2019         (inclustory)         New.         AVP.AAC.         AVP.AAC.         AVP.AAC.         AVP.AAC.           7.         Sumer, 2019         (inclustory)         New.								
1         Name 200         Observation         A         MAX ACC         MAX ACC         A         MAX ACC         <								
J.         Same 201         distance 201         Same 2010         Sam	8/4	Spring 2021	HWW	Septic tank			-	<u> </u>
1         Summ2 (7)         disk strepp         PPC         A         APP ACC PP TCC         S           4         Summ2 301         disk strepp         PPC         A         APP ACC PP TCC         S           4         Summ2 301         disk strepp         PPC         A         APP ACC PP TCC         S         Imp           1         Summ2 301         disk strepp         PPC         A         APP ACC PP TCC         S         Imp           1         Summ2 301         disk strepp         PPC         A         APP ACC PP TCC         S         Imp           1         Summ2 301         disk strepp         PPC         A         APP ACC PP TCC         S         Imp           1         Summ2 301         disk strepp         PPC         A         APP ACC PP ACC ACC PT APP CPA ATM ACC PP ACC         R           2         Summ2 301         disk strepp         PPC         APA ACC PP ACC         R         PP           3         Summ2 301         disk strepp         PPC         APA ACC PP ACC         APA ACC PP ACC         R           4         Summ2 301         disk strepp         PPC         APA ACC PP ACC         APA ACC PP ACC         APA ACC PP ACC           4	1	Summer 2019	clinical sample	urine	A	AMP, AMC		
1.     Summ2 307     descripting     even     A.     AVA ACC, PP 17C     AVA     AVA ACC, PP 17C       4.     Summ2 307     descripting     even     A.     AVA ACC, PP 17C     AVA       1.     Summ2 307     descripting     even     A.     AVA ACC, PP 17C     AVA       1.     Summ2 307     descripting     even     A.     AVA ACC, PP 17C     AVA       1.     Summ2 307     descripting     even     A.     AVA     AVA       1.     Summ2 307     descripting     even     A.     AVA     AVA       2.     Summ2 307     descripting     even     A.     AVA     AVA       2.     Summ2 307     descripting     even     A.     AVA     AVA       2.     Summ2 307     descripting     even     A.     AVA     AVA       3.     Summ2 307     descripting     even     A.     AVA     AVA       3.     Summ2 307     descripting     even     A.     AVA       4.     Summ2 307     descripting     even     A.     AVA       5.     AVA     AVA     AVA     AVA     AVA       6.     Summ2 307     descripting     even     A.	2	Summer 2019	clinical sample	urine	D		S	
1     Same, 2019     diskalangh, 2012     A. M. M. A. (P. 17C)     S. A.       1     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A. M. M. A. (P. 17C)     S. A.       1     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A. M. M. A. (P. 17C)     S. A.       1     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A.M. A. (P. 17C)     S. A.     A. M. A. (P. 17C)       1     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A.M. A. (P. 17C)     S. A.     A. M. A. (P. 17C)       2     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A.M. A. (P. 17C)     S. A.     A. M. (P. 17C)       2     Same, 2019     diskalangh, 2019     diskalangh, 2019     S. A.     A. M. (P. 17C)     S. A.     A.       3     Same, 2019     diskalangh, 2019     diskalangh, 2019     A.     A.     A. M. (P. 17C)     S. A.     A.       4     Same, 2019     diskalangh, 2019     diskalangh, 2019     A.     A.     A.     A.     A.     A.       5     Same, 2019     diskalangh, 2019     diskalangh, 2019     A.	3	Summer 2019	clinical sample	urine	B2		S	
i     June 2019     desclampt     met.     A.     AMA AMC, PP, TGC     AM       i     June 2019     desclampt     met.     AB       i     Sum 2019     desclampt     Met.        i     Sum 2019	5	Summer 2019		urine	A	AMP, AMC, PIP, TCC	R	
1         Same 201         distance 201         etc.         A.E.         APA ACP, PTC         A.E.         APA ACP, PTC         A.E.           10         Same 201         distance 201         distance 201         APA ACP, PTC         A           11         Same 201         distance 201         distance 201         APA ACP, PTC         A           12         Same 201         distance 201         distance 201         APA ACP, PTC         A           12         Same 201         distance 201         distance 201         APA ACP, PTC AC, ACP, PTP, CDA, ATM, ACP, PTA, CTP, ALM, CTP, A	6						R	
9         Sume 200         Instaturge         Mer.         No.         Viol Autor, PP 107         No.         No.           10         Sume 210         Instaturge         Mer.         D         NAL         No.         No.           11         Sume 210         Instaturge         Mer.         D         NAL         No.         No.           12         Sume 210         Instaturge         Mer.         A.         AMP AMC PD COX (A 2, CTX PP, CDX AM, ATX, CP) NAL         No.           12         Sume 210         Instaturge         Mer.         A.         AMP AMC PD COX (A 2, CTX PP, CDX AM, ATX, CP) NAL         No.           13         Sume 210         Instaturge         Mer.         A.         AMP AMC PD COX (A 2, CTX PP, CDX AM, ATX, CP) NAL         NO.           14         Sume 210         Instaturge         Mer.         A.         AMP AMC PD COX (AP, CTP, CDX ATM, ST, CP, NAL         NO.           15         Sume 210         Instaturge         Mer.         A.         AMP AMC PD COX (AP, CTP, CDX ATM, ST, CP, NAL         ND.           16         Sume 210         Instaturge         Mer.         A.         AMP AMC PD FOT COX (AP, CTP, PD, CD, ATM, ST, PD, NAL         ND.           16         Sume 210         Instaturge         Mer. <td></td> <td></td> <td></td> <td></td> <td></td> <td>Partial a Participation and a Participation</td> <td></td> <td></td>						Partial a Participation and a Participation		
b         Sume         Su							-	
1.1         Summe 2019         Cites Larges         Burg         D         NAL         State         R         I           1.5         Summe 2019         Cites Larges         Burg         BU         AK         AMP AAC         R         R           2.5         Summe 2019         Cites Larges         Burg         BU         AMP AAC         R         R           2.5         Summe 2019         Cites Larges         BU         AMP AAC         R         R         R           2.6         Summe 2019         Cites Larges         BU         AMP AAC         R         R         R           2.6         Summe 2019         Cites Larges         BU         A         AMP AAC         COX, DX, DX, DM, DX         M         M         BU         A           4.6         Summe 2019         Cites Larges         BU         A         AMP AAC         COX, DX, DX, DX, DY, CD, ATM, SXT, CD, NAL         MDB         -           4.6         Summe 2019         Cites Larges         BU         A         AMP AAC         COX, DX, DX, DX, DY, DX, DX, DX, DX, DX, DX, DX, DX, DX, DX							-	
1         Same 2017         (isolar) area         A         APP ARC         Constraint         R         N           2         Same 2017         (isolar) area         Biol         APP ARC         CON (CA, CA, CA, CA, CA, CA, CA, CA, CA, CA,	10	Summer 2019	clinical sample	blood	B2	AMP, AMC, PIP, TCC		
Sume         Sume <th< td=""><td>13</td><td>Summer 2019</td><td>clinical sample</td><td>urine</td><td>D</td><td>NAL</td><td></td><td></td></th<>	13	Summer 2019	clinical sample	urine	D	NAL		
21         Same 200         Gineal couple         wire         Number 200         Gineal couple         Number 200         Same 200         Gineal couple         Number 200         N	17	Summer 2019	clinical sample	tis suc	A	AMP, AMC	R	
B         Summer 2019         Consistency II         State         P         Summer 2019         Consistency III         Consistency III         Consistency III         Consistency III         State         P           34         Summer 2019         Consistency III         Summer 2019         Consistency III         Summer 2019         Consistency III         Summer 2019         Summer 2019         Consistency IIII         MDR           34         Summer 2019         Consistency IIII         Summer 2019         Consistency IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	22	Summer 2019	clinical sample	urine	B2	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, AN, CIP, NAL	MDR	+
Nume         Nume         Nume         AMC         AMC         Nume         Nume           21         Sume 2019         (incluring)         wire         B         AMP AAC, PP, NT         S           31         Sume 2019         (incluring)         wire         B         AMP AAC, PP, NT         MC           34         Sume 2019         (incluring)         wire         B         AMP AAC, PP, NTC, CM, CA, TM, SAT, CM, PAL,         MC           35         Sume 2019         (incluring)         wire         B         AMP AAC, PP, TCC, CM, CA, CT, TM, PD, CM, ATM, SAT, CM, PAL,         MC           46         Sume 2019         (incluring)         wire         B         A         AMP AAC, PP, TCC, CM,         R         A           47         Sume 2019         (incluring)         wire         B         A         AMP AAC, PP, TCC, CM, CAZ, CTX, FP, PC, CAM, CAM, CP, PA, AME, PP, TC, CCM, CAZ, CTX, FP, CM, ATM, SAT, CP, NAL         MR           48         Sume 2019         (incluring)         wire         B         AMP AAC, PP, TCP, TCC, CM, CAZ, CTX, FP, PC, CAM, CAM, CP, PA, AME, PP, TCP, TCC, CM, CAZ, CTX, FP, CM, ATM, SAT, AME, PP, TC, AMB, SAT, AME, PP, TCT, CAM, CAZ, CTX, FP, CM, ATM, SAT, CP, NAL         MR           61         Autors 2016         (incluring)         wire         R         AMP,	27	Summer 2019	clinical sample	urine	Bl	AMP, AMC, FOX	R	
P         Same 2019         Ideal argk         wei         D         AMP_ACT, PLATT         R           31         Same 2019         felsiol argk         wei         R2         AMP_ACC, CML, FOX, MM, JUP         MDB           44         Same 2019         felsiol argk         wei         R2         AMP_AMC, PLYCK, MAR, JUP         MDB           46         Same 2019         felsiol argk         wei         R2         AMP_AMC, PLYCK, CML, AU, CTK, FEP, CRO, ATM, STT, CPAL         MDB           47         Same 2019         felsiol argk         weiz         R2         AMP_AMC, PLYCK, CML, AU, CTK, FEP, CRO, ATM, GYL, CPAL         R3           48         Same 2019         felsiol argk         weiz         R2         AMP_AMC, PLYCT, CSM, GAL, CP, TTC, CSM, GAL, CP, TSM, CTC, TSM, FEP, CRO, ATM, GN, ANG CP, AML         MDB         .           48         Same 2019         felsiol argk         weiz         R2         ANP, AMC, PLY TTC, CSM, GAL, CP, TTC, CSM, GAL, CP, TSM, ANL         MDB         .           49         Same 2019         felsiol argk         weiz         R2         ANP, AMC, PLY TTC, CSM, GAL, CP, TTC, CSM, CAL, CTM, TSM, SAL         MDB         .           40         Same 2019         felsiol argk<	28	Summer 2019			B2	AMC	R	
Nume         Sume         No         Sume         No         Sume         Sum	-						-	
M.         Same 200         Closest org         MDB         Same 2010         Closest org         MDB         F           40         Same 2017         Calcal aregk         areg         R         AMP AAC, PP, TCC, CNL, CAJ, CLE, RED, ALM, AUT, CLE, NAL         MDB         r.           40         Same 2017         Calcal aregk         areg         D         A         AMP, AUC, PP, TCC, CNL, CAJ, CLE, REP, CRD, ATM, AUT, CLE, NAL         MDB         r.           41         Same 2017         Calcal aregk         areg         D         A         AMP, AUC, PP, TCC, CNL, CAJ, CLE, NP, CLE, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUC, PP, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUL, PP, TCC, CNL, CAJ, CLE, PP, CRD, ATM, GAL, AUL, PP, TCC, CNL, CLE, CLE, CLE, CLE, CLE, CLE, PP, CRD, ATM, ANS, TCP, AAL         MDB         r.           70         Same 2017         Calcal aregk         areg         AUP, AUC, PP, TCC, CNL, CLE, CLE, CLE, ATM, STE, TLE, AUL, PP, AUL, PP, TCC, CNL, CLE, CLE, CLE, CLE, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, CLE, CLE, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, CLE, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, CLE, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, CLE, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, CLE, AUL, PP, AUL, PP, AUL, PP, TCC, CNL, FCD, AUL, AUL, PP, AUL, PP, TCC, CNL, FCD, AUL, AUP, AUL, PP, AUL, PP,						proving reasoning a filling street		
Norms 2019         discal supple         mete         A         AMP, AMS, CPP, TCC, CNA, CAZ, CTX, FPP, CRO, ATM SAT, CPP, NAL.         MOB.         .           441         Source 2019         discal supple         mete         D         AMP, AMS, CPP, TCC, CNA, CAZ, CTX, FPP, CRO, ATM SAT, CPP, NAL.         S           441         Source 2019         discal supple         mete         B         AMP, AMS, CPP, TCC, CNA         S           47         Source 2019         discal supple         mete         B2         AMP, AMS, CPP, TCC, CNA         R           48         Source 2019         discal supple         mete         B2         AMP, AMS, CPP, TCC, CNA, CAS, CTX, FPP, CRO, ATM, GM, AM, CPP, NAL, CMP, TCP, CTM, CAS, CTM, CAS, CTX, STN, AL         MDB         .           49         Source 2019         discal supple         mete         B2         AN AM, CPP, TCP, CCM, CAS, CTX, STN, CAM, AM, CTP, NAL, CMP, TCP, CTM, CAM, AM, CTP, NAL, CMP, TCP, CAM, CAM, CAM, CTP, NAL, CMP, TCP, CAM, CAM, CAM, CTP, NAL, CMP, TCP, CAM, CAM, CTP, TAM, CAM, CTP, CAM, CAM, CTP,	-					AND AND COMPANY AND A		
90         Summer 2019         dirical surget         mate         N2         Auto, PAX, PI, PTC, CMA         S           41         Summer 2019         dirical surget         mate         A         A         A           45         Summer 2019         dirical surget         mate         R2         A <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>   </td></td<>								
41         Summ2 2019         direit areapy         wate         0         summ2 2019         direit areapy         wate         R           45         Summ2 2019         direit areapy         wate         R0         AAR, PP, TCC, CNA         R           46         Summ2 2019         direit areapy         wate         R2         AR         R           51         Summ2 2019         direit areapy         wate         R2         ALP, AAK, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, NLD         ND           51         Summ2 2019         direit areapy         wate         R2         ALP, AAK, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, ALP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, AN, CPP, TZP, TCC, CNAL, CAZ, CTX, FFP, CRO, ATM, CAJ, CAZ, CTX, FFP				urine			-	+
46         Summer 2019         disk largely         send         A         APP_ANC, PEP TCC, CNA         S           47         Summer 2019         disk largely         setd         RG         APP_ANC, PEP TCC, CNA         RE           48         Summer 2019         disk largely         setd         RG         Summer 2019         disk largely         setd         RG           54         Summer 2019         disk largely         setd         RG         ANA ANC, PP TZP, TCC, CNA, CAZ, CTX, FPP CRO, ATA, GA, ATA, NA, MD         MDR           56         Summer 2019         disk largely         setd         RG         ANA ANC, PP TZP, TCC, CNA, CAZ, CTX, FPP CRO, ATA, GA, ATA, NA, MD         Setd           61         Summer 2019         disk largely         bedd         D         ANP, ANCE, PP TZP, TCC, CNA, CAZ, CTX, FPP CRO, ATA, SAX, SAX, TA, AN, SAX, TCP, SAX, SAX, SAX, SAX, SAX, SAX, SAX, SAX		Summer 2019	clinical sample	urine		AMP, AMC, PIP, TCC		
H         Summer 2019         citacal sample         unice         PR         AMP ANC PP TC COM         R         Image: Commer 2019         citacal sample         unice         R           41         Summer 2019         citacal sample         unice         R2         A         S         S         S           51         Summer 2019         citacal sample         unice         R2         AAMP, AMC, PP, TCP, TCC, CM, CAY, CTX, FEP, CBO, ATM, SMY, AM, CMP, SMY, SMY, AM, SMY, SMY, SMY, SMY, SMY, SMY, SMY, SM	43	Summer 2019	clinical sample	urine	D		S	
H         Summer 2010         cites at largely         ower         PI         Pi<	46	Summer 2019	clinical sample	urine	A		S	
44         Summer 2019         cities at sample         same         17.2           11         Summer 2019         cities at sample         same         17.8         Summer 2019         cities at sample         same         18.2         AVM ANC, PP, TZP, TCC, CNA, CAZ, CTX, PP, CSD, ATM, STX, NAL         MDR         -           10         Summer 2019         cities at sample         same         18.2         AVM, ANC, PP, TZP, TCC, CNA, CAZ, CTX, PP, CSD, ATM, STX, NAL         MDR         -           24         Auture 2019         cities at sample         same         18.2         AVM, PANC, PP, TZP, TCC, CNA, CRX, CRN, ATM, CR, PAND, CP, TAND, CP, NAL         MDR         -           24         Auture 2019         cities at sample         same         18.2         AVM, PANC, PP, TZP, TCC, CNA, CRX, CTM, CAL, ATM, CR, PAND, CP, ATM, CP, TAND, C		Summer 2019	A			AMP, AMC, PIP, TCC, CXM		
11         Source 2010         classical souph         unic         18         Auty_Axty_PT27; TC, CM, CAZ, CTX, FDP, CBA, ANG, CBA, SA, CP, NAL,         MDB         .           34         Source 2010         classical souph         unic         182         AAV, AAX, CP, TZP, TCC, CM, CAZ, CTX, FDP, CBA, CAN, CDY, NAL,         MDB         .           34         Source 2010         classical souph         Made         D         Auty, AAX, CP, TZP, TCC, CM, CAZ, CTX, FDP, CBA, ANK, STX, NAL,         MDB         .           46         Auture 2010         classical souph         unice         182         AUX, AAX, CP, TZP, TCC, CM, CTX, CTM, ATM, STX, TAL,         MDB         .           46         Auture 2010         classical souph         unice         182         .								
Summer 2019         diskal sample         ories         APP_ANC_PIP_T2P, TCC_CNA_CAT_CTAP, COLONAL, AC MP, AN, CP, ALL         MDR         i           51         Summer 2019         diskal sample         Mond         D         AN, NA, C, PIP, TCC, CNA, CAT, CAT, CAT, CAT, CAT, SAL         MDR         i           51         Summer 2019         diskal sample         Mire         R2         AMP, ANC, PIP, TCC, CNA, CAT, CAT, SAL, SAT, CP, NAL         MDR         i           61         Autume 2019         diskal sample         mire         R2         AMP, ANC, PIP, TCC, CNA, CAT, CAT, MA, NA, CPP, TAN, LAN, MDR         NS           62         Autume 2019         diskal sample         mire         R2         Summer 2019         Mire         R2           64         Autume 2019         diskal sample         mire         R2         Summer 2019         Mire         R3           64         Autume 2019         diskal sample         mire         R2         Autumer 2019         Mire         R3           70         Autume 2019         diskal sample         mire         R4         AMP PM         R4         R4           71         Autume 2019         diskal sample         mire         R3         AMP PM         R4         R4         R4			A			<u> </u>		
Summer 2019         disk at sample         lense         PE         AN, NAL         PE         AN, NAL         PE           99         Summer 2019         disk at sample         lense         PE         ANP, ANC, PIP TZP, CCON, CAZ, CTX, PIP, CON, CAJ, CTX, CIP, NAL         MDR         r.           61         Atturne 2019         disk at sample         wrice         PE         Atturne 2019         disk at sample         NDR         r.           64         Atturne 2019         disk at sample         wrice         PE         .         S         .           64         Atturne 2019         disk at sample         wrice         PE         . </td <td></td> <td></td> <td>A</td> <td></td> <td></td> <td>AND AND DD TZD TOO ONL CAT OTY FED ODD ATH ON AN OT SHE</td> <td></td> <td></td>			A			AND AND DD TZD TOO ONL CAT OTY FED ODD ATH ON AN OT SHE		
9         Sumer 2019         diskal sample         Nome         D         ANP ANC PIP TC, CCM, CAZ, CRA, CAT, ST, NAL.         MDB         -           61         Autome 2019         diskal sample         wrice         R2         ANP ANC PIP TC, CCM, CAZ, CRA, CAT, ST, ST, CD, NAL.         MDB         -           61         Autome 2019         diskal sample         wrice         R2         -         S         -           64         Autome 2019         diskal sample         wrice         R2         -         -         S         -           64         Autome 2019         diskal sample         wrice         R2         -         -         S         -           64         Autome 2019         diskal sample         wrice         R2         -         -         S         -           64         Autome 2019         diskal sample         wrice         R2         ANP, PIP, TCC, CNL, FOX, ATM (I)         MB         -         S         -         S         -         S         -         S         -         S         A         S         -         S         -         S         A         S         A         S         A         S         A         S         A         S							-	+
Bits         Sense 200         Sinter 200 <td>58</td> <td>Summer 2019</td> <td>clinical sample</td> <td>urine</td> <td></td> <td>AN, NAL</td> <td></td> <td></td>	58	Summer 2019	clinical sample	urine		AN, NAL		
61         Auma 2009         ofield septh         weiz         B2         Auma 2009         ofield septh         weiz         B2           64         Auma 2009         ofield septh         weiz         B2         AAP AAC PEP TZP, TCC, CNA, FOX, ATM(1)         MDR           64         Auma 2009         ofield septh         weiz         B2         AAP AAC PEP TZP, TCC, CNA, FOX, ATM(1)         MDR           64         Auma 2009         ofield septh         weiz         B2         AAP AAC PEP TZP, TCC, CNA, FOX, ATM(1)         MDR           67         Auma 2009         ofield septh         weiz         B2         AAP PAP TZP, TCC, CNA, FOX, ATM(1)         MS           70         Auma 2009         ofield septh         weiz         B2         AAP PEP TCC, AN         S         I           71         Auma 2009         ofield septh         bind         B2         AAP PEP         S         I           72         Auma 2009         ofield septh         bind         A         AP PEP         S         I           73         Auma 2009         ofield septh         bind         A         AP PEP         S         I           74         Auma 2001         ofield septh         bind         A         AP PE	59	Summer 2019	clinical sample	blood	D	AMP, AMC, PIP, TZP, TCC, CXM, CAZ, CTX, FEP, CRO, ATM, SXT, NAL	MDR	+
Image         Ausem 2009         disal supple         unic.         B2           64         Ausem 2009         disal supple         unic.         B2         S           66         Ausem 2009         disal supple         unic.         B2         S           66         Ausem 2009         disal supple         unic.         B2         S           66         Ausem 2009         disal supple         unic.         B2         S           70         Ausem 2009         disal supple         unic.         B2         AVP.PDT CC_AN         R           71         Ausem 2009         disal supple         biold         B2         AVP.PDT CC_AN         R         Image           72         Ausem 2009         disal supple         biold         B2         AVP.PDT         R         Image           73         Ausem 2009         disal supple         biold         A         AVP.PDT         R         Image           74         Ausem 2009         disal supple         unic.         A         AVP.PDT         R         Image           74         Ausem 2009         disal supple         unic.         A         AVP.PTP         R         Image         Image         Image	60	Summer 2019	clinical sample	urine	B2	AMP, AMC, PIP, TCC, CXM, CTX, CRO, ATM, AN, SXT, CIP, NAL	MDR	+
Horm 2009         chiral sampk         unic         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         MDR           66         Autum 2009         chiral sampk         unics         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         MDR           66         Autum 2009         chiral sampk         unics         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, CTT, FDP, CTC, ATM         S         Image APAC PIP TZP, TCC, ATM         S         Image APAC PIP TZP, TSP, TSP, TSP, TSP, TSP, TSP, TSP, TS	61	Autumn 2019	clinical sample	urine	B2		S	
Horm 2009         chiral sampk         unic         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         MDR           66         Autum 2009         chiral sampk         unics         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         MDR           66         Autum 2009         chiral sampk         unics         B2         APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, ATM(I)         S         Image APAC PIP TZP, TCC, CNA, FOX, CTT, FDP, CTC, ATM         S         Image APAC PIP TZP, TCC, ATM         S         Image APAC PIP TZP, TSP, TSP, TSP, TSP, TSP, TSP, TSP, TS	62	Autumn 2019	clinical sample	urine	B2		S	
6f.         Autom. 2019         circal samph         wins         B2         AMP. ANC. PIP. TCP. TCC. CXM. FOX. ATM (I)         MDR         S           66         Autom. 2019         circal samph         wins         B2         S         S           67         Autom. 2019         circal samph         wins         B2         S         S           70         Autom. 2019         circal samph         wins         B2         AMP. PIP. TCC, AN         R           71         Autom. 2019         circal samph         Wins         B2         AMP. PIP. TCC, AN         R           72         Autom. 2019         circal samph         Wind         A2         AMP. PIP.         R         R           73         Autom. 2019         circal samph         Wind         A         APP. PIP.         R         R           74         Autom. 2019         circal samph         wine         D         AMP. AMC. PIP. CXM. CAZ, CTX. PIP. CBO. FOX. ATM         MDR         s           74         Autom. 2019         circal samph         wine         D         AMP. AMC. PIP. CXM. CAZ, CTX. PIP. CBO. FOX. ATM         MDR         s           75         Autom. 2019         circal samph         wine         D         AMP. AMC. PIP. CXM.			<u> </u>				-	
