DNSC 6305: Data Management for Analytics Final Project- Group 1

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Ask 1 - Searching and Identifying a Dataset to Analyze

- Identify and describe your dataset
- Identify dataset source
- Why is important and what appeals to you about it
- Acquire data and perform initial exploration to make sure it is suitable for dimensional modeling and analytical analysis
- Describe the analytical questions you want to answer with the data. (3+ major questions are required)
- Describe any concerns with the data and changes you expect to overcome

Identify and describe your dataset

For the final project, Group 1 decided to examine a dataset on oil spill incidents that took place in the state of New York. The dataset provides administrative information about each spill that occurred in their DEC region, with a unique seven-digit spill number. Additionally, the dataset also provides information on the program facility name and location, the categorical entities responsible for the spill, the spill date, location, cause, material, material type, quantity spilled, quantity recovered, units measured, affected waterbody, and the close date of the incident (the date when the cleanup activity is complete and all the paperwork for the incident is processed). The dataset is accessible for download in CSV format through the data.gov link here: https://data.ny.gov/api/views/u44d-k5fk/rows.csv. The size of the dataset is 97 MB and was last updated on 12/10/2023, according to Data.gov. The dataset has 500,000+ transactional records and 20 variables. Each record represents a unique spill incident that occurred in the state of New York.

Identify dataset source

This dataset provides information to help monitor spill incidents that cause environmental damage in New York State, their causes, and their environmental impact. The goal of this dataset is to help the New York Department of Environmental Conservation work alongside

their goals to Protect public health, the environment, and improving the health, safety, and welfare of their people. The dataset is extracted from data.ny.gov, which is a website where NY State publishes open source datasets for the purpose of visualization and analysis.

Why is important and what appeals to you about it

Our group decided to choose this dataset for two reasons:

Firstly, our group wanted to conduct an analysis that would derive valuable insights on a significant topic, such as Environmental Change. Environmental Change is a critical issue that continues to impact us, and we believe that by conducting this analysis, we can identify ways that data and its analysis can be used for the greater good. Specifically, our analysis would help the New York State Department of Environmental Conservation in identifying leading causes of spill incidents, regions with the most environmental contamination, and which areas that require more remediation support. This information would enable the department to conduct more suitable remediation programs or enhance related regulations to benefit the overall environment in New York State.

Secondly, our group selected this dataset because we felt it was suitable for dimensional modeling and analysis. With more than 500,000 unique spill records and over 50 years of data, we believe there is enough transactional data for us to analyze and interpret spill occurrences. Furthermore, with specific columns like contributing_factor, waterbody, source, material_type, and county, we can zoom into specifics to truly understand spill incidents in NY.

Analytical questions we want to analyzie with this data

1) Analyze the top 5 waterbodies most significantly impacted by spill quantity and present details regarding the spilled materials and the recovery rate for each waterbody to give more insights into the effectiveness of remediation efforts

2) Analyze the top 5 sources responsible for spill incidents based on spill quantity and provide an in-depth breakdown of contributing factors associated to each source

3) Analyze the top and bottom 5 sources based on spill recovery rates to assess their efficiencies in resolving matter and identify the counties with better performance in cleaning spills by evaluating resolution rates and recovery rates

Concerns with the data and limits we expect to overcome

In examining the dataset, we identified a few issues that we decided to address before working with the data and analyzing relationships.

1) Using csvkit to remove the zip_code: The Zip Code column is empty for a majority of records (90.55%, 491,824/543,133 rows), it was acknowledged as a gap in the data by the data dictionary. We have ample other location-based columns in the data to analyze and determine patterns, including Street Intersections of the location (via street 1 and 2), Locality, Country, State-Wide Information System (SWIS) Code, and Department of

Environmental Correction (DEC) code 1-7. Additionally, Our analysis is on a state level, hence, the granualarity for Zip Code is not needed, instead, its better for us to examine spill incidents on a County Level.

2) Dropping and Removing Data from prior to 1978 up until 1996 using SQL (Analyzing 25 Years of Data, from 1997 up until 2023/present): We discovered records of spill dates prior to 1978, which raised concerns. According to the sponsor, the New York State Department of Environmental Conservation, the NY State Spill Fund began operating in 1978, but some spills in the dataset occurred before that year, rendering these spills more as estimates. Furthermore, we observed inconsistencies, such as quantities spilled or recovered with null values and different units for the same materials, in the dataset beyond 1978, up until 1996. We attribute these inconsistencies to advancements in technology and incident recording systems. Therefore, our group decided to remove all data from before 1978 until 1996, narrowing our focus to incidents that took place within the past 25 years only.

3) Addressing Null Values within our Data Columns using SQL: Among the 20 columns in our dataset. we have NULL values for street_2, locality, waterbody, and units. We want our want to uniquely identify null values, we decide to change null values as zero for our analysis to ensure that the data would be consistent when running queries and doing visualizations.

4) Addressing Test Records with our data using SQL: We remove records that have "TEST" or "TEST SPILL" within the Program Facility Name as these are clearly test records based on the information within their remaining columns. The number of records of "TEST" or "TEST SPILL" within the Program Facility Name is 15 records. We decided to drop this to avoid inconsistencies when running our queries.

5) Concerns with the Received and Close Date Columns within the spills table: While we were wrangling the data, we discovered NULL values in both the Received Date and Close Date columns. We decided to drop these NULL values. Firstly, NULL values for "Close Date" can indicate either that spills hasn't been cleared yet or that the information is not available. Based on this, We believe we cannot be reasonably sure how to replace these NULL, hence we decided not to. Additionally, in terms of the Received Date the replacing NULL Values would also be merely on assumption rather than reasonable certainity, hence we decided not to drop the NULLs for received date as well.

Acquire data and perform initial exploration to make sure it is suitable for dimensional modeling and analytical analysis

To examine whether the data is suitable for dimensional modeling and analysis, we decided to run a few preliminary lines of code to load the data and examine its records using CSVkit. Below are the steps we took to check whether the data would be applicable for the case and for the analysis part of the assignment

Step 1: Loading the data using !wget

In [181…

```
!wget https://data.ny.gov/api/views/u44d-k5fk/rows.csv
```

```
--2023-12-11 05:10:42--  https://data.ny.gov/api/views/u44d-k5fk/rows.csv
Resolving data.ny.gov (data.ny.gov)... 52.206.140.205, 52.206.140.199, 52.206.68.2
6
Connecting to data.ny.gov (data.ny.gov)|52.206.140.205|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [text/csv]
Saving to: ‘rows.csv’

rows.csv                [         <=>         ]  92.05M  3.62MB/s    in 24s

2023-12-11 05:11:06 (3.87 MB/s) - ‘rows.csv’ saved [96524178]
```

Step 2: Using !wc -l to count the number of spills recorded within the data

In [182…
```
!wc -l rows.csv
```

```
543162 rows.csv
```

Step 3: Using !csvcut -n to list the columns that we will be examining

In [183…
```
!csvcut -n rows.csv
```

```
  1: Spill Number
  2: Program Facility Name
  3: Street 1
  4: Street 2
  5: Locality
  6: County
  7: ZIP Code
  8: SWIS Code
  9: DEC Region
 10: Spill Date
 11: Received Date
 12: Contributing Factor
 13: Waterbody
 14: Source
 15: Close Date
 16: Material Name
 17: Material Family
 18: Quantity
 19: Units
 20: Recovered
```

Step 4: Using multiple !csvcut linux codes to see the dataset and it's 20 different columns

In [184…
```
!csvcut -c1:5 rows.csv | head -5| csvlook
```

```
| Spill Number | Program Facility Name | Street 1           | Street 2 | Locality
|
| ------------ | --------------------- | ------------------ | -------- | --------
|
|      107,132 | MH 864                | RT 119/MILLWOOD RD |          | ELMSFORD
|
|      405,586 | BOWRY BAY             | WATER POLL CONTROL |          | QUEENS
|
|      405,586 | BOWRY BAY             | WATER POLL CONTROL |          | QUEENS
|
|      204,667 | POLE 16091            | GRACE AVE/BURKE AVE |          | BRONX
|
```

In [185…
```
!csvcut -c6:11 rows.csv | head -5| csvlook
```

```
| County      | ZIP Code | SWIS Code | DEC Region | Spill Date | Received Date |
| ----------- | -------- | --------- | ---------- | ---------- | ------------- |
| Westchester |          |     6,000 |          3 | 2001-10-10 |    2001-10-10 |
| Queens      |          |     4,101 |          2 | 2004-08-21 |    2004-08-21 |
| Queens      |          |     4,101 |          2 | 2004-08-21 |    2004-08-21 |
| Bronx       |          |       301 |          2 | 2002-08-02 |    2002-08-02 |
```

In [186…
```
!csvcut -c12:17 rows.csv | head -5| csvlook
```

```
| Contributing Factor | Waterbody  | Source                | Close Date | Material
Name    | Material Family |
| ------------------- | ---------- | --------------------- | ---------- | --------
-------- | --------------- |
| Unknown             |            | Unknown               | 2001-10-15 | unknown
material | Other           |
| Other               | EAST RIVER | Unknown               | 2004-09-17 | raw sewa
ge       | Other           |
| Other               | EAST RIVER | Unknown               | 2004-09-17 | raw sewa
ge       | Other           |
| Equipment Failure   |            | Commercial/Industrial | 2002-10-28 | transfor
mer oil  | Petroleum       |
```

In [187…
```
!csvcut -c17:20 rows.csv | head -5| csvlook
```

```
| Material Family | Quantity | Units   | Recovered |
| --------------- | -------- | ------- | --------- |
| Other           |       10 | Gallons |     False |
| Other           |        0 | Pounds  |     False |
| Other           |        0 |         |     False |
| Petroleum       |        1 | Gallons |     False |
```

Thoughts on the Data:

Our group believes that this data was suitable for dimensional analysis for two reasons:

1. The data has many columns, which will help us build a robust Star Schema and understand each spill based on particular factors like what contributed to it, what material it exposed, and which waterbody it harmed.

2. There is a significant number of records—more than 500,000—which will make it more reliable to analyze causal relationships between spills.

Question 1:

- Analyze the top 5 waterbodies most significantly impacted by spill quantity and present details regarding the spilled materials and the recovery rate for each waterbody to give more insights into the effectiveness of remediation efforts.

Question 2:

- Analyze the top 5 sources responsible for spill incidents based on spill quantity to provide an in-depth breakdowns of contributing factors associated with each source, offering insights into the factors contributing to spills.

Question 3:

- Analyze the top and bottom 5 sources based on spill recovery rates to assess the efficiencies of cleanup strategies. Identify the DEC region with better performance in cleaning spills by evaluating resolution rates and recovery rates. Provide guidance on how other DEC regions can benchmark their efforts to achieve cleaner and safer environments in New York State.

In [188…
```
!pwd
```

```
/home/ubuntu/notebooks/FinalProject
```

Additional Information on the Dataset

Read more about the Dataset from its Overview:

Please run the code below and it will save a file called "NYSDEC_SpillIncidents_Overview.pdf" in your Working Directory. Open it from your Working Directory to read more!

In [189…
```
!curl -L "https://data.ny.gov/api/views/u44d-k5fk/files/dkNFaHGMV5gZ-YPfr7TdMFOyrII
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  203k    0  203k    0     0  1476k      0 --:--:-- --:--:-- --:--:-- 1476k
```

Read more about the Dataset from its Data Dictionary:

Please run the code below and it will save a file called "NYSDEC_SpillIncidents_DataDictionary.pdf" in your Working Directory. Open it from your Working Directory to read more!

In [190…
```
!curl -L "https://data.ny.gov/api/views/u44d-k5fk/files/r1xCv2Mbfw9yYB8TKrXtrNtESqj
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  201k    0  201k    0     0  1675k      0 --:--:-- --:--:-- --:--:-- 1675k
```

Loading SQL Extensions and Creating the Database on SQL

Our group decided to load the SQL extensions and created the SQL Database prior to Ask 2. We decided to do so to use SQL queries to clean and wrangle the data.

Step 1: Loading the SQL extension using `%load_ext sql`

In [1]:
```
%load_ext sql
```

Please Run the Step 2 and Step 3 ONLY ONCE

(You should avoid remaking the database because, you will be overwriting it with the SAME data)

Step 2: Dropping a Database with the Username ***Student*** and the Name ***Group1_FinalAssignment***

(Even though this Database may not exist yet, it is general practice when creating a database to drop any existing databases of the same name within the same Username to avoid overwriting them)

In [2]:
```
!dropdb -U student Group1_FinalAssignment
```

Step 3: Creating a Database with the Username ***Student*** and the Name ***Group1_FinalAssignment***

In [3]:
```
!createdb -U student Group1_FinalAssignment
```

Step 4: Connecting the SQL Extension to the Database by first connecting it to Username ***Student*** and then the Database within Student named ***Group1_FinalAssignment***

In [4]:
```
%sql postgresql://student@/Group1_FinalAssignment
```

Retreiving the Data Dictionary and Creating/Loading the Data onto our SQL Database

Step 1: Using `!head` to retrieve the first 20,000 rows of data from the spills.csv file and then use `csvstat` to run statistics on the records of data.

(This is helpful in providing us with a breakdown of the different columns within our data set offering insight into the Type of Data, Whether the specific column contains NULL values, and central tendencies of the data. This is provides us an idea of the dataset quickly and helps us create the Data Dictionary accurately)

In [5]:
```
!pwd
```

```
/home/ubuntu/notebooks/FinalProject
```

In [18]:
```
!head -n 20000 rows.csv | csvstat
```

/home/ubuntu/.local/lib/python3.8/site-packages/agate/table/from_csv.py:74: RuntimeWarning: Error sniffing CSV dialect: Could not determine delimiter

1. "Spill Number"

Type of data:	Number
Contains null values:	False
Unique values:	19308
Smallest value:	9
Largest value:	9975548
Sum:	114145879030
Mean:	5707579.33
Median:	8910269
StDev:	4237250.286
Most common values:	2301892 (10x)
	216106 (6x)
	360077 (5x)
	4879 (5x)
	903093 (4x)

2. "Program Facility Name"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	18115
Longest value:	58 characters
Most common values:	+ (144x)
	@ (42x)
	3RD AVE YARD (39x)
	13TH ST PUMP STATION (30x)
	26TH WARD PLANT (21x)

3. "Street 1"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	17764
Longest value:	50 characters
Most common values:	122-66 FLATLANDS AVENUE (41x)
	305 Sawyer Avenue (37x)
	222 FIRST STREET (28x)
	122-66 FLATLANDS AVE (28x)
	3245 RICHMOND TERRACE (23x)

4. "Street 2"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	861
Longest value:	40 characters
Most common values:	None (18988x)
	222 1ST STREET (28x)
	HURRICANE IRENE FLOOD SCHOHARIE CREEK (24x)
	SCHOHARIE CREEK HURRICANE IRENE FLOOD (23x)
	HURRICANE IRENE FLOOD SCHOHARIE CREEK (7x)

5. "Locality"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	1400
Longest value:	29 characters

Most common values:	BROOKLYN (2417x)
	MANHATTAN (2226x)
	BRONX (1645x)
	NEW YORK CITY (1380x)
	NEW YORK (1227x)

6. "County"

Type of data:	Text
Contains null values:	False
Unique values:	65
Longest value:	25 characters
Most common values:	Queens (4358x)
	New York (3785x)
	Kings (2990x)
	Bronx (2291x)
	Westchester (1022x)

7. "ZIP Code"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	414
Longest value:	10 characters
Most common values:	None (18189x)
	11693 (270x)
	11694 (257x)
	14150 (48x)
	11691 (29x)

8. "SWIS Code"

Type of data:	Number
Contains null values:	False
Unique values:	686
Smallest value:	101
Largest value:	8000
Sum:	62140553
Mean:	3107.183
Median:	3101
StDev:	1523.11
Most common values:	4101 (4358x)
	3101 (3785x)
	2401 (2990x)
	301 (2291x)
	4301 (843x)

9. "DEC Region"

Type of data:	Number
Contains null values:	False
Unique values:	9
Smallest value:	1
Largest value:	9
Sum:	60418
Mean:	3.021
Median:	2
StDev:	2.027
Most common values:	2 (14300x)
	3 (1645x)
	8 (1276x)