68         Autum 200         diskal sample         wind         82           68         Autum 200         diskal sample         wind         82           70         Autum 200         diskal sample         wind         82           71         Autum 200         diskal sample         wind         82           73         Autum 200         diskal sample         blood         R2         AMP.PD         R           74         Autum 200         diskal sample         blood         A         AMP.PD         R           74         Autum 200         diskal sample         blood         A         MP.PD         R           75         Autum 200         diskal sample         blood         A         MP.ST.CGM.CAZ.CTX.FSP.CRO.FOX.ATM         R           76         Autum 200         diskal sample         wine         A         AMP.ST.CGM.CAZ.CTX.FSP.CRO.FOX.ATM         R           78         Autum 200         diskal sample         wine         R2          S           78         Autum 200         diskal sample         wine         R2          S           79         Autum 200         diskal sample         wine         R2          S </td <td></td> <td></td> <td><u>,</u></td> <td></td> <td></td> <td>AMP AMC PIR TZP TOC CYM FOX ATM (D)</td> <td>-</td> <td></td>			<u>,</u>			AMP AMC PIR TZP TOC CYM FOX ATM (D)	-	
8Autom 2019dirksh suppkwritzB21SS90Autom 2019dirksh suppkwritzB2AXP, PF, TCC, ANSS71Autom 2019dirksh suppkwritzB2AXP, PF, TCC, ANR72Autom 2019dirksh suppkbloodB2AMP, PFR73Autom 2019dirksh suppkbloodB2AMP, PFR74Autom 2019dirksh suppkbloodAAMP, PFR75Autom 2019dirksh suppkwritzDAMP, PF, TCC, CA, CAZ, CTX, FFP, CRO, POX, ATMR76Autom 2019dirksh suppkwritzDAMP, NT, CAG, CAZ, CTX, FFP, CRO, POX, ATMMDR76Autom 2019dirksh suppkwritzB2SS76Autom 2019dirksh suppkwritzB2SS76Autom 2019dirksh suppkwritzDAMP, STXR77Autom 2019dirksh suppkwritzB2SS78Autom 2019dirksh suppkwritzB2SS79Autom 2019dirksh suppkwritzB2SS70Autom 2019dirksh suppkwritzB2SS79Autom 2019dirksh suppkwritzAMP, CXM, PXX (CRO wat CAZ or fut, STXMDR70Autom 2019dirksh suppkwritzAMP, CXM, CAZ, CTX, FSP, CRO, ATM, STXMDR716Autom 201			· · · · ·			Ame, and, ele, i.e., i.e., can, eoa, a im (i)	-	
$\theta^{0}$ Auton 2009clickal samplewriteB2AVR PIP TC. ANS72Auton 2019clickal samplebloodR2AVR PIP TC. ANR73Auton 2019clickal samplebloodR2AVR PIP TC. ANR74Auton 2019clickal samplebloodR2AVR PIP TC. ANR75Auton 2019clickal samplebloodR2AVR PIP TC. ANR76Auton 2019clickal samplebloodAAVR PIP TC. ANR76Auton 2019clickal samplewriteAAVR PIP TC. ANN76Auton 2019clickal samplewriteAAVR PIP TC. ANN76Auton 2019clickal samplewriteRS78Auton 2019clickal samplewriteR2S78Auton 2019clickal samplewriteRS79Auton 2019clickal samplewriteRS70Auton 2019clickal samplewriteRS71Auton 2019clickal samplewriteRMP. CM. FCX. CR2 refs. CR3 refs. FTXR71Auton 2019clickal samplewriteRMP. CM. FCX. CR3 refs. FTXR72Auton 2019clickal samplewriteRMP. AMC. PIP CXM. CR2 refs. CR3 refs. FTXMDR73Auton 2019clickal samplewriteRMP. AMC. PIP CXM. CR4 refs. CTX. FTXMDR74Auton 2019 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
$\overline{D}$ Autom 2019clickial samplewinzR2AMP, PIPCC, ANR77Autom 2019clickial samplebloodR2AMP, PIPR9Autom 2019clickial samplebloodR2AMP, PIPR80Autom 2019clickial samplebloodR2AMP, PIPR81Autom 2019clickial samplewinicAMP, SXT, GMR82Autom 2019clickial samplewinicDAMP, PIPR84Autom 2019clickial samplewinicR2S85Autom 2019clickial samplewinicR2S86Autom 2019clickial samplewinicR2S87Autom 2019clickial samplewinicR2S90Autom 2019clickial samplewinicR2S91Autom 2019clickial samplewinicR2S92Autom 2019clickial samplewinicR2S93Autom 2019clickial samplewinicR2A94Autom 2019clickial samplewinicR2S97Autom 2019clickial samplewinicR2A98Autom 2019clickial samplewinicR2A99Autom 2019clickial samplewinicR2A91Autom 2019clickial samplewinicR2A92Autom 2019clickial sample </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td>							-	
77         Autum 2019         clinical surple         behod         B2         AMP,PP         PP           99         Autum 2019         clinical surple         Solution         R         R           80         Autum 2019         clinical surple         Solution         Solution         Solution           81         Autum 2019         clinical surple         Solution         Solution         Solution           82         Autum 2019         clinical surple         unice         D         AMP, NAC, PP, CKM, CAZ, CTX, FEP, CRO, POX, ATM         MDR           84         Autum 2019         clinical surple         unice         B2         Solution         Solution           85         Autum 2019         clinical surple         unice         A2         Solution         Solution         Solution           91         Autum 2019         clinical surple         unice         B2         Solution         So		Autumn 2019	clinical sample	urine				
P?         Autum 200         clickel surple         bend         B2         AMP,PP         B           B0         Autum 201         clickel surple         behod         A           S2         Autum 201         clickel surple         unic         A         AMP, SXT, GM         B           S4         Autum 201         clickel surple         unic         D         AMP, AMC, PIP, CKM, CAZ, CTX, FEP, CRO, FOX, ATM         MDR         -           S4         Autum 201         clickel surple         unic         B2          S            S6         Autum 201         clickel surple         unic         B2          S            90         Autum 201         clickel surple         unic         D         AMP, TX         R            91         Autum 2010         clickel surple         unic         A         AMP, CMP, CXA, CAZ, CTX, FEP, CRO, ATM, STX         MDR         S           92         Autum 2010         clickel surple         unic         A         AMP, CMP, CXA, CAZ, CTX, FEP, CRO, ATM, STX         MDR         -           101         Autum 2010         clickel surple         unic         A         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX         MDR <td>70</td> <td>Autumn 2019</td> <td>clinical sample</td> <td>urine</td> <td>B2</td> <td>AMP, PIP, TCC, AN</td> <td>R</td> <td></td>	70	Autumn 2019	clinical sample	urine	B2	AMP, PIP, TCC, AN	R	
B0         Autum 2010         diskal stangk         blood         A         P           R2         Autum 2010         diskal stangk         unice         A         AMP, SXT, GM         R           R4         Autum 2010         diskal stangk         unice         D         AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, FOX, ATM         MDR         -           R4         Autum 2010         diskal stangk         unice         R2         -         S         -           R5         Autum 2010         diskal stangk         unice         R2         -         S         -           86         Autum 2010         diskal stangk         unice         R2         -         S         -           97         Autum 2010         diskal stangk         unice         D         AMP, CXM, FOX (CBO set CAZ roSulpano)         R         -           97         Autum 2010         diskal stangk         unice         R2         -         S         -           101         Autum 2010         diskal stangk         unice         R2         -         S         -           117         Autum 2010         diskal stangk         unice         R2         -         AMP, AMC, PIP, CXM, CAZ, FOX, ATM, GN, ANS, STX <t< td=""><td>77</td><td>Autumn 2019</td><td>clinical sample</td><td>blood</td><td>B2</td><td>AMP, PIP</td><td>R</td><td></td></t<>	77	Autumn 2019	clinical sample	blood	B2	AMP, PIP	R	
Bit     Automa 2019     clinical sample     bitsod     A       B2     Automa 2019     clinical sample     unice     A     AMP, SNT, CM     R       B4     Automa 2010     clinical sample     unice     D     AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, POX, ATM     MDR     +       B4     Automa 2010     clinical sample     unice     R2     S     S     S       B4     Automa 2010     clinical sample     unice     R2     S     S     S       B4     Automa 2010     clinical sample     unice     R2     S     S     S       90     Automa 2010     clinical sample     unice     D     AMP, STX     S     S     S       91     Automa 2010     clinical sample     unice     D     AMP, CXM, PDX (CRO set: CAZ refuture)     R     S       97     Automa 2010     clinical sample     unice     A     AMP, CXM, CMP, CXM, CAZ, CTX, FEP, CRO, ATM, STX     MDR     +       101     Automa 2010     clinical sample     unice     A     AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX     MDR     +       117     Automa 2010     clinical sample     unice     A     AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX     MDR       118     Automa 2010	79	Autumn 2019	clinical sample	blood	B2	AMP,PIP	R	
82Autum 2010diskal sampleuniceAAMP, SXT, GMR $84$ Autum 2010diskal sampleuniceDAMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, POX, ATMMDR $84$ Autum 2010diskal sampleuniceR2S $86$ Autum 2010diskal sampleuniceR2S $87$ Autum 2010diskal sampleuniceAA $90$ Autum 2010diskal sampleuniceR2S $91$ Autum 2010diskal sampleuniceR2S $117$ Autum 2010diskal sampleuniceR2S $118$ Autum 2010diskal sampleuniceR2S $120$ Autum 2010diskal sampleuniceR2AN, NAL $120$ Autum 2010diskal sampleuniceR2AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR $120$ Autum 2010diskal sampleuniceR2AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR $120$ Autum 2010diskal sampleuniceR2AMP, AMC, PP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR $12$	80						S	
84Autum 2019clinical sampleuniceDAMP, AMC, PP, CXM, CAZ, CTX, FPP, CBO, FOX, ATMMDB85Autum 2010clinical sampleuniceB2S86Autum 2010clinical sampleuniceR2S90Autum 2010clinical sampleuniceDAMP, STXR91Autum 2010clinical sampleuniceB2S92Autum 2010clinical sampleuniceB2S97Autum 2010clinical sampleuniceB2S97Autum 2010clinical sampleuniceAAMP, CXC, FDX (CEO sur CAZ referations)R97Autum 2010clinical sampleuniceAAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CEO, ATM, STXMDR-110Autum 2010clinical sampleuniceB2S1111Autum 2010clinical sampleuniceDAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CEO, ATM, STXMDR-1120Autum 2010clinical sampleuniceB2ANAS1121Autum 2010clinical sampleuniceB2ANA1224Autum 2010clinical sampleuniceB2ANA1234Autum 2010clinical sampleuniceB2ANA1244Autum 2010clinical sampleuniceB2 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td>AMP SXT GM</td> <td></td> <td></td>						AMP SXT GM		
85Autum 200clinical samplemine $82$ $82$ $83$ $84$ $86$ Autum 200clinical sample $urine82828390Autum 2010clinical sampleurineR8190Autum 2010clinical sampleurineRR91Autum 2010clinical sampleurineR28197Autum 2010clinical sampleurineR28192Autum 2010clinical sampleurineR28192Autum 2010clinical sampleurineR281110Autum 2010clinical sampleurineR282110Autum 2010clinical sampleurineR282111Autum 2010clinical sampleurineR282112Autum 2010clinical sampleurineR282122Autum 2010clinical sampleurine8283123Autum 2010clinical sampleurine8283124Autum 2010clinical sampleurine8283123Autum 2010clinical sampleurine8283124Autum 2010clinical sampleurine8284125Autum 2010clinical sampleurine8284124Autum 2010clinical sampleurine82$	-							
86         Autumn 2019         clinical sample         unice         R2         Participation         S           87         Autumn 2019         clinical sample         unice         A         A         S         Image: A         S           90         Autumn 2019         clinical sample         unice         R         S         Image: A         S           91         Autumn 2019         clinical sample         unice         R2         S         Image: A         AMP, STX         S         Image: A         AMP, CXM, FOX (CRO was CAZ existing the Construction of						Ame, Ame, eie, Cam, CAZ, CTA, FEF, CRU, FUA, A Im	-	÷
B7         Autum 2019         clickal sample         unice         A         AMP, STX         S         B           90         Autum 2019         clickal sample         unice         D         AMP, STX         R         B           91         Autum 2019         clickal sample         unice         B2         S         S           97         Autum 2019         clickal sample         unice         A         AMP, STX         S         S           97         Autum 2019         clickal sample         unice         A         AMP, CXA, FDX (CRO wat CAZ crosslyane)         S         S           101         Autum 2019         clickal sample         unice         A         AMP, CXA, CPX, CAX, CTX, FPP, CRO, ATM, STX         MDR         +           118         Autum 2019         clickal sample         unice         B2         NAL         S         I           120         Autum 2019         clickal sample         unice         B2         AMP, AMC, PP, CXM, CAZ, CTX, FPP, CRO, ATM, STX         MDR         +           121         Autum 2019         clickal sample         unice         B2         AMP, AMC, PP, CM, CAZ, CTX, FPP, CRO, ATM, STX         MDR         N           122         Autum 2019         clic		Autumn 2019	clinical sample	urine				
90Auturn 2019diskal sampleuniteDAMP, STXR91Auturn 2019diskal sampleuniteR2S97Auturn 2019diskal sampleuniteRS90Auturn 2019diskal sampleuniteAAMP, CXM, FOX (CRO ver CAZ, robitume)R91Auturn 2019diskal sampleuniteAAMP, CXM, FOX (CRO ver CAZ, robitume)R110Auturn 2019diskal sampleuniteAAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR111Auturn 2019diskal sampleuniteDAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR120Auturn 2019diskal sampleuniteB2CSS1212Auturn 2019diskal sampleuniteR2AMP, AMC, PIP, CMRS122Auturn 2019diskal sampleuniteR2AMP, AMC, CMP, CMRR123Auturn 2019diskal sampleuniteR2AMP, AMC, CMP, CMRR133Auturn 2019diskal sampleuniteR2CM, ANSI133Auturn 2019diskal samplebioodR2SI134Auturn 2019diskal samplebioodAII135Auturn 2019diskal samplebioodAII134Auturn 2019diskal samplebioodAII135Auturn 2019diskal sample	86	Autumn 2019	clinical sample	urine	B2			
93Autum 2019clinkal sampleunic $B2$ S97Autum 2019clinkal sampleblood $B2$ S99Autum 2019clinkal sampleunicA $AMP, CXM, POX (CBO sur CAZ, cr5shjano)R110Autum 2019clinkal sampleunicAAMP, AMC, PIP, CXM, CAZ, cr5shjano)R111Autum 2019clinkal sampleunicAAMP, AMC, PIP, CXM, CAZ, cr5s, FEP, CBO, ATM, STXMDR118Autum 2019clinkal sampleunicDAMP, AMC, PIP, CXM, CAZ, cr5s, ATM (D, AN, SXTMDR120Autum 2019clinkal samplebloodB2S1212Autum 2019clinkal sampleunicB2AN, NALR122Autum 2019clinkal sampleunicB2AN, NALR133Autum 2019clinkal sampleunicB2ANR134Autum 2019clinkal sampleunicB2ANR133Autum 2019clinkal sampleunicB2ANR134Autum 2019clinkal sampleunicB2ANR135Autum 2019clinkal sampleunicB2ANR136Autum 2019clinkal sampleunicB2ANR137Autum 2019clinkal sampleunicB2ANR138Autum 2019clinkal sampleunicB2ANR139Autum 2019clinkal sample$	87	Autumn 2019	clinical sample	urine	A		S	
93Auturn 2019clinical sampleorineB2constraintsS97Auturn 2019clinical samplebkndH2SS98Auturn 2019clinical sampleurineAAMP, CXM, FOX (CBC) san CAZ, cr5/spinso)R110Auturn 2019clinical sampleurineRA111Auturn 2019clinical sampleurineRS1117Auturn 2019clinical sampleurineRMDR+118Auturn 2019clinical sampleurineDAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CEO, ATM (I), AN, SXTMDR+120Auturn 2019clinical sampleurineB2AN, NALR121Auturn 2019clinical sampleurineB2AN, NALR122Auturn 2019clinical sampleurineB2ANANR133Auturn 2019clinical sampleurineB2ANANR134Auturn 2019clinical sampleurineB2ANS135Auturn 2019clinical sampleurineB2ANS136Auturn 2019clinical sampleurineB2ANS137Auturn 2019clinical sampleurineB2ANS138Auturn 2019clinical sampleurineB2ANS139Auturn 2019clinical sampleurineB2 <td>90</td> <td>Autumn 2019</td> <td>clinical sample</td> <td>urine</td> <td>D</td> <td>AMP, STX</td> <td>R</td> <td></td>	90	Autumn 2019	clinical sample	urine	D	AMP, STX	R	
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9Auturn 2019clinkal sampleurineAAMP, CXM, FOX (CRO sui CAZ ofsignon)R110Auturn 2019clinkal sampleurineR2S117Auturn 2019clinkal sampleurineAAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR118Auturn 2019clinkal sampleurineAAMP, AMC, PIP, CXM, CAZ, FOX, ATM (I), AN, SXTMDR120Auturn 2019clinkal sampleurineR2S121Auturn 2019clinkal sampleurineR2AMP, AMC, PIP, CXM, CAZ, FOX, ATM (I), AN, SXTMDR122Auturn 2019clinkal sampleurineR2AN, NALR123Auturn 2019clinkal sampleurineR2AMP, AMC, PIP, CMR130Auturn 2019clinkal sampleurineR2ANAMC, CXM, GM, AN, STX, MEM, DMPMDR133Auturn 2019clinkal sampleurineR2GM, ANRR134Auturn 2019clinkal sampleurineB2GM, ANSI135Auturn 2019clinkal samplebloodR2SII136Auturn 2019clinkal samplebloodR2SI137Auturn 2019clinkal samplebloodR2SI138Auturn 2019clinkal sampleurineR4AMP, PIPK8139Auturn 2019clinkal sampleurineAAMP, PIPR140Au							S	
110Autum 2019diskal sampleuniteB25117Autum 2019diskal sampleuniteAAMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STXMDR118Autum 2019diskal samplebloodB2F120Autum 2019diskal samplebloodB2S121Autum 2019diskal sampleuniteB2AN, ALC, PIP, CXM, CAZ, FOX, ATM (I), AN, SXTMDR122Autum 2019diskal sampleuniteB2AN, ALC,RR123Autum 2019diskal sampleuniteB2AN, ALC, PIP, CAMRR124Autum 2019diskal sampleuniteB2AN, CPIP, CAMRR125Autum 2019diskal sampleuniteB2AMC, CMP, CAM, GM, AN, STX, MEM, IMPMDR136Autum 2019diskal sampleuniteB2AMC, CMP, CAM, GM, AN, STX, MEM, IMPMDR137Autum 2019diskal sampleuniteB2CM, ANRI138Autum 2019diskal sampleuniteB2CM, ANRI139Autum 2019diskal sampleuniteB2CM, ANRI139Autum 2019diskal sampleuniteAAMP, PIPRI149Autum 2019diskal sampleuniteAAMP, PIPRI153Autum 2019diskal sampleuniteAAMP, PIPRI164Minter 20	-					AMP, CXM, FOX (CRO size CAZ substitute)		
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118Autum 2019clinkal sampleuniteDAMP, AMC, PIP, CXM, CAZ, FOX, ATM (I), AN, SXTMDR120Autum 2019clinkal sampleBloodB2S121Autum 2019clinkal sampleuniteB2AN, NALR123Autum 2019clinkal sampleuniteB2AMP, AMC, PIP, CMR124Autum 2019clinkal sampleuniteB2AMP, AMC, PIP, CMR129Autum 2019clinkal sampleuniteB2AMC, CM, GM, AN, STX, MEM, IMPMDR130Autum 2019clinkal sampleuniteB2AMC, CXM, GM, AN, STX, MEM, IMPMDR133Autum 2019clinkal samplebloodB2AMR134Autum 2019clinkal sampleuniteB2GM, ANR135Autum 2019clinkal sampleuniteB2GM, ANR136Autum 2019clinkal sampleuniteB2GM, ANR137Autum 2019clinkal sampleuniteB2GM, ANR138Autum 2019clinkal sampleuniteAAMP, PIPR144Autum 2019clinkal sampleuniteRR157Winter 2020clinkal sampleuniteRR158Winter 2020clinkal sampleuniteRR157Winter 2020clinkal sampleuniteAR158Winter 2020clinkal sampleuniteA<		7101011012017				AMP AMC PIP CYM CAZ CTV EEP CPO ATM STV		
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137Autum 2019clinical samplebloodB2IntermediateS139Autum 2019clinical samplebloodASS145Autum 2019clinical sampleurineB2SS149Autum 2019clinical sampleurineAAMP,PIPR155Autum 2019clinical samplebloodAAMP,PIPR155Autum 2019clinical samplebloodAAMP,PIPR165Winter 2020clinical sampleurineB2ANR165Winter 2020clinical sampleurineDSI168Winter 2020clinical sampleurineAISI171Winter 2020clinical sampleurineAISII174Winter 2020clinical sampleurineAIIIIIISII181Winter 2020clinical sampleurineB2ANRIIIIRIIIIIIIIIIIIIIRIII<							+	
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145Autumn 2019clinical sampleurineB2ControlS149Autumn 2019clinical sampleurineAAMP, PIPR155Autumn 2019clinical samplebloodAAMP, PIPR157Winter 2020clinical sampleurineB2ANR168Winter 2020clinical sampleurineDSS168Winter 2020clinical sampleurineAA171Winter 2020clinical sampleurineAS173Winter 2020clinical sampleurineAS174Winter 2020clinical sampleurineAS175Winter 2020clinical sampleurineB2NAL181Winter 2020clinical sampleurineB2AN185Winter 2020clinical sampleurineB2AN185Winter 2020clinical sampleurineB2AN185Winter 2020clinical sampleurineB2AN185Winter 2020clinical sampleurineB2GM, AN, NALR191Winter 2020clinical sampleurineDSI197Winter 2020clinical sampleurineB2SS								
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157Winter 2020clinical sampleurineB2ANR165Winter 2020clinical sampleurineDS168Winter 2020clinical sampleurineAS171Winter 2020clinical sampleurineAS174Winter 2020clinical sampleurineAS175Winter 2020clinical sampleurineAS181Winter 2020clinical sampleurineB2NALR183Winter 2020clinical sampleurineB2QM, AN, NALR191Winter 2020clinical sampleurineDS197Winter 2020clinical sampleurineB2S	149	Autumn 2019	clinical sample	urine	A	AMP, PIP	R	
157Winter 2020clinical sampleuniteB2ANR165Winter 2020clinical sampleuniteDS168Winter 2020clinical sampleuniteAS171Winter 2020clinical sampleuniteAS174Winter 2020clinical sampleuniteAS175Winter 2020clinical sampleuniteAS175Winter 2020clinical sampleuniteB2NAL181Winter 2020clinical sampleuniteB2AN185Winter 2020clinical sampleuniteB2GM, AN, NAL191Winter 2020clinical sampleuniteDS197Winter 2020clinical sampleuniteB2Mathematical SampleS197Winter 2020clinical sampleuniteB2S	LSS	Autumn 2019	clinical sample	blood	A	A MP, PIP	R	
165Winter 2020clinical sampleurineDImage: Constraint of the sampleS168Winter 2020clinical sampleurineASS171Winter 2020clinical sampleurineASS174Winter 2020clinical sampleurineASS175Winter 2020clinical sampleurineB2NALRS181Winter 2020clinical sampleurineB2ANRS185Winter 2020clinical sampletrineB2GM, AN, NALRS191Winter 2020clinical sampleurineB2SSS197Winter 2020clinical sampleurineB2SSS	157			urine	B2		R	
168Winter 2020clinical sampleurineAImage: Second Seco								
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174     Winter 2020     clinical sample     unite     A     S       175     Winter 2020     clinical sample     unite     B2     NAL     R       181     Winter 2020     clinical sample     unite     B2     AN     R       185     Winter 2020     clinical sample     unite     B2     GM, AN, NAL     R       191     Winter 2020     clinical sample     unite     D     S       197     Winter 2020     clinical sample     unite     B2	1.000							
175     Winter 2020     clinical sample     urine     B2     NAL     R       181     Winter 2020     clinical sample     urine     B2     AN     R       185     Winter 2020     clinical sample     tissue     B2     GM, AN, NAL     R       191     Winter 2020     clinical sample     urine     D     S       197     Winter 2020     clinical sample     urine     B2	1.723	watter 2020				l	-	
181     Winter 2020     clinical sample     urine     B2     AN       185     Winter 2020     clinical sample     tissue     B2     GM, AN, NAL     R       191     Winter 2020     clinical sample     urine     D     S       197     Winter 2020     clinical sample     urine     B2			of many stars in a summer last	urin.c	A		-	
185         Winter 2020         clinical sample         tissue         B2         GM, AN, NAL         R           191         Winter 2020         clinical sample         urite         D         S           197         Winter 2020         clinical sample         urite         B2         S	174	Winter 2020						
191         Winter 2020         elinical sample         urine         D         S           197         Winter 2020         elinical sample         urine         B2         S	174 175	Winter 2020 Winter 2020					-	
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197 Winter 2020 clinical sample urine B2 S	174 175 181	W inter 2020 W inter 2020 W inter 2020	clinical sample clinical sample	urin e urin e	B2	AN	R	
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203	Winter 2020	clinical sample	blood	D	AMP, AMC, PIP, TZP, CXM, CAZ, CTX, FOX, CRO, FEP, ATM, STX, NAL	MDR	+
204	Winter 2020	clinical sample	blood	B2	AMP, AMC, PIP, AN, SXT, NAL	MDR	
210	Winter 2020	clinical sample	tissue	B2	CIP, NAL	R	
241	Summer 2020	clinical sample	urine	B2	AMP, PIP	R	
243	Summer 2020	clinical sample	urine	A		S	
245	Summer 2020	clinical sample		B2	AMP, AMC, PIP, AN, STX	MDR	
246	Summer 2020	*	urine			R	
		clinical sample	blood	B2 B1	AMP, AMC, PIP	R	
249	Summer 2020	clinical sample	hlood		AMP, CXM, FOX		
253	Summer 2020	clinical sample	urine	B2		S	
254	Summer 2020	clinical sample	urine	B2	AMP, AMC, PIP	R	
255	Summer 2020	clinical sample	blood	B2		S	
259	Summer 2020	clinical sample	urine	B2		S	
261	Summer 2020	clinical sample	urine	B2		S	
264	Summer 2020	clinical sample	blood	Bl	STX, CIP, NAL	R	
265	-		blood	B2	AMP, AMC, PIP, GM, STX	MDR	
	Summer 2020	clinical sample			AME, AME, PP, UM, STA	-	
267	Summer 2020	clinical sample	hlood	B2		S	
269	Summer 2020	clinical sample	blood	D		S	
272	Summer 2020	clinical sample	urinc	D	AMP, PIP, SXT	R	
276	Summer 2020	clinical sample	urine	B2		S	
278	Summer 2020	clinical sample	urine	B2	AMP, PIP	R	
281	Summer 2020	clinical sample	urine	D	AMP, PIP, SXT	R	
284	Summer 2020		blood	B2		S	l
		clinical sample				-	
286	Autumn 2020	clinical sample	urine	B2		S	
287	Autumn 2020	clinical sample	urine	B2	AMP, SXT, NAL	R	
288	Autumn 2020	clinical sample	blood	B2		S	
291	Autumn 2020	clinical sample	urine	B2		S	
292	Autumn 2020	clinical sample	tissue	B1	AMP	R	
294	Autumn 2020	clinical sample	urine	B2	AMP, PIP, CXM, CTX, CRO, ATM	R	+
296	Autumn 2020	clinical sample	urine	D	SXT	R	
297	Autumn 2020	· · ·		D	GM	R	
	-	clinical sample	urine	•		-	
301	Autumn 2020	clinical sample	hlood	B1		S	
303	Autumn 2020	clinical sample	urine	B2	AMP, PIP	R	
304	Autumn 2020	clinical sample	urine	B2		S	
305	Autumn 2020	clinical sample	hlood	B2		S	
307	Autumn 2020	clinical sample	urine	A	AMP, PIP, GM, AN	R	
309	Autumn 2020	clinical sample	urine	D	STX	R	
311	Autumn 2020	clinical sample	urine	B2		S	
313	Autumn 2020	clinical sample	urinc	D	AMP, PIP, AN, SXT	R	
314	Autumn 2020	1	blood	D		R	
		clinical sample			AMP, AMC, PIP	-	
318	Autumn 2020	clinical sample	urine	B2		S	
320	Autumn 2020	clinical sample	urine	B2	GM, AN	R	
324	Autumn 2020	clinical sample	urine	A		S	
325	Autumn 2020	clinical sample	hlood	A	AMP, PIP, CXM, CAZ, CTX, CRO, FEP, ATM	R	+
328	Autumn 2020	clinical sample	urine	B2	AMP, PIP, IMP	R	
331	Autumn 2020	clinical sample	urine	A	STX	R	
333	Autumn 2020	clinical sample	tissuc	B2	AMP, AMC, PIP, TZP, CXM, CTX, FEP, CRO, ATM, GM, CIP, NAL	MDR	+
					CIP, NAL	R	
334	Autumn 2020	clinical sample	urine	B2			
335	Autumn 2020	clinical sample	hlood	D	NAL	R	
336	Spring 2021	clinical sample	urine	B2	AMP	R	
350	Spring 2021	clinical sample	urine	B2	AMP, PIP, CXM, CAZ, CTX, CRO, FEP, ATM, SXT, CIP, NAL	MDR	+
355	Spring 2021	clinical sample	urine	B2	AN	R	
3.59	Spring 2021	clinical sample	urine	B2		S	
360	Spring 2021	clinical sample	urine	A		S	
361	Spring 2021	clinical sample	unine	B2	AMP, AMC, PIP	R	
362	Spring 2021 Spring 2021			B2 B2	AMP, AMC, PIP	R	
	- ×	clinical sample	urine	+			
363	Spring 2021	clinical sample	urine	A		S	
364	Spring 2021	clinical sample	urine	Bl	AMP, PIP, SXT	R	
365	Spring 2021	clinical sample	unine	B2		S	
366	Spring 2021	clinical sample	urine	B2		S	
367	Spring 2021	clinical sample	urine	D	AMP, AMC, PIP, CXM, AN, SXT, NAL	MDR	
368	Spring 2021	clinical sample	urine	D		S	
375	Spring 2021	clinical sample	unine	A	GM, AN	R	
	1 ×					-	
	Spring 2021	clinical sample	blood	B2	AMP, PIP, GM, AN, SXT	R	
378				D	SXT, IMP	R	1
381	Spring 2021	clinical sample	hlood		the statement of the st		
	Spring 2021 Spring 2021	clinical sample	hlood	B2 D	AMP, AMC, GM, AN, MEM, IMP	S MDR	