	7 (1246x)
	5 (512x)

10. "Spill Date"

Type of data:	Date
Contains null values:	True (excluded from calculations)
Unique values:	7514
Smallest value:	1911-11-11
Largest value:	2023-11-23
Most common values:	2012-10-29 (732x)
	2011-08-28 (85x)
	2006-06-28 (47x)
	1996-02-15 (18x)
	2008-09-16 (17x)

11. "Received Date"

Type of data:	Date
Contains null values:	True (excluded from calculations)
Unique values:	7027
Smallest value:	1900-06-28
Largest value:	2023-11-23
Most common values:	2012-11-13 (597x)
	2008-12-31 (492x)
	2009-12-31 (380x)
	2009-03-30 (344x)
	2010-06-30 (311x)

12. "Contributing Factor"

Type of data:	Text
Contains null values:	False
Unique values:	14
Longest value:	40 characters
Most common values:	Equipment Failure (5947x)
	Unknown (4908x)
	Other (1400x)
	Human Error (1353x)
	Tank Overfill (1327x)

13. "Waterbody"

Type of data:	Text
Contains null values:	True (excluded from calculations)
Unique values:	412
Longest value:	20 characters
Most common values:	None (18780x)
	EAST RIVER (132x)
	HUDSON RIVER (93x)
	SCHOHARIE CREEK (75x)
	KILL VAN KULL (47x)

14. "Source"

Type of data:	Text
Contains null values:	False
Unique values:	14
Longest value:	40 characters
Most common values:	Commercial/Industrial (6497x)
	Private Dwelling (5643x)

	Unknown (2527x)
	Institutional, Educational, Gov., Other (1393x)
	Commercial Vehicle (1255x)

15. "Close Date"

Type of data:	Date
Contains null values:	True (excluded from calculations)
Unique values:	6583
Smallest value:	1975-08-15
Largest value:	2023-11-29
Most common values:	2013-03-27 (572x)
	None (138x)
	2010-07-08 (127x)
	2011-03-30 (100x)
	1995-06-07 (75x)

16. "Material Name"

Type of data:	Text
Contains null values:	False
Unique values:	392
Longest value:	44 characters
Most common values:	#2 fuel oil (6690x)
	unknown petroleum (2991x)
	gasoline (1712x)
	#6 fuel oil (1269x)
	dielectric fluid (1130x)

17. "Material Family"

Type of data:	Text
Contains null values:	False
Unique values:	4
Longest value:	18 characters
Most common values:	Petroleum (17877x)
	Other (1666x)
	Hazardous Material (450x)
	Oxygenates (6x)

18. "Quantity"

Type of data:	Number
Contains null values:	False
Unique values:	248
Smallest value:	0
Largest value:	830000
Sum:	3551082.9
Mean:	177.563
Median:	0
StDev:	6907.628
Most common values:	0 (10416x)
	1 (2362x)
	5 (857x)
	10 (831x)
	2 (816x)

19. "Units"

Type of data:	Text
Contains null values:	True (excluded from calculations)

```
Unique values:          3
Longest value:          7 characters
Most common values:     Gallons (15310x)
                        None (3347x)
                        Pounds (1342x)
```

```
 20. "Recovered"

       Type of data:          Number
       Contains null values:  False
       Unique values:         140
       Smallest value:        0
       Largest value:         22900
       Sum:                   288591.53
       Mean:                  14.43
       Median:                0
       StDev:                 218.944
       Most common values:    0 (16848x)
                              1 (929x)
                              5 (243x)
                              10 (239x)
                              2 (206x)

Row count: 19999
```

Step 2: Creating our Table on SQL called spills and assigning the attributes datatypes with limits as per the results from the above csvstat result

(**Note:** it is general and common practice to drop a table from our database if it already exists to avoid overwriting it)

In [7]:
```
%%sql
DROP TABLE IF EXISTS spills;

CREATE TABLE spills (
    spill_number NUMERIC(8) NOT NULL,
    program_facility_name VARCHAR(100) NULL,
    street_1 VARCHAR(50) NULL,
    street_2 VARCHAR(50) NULL,
    locality VARCHAR(50) NULL,
    county VARCHAR(50) NULL,
    zip_code VARCHAR(50) NULL,
    swis_code NUMERIC(5) NOT NULL,
    dec_region INTEGER,
    spill_date DATE NULL,
    received_date DATE NULL,
    contributing_factor VARCHAR(50) NOT NULL,
    waterbody VARCHAR(30) NULL,
    source VARCHAR(50) NOT NULL,
    close_date DATE NULL,
    material_name VARCHAR(100) NOT NULL,
    material_family VARCHAR(20) NOT NULL,
    quantity NUMERIC(15) NOT NULL,
    units CHAR(8) NULL,
    recovered NUMERIC(15) NOT NULL
)
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[7]: []

Step 3: Loading our Table with the Data from our Directory Address.

Please Note that the Directory address will change based on where you open the file and in which notebook.

Please use `!pwd` to confirm your directory and add 'spills.csv' to the end of it to successfully run the code in Step 3.

In [8]:
```
!pwd
```

```
/home/ubuntu/notebooks/FinalProject
```

In [9]:
```
%%sql
COPY spills FROM '/home/ubuntu/notebooks/FinalProject/rows.csv'
CSV
HEADER;
```

```
 * postgresql://student@/Group1_FinalAssignment
543161 rows affected.
```

Out[9]: []

Ask 2 - Data Cleaning and Wrangling

- Based on ask 1, wrangle the data into a format suitable for dimensional modeling analysis. This may involve: – Cleaning, filtering, merging , modeling steps
- Describe your process as you proceed and document your notebook files, models
- Be specific about any key decision to modify or remove data. Describe how you overcame any challenges and document all assumptions you made

Part 1- Addressing Data Concerns

1. Using csvkit to remove the zip_code column using CSVkit and SQL

Step 1: Ensure that we are in the same directory, once again, using `!pwd`

In [10]:
```
!pwd
```

```
/home/ubuntu/notebooks/FinalProject
```

Step 2: Use `!csvcut -C` to remove the 7th column from the rows.csv file, which is the Zip Code column

In [11]:
```
!csvcut -C 7 rows.csv > spills.csv
```

Step 3: Remove downloaded csv file called rows.csv using `!rm` to clean up the working directory

In [12]:
```
!rm rows.csv
```

Step 4: Using `!wc-l` to count the number of records within the new csv file created called spills.csv to ensure that no data loss took place

In [13]:
```
!wc -l spills.csv
```

```
543162 spills.csv
```

Step 5: Using `!csvcut -n` to list the columns within the new csv file (named spills.csv) to ensure that the column named Zip Code was successfully removed

In [14]:
```
!csvcut -n spills.csv
```

```
  1: Spill Number
  2: Program Facility Name
  3: Street 1
  4: Street 2
  5: Locality
  6: County
  7: SWIS Code
  8: DEC Region
  9: Spill Date
 10: Received Date
 11: Contributing Factor
 12: Waterbody
 13: Source
 14: Close Date
 15: Material Name
 16: Material Family
 17: Quantity
 18: Units
 19: Recovered
```

Step 6: Drop the Column Zip Code from the SQL Database Table as well

Note: This is a crucial step that could create to confusion later on. We must drop the Zipcode Column within the SQL file as well to ensure consistency within our data!

In [15]:
```
%%sql
ALTER TABLE spills
DROP COLUMN zip_code
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[15]:
```
[]
```

Please Note: The Reason that we drop the column on our csv file and SQL is so, that we have can refer back to the csv file in our working directory if we need to throughout the process.

2. Dropping and Removing Data from before 1997 using SQL

Step 1: Ensure the SQL extension is loaded by running the code: `%load_ext sql`

In [16]:
```
%load_ext sql
```

```
The sql extension is already loaded. To reload it, use:
  %reload_ext sql
```

Step 2: Connecting the SQL Extension to the Database by first connecting it to Username ***Student*** and then the Database within Student named ***Group1_FinalAssignment***

In [17]:
```
%sql postgresql://student@/Group1_FinalAssignment
```

Step 3: Checking whether we are connected to the SQL Database by seeing whether we can access the Spills Table that we created in our SQL Database

In [18]:
```
%%sql
SELECT *
FROM spills
Limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[18]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code
107132	MH 864	RT 119/MILLWOOD RD	None	ELMSFORD	Westchester	6000
405586	BOWRY BAY	WATER POLL CONTROL	None	QUEENS	Queens	4101

Step 4: Dropping Data for Spill Incidents that took place before 1997 Using SQL `DELETE` and `WHERE` Statements.

Note: We are deleting records that took place before 1997 by looking at the spill_date column in our spills table, which is the date that each specific spill incident took place.

In [19]:
```
%%sql
DELETE FROM spills
WHERE spill_date < '1997-01-01';
```

```
 * postgresql://student@/Group1_FinalAssignment
153447 rows affected.
```

Out[19]:
```
[]
```

Step 5: Seeing the Number of Records after dropping spill incidents before 1997 Using the SQL Count(*) within our query

Note: We wanted to run this to make sure we still have sufficient data to analyze after we dropped records that occured prior to 1997. The count was greater 250,000 records, which meant that there was sufficient data to carry on with this data set.

In [20]:
```
%%sql
SELECT count(*)
FROM spills
```

```
 * postgresql://student@/Group1_FinalAssignment
1 rows affected.
```

Out[20]:

count
389714

3. Addressing NULL Values within our Data Columns using SQL

Step 1: Using SQL `UPDATE`, `SET`, and `CASE WHEN` Statements to Deal with NULLS within specific columns in our spills table.

Note: As mentioned above, We were made aware of the NULL Values in the Database after seeing the Data Dictionary in Ask 1, when we used `csvstat` in CSVkit. We generated data on the first 20,000 data records and noticed that these specific records had NULL Values. We decided to replace the NULL values with '0' within our database using `CASE WHEN` Statements so that with could uniquely identify NULLS and deal with NULL values in our queries in future SQL Queries for Ask 3. Please ensure that that the rows affected from this result is the same as the count above (in the previous query).

In [21]:
```
%%sql
UPDATE spills
SET
    street_1 = CASE WHEN street_1 IS NULL THEN '0' ELSE street_1 END,
    street_2 = CASE WHEN street_2 IS NULL THEN '0' ELSE street_2 END,
    locality = CASE WHEN locality IS NULL THEN '0' ELSE locality END,
    waterbody = CASE WHEN waterbody IS NULL THEN '0' ELSE waterbody END,
    units = CASE WHEN units IS NULL THEN '0' ELSE units END;
```

```
 * postgresql://student@/Group1_FinalAssignment
389714 rows affected.
```

Out[21]: []

Step 2: Using SQL `SELECT`, `FROM`, and `LIMIT` Statements to see the 5 rows from the spills table to check if the NULL values where dealt with

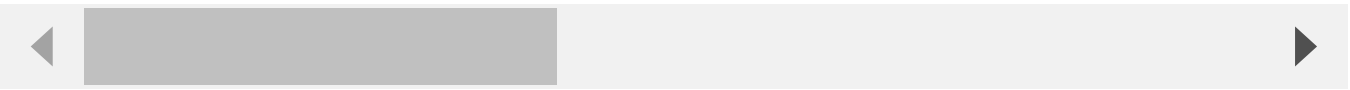
Note: We observed that the rows in the street_2 column has its NULL values which were replaced with '0', an indicator that we were able to convert the NULLS to '0' successfully.

In [22]:
```
%%sql
SELECT *
FROM spills
LIMIT 5;
```

```
 * postgresql://student@/Group1_FinalAssignment
5 rows affected.
```

Out[22]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code
107132	MH 864	RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000
405586	BOWRY BAY	WATER POLL CONTROL	0	QUEENS	Queens	4101
405586	BOWRY BAY	WATER POLL CONTROL	0	QUEENS	Queens	4101
204667	POLE 16091	GRACE AVE/BURKE AVE	0	BRONX	Bronx	301
210559	POLE ON	FERDALE LOMIS RD / RT 52	0	LIBERTY	Sullivan	5336



4. Addressing Test Records within our Data using SQL

Step 1: Finding All the Test Spills within our spills Table (Our Dataset)

Note: We were made aware that there are Test Spills within the dataset by examining the dataset in CSV format, hence we decided to find all these occcurences and drop them. In the SQL Query below you can have a look at these instances and note that they don't make up much records of the dataset hence, we can drop them.

In [23]:
```
%%sql
SELECT *
FROM spills
WHERE program_facility_name LIKE '%TEST SPILL%' OR program_facility_name LIKE '%***
```

```
 * postgresql://student@/Group1_FinalAssignment
15 rows affected.
```

Out[23]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
2301892	*** TEST SPILL ***	*** TEST SPILL ***	0	*** TEST SPILL ***	Onondaga	3415
1002983	****TEST GOWANUS BAY****	29TH ST AND 2ND	0	BROOKLYN	Kings	2401
908968	****TEST**** DEC	625 BROADWAY TEST	0	ALBANY	Albany	101
908968	****TEST**** DEC	625 BROADWAY TEST	0	ALBANY	Albany	101
909818	***TEST*** JOHN SMITH DRILL	1515 MOCKINGBIRD LN	0	ROTTERDAM	Schenectady	4728
	TEST SPILL COLONIE			LATHAM		

Step 2: Deleting all Records of the Test Spills within our spills Table (Our Dataset)

In [24]:

```
%%sql
DELETE FROM spills
WHERE program_facility_name LIKE '%TEST SPILL%' OR program_facility_name LIKE '%***
```

```
 * postgresql://student@/Group1_FinalAssignment
15 rows affected.
```

Out[24]: []

Step 3: Confirming that all the Test Spills were removed from our spills Table (Our Dataset)

Note: The result for this query should be '0 rows affected.'

In [25]:
```
%%sql
SELECT *
FROM spills
WHERE program_facility_name LIKE '%TEST SPILL%' OR program_facility_name LIKE '%***
```