Abbreviations: HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1; RWS2, river water site 2; AMP, ampicillin; AMC, amoxicillin/clavulanic acid; TZP, piperacillin' tazobactam; PIP, piperacillin; CXM, cefuroxime; CAZ, ceffazidime; CTX, cefotaxime; FOX, cefoxitin; FEP, cefepime; CRO, ceffriaxone; ATM, aztreonam; MEM, meropenem; IMP, imipenem; GM, gentamicin; AN, amikacin; SXT, sulfamethoxazole-trimethoprim; CIP, ciprofloxacin; NAL, nalidixic acid; MDR, muki-drag resistant; R, resistant'; WT, wild type; S, sensitive; DDST, double disk synergy test.

Environmental isolates	WT	N-WT	R	MDR
HWW (n=105)	54.3% (57/105)	3.8% (4/105)	7.6% (8/105)	34.3% (36/105)
WWTP (n=171)	36.8% (63/171)	3.5% (6/171)	43.3% (74/171)	16.4% (28/171)
RWS1 (n=163)	36.8% (60/163)	1.2% (2/163)	45.4% (74/163)	16.6% (27/163)
RWS2 (n=63)	36.5% (23/63)	3.1% (2/63)	42.9% (27/63)	17.5% (11/63)
Clinical isolates	S		R	MDR
urine (n=104):	41.3% (4	3/104)	45.2% (47/104)	13.5% (14/104)
blood (n=30)	43.3% (1	13/30)	43.3% (13/30)	13.4% (4/30)
tissue (n=5)	-		80% (4/5)	20% (1/5)
bbreviations: RWS1,	river water site 1; RV	VS2, river water si	te 2; WWTP, wastewat	er treatment plant;

## Table 3.3 The *E. coli* isolates from environmental habitats and clinical specimens that exhibit multidrug resistance

Number of different antibiotic	Number of environmental isolates obtained from each sample sour						
categories in which environmental MDR isolates presented resistance	HWW	WWTP effluents	RWS1	RWS2	Total		
4 antibiotic categories	5	8	16	6	35		
5 antibiotic categories	8	20	8	4	40		
6 antibiotic categories	10		3		13		
7 antibiotic categories	13			1	14		
Total MDR	36	28	27	11	102		
Number of different	Ν	umber of clinic	al isolates per	specimen type	;		
antibiotic categories in which clinical MDR isolates presented resistance	Urine	Blood		Гissue	Total		
4 antibiotic categories	2	1			3		
5 antibiotic categories	5	1			6		
6 antibiotic categories	5	1		1	7		
7 antibiotic categories	2	1			3		
Total MDR	14	4		1	19		

RWS1, river water site 1; RWS2, river water site 2.

The resistance patterns exhibited by both environmental and clinical *E. coli* isolates were classified into two categories: multiple resistant patterns (MRPs; resistance patterns to more than three antibiotic categories) and resistant patterns (RPs; resistance patterns to maximum of three different antibiotic categories).

MRPs were further separated into six sub-categories: (a) MRP1—related to ESBL production, exhibiting resistance to penicillin/inhibitor combinations (such as AMC and TZP), expanded spectrum cephalosporins (such as CTX, CRO, CAZ and FEP) with or without resistance to monobactams (ATM) and positive DDST test; (b) MPR2—related to ESBL production, showing resistance to expanded spectrum cephalosporins (such as CTX, CRO, CAZ and FEP) with or

without resistance to monobactams (ATM) and positive DDST test; (c) MRP3—related to ESBL+carbapenemase production, showing resistance to expanded spectrum cephalosporins, carbapenemes (IMP and MEM) and positive DDST and CIM test; (d) MRP4—related to ESBL and AmpC production, showing resistance to cephamycins (FOX) and penicillin/inhibitor combinations (AMC and TZP) in addition to resistance to expanded spectrum cephalosporins; (e) MRP5—related to AmpC production, exhibiting resistance to cephamycins (FOX) and penicillin/inhibitor combinations (AMC and TZP) and negative DDST test and (f) other MRPs (MRP6–10) in which resistance to penicillins and to other non-β-lactam antibiotics (such as aminoglycosides, SXT and quinolones) was observed (**Table 3.4**). MRP2 and MRP1 were the most frequent MRPs among the MDR environmental and clinical isolates. Specifically, 32.3% (33/102) of the environmental MDR isolates presented an MRP1 pattern. Furthermore, fifty environmental and eight clinical isolates with ESBL-related MRPs presented concomitant resistance to quinolones (see **Table 3.4**).

Similarly, the RPs were further divided into five sub-categories: (a) RP1—related to ESBL production patterns with resistance to expanded spectrum cephalosporins and positive DDS test; (b) RP2—related to AmpC production with resistance to penicillins, penicillin/inhibitor combinations and cephamycin; (c) RPs3 (a–d), in which resistance to penicillins and to penicillin/inhibitor combinations with or without co-resistance to non- $\beta$ -lactam antibiotics, such as quinolones, aminoglycosides and SXT, was observed; (d) RPs4 (a–g), in which resistance to penicillins with or without co-resistance to non- $\beta$ -lactam antibiotics was observed and (e) RP5-6, in which only resistance to non- $\beta$ -lactam antibiotics was observed (**Table 3.5**). Our results show that RP3a was the most frequent RP among 183 R environmental (30.6%; 56/183) and among 64 R clinical isolates (29.6%; 19/64). Additionally, four R environmental isolates (two from RWS1 and two from RWS2) and one R clinical isolate were found to be potential ESBL producers.

		Environmental isolates (source)	Clinical isolates
	PEN/ PEN-inhibitor/ ESCs + SXT	1 (WWTP)	-
	PEN/ PEN-inhibitor/ ESCs + QNs	1 (HWW)	-
	PEN/ PEN-inhibitor/ ESCs/ ATM	2 (1 RWS1, 1 RWS2)	-
	PEN/ PEN-inhibitor/ ESCs/ ATM + QNs	8 (2 HWW, 3 WWTP, 3 RWS1)	-
MRP1: Related to ESBL production	PEN/ PEN-inhibitor/ ESCs/ ATM + AMG	2 (1 WWTP, 1 RWS2)	-
and resistance to penicillin/inhibitor combinations	PEN/ PEN-inhibitor/ ESCs/ ATM + SXT	-	1
	PEN/ PEN-inhibitor/ ESCs/ ATM + SXT + QNs	2 (1 HWW + 1 RWS2)	2
	PEN/ PEN-inhibitor/ ESCs/ ATM + AMG + QNs	2 (HWW)	3
	PEN/ PEN-inhibitor/ ESCs/ ATM + AMG + SXT + QNs	11 (HWW)	1
Total MRP1: 36	29	7	
	PEN/ ESCs/ ATM + QNs	8 (4 HWW, 3 RWS1, 1 RWS2)	-
	PEN/ ESCs/ ATM + AMG	3 (2 RWS1, 1 RWS2)	-
	PEN/ ESCs/ ATM + SXT	7 (6 WWTP, 1 RWS1)	-
MRP2: Related to ESBL production	PEN/ ESCs/ ATM + SXT + QNs	2 (WWTP)	1
	PEN/ ESCs/ ATM + AMG + SXT + QNs	8 (6 HWW, 2 RWS1)	-
	PEN/ ESCs/ ATM + AMG + QNs	4 (HWW)	-
	PEN/ ESCs + SXT + QNs	1 (WWTP)	-
Total MRP2: 34		33	1
MRP 3: Related to ESBL + carbapenemase production	PEN/ PEN-inhibitor/ ESCs/ CARB/ ATM + SXT	1 (RWS1)	-
Total MRP3: 1		1	-
	PEN/ PEN-inhibitor/ ESCs/ FOX/ ATM	2 (1 HWW, 1 RWS1)	1
<b>MRP 4:</b> Related to ESBL + AmpC β-	PEN/ PEN-inhibitor/ ESCs/ FOX/ ATM + AMG + SXT	-	1
lactamases production	PEN/ PEN-inhibitor/ ESCs/ FOX/ ATM + SXT + QNs	1 (HWW)	1
	PEN/ PEN-inhibitor/ ESCs/ FOX + AMG + SXT + QNs	2 (HWW)	-
Total MRP 4: 8		5	3

	PEN/ PEN-inhibitor/ FOX + AMG + QNs	1 (WWTP)		
lated to AmpC $\beta$ -lactamases	PEN/ PEN-inhibitor/ FOX + QNs	1 (WWTP)		
	PEN/ PEN-inhibitor/ NSCs/ FOX + AMG	2 (RWS1)	2	
5: 6		4	2	
6	PEN/ PEN-inhibitor+ SXT+ QNs		9 (2 WWTP, 4 RWS1, 3 RWS2)	1
	Total MRP6: 10	9	1	
Susceptibility to	PEN/ PEN-inhibitor+ AMG + SXT	10 (6 WWTP, 4 RWS1)	5	
cephalosporins	Total MRP7: 13	10	3	
with resistance to other non $\beta$ -lactam antibiotics	PEN/ PEN-inhibitor +AMG + SXT+ QNs	7 (1 HWW, 1 WWTP, 2 RWS1, 3 RWS2)	2	
	Total MRP8: 9	7	2	
1	PEN/ PEN-inhibitor+ AMG + QNs	1 (WWTP)	-	
	Total MRP9: 1	1		
	PEN+ AMG + SXT+ QNs	3 (2 WWTP, 1 RWS1)	-	
	Total MRP10: 3	3		
	Susceptibility to cephalosporins Penicillinase production with resistance to other	ated to AmpC $\beta$ -lactamases $ \begin{array}{c} QNs \\ PEN/ PEN-inhibitor/ FOX + QNs \\ PEN/ PEN-inhibitor/ NSCs/ FOX + AMG \\ \hline \\ AMG \\ \hline \\ \hline$	ated to AmpC $\beta$ -lactamases $ \begin{array}{c} QNs & 1 (WW1P) \\ PEN/ PEN-inhibitor/ FOX + QNs & 1 (WWTP) \\ PEN/ PEN-inhibitor/ NSCs/ FOX + 2 (RWS1) \\ \hline \\ St. 6 & 4 \\ \end{array} $ Susceptibility to cephalosporins Penicillinase production with resistance to other non $\beta$ -lactam antibiotics $\begin{array}{c} PEN/ PEN-inhibitor + SXT + QNs & 9 (2 WWTP, 4 RWS1, 3 RWS2) \\ \hline \\ Total MRP6: 10 & 9 \\ PEN/ PEN-inhibitor + AMG + SXT & 10 (6 WWTP, 4 RWS1) \\ \hline \\ Total MRP7: 13 & 10 \\ PEN/ PEN-inhibitor + AMG + SXT + 7 (1 HWW, 1 WWTP, 2 QNs \\ \hline \\ PEN/ PEN-inhibitor + AMG + SXT + 7 (1 HWW, 1 WWTP, 2 QNs \\ \hline \\ Total MRP8: 9 & 7 \\ PEN/ PEN-inhibitor + AMG + QNs & 1 (WWTP) \\ \hline \\ Total MRP9: 1 & 1 \\ \hline \\ PEN+ AMG + SXT + QNs & 3 (2 WWTP, 1 RWS1) \end{array} $	

Total MRPs: 121. Total environmental isolates with MRP: 102 and total clinical isolates with MRP: 19.

Abbreviations: MRP, multiple resistant patterns; ESBL, extended-spectrum-β-lactamase; PEN, penicillins; PEN– inhibitor, penicillin-inhibitor combinations; ESCs, Extended spectrum cephalosporins; SXT, sulfamethoxazoletrimethoprim; QNs, quinolones; ATM, aztreonam; AMG, aminoglycosides; CARB, carbapenems; FOX, cefoxitin; NSCs, narrow spectrum cephalosporins; HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1; RWS2, river water site 2.

			Environmental isolates (source)	Clinical Isolates	Tota
DD1. D.		PEN/ ESCs	4 (2 RWS1, 2 RWS2)	-	4
KP1: Ke	elated to ESBL production	PEN/ ESCs/ ATM	-	2	2
RP2: R product	elated to Ampc β-lactamases ion	PEN/ PENinhibitor/ FOX	-	1	1
RP3a		PEN/ PEN-inhibitor	56 (30 WWTP, 18 RWS1, 8 RWS2)	19	75
RP3b		PEN/ PEN-inhibitor + SXT	20 (3 HWW, 8 WWTP, 5 RWS1, 4 RWS2)	1	21
RP3c		PEN/ PEN-inhibitor + AMG	4 (3 WWTP, 1 RWS1)	2	6
RP3d		PEN/ PEN-inhibitor + QNs	18 (2 HWW, 9 WWTP, 3 RWS1, 4 RWS2)	-	18
RP4a		PEN	33 (13 WWTP, 18 RWS1, 2 RWS2)	8	41
RP4b		PEN + SXT	14 (2 WWTP, 10 RWS1, 2 RWS2)	4	18
RP4c		PEN + SXT+ QNs	11 (3 WWTP, 8 RWS1)	-	11
RP4d		PEN + QNs	10 (3 WWTP, 5 RWS1, 2 RWS2)	-	10
RP4e		PEN + AMG + QNs	-	1	1
RP4f		PEN + AMG	5 (1 WWTP, 2 RWS1, 2 RWS2)	1	5
RP4g		PEN + SXT + AMG	-	3	3
RP5		QNs	5 (3 HWW, 2 WWTP)	15	20
RP6	Resistant only to non β-lactam antibiotics	SXT	-	4	4
RP6a		SXT + QNs	3 (2 RWS1, 1 RWS2)	3	7

Abbreviations: RP, resistant patterns; ESBL, extended-spectrum-β-lactamase; PEN, penicillins; ESCs, extended-spectrum cephalosporins; ATM, aztreonam; PEN.-inhibitor, penicillin-inhibitor combination; FOX, cefoxitin; SXT, sulfamethoxazole-trimethoprim; AMG, aminoglycosides; QNs, quinolones; HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1; RWS2, river water site 2.

Furthermore, in the effort to detect any seasonal fluctuations in the R, MDR, WT/S, and N-WT populations of environmental and clinical *E. coli*, the following observations were made:

a) In the summer of 2019, the highest frequency of R isolates was observed, both among environmental (58%) and clinical (48%) isolates, as well as the highest frequency of MDR (22%) among clinical (**Figure 3.2**).

b) From the autumn of 2019 to the winter of 2019-2020, among the environmental isolates, the R populations continued to prevail over the wild-type (WT), but they showed a 3% decrease accompanied by a 12% increase in MDR (**Figure 3.2**). Regarding the clinical environment, it appeared that in the autumn of 2019, both the R and MDR populations decreased, while in the winter of 2019-20, there was an increase in R, with MDR remaining stable (**Figure 3.2**).

c) In the summer of 2020 (first wave of Covid-19), among the environmental strains, the WT was the predominant type, but during this period, the highest frequency of MDR (24%) was observed (**Figure 3.2**). During the same period, among the clinical strains, the R populations remained at the same levels as in the winter of 2019-2020, while the MDR populations decreased (**Figure 3.2**).

d) In the autumn of 2020 (first wave of Covid-19), among the environmental strains, there was a 10% increase in R isolates and a 3% decrease in MDR (Figure 3.2). At the same time, among the clinical strains, there was the greatest increase in R isolates but the lowest levels of MDR (Figure 3.2).

e) In the spring of 2021 (second wave of Covid-19), among the environmental populations, the R populations decreased, but the MDR remained stable (**Figure 3.2**). During the same period in the clinical populations, similar to the environmental, the R populations decreased, but there was a 13% increase in MDR (**Figure 3.2**).

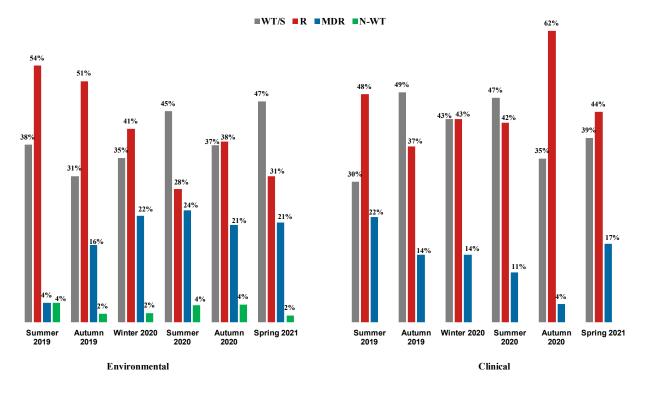


Figure 3.2 Seasonal changes in the populations of resistant (R), multidrug-resistant (MDR), wild -type/ susceptible (WT/ S) and non –wild type (N-WT) environmental and clinical E. coli *isolates* 

#### 3.3 Resistance genes detection

All of the potential  $\beta$ -lactamase producers (n = 84; 73 environmental and 11 clinical) were screened for  $\beta$ -lactamase genes. Thirty-five of the seventy- three potential  $\beta$ -lactamase producers from the environment were isolated from HWW, while the remaining ones were derived from the WWTP effluents (n = 14), RWS1 (n = 17) and RWS2 (n = 7). Regarding the eleven clinical potential  $\beta$ lactamase producers, seven, three and one were isolated from urine, blood and tissue, respectively. The characteristics of these isolates are shown in **Table 3.6**. The blaCTX-M-group 1-type gene was detected in 52 isolates (62%; 52/84), the blaCTX-M-group 9-type gene was identified in 7 isolates (8%, 7/84), the blaTEM gene was detected in 10 isolates (13%; 11/84) and the blaSHV gene was detected in 17 isolates (20%; 17/84) (**Table 3.6**).

One isolate with an MRP3 profile was positive after the CIM test, indicating the presence of carbapenemase. Via molecular carbapenemase screening, the isolate was found to be positive for the blaOXA-48-type gene, which was identified via sequencing coding for the OXA-244 enzyme (**Table 3.6** and **Table 3.7**). In four isolates with MRP-4, the blaDHA-type, blaCMY-type, and blaFOX-type genes were detected, coding for the AmpC-type enzymes (**Table 3.6** and **Table 3.7**). Detailed data for the detection rate of the  $\beta$ -lactamase genes in *E. coli* isolates derived from environmental and clinical samples are summarized in **Table 3.8**. The sequencing analysis confirmed the resistance genes with an identity value of 99% to 100% (**Table 3.7, Figure 3.3**).

Finally, the sull gene was detected in 22/29 MDR isolates exhibiting resistance to SXT (5 clinical, 7 from HWW, 6 from WWTP, 3 from RWS1 and 1 from RWS2).