```
 * postgresql://student@/Group1_FinalAssignment
0 rows affected.
```

Out[25]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code	dec_region	sp

5. Concerns with the Received and Close Date Columns within the spills table

As addressed above as well, we are unable to handle concerns with the Received and Close Dates for the Spills Table. It would be inaccurate to fill values within the records with NULL Dates because we cannot be reasonably sure about received and close dates and it would be merely an assumption on our end.

Part 2- Creating our Star Schema, Creating and Loading the Dimension Tables, and Making a Fact Table

Creating our Star Schema

Prior to beginning this part, it is important to examine the columns within the spills table to identify which attributes can serve as measures, which can be placed within fact tables, and plan the Star Schema. The Star Schema will help us create Dimension Tables to run SQL queries and understand causal relationships within the dataset.

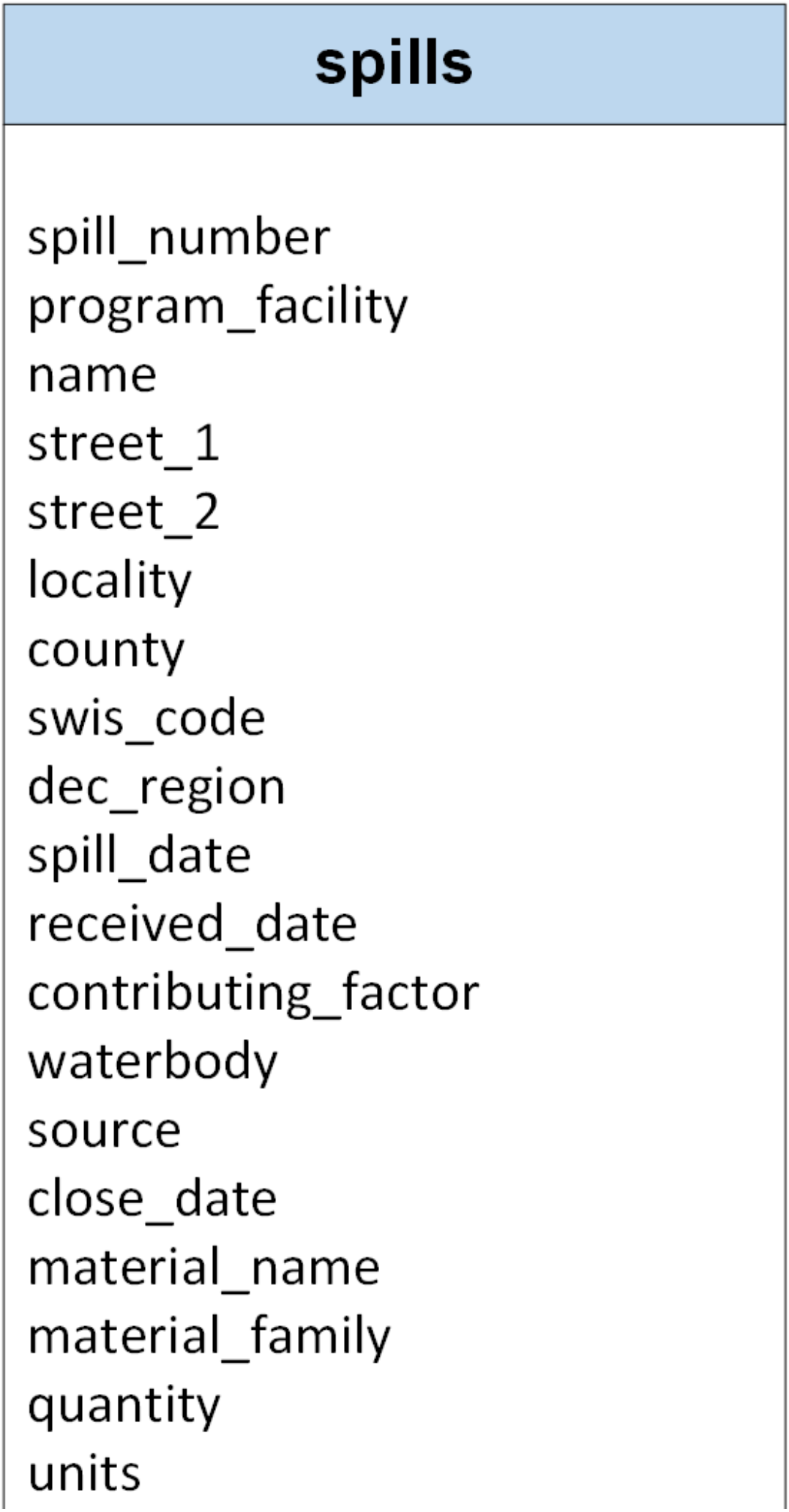
Note: This stage was done with our group in-person; however, we are uploading our Final Star Schema here to guide us in creating the multiple Dimension Tables and the single Fact Table.

Step 1: Write out all the attribues within the spills dataset for us to examine

Spills Dataset and its Attributes

In [26]:
```
from IPython.display import Image
Image(url="https://github.com/maneeshtekwani/DMFA_Group1_FinalAssignment/blob/main/
```

Out[26]:


spills
spill_number
program_facility
name
street_1
street_2
locality
county
swis_code
dec_region
spill_date
received_date
contributing_factor
waterbody
source
close_date
material_name
material_family
quantity
units

recovered

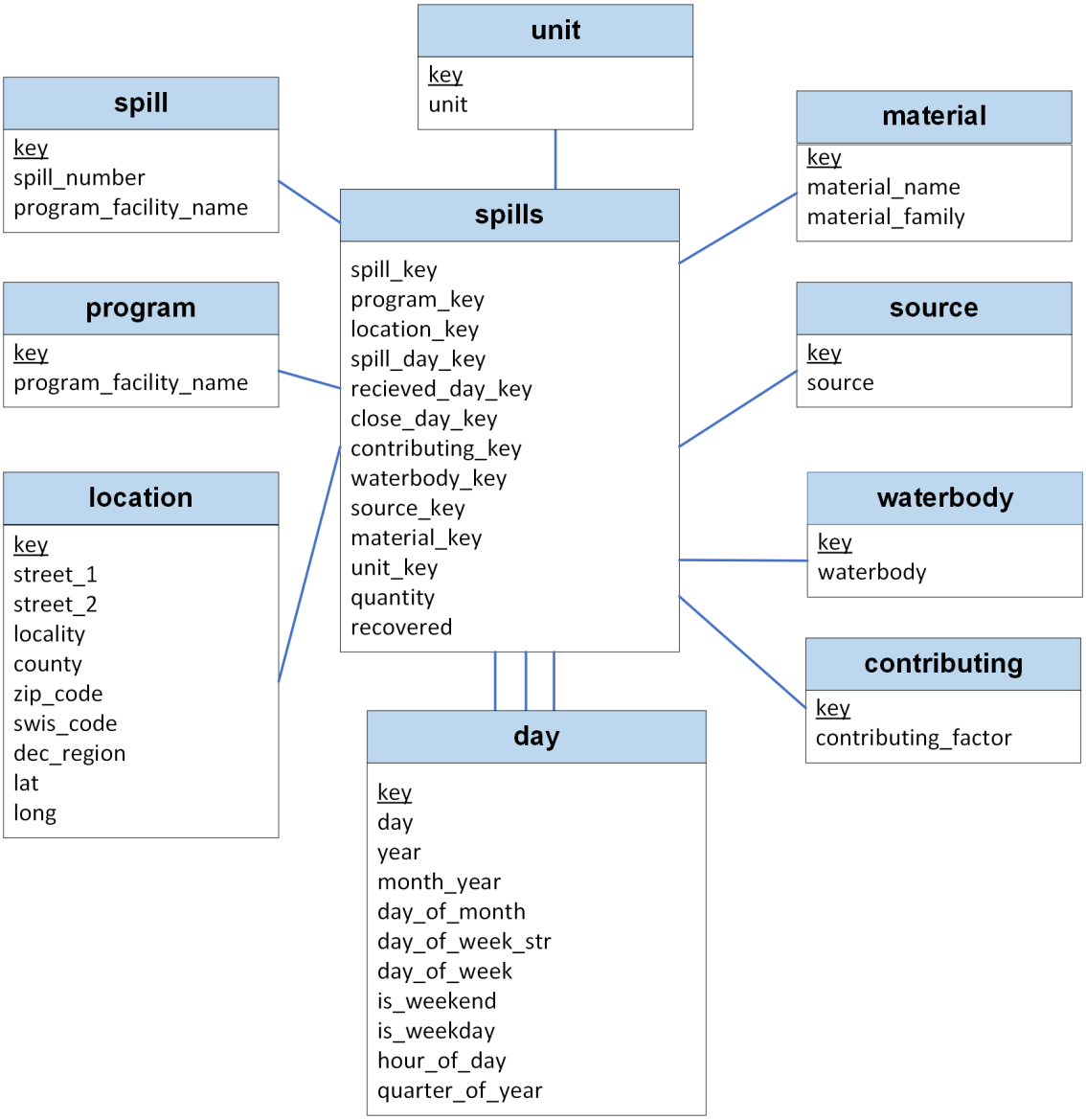
Step 2: Creating the Star Schema after discussing within our group

Note: Spills is our Fact Table and the Tables connecting to it are our Dimensions

Star Schema with the Fact Table and Dimension Tables

In [27]:
```
from IPython.display import Image
Image(url="https://github.com/maneeshtekwani/DMFA_Group1_FinalAssignment/blob/main/
```

Out[27]:



Creating and Loading the Dimension Tables

1. Creating the Dimension Table for Spill

Step 1: Creating the Dimension Table for Spill using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a

primary key to uniquely identify our dimension table, which is why we created one when we made the Spill Dimension table.

In [28]:
```
%%sql
DROP TABLE IF EXISTS spill;

CREATE TABLE spill (
    key SERIAL PRIMARY KEY,
    spill_number NUMERIC
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[28]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Spill** dimension table

In [29]:
```
%%sql
INSERT INTO spill (spill_number)
SELECT DISTINCT spill_number
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
370995 rows affected.
```

Out[29]: []

Step 3: Using SQL Statements `UPDATE` , `SET` , and `WHERE` to update the Nulls within the **Spill** Dimension Table to '0'

In [30]:
```
%%sql
UPDATE spill
SET spill_number = 0
WHERE spill_number IS NULL;
```

```
 * postgresql://student@/Group1_FinalAssignment
0 rows affected.
```

Out[30]: []

Step 4: Using SQL to see whether the Spill Dimension Table was successfully created and whether it has the attributes we need within, which are key and spill_number

In [31]:
```
%%sql
SELECT *
FROM spill
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[31]:

key	spill_number
1	1311468
2	475040

Step 5: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the spill dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [32]:
```
%%sql
ALTER TABLE spills
ADD COLUMN spill_key INTEGER,
ADD CONSTRAINT fk_spill
    FOREIGN KEY (spill_key)
    REFERENCES spill (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[32]: []

Step 6: Checking whether the spill_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [33]:
```
%%sql
SELECT *
FROM spills
LIMIT 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[33]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code
107132	MH 864	RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000
405586	BOWRY BAY	WATER POLL CONTROL	0	QUEENS	Queens	4101

Step 7: Updating the spills table to match spill_key (a foreign key within the spills table) to key (a primary key within the spill table) using SQL Statements `UPDATE` , `SET` , `FROM` and `WHERE`

In [34]:
```
%%sql
UPDATE spills
SET spill_key = spill.key
FROM spill
WHERE spills.spill_number = spill.spill_number;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[34]: []

Step 8: Checking whether the foreign key is sucessfully referring to the primary key in the spill table. We can check this by seeing whether the column named spill_key in the spills fact table is updated with values now.

In [35]:
```
%%sql
SELECT *
FROM spills
Limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[35]:

spill_number	program_facility_name	street_1	street_2	locality	county	swis_code
107132	MH 864	RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000
204667	POLE 16091	GRACE AVE/BURKE AVE	0	BRONX	Bronx	301

Step 9: Dropping the Column spill_number using SQL statement `DROP COLUMN` from the spills table, since the spill_number is present in the 'spill' table and we are making 'spills' our fact table

In [36]:
```
%%sql
ALTER TABLE spills
DROP COLUMN spill_number
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[36]:
```
[]
```

Step 10: Checking whether the column spill_number is dropped successfully from spills, our fact table

In [37]:
```
%%sql
SELECT *
From spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[37]:

program_facility_name	street_1	street_2	locality	county	swis_code	dec_region	sp
MH 864	RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000	3	2
POLE 16091	GRACE AVE/BURKE AVE	0	BRONX	Bronx	301	2	2

2. Creating the Dimension Table for Program

Step 1: Creating the Dimension Table for Program using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a

primary key to uniquely identify our dimension table, which is why we created one while we made the Program Dimension table.

In [38]:
```
%%sql
DROP TABLE IF EXISTS program;

CREATE TABLE program (
    key SERIAL PRIMARY KEY,
    program_facility_name VARCHAR(80)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[38]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Program** dimension table

In [39]:
```
%%sql
INSERT INTO program (program_facility_name)
SELECT DISTINCT program_facility_name
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
212525 rows affected.
```

Out[39]: []

Step 3: Using SQL Statements `UPDATE` , `SET` , and `WHERE` to update the Nulls within the **Program** Dimension Table to '0'

In [40]:
```
%%sql
UPDATE program
SET program_facility_name = 0
WHERE program_facility_name IS NULL;
```

```
 * postgresql://student@/Group1_FinalAssignment
0 rows affected.
```

Out[40]: []

Step 4: Using SQL to see whether the Program Dimension Table was successfully created and whether it has the attributes we need within, which are key and program_facility_name

In [41]:
```
%%sql
SELECT *
FROM program
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[41]:

key	program_facility_name
1	SWARTZ MART
2	RESIDENCE-ABENAKI TRL

Step 5: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Program dimesion table to the spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [42]:
```
%%sql
ALTER TABLE spills
ADD COLUMN program_key INTEGER,
ADD CONSTRAINT fk_program
    FOREIGN KEY (program_key)
    REFERENCES program (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[42]: []

Step 6: Checking whether the program_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [43]:
```
%%sql
SELECT *
FROM spills
LIMIT 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[43]:

program_facility_name	street_1	street_2	locality	county	swis_code	dec_region	sp
MH 864	RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000	3	2
POLE 16091	GRACE AVE/BURKE AVE	0	BRONX	Bronx	301	2	2

Step 7: Updating the spills table to match program_key (a foreign key within the spills table) to key (a primary key within the program table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [44]:
```
%%sql
UPDATE spills
SET program_key = program.key
FROM program
WHERE spills.program_facility_name = program.program_facility_name;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[44]: []

Step 8: Checking whether the foreign key is sucessfully referring to the primary key in the program table. We can check this by seeing whether the column named program_key in the spills fact table is updated with values now.

In [45]:
```
%%sql
SELECT *
FROM spills
Limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[45]:

program_facility_name	street_1	street_2	locality	county	swis_code	dec_region	spill_date	rec
BOWRY BAY	WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	
BOWRY BAY	WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	

Step 9: Dropping the Column program_facility_name using SQL statement `DROP COLUMN` from the spills table, since the program_facility_name is present in the 'program' table and we are making 'spills' our fact table

In [46]:
```
%%sql
ALTER TABLE spills
DROP COLUMN program_facility_name
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[46]: []

Step 10: Checking whether the column program_facility_name is dropped successfully from spills, our fact table

In [47]:
```
%%sql
SELECT *
From spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[47]:

street_1	street_2	locality	county	swis_code	dec_region	spill_date	received_date	contributing
WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	2004-08-21	
WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	2004-08-21	

3. Creating the Dimension Table for Location

Step 1: Creating the Dimension Table for Location using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one while we made the Location Dimension table.

In [48]:
```
%%sql
DROP TABLE IF EXISTS location;

CREATE TABLE location (
    key SERIAL PRIMARY KEY,
    street_1 VARCHAR(50),
    street_2 VARCHAR(50),
    locality VARCHAR(50),
    county VARCHAR(50),
    swis_code NUMERIC(6),
    dec_region INTEGER
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[48]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Location** dimension table

In [49]:
```
%%sql
INSERT INTO location (street_1, street_2, locality, county, swis_code, dec_region)
SELECT DISTINCT street_1, street_2, locality, county, swis_code, dec_region
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
310699 rows affected.
```

Out[49]: []

Step 3: Using SQL to see whether the Location Dimension Table was successfully created and whether it has the attributes we need within, which are key, street_1, street_2, locality, county, swis_code, and dec_region

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Location dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [50]:
```
%%sql
ALTER TABLE spills
ADD COLUMN location_key INTEGER,
ADD CONSTRAINT fk_location
    FOREIGN KEY (location_key)
    REFERENCES location (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[50]: []

Step 5: Checking whether the location_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [51]:
```
%%sql
select *
from spills
limit 3
```

```
 * postgresql://student@/Group1_FinalAssignment
3 rows affected.
```

Out[51]:

street_1	street_2	locality	county	swis_code	dec_region	spill_date	received_date
WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	2004-08-21
WATER POLL CONTROL	0	QUEENS	Queens	4101	2	2004-08-21	2004-08-21
RT 119/MILLWOOD RD	0	ELMSFORD	Westchester	6000	3	2001-10-10	2001-10-10

Step 6: Updating the spills table to match location_key (a foreign key within the spills table) to key (a primary key within the location table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [52]:
```
%%sql
UPDATE spills
SET location_key = location.key
FROM location
WHERE spills.street_1 = location.street_1
    AND spills.street_2 = location.street_2
    AND spills.swis_code = location.swis_code
    AND spills.dec_region = location.dec_region;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[52]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the location table. We can check this by seeing whether the column named location_key in the spills fact table is updated with values now.

In [53]:
```
%%sql
SELECT *
FROM spills
limit 3
```

```
 * postgresql://student@/Group1_FinalAssignment
3 rows affected.
```

Out[53]:

street_1	street_2	locality	county	swis_code	dec_region	spill_date	received_date
FERDALE LOMIS RD / RT 52	0	LIBERTY	Sullivan	5336	3	2003-01-20	2003-01-20
GRACE AVE/BURKE AVE	0	BRONX	Bronx	301	2	2002-08-02	2002-08-02
RT						2001-10-	

Step 8: Dropping the Columns for Location using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'location' table and we are making 'spills' our fact table

In [54]:
```
%%sql
ALTER TABLE spills
DROP COLUMN street_1,
DROP COLUMN street_2,
DROP COLUMN locality,
DROP COLUMN county,
DROP COLUMN swis_code,
DROP COLUMN dec_region
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[54]: []

Step 9: Checking whether the location columns are dropped successfully from spills, our fact table

In [55]:
```
%%sql
SELECT *
FROM spills
Limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[55]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2003-01-20	2003-01-20	Traffic Accident	0	Commercial/Industrial	2003-01-22	transfor
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

4. Creating the Dimension Table for Day

Step 1: Creating the Dimension Table for Day using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one when we made the Day Dimension table.