## Table 3.6 Characteristics of environmental and clinical isolates harboring $\beta$ -lactamase genes

Isolate ID	Type of Sample/ Sampling site	Sampling Season	Phylogenetic group	Resistance Pattern	Resistance profile		DDST	CIM test	B-lactamases	Plasmid size (MDa)
297	Treated wastewater/WWTP outlet	Summer 2019	A	AMP, AMC, PIP, CAZ, CRO, ATM, AN	MDR	MRP1	+		SHV	21.8
344	HWW/septic tank	Autumn 2019	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL	MDR	MRP2	+		SHV	23.6, 15.77, 4.9
345	HWW/septic tank	Autumn 2019	A	AMP, PIP, CAZ, CTX, CRO, ATM, NAL	MDR	MRP2	+		SHV	40.2, 32.2, 9.5, 5.8
356	River water/RWS1	Autumn 2019	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM	MDR	MRP1	+		CTX-M group 1	6.4, 4.0
367	River water/RWS1	Autumn 2019	A	AMP, AMC, TZP, PIP, CXM, CAZ, CTX, FEP, FOX, CRO, ATM, MEM, IMP	MDR	MRP4	-	-	-	4.5
405	River water/RWS1	Winter 2020	D	AMP, AMC, PIP, CXM, CTX, CRO, ATM, CIP, NAL	MDR	MRP1	+		CTX-M group 1	32.2, 23.9
408	River water/RWS1	Winter 2020	D	AMP, AMC, TZP, PIP, TCC, CXM, CAZ, CTX, FEP, CRO, ATM, MEM, SXT	MDR	MRP3	+	+	CTX-M group 1, OXA-48	37.7, 16.4, 12.7
426	HWW/septic tank	Winter 2020	D	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	MRP1	+		SHV	37.7, 30.4, 12.7, 7.0
427	HWW/septic tank	Winter 2020	82	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	MDR	MRP1	+		SHV	39.1, 7.14, 6.6
431	HWW/septic tank	Winter 2020	82	AMP, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	MDR	MRP2	+		SHV	39.1, 7.14, 6.6
434	HWW/septic tank	Winter 2020	82	AMP, AMC, PIP, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	MRP1	+		SHV	33.9, 17.7, 10.3, 6.4
436	HWW/septic tank	Winter 2020	82	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, ATM, AN, CIP, NAL	MDR	MRP1	+		SHV	22.3
472	River water/RWS1	Summer 2020	A	AMP, AMC, PIP, CXM, CTX, CRO, ATM, NAL	MDR	MRP1	+		CTX-M group 9, TEM	28.6
477	River water/RWS1	Summer 2020	81	AMP, PIP, CXM, CAZ, CRO, ATM, CIP, NAL	MDR	MRP2	+		SHV	25.4, 4.0
491	Treated wastewater/WWTP outlet	Summer 2020	A	AMP, AMC, PIP, CXM, CTX, CRO, FEP, ATM, NAL	MDR	MRP1	+		CTX-M group 1	34.2
494	Treated wastewater/WWTP outlet	Summer 2020	81	AMP, AMC, PIP, CXM, CTX, CRO, SXT	MDR	MRP1	+		TEM	21.8, 5.6
497	Treated wastewater/WWTP outlet	Summer 2020	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	MRP1	+		CTX-M group 1	22.7
506	Treated wastewater/WWTP outlet	Summer 2020	D	AMP, PIP, CXM, CAZ, CTX, FEP, ATM, SXT, NAL	MDR	MRP2	+		CTX-M group 1	31.47
510	Treated wastewater/WWTP outlet	Summer 2020	82	AMP, PIP, CXM, CTX, CRO, SXT, CIP, NAL	MDR	MRP2	+		-	26.5
540	HWW/septic tank	Summer 2020	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	4,8, 4.0
542	HWW/septic tank	Summer 2020	A	AMP, AMC, PIP, CXM, CTX, CRO, CIP, NAL	MDR	MRP1	+		CTX-M group 1	-
543	HWW/septic tank	Summer 2020	A	AMP, AMC, PIP, CXM, CTX, CRO, FEP, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1, TEM	-

546	HWW/septic tank	Summer 2020	82	AMP, AMC, PIP, CXM, CAZ, CTX, CRO, FOX, ATM, NAL, CIP	MDR	MRP4	+	SHV, AmpC_CMY	24.4
550	HWW/septic tank	Summer 2020	A	AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, CIP, NAL	MDR	MRP4	-	-	5.6, 4.2
552	HWW/septic tank	Summer 2020	А	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO ATM, GM, SXT, CIP, NAL	MDR	MRP1	+	CTX-Mgroup 1	-
553	HWW/septic tank	Summer 2020	A	AMP, AMC, PIP, CXM, CTX, CRO, ATM, SXT, CIP, NAL	MDR	MRP1	+	CTX-Mgroup 1	24.5, 5.8, 4.1
555	HWW/septic tank	Summer 2020	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+	CTX-Mgroup 1	28.9, 10.6, 4.0
556	HWW/septic tank	Summer 2020	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL	MDR	MRP2	+	SHV	48.7, 27.4, 10.8
557	HWW/septic tank	Summer 2020	А	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+	CTX-M group 1, TEM, SHV	22.4
558	HWW/septic tank	Summer 2020	А	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+	CTX-Mgroup 1	4.8, 3.7
581	HWW/septic tank	Summer 2020	A	AMP, AMC, TZP, PIP, CXM, FOX, FEP, GM, SXT, NAL, CIP	MDR	MRP4	-	AmpC_FOX	35.6
594	River water/RWS1	Autumn 2020	81	AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	MRP2	+	SHV	22.0
<u>59</u> 5	River water/RWS1	Autumn 2020	82	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM	MDR	MRP2	+	CTX-Mgroup 1	25.4, 4.5
598	River water/RW51	Autumn 2020	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, NAL	MDR	MRP2	+	CTX-Mgroup 1	28.6
601	River water/RWS1	Autumn 2020	А	AMP, PIP, CXM, CAZ, CTX, FEP, CRO	R	RP1	+	CTX-Mgroup 9	28.6
602	River water/RWS1	Autumn 2020	А	AMP, PIP, CXM, CAZ, CRO, ATM	MDR	MRP2	+	-	30.3, 4.2
610	River water/RWS1	Autumn 2020	D	amp, Pip, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, NAL	MDR	MRP2	+	CTX-Mgroup 1	28.6
611	River water/RWS1	Autumn 2020	А	AMP, PIP, CXM, CTX, FEP, CRO	R	RP1	+	CTX-Mgroup 9	28.6, 4.8
614	River water/RWS2	Autumn 2020	А	AMP, PIP, CXM, CTX, FEP, CRO	R	RP1	+	CTX-Mgroup 9	30.9, 5.1
616	River water/RWS2	Autumn 2020	А	AMP, PIP, CXM, CTX, FEP, CRO	R	RP1	+	CTX-Mgroup 9	30.9, 5.1
618	River water/RWS2	Autumn 2020	А	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM	MDR	MRP1	+	CTX-Mgroup 9	29.8, 4.9
620	River water/RWS2	Autumn 2020	А	AMP, PIP, CXM, CTX, FEP, CRO, ATM, AN	MDR	MRP2	+	-	29.8, 5.1
630	River water/RWS2	Autumn 2020	A	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, AN	MDR	MRP1	+	-	30.9, 27, 5.2
638	Treated wastewater/WWTP outlet	Autumn 2020	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT, NAL	MDR	MRP2	+	CTX-M group 1	33.76, 22.6
645	Treated wastewater/WWTP outlet	Autumn 2020	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	MRP1	+	CTX-Mgroup 1	30.9, 27.0
673	HWW/septic tank	Autumn 2020	А	AMP, PIP, CAZ, CRO, ATM, NAL	MDR	MRP2	+	SHV	43.2, 29.3, 4.2

678	HWW/septic tank	Autumn 2020	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	31, 6.8, 3.1
680	HWW/septic tank	Autumn 2020	А	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	3.0, 2.0, 1.5
681	HWW/septic tank	Autumn 2020	А	AMP, PIP, CXM, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP2	+		CTX-M group 1	33.4, 4.9
682	HWW/septic tank	Autumn 2020	А	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	32.8, 2.2, 1.7, 1.3
683	HWW/septic tank	Autumn 2020	А	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	55.4, 40.2, 6.9, 5.0
684	HWW/septic tank	Autumn 2020	А	AMP, PIP, CXM, CTX, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP2	+		CTX-M group 1, TEM, SHV	2.4, 1.6
685	HWW/septic tank	Autumn 2020	А	AMP, PIP, CXM, CTX, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	-
686	HWW/septic tank	Autumn 2020	A	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP1	+		CTX-M group 1	-
738	River water/RWS1	Spring 2021	B2	AMP, AMC, TZP, PIP, CXM, FOX, CAZ, GM, AN	MDR	MRP5	-		TEM	50.7
739	River water/RWS1	Spring 2021	А	AMP, PIP, CXM, CAZ, CTX, CRO, ATM, CIP, NAL	MDR	MRP2	+		SHV	25.4
740	River water/RWS1	Spring 2021	А	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	MRP2	+		CTX-M group 1	25.4
748	River water/RWS1	Spring 2021	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, NAL	MDR	MRP1	+		CTX-M group 1	32.2, 25.4
785	River water/RWS2	Spring 2021	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, IMP, SXT, NAL	MDR	MRP1	+	-	CTX-M group 1	48.4
791	River water/RWS2	Spring 2021	D	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, CIP, NAL	MDR	MRP2	+		CTX-M group 1	28.24, 23.62, 7.4
792	Treated wastewater/WWTP outlet	Spring 2021	А	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	MRP2	+		CTX-M group 1	29.53, 24.7
801	Treated wastewater/WWTP outlet	Spring 2021	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	MRP2	+		CTX-M group 1	29.53, 17.28
802	Treated wastewater/WWTP outlet	Spring 2021	А	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	MRP2	+		CTX-M group 1	32.3
803	Treated wastewater/WWTP outlet	Spring 2021	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, SXT	MDR	MRP2	+		CTX-M group 1	25.3, 3.4
806	Treated wastewater/WWTP outlet	Spring 2021	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX	MDR	MRP2	+		CTX-M group 1	25.3, 5.4, 4.5
810	Treated wastewater/WWTP outlet	Spring 2021	B2	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX	MDR	MRP2	+		CTX-M group 9	28.3, 18.9, 7.4

836	HWW/septic tank	Spring 2021	82	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, CIP, NAL	MDR	MRP2	+	CTX-M group 1	
837	HWW/septic tank	Spring 2021	B2	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, AN, CIP, NAL	MDR	MRP2	+	CTX-M group 1	-
838	HWW/septic tank	Spring 2021	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP2	+	CTX-M group 1	38.6, 29.4, 26.4, 5.5
839	HWW/septic tank	Spring 2021	A	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, SXT, CIP, NAL	MDR	MRP2	+	CTX-M group 1	37.2, 6.3, 4.5
841	HWW/septic tank	Spring 2021	82	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, GM, AN, CIP, NAL	MDR	MRP2	+	CTX-M group 1	-
852	HWW/septic tank	Spring 2021	B2	AMP, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, AN, CIP, NAL	MDR	MRP2	+	CTX-M group 1	44.2
858	HWW/septic tank	Spring 2021	A	AMP, AMC, PIP, CXM, CAZ, CTX, FOX, CRO, ATM, IMP	MDR	MRP4		AmpC_CMY	50.3, 42.8, 8.3, 6.9
22cli	dinical/urine	Summer 2019	B2	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, AN, CIP, NAL	MDR	MRP1	+	CTX-M group 1	46.0, 33.0
54cli	dinical/urine	Summer 2019	82	AMP, AMC, PIP, TZP, TCC, CXM, CAZ, CTX, FEP, CRO, ATM, GM, AN, CIP, NAL	MDR	MRP1	+	CTX-M group 1, TEM	43, 27 .8
59cli	clinical/blood	Summer 2019	D	AMP, AMC, PIP, TZP, TCC, CXM, CAZ, CTX, FEP, CRO, ATM, SXT, NAL	MDR	MRP1	+	CTX-M group 1, TEM	35.0
60cli	dinical/urine	Summer 2019	82	AMP, AMC, PIP, TCC, CXM, CTX, CRO, ATM, AN, SXT, CIP, NAL	MDR	MRP1	+	CTX-M group 1	34.2
84cli	dinical/urine	Autumn 2019	D	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, FOX, ATM	MDR	MRP4	+	-	41.5
117di	dinical/urine	Autumn 2019	A	AMP, AMC, PIP, CXM, CAZ, CTX, FEP, CRO, ATM, STX	MDR	MRP1	+	CTX-M group 1, TEM	40.2, 29.2, 5.8, 5.2
203di	clinical/blood	Winter 2020	D	AMP, AMC, PIP CXM, CAZ, CTX, FOX, CRO, ATM, STX, NAL	MDR	MRP4	+	CTX-M group 1, TEM, AmpC_DHA	44.3, 40.2
294di	dinical/urine	Autumn 2020	82	AMP, PIP, CXM, CTX, CRO, ATM	R	RP1	+	CTX-M group 1	29.4
325di	clinical/blood	Winter 2021	A	AMP, PIP, CXM, CAZ, CTX, CRO, ATM	R	RP1	+	CTX-M group 1	40.2
333di	clinical/wound	Winter 2021	82	AMP, AMC, PIP, CXM, CTX, FEP, CRO, ATM, GM, CIP, NAL	MDR	MRP1	+	CTX-M group 1, SHV	27.9
350di	dinical/urine	Spring 2021	B2	AMP, PIP, CXM, CAZ, CTX, CRO, FEP, ATM, SXT, CIP, NAL	MDR	MRP2	+	CTX-M group 1	50.3, 40.2, 5.3

Abbreviations: DDST, double disk synergy test; HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, niver water site 1; RWS2, river water site 2; AMP, ampicillin; AMC, amoxicillin/clavulanic acid; TZP, piperacillin/ tazobactam; PIP, piperacillin; CXM, cefuroxime; CAZ, ceftazidime; CTX, cefotaxime; FOX, cefoxitin; FEP, cefepime; CRO, ceftriaxone; ATM, aztreonam; MEM, meropenem; IMP, imipenem; GM, gentamicin; AN, amikacin; SXT, sulfamethoxazole-trimethoprim; CIP, ciprofloxacin; NAL, nalidixic acid; MDR, multi-drug resistant; R, resistant.

E. coli isolates	NCBI Reference Sequence	bla gene	Query cover	Identity value
<i>E. coli</i> -22_CTX-M-group 1 (clinical/ urine)	NG_048935.1	blaCTX-M-15-like (ESBL)	99%	99.04%
<i>E. coli</i> -59_CTX-M-group 1 (clinical/ blood)	NG_048935.1	blaCTX-M-15-like (ESBL)	97%	99.27%
<i>E. coli</i> -60_CTX-M-group 1 (clinical/ urine)	NG_048935.1	blaCTX-M-15-like (ESBL)	99%	99.74%
<i>E. coli</i> -491_CTX-M group 1 (environmental/ WWTP)	NG_048897.1	blaCTX-M-1-like (ESBL)	96%	99.27%
<i>E. coli</i> -678_CTX-M-group 1 (environmental/ HWW)	NG_048935.1	blaCTX-M-15-like (ESBL)	95%	99.51%
<i>E. coli</i> -472_CTX-M-group 9 (environmental/ RWS1)	NG_049043.1	blaCTX-M-9-like (ESBL)	90%	99.39%
<i>E. coli</i> -616_CTX-M-group 9 (environmental/ RSW2)	NG_049043.1	blaCTX-M-9 (ESBL)	90%	100%
<i>E. coli</i> -618_CTX-M-group 9 (environmental/ RSW2)	NG_049043.1	blaCTX-M-9 (ESBL)	98%	100%
<i>E. coli</i> -858_CMY-2 like AmpC (environmental/ HWW)	NG_048834.1	blaCMY-4-like (AmpC type β- lactamases)	97%	99.81%
<i>E. coli</i> -581_FOX like AmpC (environmental/ HWW)	NG_068170.1	blaFOX-17 (AmpC type β- lactamases)	98%	100%
<i>E. coli</i> -408_OXA-48 like (environmental/ RWS1)	NG_049539.1	blaOXA-244 (carbapenemase_OXA- 48 family class D β-lactamase)	99%	100%
<i>E. coli</i> -297_SHV-like (environmental/ WWTP)	NG_050087.1	blaSHV-5-like (ESBL)	97%	99.14%
<i>E. coli</i> -333_SHV-like (clinical/ wound)	NG_050008.1	blaSHV-13-like (ESBL)	97%	99.57%
Ecoli-427_SHV- like_(environmental/HWW)	NG_050008.1	blaSHV-13-like (ESBL)	97%	99.13%
<i>E. coli</i> -739_SHV-like (environmetal/RWS1)	NG_050008.1	blaSHV-13 (ESBL)	97%	100%
<i>E. coli</i> -203_TEM-like (clinical/ blood)	NG_050186.1	blaTEM-143-like (ESBL)	99%	99.88%
<i>E. coli</i> -494_TEM-like (environmental/ WWTP)	NG_050239.1	blaTEM-207-like (ESBL)	99%	99.75%
<i>E. coli</i> -738_TEM-like (environmental/ RWS1)	NG_050186.1	blaTEM-143-like (ESBL)	99%	99.88%

		Clinical					
β-lactam	isolates	HWW	WWTP effluents	RWS 1	RWS2	Total	
	BlaCTX-M-group 1-type	10	22	10	8	2	52
ESBL genes	BlaCTX-M-group 9-type			1	3	3	7
	BlaSHV	1	12	2	3		17
	BlaTEM	4	3	2	3		12
Carbapenemase genes	BlaOXA-48-type				1		1
	BlaCMY-type		2				2
AmpC type genes	BlaFOX-type		1				1
	BlaDHA-type	1					1

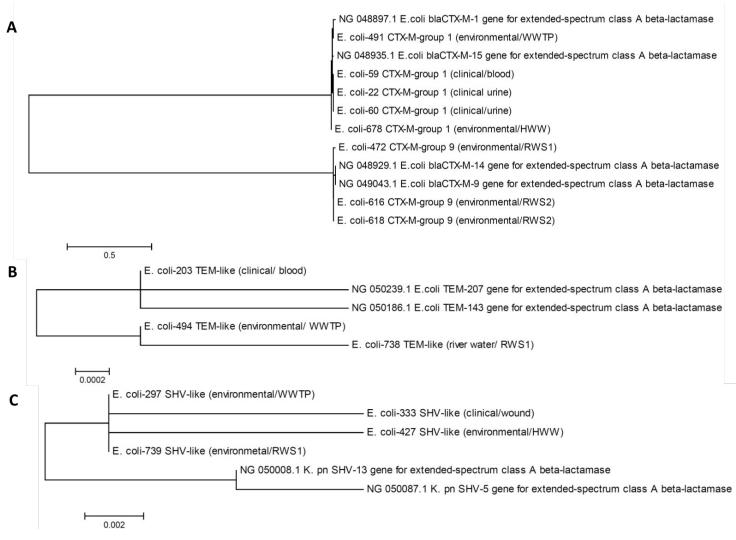


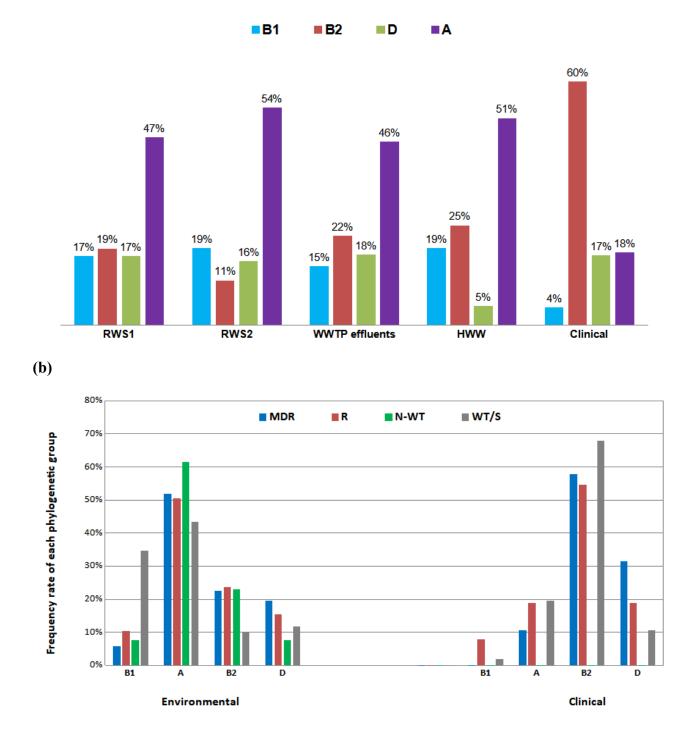
Figure 3.3 Maximum Likelihood phylogenetic trees for A) blaCTX-M-groups, B) blaTEM and C) blaSHV nucleotide sequences.

#### 3.4 Molecular typing analysis

#### 3.4.1 Phylogrouping typing results and statistical analysis

According to Clermont's schema *E. coli* isolates were classified into four main phylogenetic groups, A, B2, B1, and D. Based on results, There was a statistically significant correlation between the phylogenetic group and the origin of the sample [X2 (12, N = 641) = 110.63, p < 0.001)] (**Table 3.9a, b**). Group A was the predominant group (48%, 242/502) in all of the environmental sample sources, followed by B2 (20%, 102/502), B1 (17%, 85/502) and D (15%, 73/502) (**Figure 3.4a**). Moreover, the occurrence of group B2 was higher in the *E. coli* isolates from wastewater samples (WWTP effluents and HWW) compared to other environmental sources, after evaluating the adjusted ratios (**Table 3.9a, b**). In contrast to the environmental isolates, regarding the clinical isolates, group B2 was the predominant phylogenetic group (60%; 84/139), followed by A (18%, 25/139), D (17%, 24/139) and B1 (4%, 6/139) (**Figure 3.4a**). The above comparisons are in agreement with the adjusted ratios (**Table 3.9a, b**).

Furthermore, the chi-square test of independence showed that there was an association between the phylogenetic group and the resistance profiles [X2 (18, N = 641) = 184.09, p < 0.001] (**Table 3.10 a**, **b**). Group A was the dominant group among all of the *E. coli* populations, including MDR, R, WT and N-WT, in environmental samples, while group B2 was dominant in the clinical isolates, among all of the populations, including MDR, R and S (**Table 3.10a**, **b**; Figure 3.4b).



**(a)** 

Figure 3.4 (a) The distribution of each phylogenetic group among different habitats and (b) the relationship between phylogenetic groups and resistance profiles.

[Abbreviations: RWS1, river water site 1; RWS2, river water site 2; WWTP, wastewater treatment plant; HWW, hospital wastewater; MDR, multi-drug resistant; R, resistant; N-WT, non-wild type; WT, wild type]

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## Table 3.9a Examination of the relationship between phylogenetic groups and origin of the sample;Sample and Group Crosstabulation

				Grou	ıps		Total
			B1	B2	D	Α	Total
		Count	28	31	28	76	163
		Expected Count	23.1	47.3	24.7	67.9	163.0
	RWS1	Residual	4.9	-16.3	3.3	8.1	
		Standardized Residual	1.0	-2.4	.7	1.0	
		Adjusted Residual	1.3	-3.3	.8	1.5	
		Count	12	7	10	34	63
		Expected Count	8.9	18.3	9.5	26.2	63.0
	RWS2	Residual	3.1	-11.3	.5	7.8	
		Standardized Residual	1.0	-2.6	.2	1.5	
		Adjusted Residual	1.2	-3.3	.2	2.1	
		Count	25	38	30	78	171
		Expected Count	24.3	49.6	25.9	71.2	171.0
Samples	WWTP	Residual	.7	-11.6	4.1	6.8	
Sa		Standardized Residual	.1	-1.6	.8	.8	
		Adjusted Residual	.2	-2.3	1.0	1.2	
		Count	20	26	5	54	105
		Expected Count	14.9	30.5	15.9	43.7	105.0
	HWW	Residual	5.1	-4.5	-10.9	10.3	
		Standardized Residual	1.3	8	-2.7	1.6	
		Adjusted Residual	1.6	-1.1	-3.2	2.2	
		Count	6	84	24	25	139
		Expected Count	19.7	40.3	21.0	57.9	139.0
	Clinical	Residual	-13.7	43.7	3.0	-32.9	
		Standardized Residual	-3.1	6.9	.6	-4.3	
		Adjusted Residual	-3.8	9.2	.8	-6.4	

Total Count			91		186	97	267	641		
	Expected Count			91.0	186.0	186.0 97.0 267.0 6				
Table 3.9b Examination of the relationship between phylogenetic groups and origin of the sample;         Pearson's chi-square test results								mple;		
		Value		df	Asymptotic Significance (2-sided)					
Pearson Chi-Square		110.630a		12	<.001					
Likelihood Ratio		113.156		12	<.001					
Linear-by-Linear Association		10.731		1	.001					
N of Valid Cases 641										
a 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.94.										

Γ

				Gro	oups		Total
			B1	Α	B2	D	Iotai
		Count	6	53	23	20	102
		Expected Count	16.4	42.5	27.7	15.4	102.0
	MDR	Residual	-10.4	10.5	-4.7	4.6	
Environmental Resistance profile		Standardized Residual	-2.6	1.6	9	1.2	
nce p		Adjusted Residual	-3.1	2.3	-1.1	1.4	
esista		Count	19	92	43	28	182
ital K		Expected Count	29.2	75.8	49.4	27.5	182.0
nmen	R	Residual	-10.2	16.2	-6.4	.5	
Enviro		Standardized Residual	-1.9	1.9	9	.1	
		Adjusted Residual	-2.4	2.9	-1.3	.1	
	N-WT	Count	1	8	3	1	13
		Expected Count	2.1	5.4	3.5	2.0	13.0

		Residual	-1.1	2.6	5	-1.0	
		Standardized Residual	8	1.1	3	7	
		Adjusted Residual	8	1.5	3	8	
		Count	71	89	21	24	205
		Expected Count	32.9	85.4	55.6	31.0	205.0
	WT	Residual	38.1	3.6	-34.6	-7.0	
		Standardized Residual	6.6	.4	-4.6	-1.3	
		Adjusted Residual	8.8	.6	-6.6	-1.7	
		Count	1	11	38	6	56
	S	Expected Count	9.0	23.3	15.2	8.5	56.0
		Residual	-8.0	-12.3	22.8	-2.5	
		Standardized Residual	-2.7	-2.6	5.8	8	
		Adjusted Residual	-3.0	-3.5	7.2	-1.0	
file	MDR	Count	0	2	11	6	19
e pro		Expected Count	3.1	7.9	5.2	2.9	19.0
stanc		Residual	-3.1	-5.9	5.8	3.1	
Clinical Resistance profile		Standardized Residual	-1.7	-2.1	2.6	1.8	
Clir		Adjusted Residual	-1.9	-2.8	3.1	2.0	
		Count	5	12	35	12	64
		Expected Count	10.3	26.7	17.4	9.7	64.0
	R	Residual	-5.3	-14.7	17.6	2.3	
		Standardized Residual	-1.6	-2.8	4.2	.7	
		Adjusted Residual	-1.9	-3.9	5.2	.9	
Tota	1	Count	103	267	174	97	641
		Expected Count	103.0	267.0	174.0	97.0	641.0

# Table 3.10b Examination of the relationship between phylogenetic groups and resistance profile; Pearson's chi-square test results

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	184.099a	18	<.001
Likelihood Ratio	179.391	18	<.001
Linear-by-Linear Association	4.029	1	.045
N of Valid Cases	641		
a 5 cells (17.9%) have expected count	less than 5. The minim	um expected c	count is 1.97.

Additionally, in the effort to detect any seasonal fluctuations among the phylogenetic groups of both environmental and clinical *E. coli* isolates, it was found that:

Group A consistently remains the predominant group among environmental isolates across all seasons (**Figure 3.5**). However, in the winter of 2019-2020 and the spring of 2021 (second wave of Covid-19), the highest frequencies of group B2 were observed, at 35% and 28%, respectively (**Figure 3.5**). In the autumn of 2020 (first wave of Covid-19), an increase in group D was observed, with a frequency of 23% (**Figure 3.5**).

Regarding clinical strains, phylogenetic group B2 predominates in all seasons (**Figure 3.5**). A significant rise in group B2 was noted in the autumn of 2019 and the summer of 2020 (first wave of Covid-19), whereas group D increased in the autumn of 2020 (first wave of Covid-19) and in the spring of 2021 (second wave of Covid-19) (**Figure 3.5**).

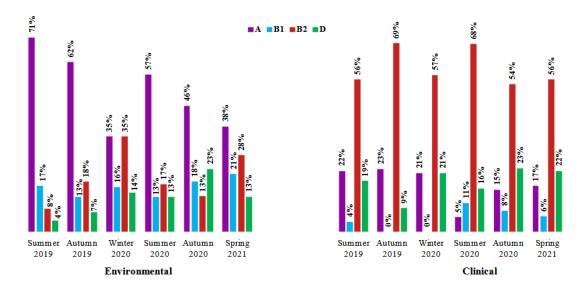


Figure 3.5 Seasonal changes in the phylogenetics groups among environmental and clinical E. coli isolates

#### 3.4.2. Pulsed field gel electrophoresis (PFGE) results

PFGE was applied to 51 representative MDR isolates derived from different environments (6 clinical isolates, 17 from HWW, 13 from WWTP effluents, 8 from RSW1, and 7 from RSW2), in order to group them into clusters based on the percentage similarity of their PFGE patterns. The results revealed considerable heterogeneity (**Figure 3.6**), even among strains such as those from the clinical setting and HWW, which have a very close epidemiological relationship. However, as illustrated in the **Figure 3.6**, certain isolates, that exhibited the same resistance pattern and carried the same resistance gene, such as 683, 684, 681 (derived for HWW) and the clinical isolate 350 (see Table 3.1), displayed the same PFGE pattern.

Among the clinical isolates, substantial heterogeneity was also observed, which is expected, given that most the clinical strains were not isolated from hospitalized patients (i.e., they are not related to nosocomial infections) but from emergency cases.

In conclusion, PFGE analysis revealed diverse genetic fingerprints and thus did not provide additional information on the molecular classification of the *E. coli* isolates.

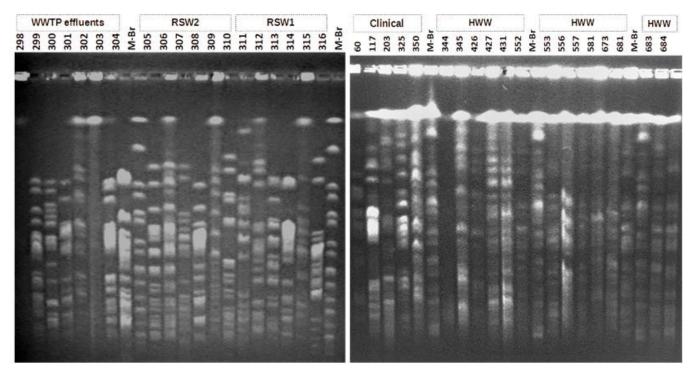


Figure 3.6 PFGE analysis; Diverse PFGE patterns of E. coli isolated from clinical and environmental samples.

[Abbreviations: HWW, hospital wastewater; WWTP, wastewater treatment plant; RWS1, river water site 1; RWS2, river water site 2]

#### 3.4.3 Plasmid typing resutls

According to the results of plasmid typing, plasmids with molecular size larger than 20 MDa were detected in sixty nine out of the eighty four  $\beta$ -lactamase producers that were subjected to this analysis. Eight isolates harbored small plasmids with a molecular size of less than 8 MDa, while no plasmids were detected in the remaining seven strains. The **Table 3.6** presents the results of plasmid typing (plasmid patterns) as well as and other characteristics (such as type of sample, resistance pattern, resistance gene, phylogenetic group) of the eighty four isolates that were analyzed.

Although the plasmid profiles showed heterogeneity, some strains exhibited similar or identical patterns, as with isolates 601, 611, 614, 616, 618, 620 shown in the **Figure 3.7**, which derived from river water (RWS1 and RWS2) and carry the ESBL gene blaCTX-M-group-9 (see **Table 3.6**).

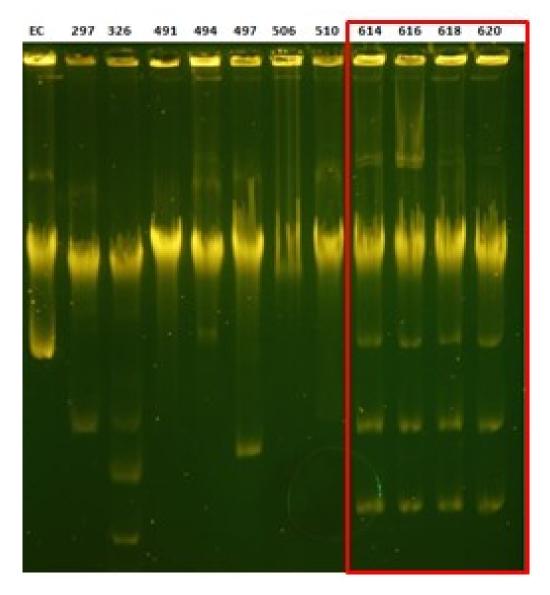


Figure 3.7 Electrophoresis of plasmid DNA.

#### 3.5 Results of resistance transfer frequency

Out of thirty three (27 environmental and 6 clinical) in only thirteen  $\beta$ -lactamase producing *E. coli* isolates, the conjugation experiments were successful in transferring  $\beta$ -lactam resistance at a high rate (**Table 3.11**). It is likely that the remaining 20 strains possessed non-conjugative plasmids or that the  $\beta$ -lactamase genes were chromosomally located. The majority of those thirteen paternal strains (donors) were characterized as MDR (84.3%; 11/13) and the most frequent resistance was to CTX and FEP (84.3%; 11/13) followed by the resistance to ATM (76.9%; 10/13). According to results of antimicrobial susceptibility test which was performed in all plasmid recipients isolates (transconjugants), their resistance patterns were similar or identical with their corresponding donors (**Table 3.11**). For  $\beta$ -lactams antibiotics the transmitted resistance reached 100% for CTX and ATM, and 83.3%, 81.8%, 50% and 25% for CAZ, FEP, FOX and AMC respectively (**Table 3.11**). For non  $\beta$ -lactams antibiotics, resistance to NAL was transferred to seven of the thirteen transconjugant clones (54%, 7/13), to TOB and SXT in three clones (23%, 3/13), and to CIP in one clone (7.6%, 1/13) (**Table 3.11**).

The plasmid sizes of the transconjugant clones ranged between 21-48 MDa, and most showed plasmid patterns similar to those of their corresponding parental strains (Table 3.11). PCR was used to detect  $\beta$ -lactamase genes in the transconjugant clones. According to PCR results, most of the transconjugant clones contained the same genes as their corresponding parental strains (Table 3.11). Of the thirteen parental strains capable of transferring plasmids, seven carried the blaCTX-Mgroup-1 gene, three carried the blaCTX-M-group-9 gene, and three carried the blaSHV-type gene. Additionally, four parental strains, 203cli, 408, 472, and 546, carried more than one  $\beta$ -lactamase gene (Table 3.11). Specifically, in parental clone 203cli, the  $\beta$ -lactamase genes blaCTX-M-group 1, blaTEM-type, and blaDHA-type were detected, in parental clone 408 the genes blaCTX-M group 1 and blaOXA-48-type, in parental clone 472 the genes blaCTX-M group 9 and blaTEM-type, and in clone 546 the genes blaSHV-type and blaCMY-type (Table 3.11). However, in the transconjugant clones derived from parental strains 203cli, 408, 472, and 546, which encoded more than one βlactamase, only the blaDHA-type (blaDHA-1), blaCTX-M group 1, blaCTX-M group 9, and blaSHV genes, respectively, were transferred. No clones were selected that transferred the blaCTX-M group 1 + blaTEM, blaOXA-48-type, blaTEM-type, and blaCMY-type genes. This explains the differences observed in resistance patterns between these specific transconjugant clones and their corresponding parental strains (Table 3.11) and leads to the conclusion that the genes are located on different genetic units. The inability to transfer the remaining genes may be due either to the very low frequency of plasmid transfer, which is undetectable under the applied laboratory conditions, or to the chromosomal location of the genes. Additionally, the resistance to non- $\beta$ -lactam antibiotics,

such as NAL, CIP, TOB, and SXT, observed in some transconjugant clones, suggests that the transferred plasmids carried multiple resistance genes and not only  $\beta$ -lactamase genes.

lsolate	Type of Sample/ Sampling site	Phylogenetic group	Resistance Pattern	DDS test	CIM test	β-lactamases	Plasmid profile (MDa)	Transfer frequency	Incompatibility group	Other resistance determinants
203cli	blood/urine	D	AMP, AMC, PIP, CAZ, CTX, CRO, FEP, ATM, FOX, IPM, MEM, SXT, NAL	-	-	CTX-M group 1, TEM, DHA-1	44.3, 40.2	0.087 <b>*</b> 10 <sup>-3</sup>	IncFII	qnrB4, sul1, dfrA17
trc203cli			AMP, AMC, PIP, CAZ, CTX, ATM, FOX, IPM, SXT, NAL	-	-	DHA-1	40.2		IncFII	qnrB4, sul1, dfrA17
294cli	urine/clinical	B2	AMP, PIP, CTX, CRO, FEP, ATM, SXT, NAL	+	NT*	CTX-M group 1	29.4	0.096*10 <sup>3</sup>	ND**	ND
trc294cli			AMP, PIP, CTX, CRO, FEP, ATM, SXT, NAL	+	NT	CTX-M group 1	29.4		ND	ND
297	wastewater/ WWTP	A	AMP, PIP, CAZ, ATM, NAL	+	NT	SHV-12	21.8	0.4*10 <sup>-4</sup>	IncX3	qnrS1, aac(6')-Ib3
trc297			AMP, PIP, CAZ, ATM, NAL	+	NT	SHV-12	21.8		IncX3	qnrS1, aac(6')-Ib3
408	river water/ RWS1	D	AMP, AMC, PIP, CTX, CRO, FEP, ATM, MEM, SXT	+	+	CTX-M group 1, OXA-48	37.7, 16.4, 12.7	0.098*10 <sup>-3</sup>	ND	ND
trc408			AMP, PIP, CTX, CRO, ATM	+	-	CTX-M group 1	37.7		ND	ND
472	river water/ RWS1	A	AMP, AMC, PIP, CTX, CRO, FEP, NAL	+	NT	CTX-M group 9, TEM	28.6	0.12*10 <sup>-4</sup>	ND	ND
trc472			AMP, PIP, CTX, CRO, FEP, NAL	+	NT	CTX-M group 9	28.6		ND	ND
506	wastewater/ WWTP	D	AMP, PIP, CTX, CRO, FEP, ATM, SXT, NAL	+	NT	CTX-M group 1	31.5	2.25*10 <sup>-2</sup>	ND	ND
trc506			AMP, PIP, CTX, CRO, FEP, ATM	+	NT	CTX-M group 1	31.5		ND	ND