In [56]:
```
%%sql
DROP TABLE IF EXISTS day;

CREATE TABLE day (
    key SERIAL PRIMARY KEY,
    day CHAR(10),
    year INTEGER,
    month_of_year_str VARCHAR(12),
    month_of_year INTEGER,
    day_of_month INTEGER,
    day_of_week_str CHAR(9),
    day_of_week INTEGER,
    is_weekend BOOLEAN,
    is_weekday BOOLEAN,
    hour_of_day INTEGER,
    quarter_of_year INTEGER
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[56]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Day** dimension table

Note: Please note that we decided to choose day as the granularity for this dimension because day is the most granular measure we have avaliable within the date column in the spills dataset. We also used `CAST(TO_CHAR)` and `CASE WHEN` SQL Statements to convert the date table to provide us with month names in the Character Format and inform us whether days were on weekdays or weekends.

We were able to generate this query with the help of what we learned in class with the Bikeshare Example.

In [57]:
```
%%sql
INSERT INTO day (day, year, month_of_year_str, month_of_year, day_of_month,
                 day_of_week_str, day_of_week, is_weekend, is_weekday,
                 hour_of_day, quarter_of_year)
SELECT DISTINCT TO_CHAR(spill_date, 'YYYY-MM-DD') AS day,
    CAST(TO_CHAR(spill_date, 'YYYY') AS INTEGER) AS year,
    TO_CHAR(spill_date, 'Month') AS month_of_year_str,
    CAST(TO_CHAR(spill_date, 'MM') AS INTEGER) AS month_of_year,
    CAST(TO_CHAR(spill_date, 'DD') AS INTEGER) AS day_of_month,
    TO_CHAR(spill_date, 'Day') AS day_of_week_str,
    CAST(TO_CHAR(spill_date, 'D') AS INTEGER) AS day_of_week,
    CASE WHEN CAST(TO_CHAR(spill_date, 'D') AS INTEGER) IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekend,
    CASE WHEN CAST(TO_CHAR(spill_date, 'D') AS INTEGER) NOT IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekday,
    CAST(TO_CHAR(spill_date, 'HH24') AS INTEGER) AS hour_of_day,
    CAST(TO_CHAR(spill_date, 'Q') AS INTEGER) AS quarter_of_year
FROM spills
UNION
```

```
SELECT DISTINCT TO_CHAR(received_date, 'YYYY-MM-DD') AS day,
    CAST(TO_CHAR(received_date, 'YYYY') AS INTEGER) AS year,
    TO_CHAR(received_date, 'Month') AS month_of_year_str,
    CAST(TO_CHAR(received_date, 'MM') AS INTEGER) AS month_of_year,
    CAST(TO_CHAR(received_date, 'DD') AS INTEGER) AS day_of_month,
    TO_CHAR(received_date, 'Day') AS day_of_week_str,
    CAST(TO_CHAR(received_date, 'D') AS INTEGER) AS day_of_week,
    CASE WHEN CAST(TO_CHAR(received_date, 'D') AS INTEGER) IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekend,
    CASE WHEN CAST(TO_CHAR(received_date, 'D') AS INTEGER) NOT IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekday,
    CAST(TO_CHAR(received_date, 'HH24') AS INTEGER) AS hour_of_day,
    CAST(TO_CHAR(received_date, 'Q') AS INTEGER) AS quarter_of_year
FROM spills
UNION
SELECT DISTINCT TO_CHAR(close_date, 'YYYY-MM-DD') AS day,
    CAST(TO_CHAR(close_date, 'YYYY') AS INTEGER) AS year,
    TO_CHAR(close_date, 'Month') AS month_of_year_str,
    CAST(TO_CHAR(close_date, 'MM') AS INTEGER) AS month_of_year,
    CAST(TO_CHAR(close_date, 'DD') AS INTEGER) AS day_of_month,
    TO_CHAR(close_date, 'Day') AS day_of_week_str,
    CAST(TO_CHAR(close_date, 'D') AS INTEGER) AS day_of_week,
    CASE WHEN CAST(TO_CHAR(close_date, 'D') AS INTEGER) IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekend,
    CASE WHEN CAST(TO_CHAR(close_date, 'D') AS INTEGER) NOT IN (1, 7)
        THEN TRUE
        ELSE FALSE
    END AS is_weekday,
    CAST(TO_CHAR(close_date, 'HH24') AS INTEGER) AS hour_of_day,
    CAST(TO_CHAR(close_date, 'Q') AS INTEGER) AS quarter_of_year
FROM spills
```

```
 * postgresql://student@/Group1_FinalAssignment
10020 rows affected.
```

Out[57]: []

Step 3: Using SQL to see whether the Day Dimension Table was successfully created and whether it has the attributes we need within.

Note: The Day Dimension has additional columns like day_of_the_week_str, is_weekend, is_weekday, hour_of_day, and quarter_of_year, which may seem unnecessary at the moment; however, in the future it would be helpful. It would be helpful if we wanted to assess what quarter had the most spills, what day had the most spills, etc. in the future.

In [58]:
```
%%sql
SELECT * FROM day
LIMIT 10
```

```
 * postgresql://student@/Group1_FinalAssignment
10 rows affected.
```

Out[58]:

key	day	year	month_of_year_str	month_of_year	day_of_month	day_of_week_str	day_of_week
1	2014-04-02	2014	April	4	2	Wednesday	4
2	2009-01-16	2009	January	1	16	Friday	6
3	2015-04-10	2015	April	4	10	Friday	6
4	2002-09-17	2002	September	9	17	Tuesday	3
5	2013-11-04	2013	November	11	4	Monday	2
6	2009-11-15	2009	November	11	15	Sunday	1
7	2003-08-11	2003	August	8	11	Monday	2
8	2022-04-12	2022	April	4	12	Tuesday	3
9	2000-08-24	2000	August	8	24	Thursday	5

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Day dimension table to the spills fact table.

We need to Alter the table 3 times since, we need 3 foreign keys for date: spill_day_key, received_day_key, close_day_key.

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

Step 4.a.i: Using the SQL Statement `ALTER TABLE` to create the foreign key named spill_day_key within the spills table

In [59]:
```
%%sql
ALTER TABLE spills
ADD COLUMN spill_day_key INTEGER,
ADD CONSTRAINT fk_spill_day
    FOREIGN KEY (spill_day_key)
    REFERENCES day (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[59]:
```
[]
```

Step 4.a.ii: Checking whether spill_day_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [60]:
```
%%sql
select *
```

```
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[60]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2003-01-20	2003-01-20	Traffic Accident	0	Commercial/Industrial	2003-01-22	transfor
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

Step 4.a.iii: Updating the spills table to match spill_day_key (a foreign key within the spills table) to key (a primary key within the date table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [61]:
```
%%sql
UPDATE spills
SET spill_day_key = day.key
FROM day
WHERE TO_CHAR(spills.spill_date, 'YYYY-MM-DD') = day.day;
```

```
 * postgresql://student@/Group1_FinalAssignment
389547 rows affected.
```

Out[61]: []

Step 4.a.iv: Checking whether the foreign key is sucessfully referring to the primary key in the date table. We can check this by seeing whether the column named spill_day_key in the spills fact table is updated with values now.

In [62]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[62]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2001-10-10	2001-10-10	Unknown	0	Unknown	2001-10-15	ur r
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

Step 4.b.i: Using the SQL Statement `ALTER TABLE` to create the foreign key named received_day_key within the spills table

In [63]:
```
%%sql
ALTER TABLE spills
ADD COLUMN received_day_key INTEGER,
ADD CONSTRAINT fk_received_day
```

```
    FOREIGN KEY (received_day_key)
    REFERENCES day (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[63]: []

Step 4.b.ii: Checking whether received_day_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [64]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[64]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2001-10-10	2001-10-10	Unknown	0	Unknown	2001-10-15	ur r
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

Step 4.b.iii: Updating the spills table to match received_day_key (a foreign key within the spills table) to key (a primary key within the date table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [65]:
```
%%sql
UPDATE spills
SET received_day_key = day.key
FROM day
WHERE TO_CHAR(spills.received_date, 'YYYY-MM-DD') = day.day;
```

```
 * postgresql://student@/Group1_FinalAssignment
389618 rows affected.
```

Out[65]: []

Step 4.b.iv: Checking whether the foreign key is sucessfully referring to the primary key in the date table. We can check this by seeing whether the column named received_day_key in the spills fact table is updated with values now.

In [66]:
```
%%sql
SELECT *
FROM spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[66]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2001-10-10	2001-10-10	Unknown	0	Unknown	2001-10-15	ur r

Step 4.c.i: Using the SQL Statement `ALTER TABLE` to create the foreign key named close_day_key within the spills table

In [67]:
```
%%sql
ALTER TABLE spills
ADD COLUMN close_day_key INTEGER,
ADD CONSTRAINT fk_close_day_key
    FOREIGN KEY (close_day_key)
    REFERENCES day (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[67]: []

Step 4.c.ii: Checking whether close_day_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [68]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[68]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2001-10-10	2001-10-10	Unknown	0	Unknown	2001-10-15	ur r
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

Step 4.c.iii: Updating the spills table to match close_day_key (a foreign key within the spills table) to key (a primary key within the date table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [69]:
```
%%sql
UPDATE spills
SET close_day_key = day.key
FROM day
WHERE TO_CHAR(spills.close_date, 'YYYY-MM-DD') = day.day;
```

```
 * postgresql://student@/Group1_FinalAssignment
379725 rows affected.
```

Out[69]: []

Step 4.c.iv: Checking whether the foreign key is sucessfully referring to the primary key in the date table. We can check this by seeing whether the column named close_day_key in the

spills fact table is updated with values now.

In [70]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[70]:

spill_date	received_date	contributing_factor	waterbody	source	close_date	materia
2001-10-10	2001-10-10	Unknown	0	Unknown	2001-10-15	ur r
2002-08-02	2002-08-02	Equipment Failure	0	Commercial/Industrial	2002-10-28	transfor

Step 5: Dropping the Columns for Location using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'day' table and we are making 'spills' our fact table

In [71]:
```
%%sql
ALTER TABLE spills
DROP COLUMN spill_date,
DROP COLUMN received_date,
DROP COLUMN close_date
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[71]: []

Step 6: Checking whether the columns are dropped successfully from spills, our fact table

In [72]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[72]:

contributing_factor	waterbody	source	material_name	material_family	quantity	u
Unknown	0	Unknown	unknown material	Other	10	Ga
Equipment Failure	0	Commercial/Industrial	transformer oil	Petroleum	1	Ga

5. Creating the Dimension Table for Contributing

Step 1: Creating the Dimension Table for Contributing using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary key to uniquely identify our dimension table, which is why we created one while we made the Contributing Dimension table.

In [73]:
```
%%sql
DROP TABLE IF EXISTS contributing;

CREATE TABLE contributing (
    key SERIAL PRIMARY KEY,
    contributing_factor VARCHAR(50)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[73]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Contribution** dimension table

In [74]:
```
%%sql
INSERT INTO contributing (contributing_factor)
SELECT DISTINCT contributing_factor
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
14 rows affected.
```

Out[74]: []

Step 3: Using SQL to see whether the Contribution Dimension Table was successfully created and whether it has the attributes we need within which are key and contribution_factor

In [75]:
```
%%sql
select *
from contributing
```

```
 * postgresql://student@/Group1_FinalAssignment
14 rows affected.
```

Out[75]:

key	contributing_factor
1	Tank Failure
2	Other
3	Unknown
4	Missing Code in Old Data - Must be fixed
5	Equipment Failure
6	Traffic Accident
7	Tank Test Failure
8	Tank Overfill
9	Vandalism
10	Human Error
11	Deliberate
12	Storm
13	Abandoned Drums
14	Housekeeping

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Contributing dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [76]:
```
%%sql
ALTER TABLE spills
ADD COLUMN contributing_key INTEGER,
ADD CONSTRAINT fk_contributing_key
    FOREIGN KEY (contributing_key)
    REFERENCES contributing (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[76]:
```
[]
```

Step 5: Checking whether the contribution_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [77]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[77]:

contributing_factor	waterbody	source	material_name	material_family	quantity	u
Unknown	0	Unknown	unknown material	Other	10	Ga
Equipment Failure	0	Commercial/Industrial	transformer oil	Petroleum	1	Ga

Step 6: Updating the spills table to match contributing_key (a foreign key within the spills table) to key (a primary key within the contribution table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [78]:
```
%%sql
UPDATE spills
SET contributing_key = contributing.key
FROM contributing
WHERE spills.contributing_factor = contributing.contributing_factor;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[78]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the contribution table. We can check this by seeing whether the column named contributing_key in the spills fact table is updated with values now.

In [79]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[79]:

contributing_factor	waterbody	source	material_name	material_family	quantity	u
Unknown	0	Unknown	unknown material	Other	10	Ga
Equipment Failure	0	Commercial/Industrial	transformer oil	Petroleum	1	Ga

Step 8: Dropping the Columns for contributing_factor using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'contributing' table and we are making 'spills' our fact table

In [80]:
```
%%sql
alter table spills
DROP column contributing_factor
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[80]: []

Step 9: Checking whether the contributing_factor column is dropped successfully from spills, our fact table

In [81]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[81]:

waterbody	source	material_name	material_family	quantity	units	recovered	spil
0	Unknown	unknown material	Other	10	Gallons	0	1:
0	Commercial/Industrial	transformer oil	Petroleum	1	Gallons	0	1!

6. Creating the Dimension Table for Waterbody

Step 1: Creating the Dimension Table for Waterbody using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one while we made the Waterbody Dimension table.

In [82]:
```
%%sql
DROP TABLE IF EXISTS waterbody;

CREATE TABLE waterbody (
    key SERIAL PRIMARY KEY,
    waterbody VARCHAR(30)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[82]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Waterbody** dimension table

In [83]:
```
%%sql
INSERT INTO waterbody (waterbody)
SELECT DISTINCT waterbody
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
5323 rows affected.
```

Out[83]: []

Step 3: Using SQL to see whether the Waterbody Dimension Table was successfully created and whether it has the attributes we need within which are key and waterbody

In [84]:
```
%%sql
select *
from waterbody
limit 5
```

```
 * postgresql://student@/Group1_FinalAssignment
5 rows affected.
```

Out[84]:

key	waterbody
1	KENSICO RESVOIR
2	MARSHY AREA
3	JAMAICA WELLS ZONE
4	UPPER RAQUETTE RIVER
5	WESTCOTT BROOK

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Waterbody dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [85]:
```
%%sql
ALTER TABLE spills
ADD COLUMN waterbody_key INTEGER,
ADD CONSTRAINT fk_waterbody_key
    FOREIGN KEY (waterbody_key)
    REFERENCES waterbody (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[85]: []

Step 5: Checking whether the waterbody_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [86]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[86]:

waterbody	source	material_name	material_family	quantity	units	recovered	spil
0	Unknown	unknown material	Other	10	Gallons	0	1:
0	Commercial/Industrial	transformer oil	Petroleum	1	Gallons	0	1!

Step 6: Updating the spills table to match waterbody_key (a foreign key within the spills table) to key (a primary key within the waterbody table) using SQL Statements `UPDATE`, `SET`, `FROM`, and `WHERE`

In [87]:
```
%%sql
UPDATE spills
SET waterbody_key = waterbody.key
FROM waterbody
WHERE spills.waterbody = waterbody.waterbody;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[87]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the waterbody table. We can check this by seeing whether the column named waterbody_key in the spills fact table is updated with values now.

In [88]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[88]:

waterbody	source	material_name	material_family	quantity	units	recovered	spil
0	Unknown	unknown material	Other	10	Gallons	0	1:
0	Commercial/Industrial	transformer oil	Petroleum	1	Gallons	0	1!