 Table 3.11 Comparison of resistance traits between transconjugant and parental clones

546	HWW/ septic tank	82	AMP, AMC, PIP, CAZ, CTX, CRO, FEP, ATM, FOX, NAL, CIP	+	NT	SHV, CMY	24.4	0.29*10 <sup>-2</sup>	ND	ND
trc546			AMP, PIP, CAZ, CTX, CRO, FEP, ATM, NAL, CIP	+	NT	SHV	24.4		ND	ND
556	HWW/ septic tank	A	AMP, PIP, CAZ, ATM, NAL	+	NT	SHV	48.7, 27.4, 10.8	0.428*10 <sup>-2</sup>	ND	ND
trc556			AMP, PIP, CAZ, ATM, NAL	+	NT	SHV	48.7, 27.4		ND	ND
601	river water/ RWS1	A	AMP, PIP, CTX, CRO, FEP, TOB	÷	NT	CTX-M group 9	28.6, 5.4	0.83*10 <sup>-2</sup>	ND	ND
trc601			AMP, PIP, CTX, CRO, FEP, TOB	+	NT	CTX-M group 9	28.6		ND	ND
610	river water/ RWS1	D	AMP, PIP, CAZ, CTX, CRO, FEP, ATM, GM, TOB, SXT, NAL	+	NT	CTX-M group 1	28.6	0.11*10 <sup>-6</sup>	ND	ND
trc610			AMP, PIP, CTX, CRO, FEP, ATM, TOB	+	NT	CTX-M group 1	28.6		ND	ND
618	river water/ RWS2	A	AMP, PIP, CTX, CRO, FEP, ATM, TOB	+	NT	CTX-M group 9 (CTX-M-14)	29.8, <b>4</b> .9	0.875*10 <sup>-2</sup>	IncFil	mph(A), cml A1, aac(6')-Ib3, sul 1, qacE
trc618			AMP, PIP, CTX, CRO, FEP, ATM, TOB	+	NT	CTX-M group 9 (CTX-M-14)	29.8		Incfil	mph(A), cml A1, aac(6')-Ib3, sul 1, qacE
638	wastewater/ WWTP	D	AMP, PIP, CAZ, CTX, CRO, FEP, ATM, SXT, NAL	+	NT	CTX-M group 1	33.8, 22.6	0.16*10 <sup>-4</sup>	ND	ND
trc638			AMP, PIP, CAZ, CTX, CRO, FEP, ATM, SXT	+	NT	CTX-M group 1	33.8		ND	ND
791	river water/ RWS2	D	AMP, PIP, CTX, CRO, FEP, NAL	+	NT	CTX-M group 1	28.3, 23.6, 7.4, 4.5	0.58*10 <sup>-3</sup>	ND	ND
trc791			AMP, PIP, CTX, CRO, FEP, NAL	+	NT	CTX-M group 1	28.3		ND	ND
Trc: transco	onjugant clone									

•NT: not tested,

\*\*ND: not determined

Abbreviations: AMP, ampicillin; AMC, amoxicillin/clavulanic acid; TZP, piperacillin/ tazobactam; PIP, piperacillin; CXM, cefuroxime; CAZ, ceftazidime; CTX, cefotaxime; FOX, cefoxitin; FEP, cefepime; CRO, ceftriaxone; ATM, aztreonam; MEM, meropenem; IMP, imipenem; GM, gentamicin; AN, amikacin; TOB, Tobramycin; SXT, sulfamethoxazole-trimethoprim; CIP, ciprofloxacin; NAL, nalidixic acid, DDST, double disk synergy test; CIM, carbapenem inactivation method;

#### **3.6 NGS plasmid analysis:sequencing, assembly, annotation**

Sequencing of  $\beta$ -lactamase gene- carrying plasmids ptrc203cli, ptrc297, ptrc618 which harbored the genes blaDHA-type, blaSHV-type and blaCTX-M-group-1, respectively was performed using Oxford Nanopore Technology (ONT). Sequencing and the resulting reads are then subjected to quality filtering, assembly, and annotation using the Nanopore data analysis pipeline developed by Eurofins. The draft sequence of those plasmids was used for characterization of the  $\beta$ -lactamase genetic environment.

a) Genomic features of the plasmid ptrc203cli

Plasmid analysis reveal that the plasmid ptrc203cli, which was isolated from the transconjugant clone trc203cli, had a size of 81.582 bp and, according to the results of PlasmidFinder, belonged to the IncFII incompatibility group (**Figure 3.8a**). ResFinder results indicated that plasmid ptrc203cli carried multiple ARGs conferring resistance to extended- spectrum cephalosporins (blaDHA-1), sulfonamides (sul1), trimethoprim (trimethoprim-resistant dihydrofolate reductase gene, dfrA17) and reduced susceptibility to fluoroquinolones (quinolone resistance pentapeptide repeat gene, qnrB4) **Figure 3.9a**. The **Table 3.12** presents the results of ResFinder.

According to the analysis through Proskee, upstream of the blaDHA-1 (ampC) were also detected the transcriptional activator ampR, which regulate ampC  $\beta$ -lactamase expression. The resistance genes were flanked by transposable elements, specifically by insertion sequences (IS elements). Both the resistance genes and the IS elements were located in a specific section of the plasmid, approximately 19.500 bp in size, forming the multidrug resistance (MDR) region. More specifically, within this MDR region, the blaDHA-1 gene, the ampR gene, the qnrB4 gene, and the sul1 gene were located within a region flanked by IS26 sequences, forming the transposable genetic unit IS26-qnrB4...//..blaDHA-1-ampR-sul1-IS26-IS1R (**Figure 3.9a**).

According to the results of BLAST and BRIG analyses, the ptrc203cli plasmid showed a total coverage of 95% with the previously described plasmids pUB\_DHA-1 (GenBank accession no. MK048477.1) and p3-S1-IND-02-A (GenBank accession no. CP145649.1), with the identity in the covered regions reaching 99.95% and 100%, respectively (**Figure 3.10a**). These two reference plasmids, like ptrc203cli, had been detected in *E. coli* strains isolated from human biological samples, specifically from feces and urine

#### b) Genomic features of the plasmid ptrc297

Plasmid analysis shown that plasmid ptrc297, which was isolated from the transconjugant clone trc297cli, had a size of 46.338 bp and, according to the results of PlasmidFinder, was classified within the IncX3 incompatibility group (**Figure 3.8b**). ResFinder results indicated that plasmid

ptrc297 carried ARGs conferring resistance to extended- spectrum cephalosporins (blaSHV-12) and reduced susceptibility to quinolones (qnrS1). The **Table 3.12** presents the results of ResFinder for the plasmid ptrc297.

The ARGs and the IS elements were located on a ~10000 bp fragment of the ptrc297 plasmid, forming the resistance region. Specifically, this resistance region of ptrc297 was enclosed by the transposable elements ISKpn19 and IS26, within which the qnrS1 and blaSHV-12 genes were located, forming the genetic region ISKpn19 - qnrS1 - IS26 - blaSHV-12 - IS26 (**Figure 3.9b**). According to the BLAST and BRIG analyses, the ptrc297 plasmid had a coverage rate of 52%, 50%, and 49%, respectively, with the already characterized plasmids pCF12 (GenBank accession no. MT720906.1), pTKEC21-17 (GenBank accession no. CP092451.1), and pEC-147 (GenBank accession no. KX618702.1), while the identity in the regions where coverage was observed reached 99.9% in all three cases. Regarding the origin of the reference plasmids, the pCF12 plasmid was isolated from *Citrobacter freundii*, while the pTKEC21-17 and pEC-147 plasmids were isolated from *E. coli* isolates, which had been recovered from sewage and poultry feces, respectively (**Figure 3.10b**).

#### c) Genomic features of the plasmid ptrc618

Plasmid analysis reveal that the plasmid ptrc618, which was isolated from the transconjugant clone trc618, had a size of 104.665 bp and, and based on the PlasmidFinder results it belongs to incompatibility group IncFII (**Figure 3.8c**). ResFinder results indicated that plasmid ptrc618 harbored multiple ARGs conferring resistance to extended- spectrum cephalosporins (blaCTX-M-14), macrolides (mphA), aminoglycosides [aac (6')-Ib3] and chloramphenicol (cmlA1). The **Table 3.12** presents the results of ResFinder for the plasmid ptrc618.

The analysis through Proskee showed that the resistance genes and the adjacent transposable IS elements were located in a region approximately 25.000 bp in size, forming the MDR region of the plasmid. More specifically, within the MDR region were located: (a) the operon mphA-mrx(A)-mphR(A), which was linked to macrolide resistance, was bracketed by the elements IS26 (downstream) and IS6100 (upstream), (b) the integron type 1, which contained the integrase gene int1 and the genes aac(6')-Ib3, cmlA1, deltaqacE (antiseptic-resistance gene), sul1, and (c) the gene blaCTX-M-14, flanked by the transposable elements ISEcp1-IS903B (upstream) and ISEcp1-IS26 (downstream),

forming the transposable genetic structure IS26-- mphA-mrx(A)-mphR(A) -- IS6100...int1-aac(6')-Ib3 -- cmlA1 -- deltaqacE-- sul1—ISpsy43-- ISEcp1-IS903B -- blaCTX-M-14-- ISEcp1-IS26 (Figure 3.9c). The results from the analyses using the software BLAST and BRIG revealed that the plasmid ptrc618 had a total coverage of 93% and 88%, respectively, with the previously characterized plasmids pCTXM14\_005215 (GenBank accession no. CP092974.1) and pEC22-3 (GenBank accession no. CP060894.1). The similarity percentage for the regions covered was 99.9% in both cases. These two reference plasmids were isolated from *E. coli* strains detected in human biological samples (rectal swabs and sputum) (**Figure 3.10c**).

Both IncX3 and IncFII plasmids are conjugative, meaning they can spread resistance genes through horizontal gene transfer, but the range of species they can transfer to differs, with IncX3 having a broader reach. IncX3 plasmids can replicate in various Gram-negative bacteria, particularly within the Enterobacteriaceae family. Their host range is broader than some narrow host range plasmids but not as extensive as those with very broad host ranges. On the other hand, IncFII plasmids are primarily restricted to Enterobacteriaceae, such as *E. coli*, Salmonella spp, and Klebsiella spp. They do not typically replicate in as broad a range of hosts as IncX3 plasmids.

Table 3.12 R	esFinder resu	ults for p	lasmids pti	rc203cli, pt	trc297 and	l ptrc618		
plasmid	Resistance gene	Identity	Alignment Length/ Gene Length	Coverage	Position in reference	Position in contig	Phenotype	Accession no.
ptrc_203cli	blaDHA-1	99.91%	1140/1140	100	11140	32394378	Amoxicillin, Amoxicillin+Clavulanic acid, Ampicillin, Ampicillin+Clavulanic acid, Cefotaxime, Cefoxitin, Ceftazidime, Piperacillin, Piperacillin+Tazobactam, Ticarcillin, Ticarcillin,	Y16410
	qnrB4	100%	645/645	100.0	1645	8005380697	Ciprofloxacin	DQ303921
	sul1	100%	840/840	100.0	1840	59556794	Sulfamethoxazole	U12338
	dfrA17	100%	474/474	100.0	1474	7464575118	Trimethoprim	FJ460238
ptrc_297	blaSHV-12	100%	861/861	100	1861	1507615936	Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Piperacillin, Ticarcillin	KF976405
	qnrS1	100%	657/657	100	1657	1307413730	Ciprofloxacin	AB187515
	aac(6')-Ib3	100%	555/555	100	1555	8643586989	Amikacin, Tobramycin	X60321
ptrc_618	blaCTX-M-14	100%	876/876	100	1876	9231093185	Amoxicillin, Ampicillin, Aztreonam, Cefepime, Cefotaxime, Ceftazidime, Ceftriaxone, Piperacillin, Ticarcillin	AF252622
	mph(A)	100%	906/906	100	1906	8050581410	Erythromycin, Azithromycin, Spiramycin, Telithromycin	D16251
	cmlA1	99.92%	1260/1260	100	11260	8725688515	Chloramphenicol	AB212941

<u>Plasmid</u>	Identity Query / Iemplate length Contig Position in contig Note Accession number
IncEII	100 261 / 261 11108976295_trc203cli 7080971069 - AY458016
Extended Out	2ut:
<pre># IncFII_AY49</pre>	58016
template:	CACACCATCCTGCACTTACAATGCGCAGAAGGAGCGCGCGC
query:	CACACCATCCTGCACTTACAATGCGCAGAAGGAGCGAGCACAGAAAGAA
template:	TTCCGGGCATATAACTATACTCCCCGCATAGCTGAATTGTTGGCTATACGGTTTAAGTGG
query:	
template:	GCCCCGGTAATCTTTTCGTACTCGCCAAAGTTGAAGAAGATTATCGGGGTTTTTGCTTTT
query:	
template:	CTGGCTCCTGTAAATCCACATCAGAACCAGTTCCTTGCCACCTTACGGCGTGGCCAGCCA
query:	CTGGCTCCTGTAAATCCACATCAGAACCAGTTCCTTGCCACCTTACGGCGTGGCCAGCCA
template:	CAAAATTCCTTAAACGATCAG
query:	

### **(b)**

*******	*******	*****	*********	*****	******	*****
Plasmid		Query / Iemplate		Position in contig	Note	Accession number
******	******	******	*********	******	*******	*****
IncX3	100	374 / 374	11108795091_trc297_2	2316623539	-	JN247852
IncX3	99.73	374 / 374	11108795091_trc297_2	219592	-	JN247852

#### Extended Output:

-	<pre># IncX3_JN247852 template: ATGCGGTTGTTGCTATCTTTAGATATGAAGATCCTCAGATCTTCATATCTAAAGGTGAGA</pre>							
template:								
query:	ATGCGGTTGTTGCTATCTTTAGATATGAAGATCCTCAGATCTTCATATCTAAAGGTGAGA							
template:	GGTTTTTTAATTAAAGGTTGTATTGTTGTCTTGAATTACAACCTTTGTGGGGTTATGATT							
guery:	GGTTTTTTAATTAAAGGTTGTATTGTTGTCTTGAATTACAACCTTTGTGGGGGTTATGATT							
template:	TGCCTACATAGGAAAGGTTATATGAGGCTTATCGTGAAGACAGTAACGGGATTAACGAAA							
guery:	TGCCTACATAGGAAAGGTTATATGAGGCTTATCGTGAAGACAGTAACGGGATTAACGAAA							
template:	GTTAGACATAGAAATGAAGTTGGGGTAACTCTTGCATCCCTTTCCCCTTTCAGCAAAAAGA							
guery:	GTTAGACATAGAAATGAAGTTGGGGTAACTCTTGCATCCCTTTCCCCTTTCAGCAAAAAGA							
template:	GTGCTTTTTCTGGCTCTTTGCCAGATTGATACAAAGGAAATGTTAGATGATGATGATATTTTG							
guery:	GTGCTTTTTCTGGCTCTTTGCCAGATTGATACAAAGGAAATGTTAGATGATGATGATATTTTG							
template:	GAGGTTGATGCTGACTTTTTTTCAAAAGCTACTTCTTTAGATAAATATGCCTCTTATGCA							
guery:	GAGGTTGATGCTGACTTTTTTCAAAAGCTACTTCTTTAGATAAATATGCCTCTTATGCA							
template:	GCTCTGAAAGAGGG							
guery:	 GCTCTGAAAGAGGG							

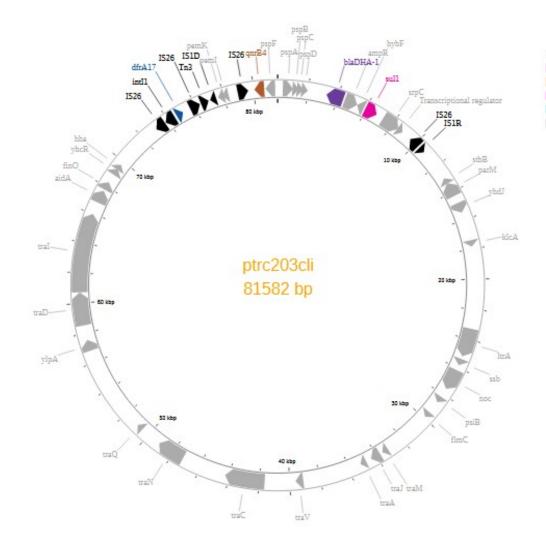
*******	*****	*****	*****	*****
Plasmid	Identity Query / Iemplate	length Contig	Position in contig	Note Accession number
IncEII	100 261 / 261		18_1 50255285	- AY458016
Extended Out	put:			
<pre># IncFII_AY4</pre>				
template:	CACACCATCCTGCACTTACAATGCGCAGAAAGAAGCGAGCG			
auery:				
Manager 1				
template:		CGCATAGCTGAATTGTTGGCTATACG		
2112211		CGCATAGCTGAATTGTTGGCTATACG		
query:	TTEEGGGEATATACTATACTEE	COCATAGETGAATTGTTGGETATACG	GTTTAAGTGG	
template:	GCCCCGGTAATCTTTTCGTACTCG	CCAAAGTTGAAGAAGATTATCGGGGT	TTTTGCTTTT	
query:	GCCCCGGTAATCTTTTCGTACTCG	CCAAAGTTGAAGAAGATTATCGGGGT	TTTGCTTT	
template:	CTGGCTCCTGTAAATCCACATCAG	AACCAGTTCCTTGCCACCTTACGGCG	TGGCCAGCCA	
query:	CTGGCTCCTGTAAATCCACATCAG	AACCAGTTCCTTGCCACCTTACGGCG	TGGCCAGCCA	
template:	CAAAATTCCTTAAACGATCAG			
query:	CAAAATTCCTTAAACGATCAG			

(c)

Figure 3.8 Results of PlasmidFinder regarding the plasmid compatibility groups a) ptrc203cli, b) ptrc297, and c) ptrc618

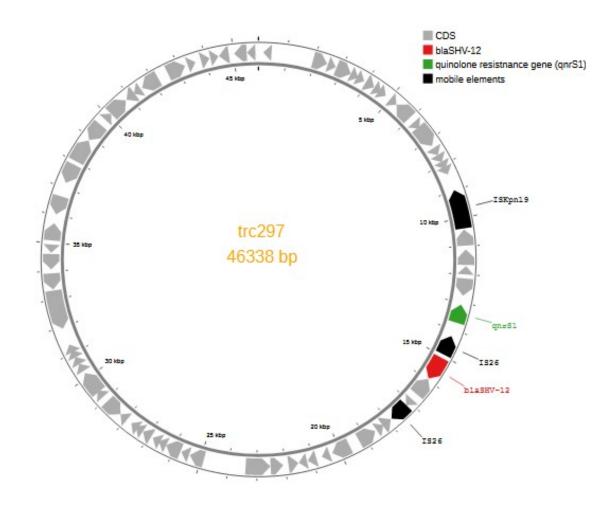
111

**(a)** 



#### CDS

- blaDHA-1 (B-lactamase, AmpC)
- qnrB4 (fluoroquinolones resistance gene)
- dfrA17 (trimethoprim resistance gene)
- mobile elements



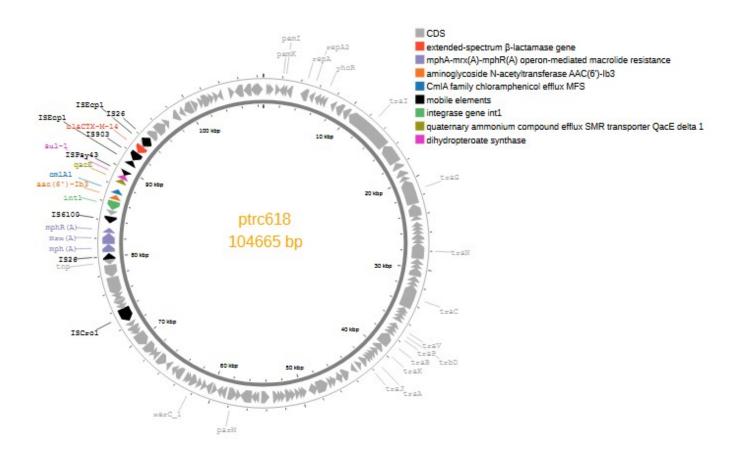
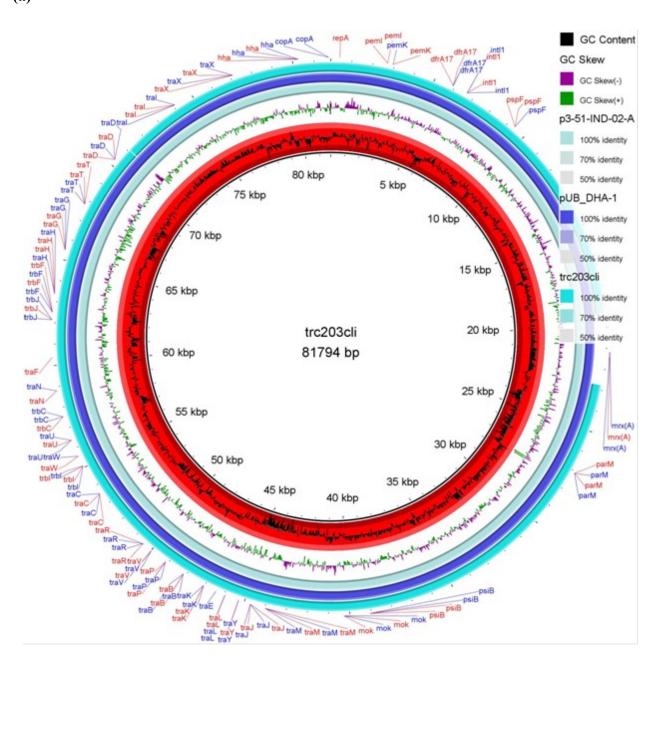
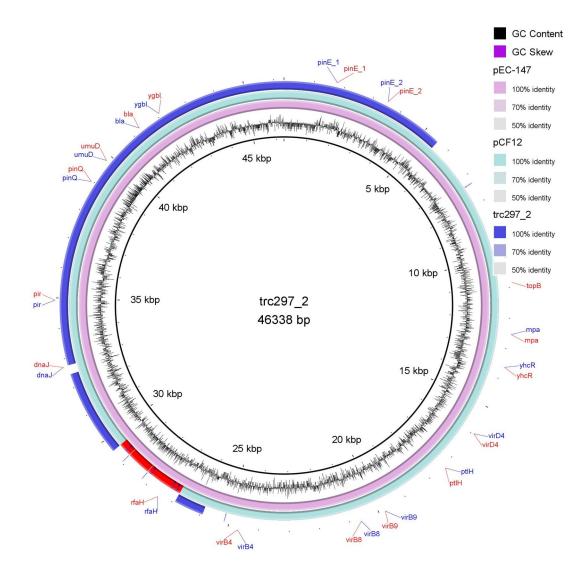


Figure 3.9 The plasmid maps constructed by proskee software and depict the resistance genes as well as the mobile elements which were identified in (a) ptrc203cli, (b) ptrc297 and (c) ptrc618.



**(b)** 



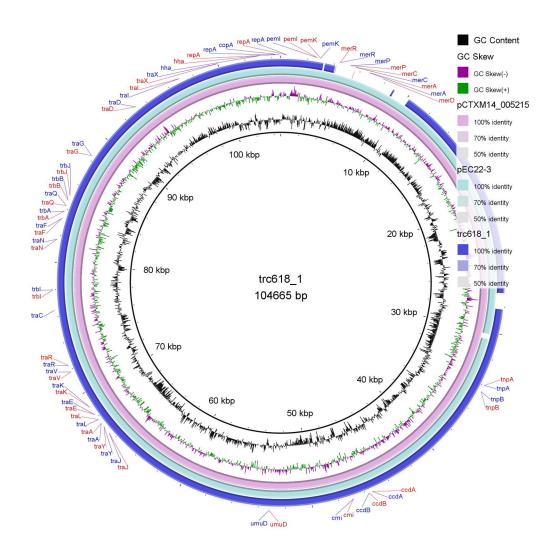


Figure 3.10 Comparative analysis of plasmids generated using BRIG. : (a) comparison between ptrc203cli, pUB\_DHA-1 and p3-S1-IND-02-A, (b) comparison between ptrc297, pEC-147 and pCF12. (c) comparison between ptrc618, pCTX-M-14\_005215 and pEC22-3.

#### 4. Discussion

The rise of antibiotic resistant bacteria (ARB), particularly multidrug-resistant (MDR) Enterobacterales, is a growing global health crisis [54, 55, 56]. These resistant organisms pose a significant threat to public health due to the diminishing effectiveness of standard antibiotic treatments [54, 55, 56, 57, 58]. In this context, the present study focused on assessing antimicrobial resistance patterns, detecting antimicrobial resistance genes associated with resistant phenotypes, determining the genetic environment of resistance genes, and identifying molecular genotypes in *E. coli* isolates derived from various environments, including wastewater, river water, and clinical samples [54, 56, 57, 58]. The study's findings underscore the critical role of environmental reservoirs in the persistence and dissemination of antimicrobial resistance, reinforcing the need for a One Health approach to combat AMR.

The One Health approach, which emphasizes the interconnectedness of human, animal, and environmental health, has gained traction in the fight against AMR [53, 54, 55]. *E. coli* is a fundamental fecal indicator and a reliable marker for tracking AMR trends [27, 40, 78]. Monitoring *E. coli* in environmental samples provides crucial data for assessing the spread and dynamics of AMR. [40, 78].

Our study supports this notion by demonstrating that treated wastewater and surface waters harbor *E. coli* isolates resistant to commonly used antibiotics, such as ampicillin (AMP), ciprofloxacin (CIP), sulfamethoxazole/trimethoprim (SXT), and extended-spectrum cephalosporins (ESCs) **[8, 18, 19, 113]**. Our results indicate that resistance to penicillins (AMP and PIP) was the most prevalent among both environmental and clinical isolates, while a high quinolone (CIP) resistance rate was also observed in HWW (see **Figure 3.1**) **[114, 115, 116, 117]**. These findings are consistent with previous studies in Europe and North America, which have documented the persistence of ARB in treated wastewater and surface waters, often due to the incomplete removal of these organisms by conventional wastewater treatment plants (WWTPs). The detection of MDR *E. coli* in these environments is particularly concerning, as it suggests that these water bodies could act as reservoirs for ARB and ARG that may re-enter human populations through various pathways, including irrigation of crops, recreational water use, and contamination of drinking water supplies **[7, 23-26, 84-89]**. Moreover, the presence of *E. coli* as a fecal indicator organism in these settings highlights the potential for these environments to facilitate the transmission of pathogens, further exacerbating public health risks **[27, 40, 78]**.

The study's findings also provide insights into the impact of the COVID-19 pandemic on AMR dynamics. The pandemic saw a significant increase in antibiotic use due to concerns about bacterial

co-infections in COVID-19 patients, despite its viral nature [**118**, **119**, **120**]. Studies have reported that up to 70% of COVID-19 patients received antibiotics, even though bacterial co-infections were relatively rare, occurring in less than 10% of cases [**118**, **119**]. This widespread use of antibiotics, particularly broad-spectrum agents like azithromycin and ceftriaxone, has raised concerns about the acceleration of AMR during the pandemic [**118-121**]. Although our study did not find significant differences in resistance patterns between the pre-COVID and COVID periods, these results may be attributed to limitations such as restricted sampling opportunities during lockdowns.

The increased use of antibiotics during the pandemic could potentially have long-term consequences on the spread of AMR [118-121]. The over-prescription of antibiotics, especially when not clinically indicated, contributes to the selection pressure that drives the evolution and spread of resistant strains [11-13, 119]. The potential for these resistant strains to enter environmental reservoirs, as suggested by our findings, further complicates efforts to control AMR, as these environments can serve as long-term reservoirs and sources of resistant bacteria.

Environmental settings, particularly water bodies contaminated by human and animal waste, have been identified as significant reservoirs for ARB, including several extended- spectrum cephalosporin- resistant E. coli (ESC-EC) [27, 39, 40, 78-86, 113, 114]. According to the results of this study, out of the 84 total ESC-EC isolates, the majority originated from wastewater (both hospital and treated wastewater) and involved ESBL-producing isolates. Specifically, ESBLproducers, particularly those from the CTX-M-group 1, which is the predominant type in both environmental and clinical settings, were widely isolated from various aquatic environments (such as rivers and lakes) as well as from hospitalized patients [114 -117, 122, 123, 124]. A portion of CTX-M-group1 producers isolated from patients' samples and wastewaters or river waters had the same resistance profiles, belonged to the same phylogenetic group and carried the same resistance gene (see Table 3.6). Isolates encoding blaCTX-M-group 9, another common subtype of blaCTX-M genes, were primarily found in river water samples, all of which shared the same plasmid pattern (see Table 3.6). Similarly to other studies [24, 35, 34, 125, 126], blaCTX-M-group 9, particularly the blaCTX-M-14 variant, are increasingly being detected in water sources, often linked to agricultural runoff and urban wastewater discharge. Furthermore, in hospital wastewater, blaSHV isolates were also commonly found, which may be related to the high prevalence of blaSHVproducing Enterobacteriales in clinical settings. [35, 34, 125, 126]. Regarding AmpC β-lactamase genes, two strains with blaCMY-4-like and one with blaFOX-17 were detected in hospital wastewater, while a clinical isolate with a blaDHA gene was also identified. In contrast to the widespread occurrence of ESC-EC, the presence of carbapenem-resistant E. coli, both in clinical and environmental populations, was very low. However, an isolate carrying the blaOXA-48 gene,

and specifically the variant blaOXA-244, was isolated from river water. According to other studies, this variant has been detected in river water, estuaries, and even drinking water [**63**, **78-90**].

According to the conjugation experiments conducted on a subset of ESC-EC strains, these genes were found to be located on conjugative plasmids, with a relatively high frequency of  $\beta$ -lactam resistance transfer. Moreover, in some conjugative clones, resistance to non-β-lactam antibiotics, (TOB), such as nalidixic acid (NAL), ciprofloxacin (CIP), tobramycin and sulfamethoxazole/trimethoprim (SXT), was also observed (see Table 3.11). This indicates that the acquired plasmid also co-transferred additional resistance genes, conferring resistance to other antibiotic groups such as (fluoro)quinolones and aminoglycosides, resulting in multidrug resistance. This observation was confirmed through the sequencing of three  $\beta$ -lactamase gene-carrying plasmids-ptrc203cli, ptrc297, and ptrc618-which harbored the genes blaDHA-1, blaSHV-12, and blaCTX-M-14, respectively (Table 3.11). Specifically, the plasmid ptrc203cli contained multiple antibiotic resistance genes (ARGs), including blaDHA-1 for resistance to extended-spectrum cephalosporins, sul1 for sulfonamides, dfrA17 for trimethoprim, and qnrB4 for reduced susceptibility to fluoroquinolones (Table 3.12, Figure 3.9a). Plasmid ptrc297 carried blaSHV-12, providing resistance to extended-spectrum cephalosporins, and qnrS1, which reduces susceptibility to quinolones (Table 3.12, Figure 3.9b). Plasmid ptrc618 harbored the mphA-mrx(A)-mphR(A) operon associated with macrolide resistance, along with aac(6')-Ib3 (aminoglycoside resistance), cmlA1 (chloramphenicol resistance), qacE (quaternary ammonium compounds resistance), and sull (sulfonamide resistance) (Table 3.12, Figure 3.9c). The plasmids ptrc203cli and ptrc618 were classified under the IncFII incompatibility group, while ptrc297 was categorized as IncX3. Both plasmid groups are conjugative and stable within bacterial hosts, commonly found in E. coli, Klebsiella pneumoniae, and other Enterobacteriaceae members, have been reported in both clinical and environmental isolates, and are associated with the dissemination of multidrug resistance [127, 128]. However, IncX3 plasmids are not as widespread as IncFII but have a somewhat broader host range compared to IncFII, potentially due to their smaller size and different replication mechanisms [127, 128]. Additionally, in all three of these plasmids, resistance genes or entire multidrug-resistant (MDR) regions were flanked by insertion sequence (IS) elements, particularly IS26, which facilitate the rearrangement and accumulation of resistance genes. This interplay between plasmids and IS elements significantly impacts the spread of multidrug resistance within bacterial populations [27, 37, 38, 39, 41, 127, 128].

To identify dominant genotypes in each habitat and their epidemiological relationships, the molecular technique of phylogrouping was applied. According to the phylogrouping results, in our clinical isolates, the B2 phylogroup predominated and was also the second most frequent group found in HWW and WWTP effluents (Figure 3.4a, Table 3.9a). Indeed, the B2 phylogenetic group

has been previously reported to be dominant in hospital environments [**129-132**]. Isolates from both groups B2 and D, known for their pathogenic potential, possessed the chuA gene[**108**], responsible for hemin utilization [**129- 134**]. This indicates a strong correlation between pathogenicity and phylogenetic groups B2 and D. In our study, a portion of clinical and environmental MDR and resistant (R) isolates were classified into phylogenetic groups B2 and D (Figure 3.4b), highlighting the significant human health risks associated with potential pathogenic R and MDR *E. coli* isolates from environmental sources such as rivers.

To detect potential changes in the frequency of each phylogenetic group in different environments before and during the COVID-19 pandemic, we observed that in the winter of 2019-2020 and the spring of 2021 (the second wave of COVID-19), the B2 group had the highest frequencies observed among environmental isolates, at 35% and 28%, respectively (**Figure 3.5**). Additionally, among environmental isolates, an increase in group D was noted in the autumn of 2020 (the first wave of COVID-19), with a frequency of 23% (**Figure 3.5**). Regarding clinical strains, a significant rise in group B2 was observed in the autumn of 2019 and the summer of 2020 (the first wave of COVID-19), while group D increased in the autumn of 2020 (the first wave of COVID-19), while group D increased in the autumn of 2020 (the first wave of COVID-19), while group D increased in the autumn of 2020 (the first wave of COVID-19) and the spring of 2021 (the second wave of COVID-19) (**Figure 3.5**), suggesting that pandemic-related changes in environmental conditions and human activity influenced microbial population dynamics.

Although Pulsed-Field Gel Electrophoresis (PFGE) is considered the gold standard for epidemiological analysis and a valuable tool for detecting nosocomial outbreaks, it is less effective when dealing with non-clonal, genetically diverse populations found in broader environments such as wastewater or river water. This makes it inadequate for identifying subtle molecular differences. This limitation has been demonstrated in several studies [135, 136, 137], as well as in our own findings, where PFGE revealed considerable heterogeneity, even among strains from clinical settings and hospital wastewater (HWW), which share a close epidemiological relationship. Furthermore, significant heterogeneity was observed even among the clinical isolates, which is expected, as most of these strains were not related to nosocomial infections. Therefore, this method did not provide additional insights into the molecular classification of the *E. coli* isolates.

To sum up, the reported results reveal that treated wastewater and river water are sources of resistant bacteria. The potential reuse of treated wastewater and river water, particularly for restricted crop irrigation depending on the method of watering (e.g., spraying), may expose humans to the risk of developing gastroenteritis, especially via droplet ingestion [138, 139, 140]. As E. coli is the leading cause of both community- and hospital-acquired UTIs, the detection of MDR strains in environmental samples raises significant public health concerns. For UTI treatment, the recommended antimicrobials are SXT, CIP, and AMC. In our study, *E. coli* strains that were found to be multidrug-resistant (MDR), including those with co-resistance to SXT, CIP, and AMC (Table

**3.4**), were isolated not only from the biological fluids of patients but also from all environmental habitats (see **Figure 3.1**). This demonstrates that human health risks can arise from exposure to MDR *E. coli* isolates present in waste and aquatic environments.

In our study, due to strict lockdown measures imposed during the COVID-19 pandemic, we were unable to carry out some samplings, which made seasonal analysis infeasible. Additionally, the molecular typing techniques employed did not provide adequate clustering information regarding the circulation of specific E. coli types between clinical settings and the environment. Nevertheless, this study represents the first systematic collection of E. coli isolates obtained from wastewater and river water samples from Livadeia, Greece, an area that combines urban life, husbandry, and agriculture. Despite these limitations, this study provides valuable insights into E. coli resistance profiles, the genotypes present, and the resistance mechanisms involved in the spread of resistance in wastewater and aquatic habitats. Future efforts will focus on conducting plasmid sequencing on additional E. coli isolates. This approach will yield comprehensive insights into the genetic context of circulating resistance genes and elucidate the molecular mechanisms contributing to antimicrobial resistance in these bacteria. The presence of antimicrobial-resistant (AR) E. coli isolates with the same multidrug-resistant profiles (MRPs) in clinical and hospital wastewater (HWW) samples sheds light on the spread of resistant bacteria in water bodies. The reported findings suggest a potential exchange of AR bacterial populations and similar AR determinants between clinical and environmental habitats. This raises concerns for public health, as aquatic environments could serve as reservoirs for the transmission of resistance genes to various bacterial species.

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