Step 8: Dropping the Columns for waterbody using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'Waterbody' table and we are making 'spills' our fact table

In [89]:
```
%%sql
alter table spills
DROP column waterbody
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[89]: []

Step 9: Checking whether the column columns are dropped successfully from spills, our fact table

In [90]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[90]:

source	material_name	material_family	quantity	units	recovered	spill_key	progr
Unknown	unknown material	Other	10	Gallons	0	131000	

7. Creating the Dimension Table for Source

Step 1: Creating the Dimension Table for Source using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one while we made the Source Dimension table.

In [91]:
```
%%sql
DROP TABLE IF EXISTS source;

CREATE TABLE source (
    key SERIAL PRIMARY KEY,
    source VARCHAR(50)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[91]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Source** dimension table

In [92]:
```
%%sql
INSERT INTO source (source)
SELECT DISTINCT source
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
16 rows affected.
```

Out[92]: []

Step 3: Using SQL to see whether the Source Dimension Table was successfully created and whether it has the attributes we need within, which are key and source,

In [93]:
```
%%sql
select *
from source
```

```
 * postgresql://student@/Group1_FinalAssignment
16 rows affected.
```

Out[93]:

key	source
1	Railroad Car
2	Commercial/Industrial
3	Tank Truck
4	Unknown
5	Airport/Aircraft
6	Commercial Vehicle
7	Missing Code in Old Data - Must be fixed
8	Institutional, Educational, Gov., Other
9	Major Facility (MOSF) > 400,000 gal
10	Private Dwelling
11	Transformer
12	Vessel
13	Non Major Facility > 1,100 gal
14	Chemical Bulk Storage Facility
15	Passenger Vehicle
16	Gasoline Station or other PBS Facility

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Source dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [94]:
```
%%sql
ALTER TABLE spills
ADD COLUMN source_key INTEGER,
ADD CONSTRAINT fk_source_key
    FOREIGN KEY (source_key)
    REFERENCES source (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[94]: []

Step 5: Checking whether the source_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [95]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[95]:

source	material_name	material_family	quantity	units	recovered	spill_key	progr
Unknown	unknown material	Other	10	Gallons	0	131000	

Step 6: Updating the spills table to match source_key (a foreign key within the spills table) to key (a primary key within the location table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [96]:
```
%%sql
UPDATE spills
SET source_key = source.key
FROM source
WHERE spills.source = source.source;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[96]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the source table. We can check this by seeing whether the column named source_key in the spills fact table is updated with values now.

In [97]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[97]:

source	material_name	material_family	quantity	units	recovered	spill_key	progr
Unknown	unknown material	Other	10	Gallons	0	131000	
Commercial/Industrial	transformer oil	Petroleum	1	Gallons	0	157880	

Step 8: Dropping the Columns for Source using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'source' table and we are making 'spills' our fact table

In [98]:
```
%%sql
alter table spills
DROP column source
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[98]: []

Step 9: Checking whether the column columns are dropped successfully from spills, our fact table

In [99]:
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[99]:

material_name	material_family	quantity	units	recovered	spill_key	program_key	location_key
unknown material	Other	10	Gallons	0	131000	146951	287575
transformer oil	Petroleum	1	Gallons	0	157880	206752	249967

8. Creating the Dimension Table for Material

Step 1: Creating the Dimension Table for Material using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one while we made the Material Dimension table.

In [100…
```
%%sql
DROP TABLE IF EXISTS material;

CREATE TABLE material (
    key SERIAL PRIMARY KEY,
    material_name VARCHAR(100),
    material_family VARCHAR(20)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[100]: []

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Material** dimension table

In [101…
```
%%sql
INSERT INTO material (material_name, material_family)
SELECT DISTINCT material_name, material_family
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
5276 rows affected.
```

Out[101]: []

Step 3: Using SQL to see whether the Material Dimension Table was successfully created and whether it has the attributes we need within, which are key, material_name, and material_family

In [102…

```
%%sql
select *
from material
limit 5
```

```
 * postgresql://student@/Group1_FinalAssignment
5 rows affected.
```

Out[102]:

key	material_name	material_family
1	#2 fuel oil	Petroleum
2	#2 fuel oil (on-site consumption)	Petroleum
3	#2 fuel oil (resale/redistribute)	Petroleum
4	#4 fuel oil	Petroleum
5	#4 fuel oil (on-site consumption)	Petroleum

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Material dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [103…

```
%%sql
ALTER TABLE spills
ADD COLUMN material_key INTEGER,
ADD CONSTRAINT fk_material_key
    FOREIGN KEY (material_key)
    REFERENCES material (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[103]: []

Step 5: Checking whether the material_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [104…

```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[104]:

material_name	material_family	quantity	units	recovered	spill_key	program_key	location_key
unknown material	Other	10	Gallons	0	131000	146951	287575
transformer oil	Petroleum	1	Gallons	0	157880	206752	249967

Step 6: Updating the spills table to match material_key (a foreign key within the spills table) to key (a primary key within the Material table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [105…
```
%%sql
UPDATE spills
SET material_key = material.key
FROM material
WHERE spills.material_name = material.material_name;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[105]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the material table. We can check this by seeing whether the column named material_key in the spills fact table is updated with values now.

In [106…
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[106]:

material_name	material_family	quantity	units	recovered	spill_key	program_key	location_key
unknown material	Other	10	Gallons	0	131000	146951	287575
transformer oil	Petroleum	1	Gallons	0	157880	206752	249967

Step 8: Dropping the Columns for material_name and material_family using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'material' table and we are making 'spills' our fact table

In [107…
```
%%sql
ALTER TABLE spills
DROP column material_name,
DROP column material_family
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[107]: []

Step 9: Checking whether the material columns are dropped successfully from spills, our fact table

In [108…
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[108]:

quantity	units	recovered	spill key	program key	location key	spill day key	received day key
10	Gallons	0	131000	146951	287575	5402	5402

9. Creating the Dimension Table for Unit

Step 1: Creating the Dimension Table for Unit using the SQL Statement `CREATE TABLE`

Note: It is common practice to `DROP TABLE` prior to creating a new table to avoid overwriting any information that already exists within the database. Additionally, we need a primary to uniquely identify our dimension table, which is why we created one while we made the Unit Dimension table.

In [109…

```
%%sql
DROP TABLE IF EXISTS unit;

CREATE TABLE unit (
    key SERIAL PRIMARY KEY,
    units CHAR(8)
);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
Done.
```

Out[109]: []

In [110…

```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[110]:

quantity	units	recovered	spill key	program key	location key	spill day key	received day key
10	Gallons	0	131000	146951	287575	5402	5402
1	Gallons	0	157880	206752	249967	8399	8399

Step 2: Using SQL Statement `INSERT INTO` to upload the data from the **Spills** table to the **Unit** dimension table

In [111…

```
%%sql
INSERT INTO unit (units)
SELECT DISTINCT units
FROM spills;
```

```
 * postgresql://student@/Group1_FinalAssignment
3 rows affected.
```

Out[111]: []

Step 3: Using SQL to see whether the Unit Dimension Table was successfully created and whether it has the attributes we need within, which are key and units

Step 5: Checking whether the unit_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [112…
```
%%sql
select *
from unit
```

```
 * postgresql://student@/Group1_FinalAssignment
3 rows affected.
```

Out[112]:

key	units
1	Gallons
2	0
3	Pounds

Step 4: Using SQL `ALTER TABLE` and other SQL statements to create a foreign key in the spills table that connects the Unit dimesion table to spills fact table

Note: While creating the Dimensions, our Spills Table is gradually and eventually being converted to be the fact table (as seen in the Star Schema)

In [113…
```
%%sql
ALTER TABLE spills
ADD COLUMN unit_key INTEGER,
ADD CONSTRAINT fk_unit_key
    FOREIGN KEY (unit_key)
    REFERENCES unit (key);
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[113]: []

Step 5: Checking whether the unit_key is created as a foreign key within in the spills table (which is becoming our fact table)

In [114…
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[114]:

quantity	units	recovered	spill_key	program_key	location_key	spill_day_key	received_day_key
10	Gallons	0	131000	146951	287575	5402	5402
1	Gallons	0	157880	206752	249967	8399	8399

Step 6: Updating the spills table to match unit_key (a foreign key within the spills table) to key (a primary key within the location table) using SQL Statements `UPDATE`, `SET`, `FROM` and `WHERE`

In [115…
```
%%sql
UPDATE spills
SET unit_key = unit.key
FROM unit
WHERE spills.units = unit.units;
```

```
 * postgresql://student@/Group1_FinalAssignment
389699 rows affected.
```

Out[115]: []

Step 7: Checking whether the foreign key is sucessfully referring to the primary key in the unit table. We can check this by seeing whether the column named unit_key in the spills fact table is updated with values now.

In [116…
```
%%sql
select *
from spills
limit 2
```

```
 * postgresql://student@/Group1_FinalAssignment
2 rows affected.
```

Out[116]:

quantity	units	recovered	spill key	program key	location key	spill day key	received day key
10	Gallons	0	131000	146951	287575	5402	5402
1	Gallons	0	157880	206752	249967	8399	8399

Step 8: Dropping the Columns for unit using SQL statement `DROP COLUMN` from the spills table, since the columns are present within 'unit' table and we are making 'spills' our fact table

In [117…
```
%%sql
alter table spills
DROP column units
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[117]: []

Step 9: Checking whether the column columns are dropped successfully from spills, our fact table

In [118…
```
%%sql
select *
from spills
limit 10
```

```
 * postgresql://student@/Group1_FinalAssignment
10 rows affected.
```

Out[118]:

quantity	recovered	spill key	program key	location key	spill day key	received day key	close da
10	0	131000	146951	287575	5402	5402	
1	0	157880	206752	249967	8399	8399	
6	6	31030	51559	246769	9129	9129	
0	0	315514	181095	306337	4631	4631	
0	0	315514	181095	306337	4631	4631	
40	40	291045	191451	6250	5040	7792	
10	0	328466	31593	30803	556	556	
1	0	169574	26613	3	3213	3213	
0	0	306960	93693	50398	5478	5478	

Checking that the Spills Fact Table is created successfully

Note: We created the Spills Fact Table gradually and incrementally when creating the 9 Dimensions above by dropping the columns and inserting foreign keys. Please Note that the 9 Dimensions are spill, program, location, day, contributing, waterbody, material, and unit. The Fact table is named Spills which connects to all these dimensions. Also note, the fact table, spills, has two measures quantity and recovered. Quantity refers to the amount spilled and Recovered refers to the amount recover in each spill incident.

In [120…

```
%%sql
select *
from spills
limit 10
```

```
 * postgresql://student@/Group1_FinalAssignment
10 rows affected.
```

Out[120]:

quantity	recovered	spill key	program key	location key	spill day key	received day key	close da
10	0	131000	146951	287575	5402	5402	
1	0	157880	206752	249967	8399	8399	
6	6	31030	51559	246769	9129	9129	
0	0	315514	181095	306337	4631	4631	
0	0	315514	181095	306337	4631	4631	
40	40	291045	191451	6250	5040	7792	
10	0	328466	31593	30803	556	556	
1	0	169574	26613	3	3213	3213	
0	0	306960	93693	50398	5478	5478	
0	0	279755	167784	50407	2792	2792	

Ask 3 - Data Exploration

- Explore and analyze your data Q1 (Provide all queries in the notebook that answer the questions, Be clear on the answers you discover and whether the results match your expectations, Include charts or other visuals that support your analysis)
- Explore and analyze your data Q2 (Provide all queries in the notebook that answer the questions, Be clear on the answers you discover and whether the results match your expectations, Include charts or other visuals that support your analysis)
- Explore and analyze your data Q3 (Provide all queries in the notebook that answer the questions, Be clear on the answers you discover and whether the results match your expectations, Include charts or other visuals that support your analysis)

Question 1: Examining the Waterbodies, Spilled Material, and Recovery Rate

Analyze the top 5 waterbodies most significantly impacted by spill quantity and present details regarding the spilled materials and the recovery rate for each waterbody to give more insights into the effectiveness of remediation efforts.

Our Group felt the need to split this query into two parts. Intitally examining the most effected/polluted waterbodies was important; however, we must also provide information on what kind of materials are spilled so, the NY State Department of Remediation can set out policies to rectify or remediate the problem. Each material spilled has different retrieval methods and effects on the waterbody so, it is important the sponsor is aware of what material were spilled to assess the importance of addressing one waterbody over another and their approach in cleaning up.

Part 1: Assess the Most Affected Waterbodies & **Part 2:** Provides insight into the spilled materials and their recovered rates to inform how much of a specific material exist in a particular waterbody (helping with the clean up and recovery of the specific material process)

Part 1: Examining the Top 5 Waterbodies

Step 1: Writing an SQL Query to identify which waterbodies had the highest count of spills.

Note: In this step, we are first running a query to briefly examine the Waterbodies. We are looking primarily for the Outliers that we will address in the Next Step.

In [121…

```
%%sql
SELECT
    count(*), w.waterbody, SUM(quantity) AS spill_quantity
FROM
    spills s
JOIN
    waterbody w ON s.waterbody_key = w.key
GROUP BY
    w.waterbody
ORDER BY
    count(*) DESC
LIMIT 15;
```

```
 * postgresql://student@/Group1_FinalAssignment
15 rows affected.
```

Out[121]:

count	waterbody	spill_quantity
364393	0	100076898658
1839	HUDSON RIVER	28953062
858	EAST RIVER	26567011
664	NONE	590217
544	CREEK	1089351
390	N/A	15737
384	NIAGARA RIVER	1338235
378	LONG ISLAND SOUND	13662437
297	STREAM	28435
296	LAKE GEORGE	5808
282	POND	82727
231	GREAT SOUTH BAY	1025
227	MOHAWK RIVER	651497
213	LAKE ONTARIO	51443
199	UNKNOWN	168815

Step 2: Creating a view that filters the waterbodies that have been affected most by petroleum spills by quantity (which is the quantity spilled)

Note: In the above step, we observe that there are spill incidents with waterbody names that don't offer any unique location or value (Such as '0','NONE','CREEK','N/A','STREAM','POND','UNKNOWN'), hence, for these waterbodies we are using the `NOT IN` SQL Statement to make sure that we don't obeserve these waterbodies when examining Top Waterbodies by their Spill Quantity.

Explanation of the Code:

- We need to examine the Top Waterbodies by waterbody name, count, spill quantity, and units. Hence we are using the `JOIN` SQL Statement to join the tables waterbody, unit,and material.
- Additionally, We are joining by the day table to avoid counting one unique spill twice.
- We want to look at the data that has units in "Gallons" and material_family of "Petroleum" because it is consistently the most common units and material_family within the Spills Dataset.
- Additionally, we are also looking at the Years from 2002 onwards and dealing with the NULL quantities by looking only for quantity values greater than 0

In [122…

```
%%sql
CREATE OR REPLACE VIEW top_waterbody AS
SELECT
    w.waterbody,
    count(*) AS number_of_spills,
    SUM(s.quantity) AS spill_quantity,
```

```
    u.units
FROM
    spills AS s
JOIN
    waterbody w ON s.waterbody_key = w.key
JOIN
    unit u ON s.unit_key = u.key
JOIN
    day d ON s.spill_day_key = d.key
JOIN
    material m ON s.material_key = m.key
WHERE
    w.waterbody NOT IN ('0','NONE','N/A','STREAM','POND','UNKNOWN')
    AND
    u.units = 'Gallons'
    AND
    s.quantity > 0
    AND
    m.material_family = 'Petroleum'
    AND
    d.year > '2002'
GROUP BY
    w.waterbody, u.units
ORDER BY
    spill_quantity DESC
;
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[122]: []

Step 3: Using the View we created above to get only the Top 5 Most Affected Waterbodies

In [123…

```
%%sql
SELECT * FROM top_waterbody LIMIT 5;
```

```
 * postgresql://student@/Group1_FinalAssignment
5 rows affected.
```

Out[123]:

waterbody	number of spills	spill quantity	units
GARDENER CREEK, OSWE	1	16000000	Gallons
LONG ISLAND SOUND	62	13044739	Gallons
BUFFALO RIVER	6	3192146	Gallons
STONY CREEK	2	3000002	Gallons
HUDSON RIVER	211	2452006	Gallons

Step 4: Extracting the SQL query data into Python for Visualization purposes

In [124…

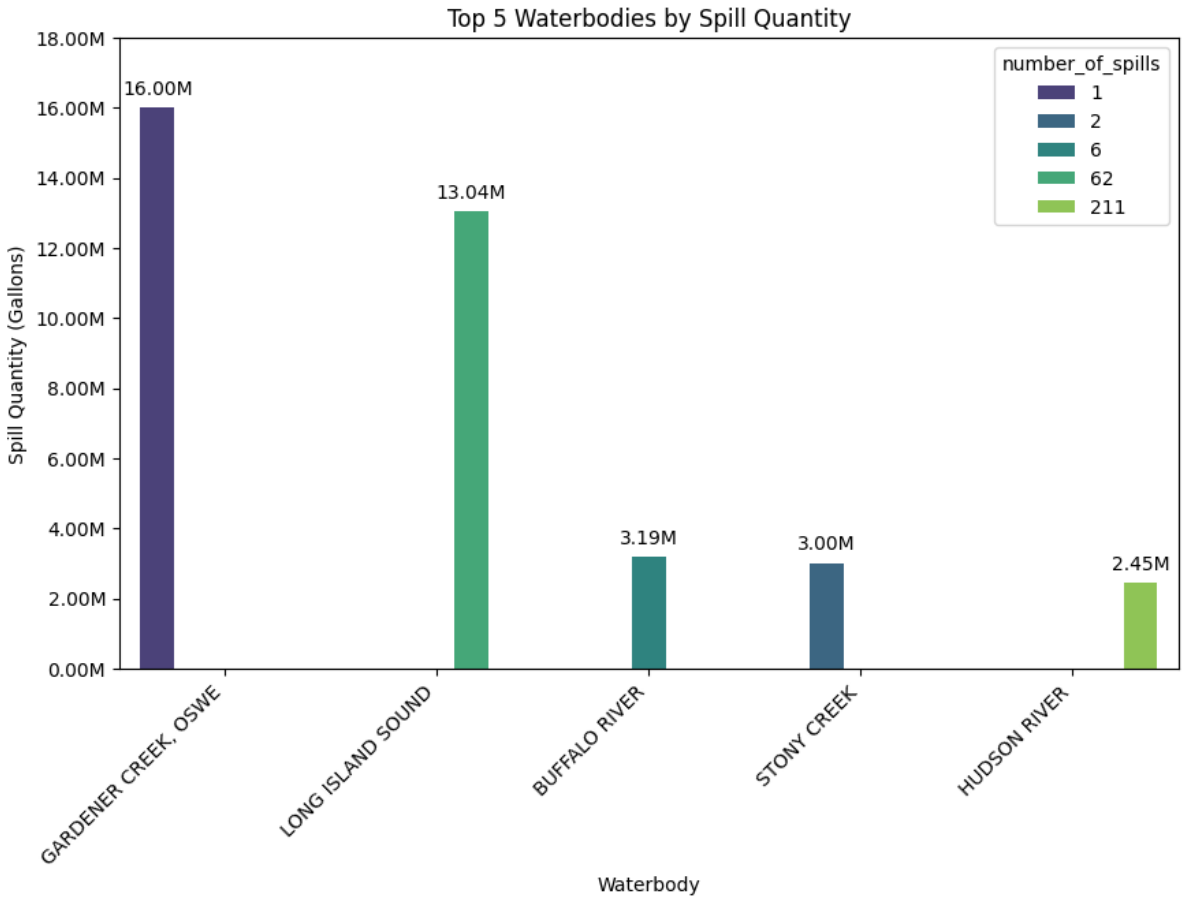
```
sum_waterbody = _
```

Step 5: Converting the Data into a Panda DataFrame and Using Seaborn and Matplotlib Python Libraroes for Visualizing the Top 5 Waterbodies by Spill Quantity

In [125…

```
# Importing Pandas, Seaborn, and Matplotlib Libraries to use for visualization purp
import pandas as pd
import seaborn as sns
```

```
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter

sum_WB = pd.DataFrame(sum_waterbody)


plt.figure(figsize=(10, 6))
ax = sns.barplot(x='waterbody', y='spill_quantity',hue='number_of_spills', data=sum

#Labeling the X and Y axes, and Putting a Title on the Plot
plt.title('Top 5 Waterbodies by Spill Quantity')
plt.xlabel('Waterbody')
plt.ylabel('Spill Quantity (Gallons)')
plt.yticks(ticks=plt.yticks()[0], labels=['{:.0f}'.format(label) for label in plt.y
plt.xticks(rotation=45,ha='right')

def format_func(value, tick_number):
    return '{:.2f}M'.format(value / 1000000)

ax.yaxis.set_major_formatter(FuncFormatter(format_func))

for p in ax.patches:
    label = format_func(p.get_height(), None)
    ax.annotate(label, (p.get_x() + p.get_width() / 2., p.get_height()),
                ha='center', va='center', xytext=(0, 10), textcoords='offset points
# Presenting the Plot
plt.show()
```



Observations for Query 1, Part 1

As you can see above the Data shows the Top 5 Water Bodies and their names on the X axis, their Spilled Quantities on the Y axis, and the Colors represents the number of Spills that

have occured within that waterbody since 2002. We can easily observe that Gardener Creek Oswe is the most polluted waterbody in the State of NY in the last 2 decades. Polluted with almost 16 million gallons of Petroleum spilled in only 1 spill incident, Gardener Creek is most negatively effected waterbody. It will be the Top Concern for the NY State Department of Environmental Remediation to rectify this since, it will have most devasting impact on the Waterbody and the overall envrionment. Long Island Sound with more than 62 spills since 2002 is also a top concern since it is the second highest in terms of Spill Quantity. Stony Creek with only 2 spills has almost the same quantity spilled as Buffalo River, which would mean that Stony Creek must be addressed first and then Buffalo River should be examined. Hudson River is the least polluted waterbody with 211 spills and the lowest spill quantity of Petroleum. Our group attributes this mainly to the fact that the Hudson River is one of the most prominent waterbodies in the state of NY, hence there might be stricter laws/policies on polluting its waterbodies. The NY State Department should be proud of their work in setting strict policies for the Hudson River because it seems to be working and the detrimental effects of petroleum pollution has lessened within the last two decades.

Agenda:

1. Gardener Creek Oswe is a Top Concern (1 Spill of 16 million gallons!)
2. Long Island Sound is High Concern (2 spills of 12 million gallons)
3. Buffalo River is Medium Concern (4 spills of 4 million gallons)
4. Stony Creek is Low-Medium Concern (6 spills of less than 4 million gallons)
5. Hudson River is Low Concern (211 spills of 2 million gallons). Should be used as a case-study example to set laws and regulations to deter people from polluting the other four waterbodies.

Part 2: Examing the Top 5 Waterbodies with a Distribution of the Specific Petroleum Materials Spilled

Step 1: For Each of the Waterbodies Above, Looking at the Distribution of Petroleum Materials that caused the most spills

Note: We used `RANK()` and `PARTITION BY` to rank the materials and count the quantity (spilled quantity) within particular waterbodies by count

In [126…

```
%%sql
WITH rankedSpillWB AS
    (SELECT
        w.waterbody,
        m.material_name,
        m.material_family,
        count(*) AS number_of_spills,
        SUM(quantity) AS spill_quantity,
        SUM(recovered) AS recovered_quantity,
        u.units,
        RANK() OVER (PARTITION BY w.waterbody ORDER BY SUM(quantity) DESC) as mater
    FROM
        spills AS s
    JOIN
        waterbody w ON s.waterbody_key = w.key
    JOIN
        material m ON s.material_key = m.key
```

```
    JOIN
        unit u ON s.unit_key = u.key
    JOIN
        day d ON s.spill_day_key = d.key
    WHERE
        w.waterbody IN (SELECT waterbody FROM top_waterbody LIMIT 5)
        AND
        u.units = 'Gallons'
        AND
        d.year > '2002'
        AND
        s.quantity > 0
        AND
        m.material_family = 'Petroleum'
    GROUP BY
        w.waterbody,
        m.material_name,
        u.units,
        m.material_family
    ORDER BY
        waterbody)
SELECT
    *
FROM
    rankedSpillWB
WHERE
    material_rank < 6;
```

```
 * postgresql://student@/Group1_FinalAssignment
17 rows affected.
```

Out[126]:

waterbody	material_name	material_family	number_of_spills	spill_quantity	recovered_quantity	
BUFFALO RIVER	diesel	Petroleum	3	3192076	0	Ga
BUFFALO RIVER	bunker c oil	Petroleum	1	30	0	Ga
BUFFALO RIVER	unknown petroleum	Petroleum	1	30	0	Ga
BUFFALO RIVER	hydraulic oil	Petroleum	1	10	0	Ga
GARDENER CREEK, OSWE	#6 fuel oil	Petroleum	1	16000000	0	Ga
HUDSON RIVER	#2 fuel oil	Petroleum	26	2370354	0	Ga
HUDSON RIVER	diesel	Petroleum	49	51058	204	Ga
HUDSON RIVER	gasoline	Petroleum	23	19753	10	Ga
HUDSON RIVER	crude oil	Petroleum	1	5000	0	Ga
HUDSON RIVER	dielectric fluid	Petroleum	3	1258	0	Ga
LONG ISLAND SOUND	#6 fuel oil	Petroleum	8	13009726	1	Ga
LONG ISLAND SOUND	dielectric fluid	Petroleum	5	12600	0	Ga
LONG ISLAND SOUND	#2 fuel oil	Petroleum	5	12250	8	Ga
LONG ISLAND SOUND	cable oil	Petroleum	1	6666	1300	Ga
LONG ISLAND SOUND	gasoline	Petroleum	13	2353	1842	Ga
STONY CREEK	jet fuel	Petroleum	1	3000000	0	Ga

Step 2: Extracting the Top 5 Waterbody Spill Distribution Data into Python

In [127…

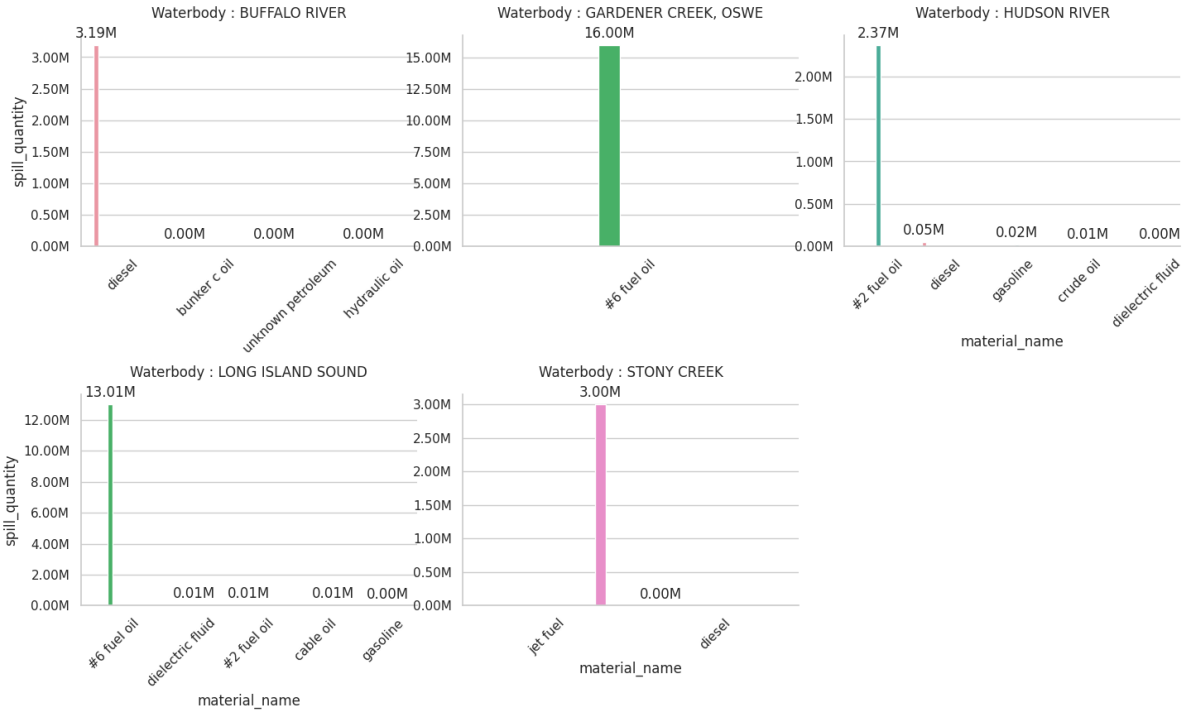
```
material_top_5_WB = _
```

Step 3: Visualizing the Top 5 Waterbody Spill Distribution Data

We wanted to Examine the Top 5 Waterbodies and examine which material_name had the highest frequency of spills within the waterbody

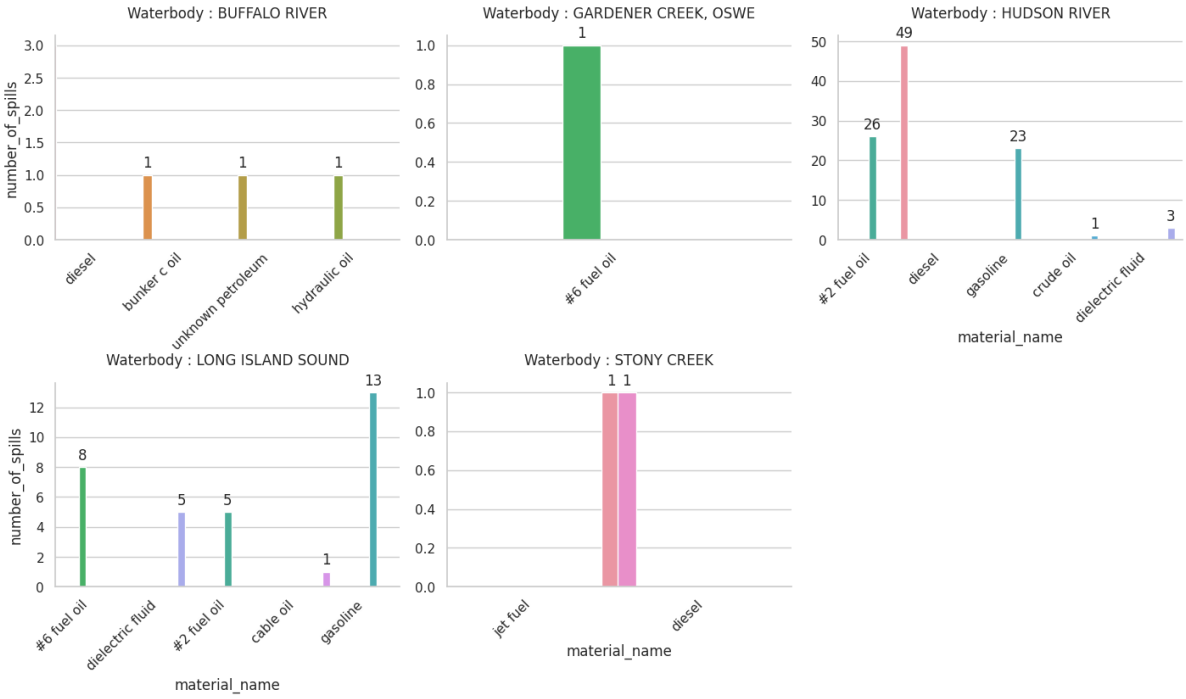
In [128…

```
import seaborn as sns
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter

top_5_WB_dist = pd.DataFrame(material_top_5_WB)

def format_func(value, tick_number):
    return '{:.2f}M'.format(value / 1000000)

g = sns.catplot(
    data=top_5_WB_dist,
    col='waterbody',  # Separate plots based on the values in 'category1'
    x='material_name',    # Separate data into slices based on the values in 'categ
    kind='bar',        # Specify the type of plot as pie chart
    y='spill_quantity',       # The numeric values determining the size of each slic
    col_wrap=3,        # Number of columns in the grid (adjust as needed)
    height=4,          # Height of each subplot
    width=0.7,
    aspect=1.2,        # Aspect ratio of each subplot
    hue='material_name',   # Different colors for each category in 'category2'
    sharey=False,
    sharex=False
)

# Setting the plot labels and title
g.set_titles('Waterbody : {col_name}',size=12, pad=15)


for ax in g.axes.flat:
    ax.set_xticklabels(ax.get_xticklabels(), rotation=45, ha='center')
    ax.yaxis.set_major_formatter(FuncFormatter(format_func))
    for p in ax.patches:
        val = p.get_height()/1000000
        ax.annotate(f'{val:.2f}M', (p.get_x() + p.get_width() / 2., p.get_height())
                    ha='center', va='center', xytext=(0, 10), textcoords='offset po
        

# Show the plot
plt.subplots_adjust(hspace=0.7)
plt.show()
```



In [166…

```
import seaborn as sns
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter


# Create a catplot with pie charts
g = sns.catplot(
    data=top_5_WB_dist,
    col='waterbody',  # Separate plots based on the values in 'category1'
    x='material_name',     # Separate data into slices based on the values in 'categ
    kind='bar',        # Specify the type of plot as pie chart
    y='number_of_spills',       # The numeric values determining the size of each sl
    col_wrap=3,        # Number of columns in the grid (adjust as needed)
    height=4,          # Height of each subplot
    width=1.2,
    aspect=1.2,        # Aspect ratio of each subplot
    hue='material_name',    # Different colors for each category in 'category2'
    sharey=False,
    sharex=False
)

# Set plot labels and title
g.set_titles('Waterbody : {col_name}',size=12, pad=15)

for ax in g.axes.flat:
    ax.set_xticklabels(ax.get_xticklabels(), rotation=45, ha='right')
    for p in ax.patches:
        ax.annotate(f'{p.get_height():.0f}', (p.get_x() + p.get_width() / 2., p.get
                    ha='center', va='center', xytext=(0, 10), textcoords='offset po

# Show the plot
plt.subplots_adjust(hspace=0.7,top=0.9)
plt.show()
```



Observations on Part 2

Prior to Examining the Results, We must focus on the Agenda from Part 1 to address it.

1. Gardner Creek Oswego is a Top Concern (1 Spill of 16 million gallons!)

- We can clearly observe that the spill of the top most concern is Garderner Creek, but we notice that the spilled material_name was #6 fuel oil, which is used in industrial burners and bunker fuel for ocean travelling vessels. Gardner Creek Oswego is a stream within the US and Canada; therefore, we can assume that vessels are spilling this form of petroleum into the ocean. To rectify this, the NY State of Remediation must discuss some policies to contain these spills.

2. Long Island Sound is High Concern (2 spills of 12 million gallons)

- We can notice that Gasoline is the highest polluted material within this waterbody. The NY State of Remediation must discuss better ways to reverse pollution of Gasoline in this Waterbody.

3. Buffalo River is Medium Concern (4 spills of 4 million gallons)

- We can notice that Buffalo River has 4 spills and diesel is the most spilled quantity.

4. Stony Creek is Low-Medium Concern (6 spills of less than 4 million gallons)

- We can notice that Stony Creek has two different kinds of spills which are jetfuel and diesel. Both material_names have a detrimental effect on the environment. It is important that this must be addressed additionally to reverse the environmental effects.

5. Hudson River is Low Concern (211 spills of 2 million gallons).

- The Spilled material that is highest is diesel, which must be a result from vessel spilling.

Question 2: Top Sources of Spills and their Contributing Factors

Analyze the top 5 sources responsible for spill incidents based on spill quantity to provide an in-depth breakdowns of contributing factors associated with each source, offering insights into the factors contributing to spills.

Business Case

We are focusing on top sources and its associated contributing factors because as a government agency trying to regulate and control spills we need to direct our effort towards the root causes and mitigate the circumstances around it through the policies we can enforce. So by looking at the sources/contributing factor we can have more actionable criterion.

Note: Since 90% of the spills are Petroleum spills, we are focusing only on that category for our analysis, insights and decision making

Strategy of Analysis

- Get Top 5 Sources based on aggregated Spill Quantity for Petroleum
- Find the Top Contributing Factors for each of the top 5 sources

Part I: Getting the Top 5 Sources of Petroleum Spills

Step 1: Creating a view that will give the top sources

In [130…

```
%%sql
CREATE OR REPLACE VIEW top_sources AS
SELECT
    so.source,
    count(*) number_of_spills,
    SUM(sp.quantity) spill_quantity,
    u.units
FROM
    spills sp
JOIN
    source so ON sp.source_key = so.key
JOIN
    contributing c ON sp.contributing_key = c.key
JOIN
    unit u ON sp.unit_key = u.key
JOIN
    day d ON sp.spill_day_key = d.key
WHERE
    u.units = 'Gallons'
    AND
    d.year > '2002'
    AND
    sp.quantity > 0
GROUP BY
    so.source,
    u.units
ORDER BY
```

```
    spill_quantity DESC
;
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[130]: []

Step 2: Only filtering the top 5 from the query above

In [131…
```
%%sql
SELECT * FROM top_sources LIMIT 5;
```

```
 * postgresql://student@/Group1_FinalAssignment
5 rows affected.
```

Out[131]:

source	number of spills	spill quantity	units
Commercial/Industrial	36647	119298687	Gallons
Major Facility (MOSF) > 400,000 gal	985	62317050	Gallons
Institutional, Educational, Gov., Other	7535	19794958	Gallons
Airport/Aircraft	694	3431416	Gallons
Private Dwelling	23347	3207654	Gallons

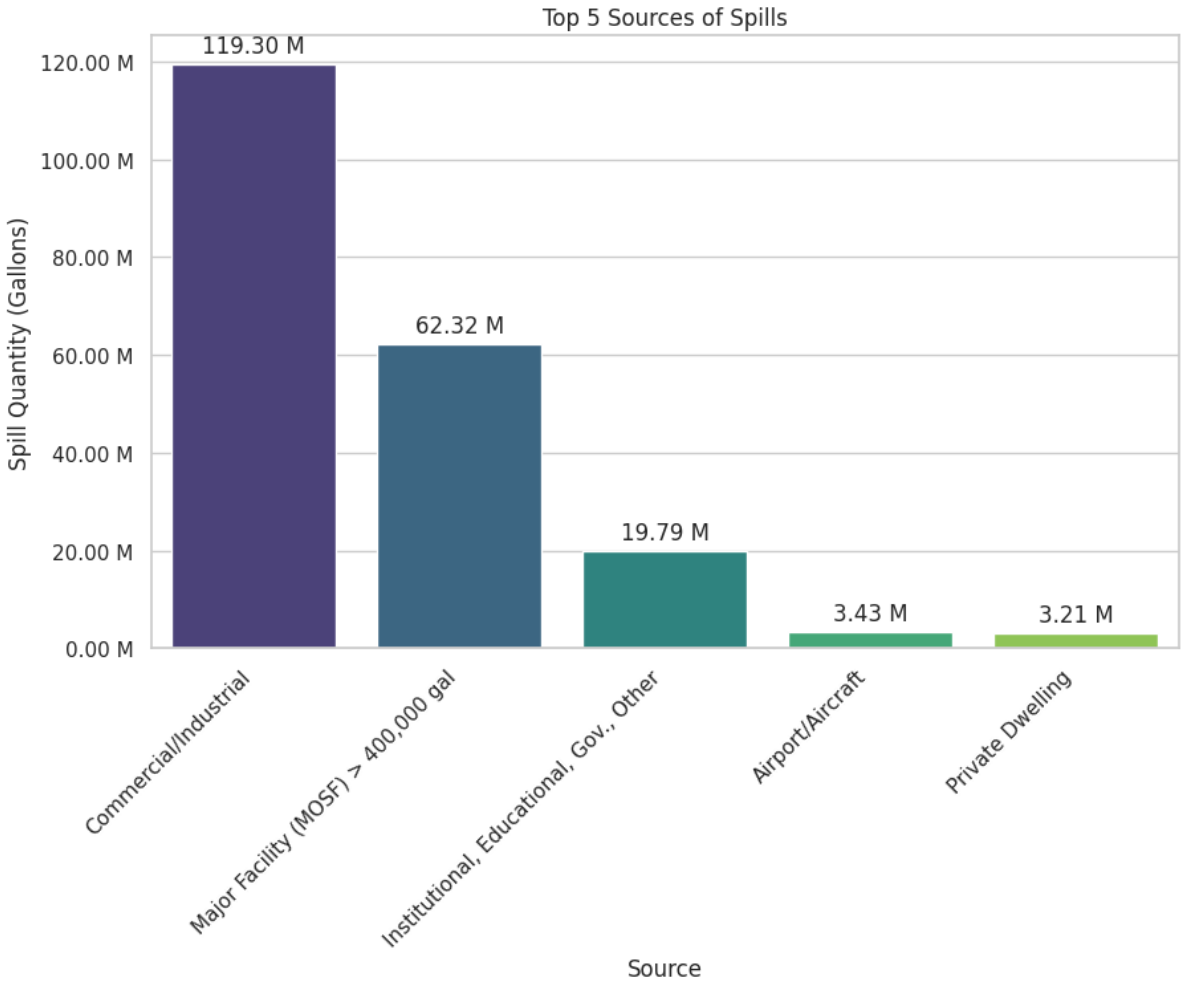
Step 3: Extracting the results to pandas

In [132…
```
import pandas as pd
results = _
top_5_sources = pd.DataFrame(results)
```

Step 4: Visualizing the To 5 Sources

In [160…
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter

# Create a stacked bar chart using seaborn
plt.figure(figsize=(10, 6))
ax = sns.barplot(x='source', y='spill_quantity',  data=top_5_sources, palette='viri


# Customize the plot
plt.title('Top 5 Sources of Spills')
plt.xlabel('Source')
plt.ylabel('Spill Quantity (Gallons)')
plt.xticks(rotation=45,ha='right')

def format_func(value, tick_number):
    return '{:.2f} M'.format(value / 1000000)

ax.yaxis.set_major_formatter(FuncFormatter(format_func))

for p in ax.patches:
    label = format_func(p.get_height(), None)
    ax.annotate(label, (p.get_x() + p.get_width() / 2., p.get_height()),
                ha='center', va='center', xytext=(0, 10), textcoords='offset points
```

```
# Show the plot
plt.show()
```



Part II: Getting the Distribution of the top 5 Sources by their Contributing Factors

Step 1: Use the first query to filter top 5 sources and then match them with their contributing factors while ranking adn filtering for top 5 again

In [134…

```
%%sql
WITH rankedSourceContrib AS
    (SELECT
        so.source,
        c.contributing_factor,
        count(*) number_of_spills,
        SUM(sp.quantity) spill_quantity,
        u.units,
        RANK() OVER (PARTITION BY so.source ORDER BY SUM(sp.quantity) DESC) as sour
    FROM
        spills sp
    JOIN
        source so ON sp.source_key = so.key
    JOIN
        contributing c ON sp.contributing_key = c.key
    JOIN
        unit u ON sp.unit_key = u.key
    JOIN
        material m ON sp.material_key = m.key
    JOIN
        day d On sp.spill_day_key = d.key
```

```
    WHERE
        so.source IN (SELECT source FROM top_sources LIMIT 5)
        and
        c.contributing_factor NOT IN ('Other','Unknown')
        and
        u.units = 'Gallons'
        and
        d.year > '2002'
        and
        sp.quantity > 0
    GROUP BY
        so.source,
        u.units,
        c.contributing_factor
    ORDER BY
        spill_quantity DESC)

SELECT * FROM rankedSourceContrib
WHERE source_rank < 6
ORDER BY source, source_rank
```

```
 * postgresql://student@/Group1_FinalAssignment
25 rows affected.
```

Out[134]:

source	contributing_factor	number_of_spills	spill_quantity	units	source_rank
Airport/Aircraft	Equipment Failure	449	10303	Gallons	1
Airport/Aircraft	Human Error	146	2151	Gallons	2
Airport/Aircraft	Deliberate	1	200	Gallons	3
Airport/Aircraft	Traffic Accident	8	164	Gallons	4
Airport/Aircraft	Storm	1	80	Gallons	5
Commercial/Industrial	Equipment Failure	22160	86530640	Gallons	1
Commercial/Industrial	Storm	894	21727452	Gallons	2
Commercial/Industrial	Human Error	3740	1177391	Gallons	3
Commercial/Industrial	Deliberate	399	1109882	Gallons	4
Commercial/Industrial	Traffic Accident	1575	235978	Gallons	5
Institutional, Educational, Gov., Other	Equipment Failure	4277	12587843	Gallons	1
Institutional, Educational, Gov., Other	Storm	51	758350	Gallons	2
Institutional, Educational, Gov., Other	Human Error	945	163683	Gallons	3
Institutional, Educational, Gov., Other	Deliberate	95	35374	Gallons	4
Institutional, Educational, Gov., Other	Traffic Accident	212	20663	Gallons	5
Major Facility (MOSF) > 400,000 gal	Vandalism	2	16000050	Gallons	1
Major Facility (MOSF) > 400,000 gal	Storm	25	13090594	Gallons	2
Major Facility (MOSF) > 400,000 gal	Equipment Failure	580	3070390	Gallons	3
Major Facility (MOSF) > 400,000 gal	Deliberate	3	2305002	Gallons	4
Major Facility (MOSF) > 400,000 gal	Human Error	166	81887	Gallons	5
Private Dwelling	Equipment Failure	14891	899007	Gallons	1
Private Dwelling	Human Error	3116	96567	Gallons	2
Private Dwelling	Tank Failure	562	61500	Gallons	3
Private Dwelling	Storm	541	34179	Gallons	4
Private Dwelling	Deliberate	361	15936	Gallons	5

Step 2: Importing Query Output to Pandas

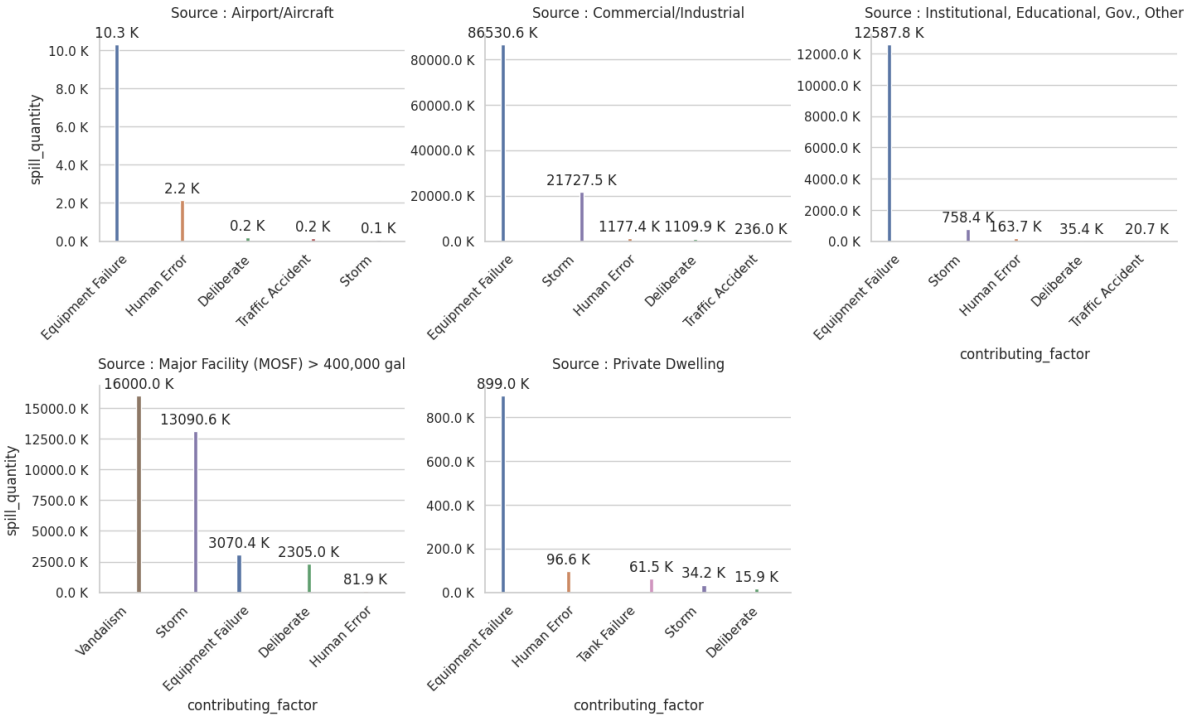
In [135…

```
source_dist = _

import pandas as pd

source_dist = pd.DataFrame(source_dist)

source_dist.to_csv('source_dist.csv', index=False)
```

Step 3: Visualizing the Results by distribution of Contributing Factor for Each Source

In [174…

```
import seaborn as sns
import matplotlib.pyplot as plt

def format_func(value, tick_number):
    return '{:.1f} K'.format(value / 1000)

g = sns.catplot(
    data=source_dist,
    col='source',
    x='contributing_factor',
    kind='bar',
    y='spill_quantity',
    col_wrap=3,
    height=4,
    width=0.5,
    aspect=1.2,
    hue='contributing_factor',
    sharey=False,
    sharex=False
)


g.set_titles('Source : {col_name}',size=12, pad=15)

for ax in g.axes.flat:
    ax.set_xticklabels(ax.get_xticklabels(), rotation=45, ha='right')
    ax.yaxis.set_major_formatter(FuncFormatter(format_func))
    for p in ax.patches:
        val = p.get_height()/1000
        ax.annotate(f'{val:.1f} K', (p.get_x() + p.get_width() / 2., p.get_height()
                    ha='center', va='center', xytext=(0, 10), textcoords='offset po


plt.subplots_adjust(hspace=0.7)
plt.show()
```



Business Outcomes and Findings:

- As seen from the results above the top 5 sources are as follows:
  - Commercial/Industrial
  - Major Facility
  - Institutional, Educational, Gov, Other
  - Airport/Aircraft
  - Private Dwelling
- For 4 of the 5 top 5 sources most common reason of spills is **Equipment Failure**, meaning need to focus on actions for the mitigation of such incidents. Some possible alleviating programs could be:
  - Introducing more stringment requirements around maintainance protocols
  - Requiring more training certification for handling petroleum products
  - Plan end of life rules for machines involving the pipeline of petroleum products
- **Storms** (or weather related issues) is standout cause for spills for many and to prevent such spills, weather proofing specific laws could be put in place to protext from future spills
- **Major facilities** tend to be the most impacted by **Vandalism** that cause the majority of the spills so there's more need to have security protocols for those sources to mitigate the circumstances
- **Major facilities** experience the most substantial spill volumes, suggesting that large-scale operations are the most significant contributors to spill incidents and should be a primary focus for spill prevention efforts.
- **Human error** is a notable factor in spills at private dwellings, highlighting the importance of public awareness and education on spill prevention in residential areas.

Question 3: Resolution Time and Recovery Rate by County

Analyze the top and bottom 5 counties based on spill recovery rates to assess their efficiencies in resolving matter and identify the counties with better performance in cleaning spills by evaluating resolution rates and recovery rates

Business Case

After analysing the impact on waterbodies, sources and contributing factors, another important metric we need for informed decision making and efficient resources allocation as a government regulating agency is to look at the effectiveness or the ability to deal with spills that are not prevented even after mitigation techniques. To analyse those metrics we look at the recovery percentage of the spills by county and the average resolution time for each spill so that we can gauge which areas are doing the nest and which are doing the worst. In doing so we can focus on the areas that require more attention in terms of resources as well as new methods or tools to help them deal with spills.

Note: Since 90% of the spills are Petroleum spills, we are focusing only on that category for our analysis, insights and decision making

Strategy of Analysis

- Find the average reporting time, resolution time and recovery rate for each county
- Compare different counties in their performance
- Compare the relationship between length of average resolution and recovery rate

Part I: Creating the Query to Calculate the average reporting time, resolution time and recovery rate for each county

Step 1: Create the view for the query

In [137…

```
%%sql
CREATE OR REPLACE VIEW response_by_county AS
SELECT
    l.county,
    COUNT(*) AS num_of_spills,
    SUM(s.quantity) AS spill_quantity,
    SUM(s.recovered) AS recovered_quantity,
    ROUND(AVG(d2.day::date - d1.day::date)) AS avg_reporting_time_in_days,
    ROUND(AVG(d3.day::date - d1.day::date)) AS avg_resolution_time_in_days,
    ROUND(100*SUM(s.recovered)/SUM(s.quantity),2) AS spill_recovery_percentage
FROM
    spills s
JOIN
    unit u ON s.unit_key = u.key
JOIN
    material m ON s.material_key = m.key
JOIN
    location l ON s.location_key = l.key
JOIN
    day d1 ON s.spill_day_key = d1.key
JOIN
    day d2 ON s.received_day_key = d2.key
```

```
JOIN
    day d3 ON s.close_day_key = d3.key
WHERE
    u.units = 'Gallons' and
    s.quantity <> 0 and
    m.material_family = 'Petroleum' and
    s.spill_day_key IS NOT NULL and
    s.close_day_key IS NOT NULL
GROUP BY
    l.county;
```

```
 * postgresql://student@/Group1_FinalAssignment
Done.
```

Out[137]: []

Step 2: Use the query and filter for counties that are above the threshold of average number of spills by county because that gives us a better indication of how each county tackles its spill cases

In [144…

```
%%sql
SELECT
    *
FROM
    response_by_county
WHERE
    num_of_spills > (SELECT AVG(r.num_of_spills) FROM response_by_county r)
ORDER BY
    spill_recovery_percentage;
```

```
 * postgresql://student@/Group1_FinalAssignment
20 rows affected.
```

Out[144]:

county	num_of_spills	spill_quantity	recovered_quantity	avg_reporting_time_in_days	avg_resol
Orange	4322	4842934	10254	1	
Suffolk	15009	14177081	31599	2	
Dutchess	3058	2631684	15984	1	
Oneida	2443	3160108	28323	1	
Queens	10755	7216696	191723	2	
Bronx	5349	861214	24390	3	
Kings	7972	871219	30854	2	
Nassau	12860	916412	32440	1	
Erie	5770	3450406	129387	1	
Albany	4030	1763218	66315	1	
Westchester	12895	988709	57636	2	
Ulster	2621	97088	6097	3	
Niagara	2075	579500	39407	2	
St Lawrence	2329	263724	19730	4	
Saratoga	2832	74900	5806	3	
Monroe	4853	266384	34093	1	
New York	8946	840484	119150	3	
Jefferson	2080	105539	25152	2	
Rockland	2659	207728	56441	0	

Step 3: Output the Data to Pandas and also to a csv file for geomapping in tableau

In [145…

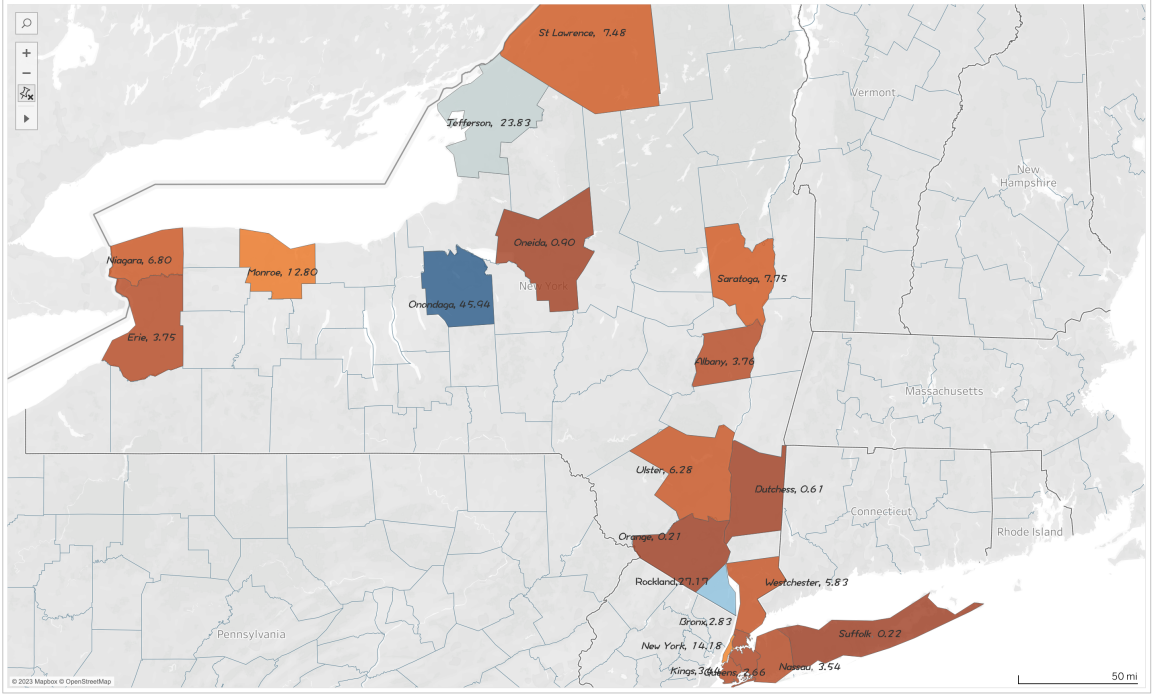
```
import pandas as pd

counties_data = _

counties_recovery = pd.DataFrame(counties_data)

counties_recovery.to_csv('counties_recovery.csv', index=False)
```

Step 4: Using the results from tableu looking at the distribution of recovery rate by county location in the state of New York

In [141…

```
from IPython.display import Image
Image(url="https://github.com/maneeshtekwani/DMFA_Group1_FinalAssignment/blob/main/
```

Out[141]:



Part II: Comparing the Recovery Rates and Average Resolution Times for spills for each county

Step 1: Plot the results from eariler query to see the **Spill Recovery Percentage** by county

In [146…

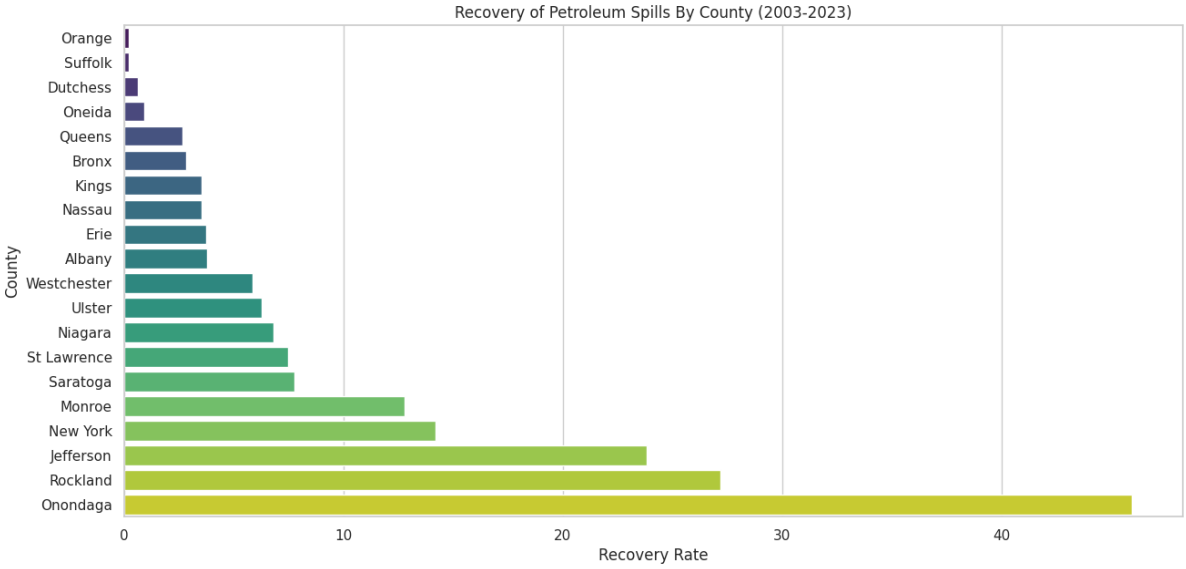
```
counties_recovery.head()
```

Out[146]:

	county	num_of_spills	spill_quantity	recovered_quantity	avg_reporting_time_in_days	avg_reso
0	Orange	4322	4842934	10254	1	
1	Suffolk	15009	14177081	31599	2	
2	Dutchess	3058	2631684	15984	1	
3	Oneida	2443	3160108	28323	1	
4	Queens	10755	7216696	191723	2	

In [158…

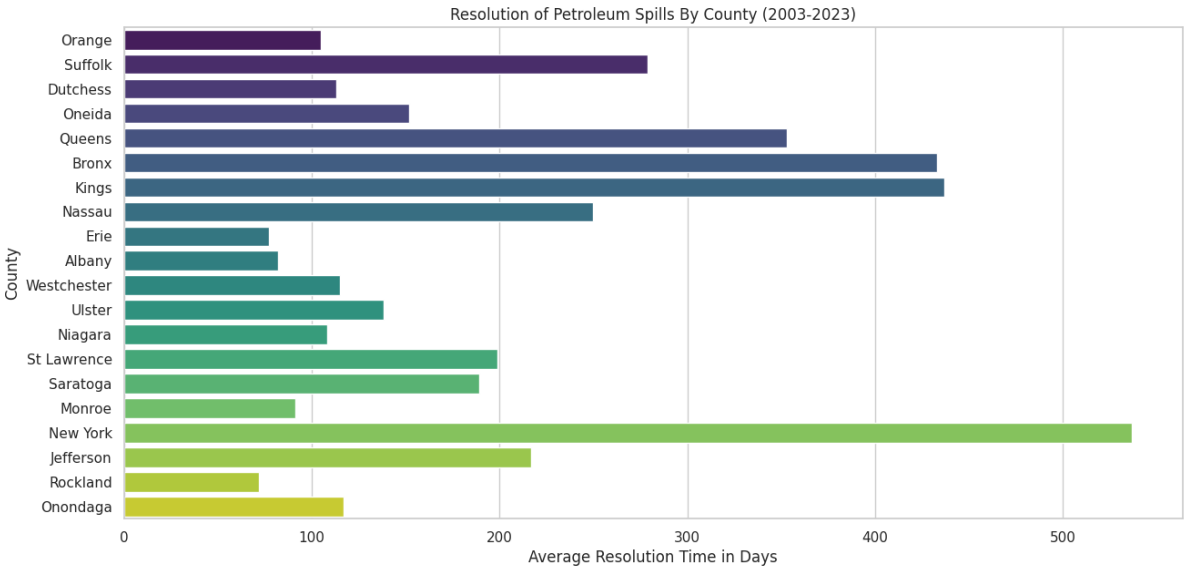
```
import seaborn as sns
import matplotlib.pyplot as plt

sns.set(style="whitegrid")
plt.figure(figsize=(15, 7))

# Use the barplot function
ax = sns.barplot(y='county', x='spill_recovery_percentage', data=counties_recovery,

# Customize the plot
ax.set_title('Recovery of Petroleum Spills By County (2003-2023)')
ax.set_xlabel('Recovery Rate')
ax.set_ylabel('County')

# Display the plot
plt.show()
```



Step 2: Plot the results from eariler query to see the **Average Spill Resolution Time in Days** by county

In [156…

```
import seaborn as sns
import matplotlib.pyplot as plt
# Create a horizontal bar plot using Seaborn
sns.set(style="whitegrid")
plt.figure(figsize=(15, 7))

# Use the barplot functionavg_resolution_time_in_days
ax = sns.barplot(y='county', x='avg_resolution_time_in_days', data=counties_recover

# Customize the plot
ax.set_title('Resolution of Petroleum Spills By County (2003-2023)')
ax.set_xlabel('Average Resolution Time in Days')
ax.set_ylabel('County')

# Display the plot
plt.show()
```



Business Outcomes and Findings:

- **Top Performer:** From the first analysis we can see that **Onandaga** county has the best recovery rate and also one of the best resolution times compared to others. This county

could be used to see what works best for dealing with spills and use those techniques at other counties that suffer

- **Correlation Between Resolution Time and Recovery Rate:** The counties with shorter average resolution times for petroleum spills do not necessarily show higher recovery rates, suggesting that quick resolution does not always equate to more effective recovery.

- **Discrepancies in County Responses:** Some counties, like Saratoga and St. Lawrence, appear in both graphs with notable performance - lower resolution times and higher recovery rates, indicating a potentially more effective spill management approach.

- **Potential for Optimization:** Counties with longer resolution times and lower recovery rates, such as Onondaga and Rockland, may benefit from examining the practices of counties like Saratoga and St. Lawrence to improve their spill management strategies.