Greenbacks Vs. Greenspace

Part I.
Problem Statement:

Gavin Newsom has 550 acres of land to divide up and make a profit off of, 150 acres are from the AT&T parking lots, 100 acres are from the Hunter's Point Naval Shipyard, and 300 acres are from the Presidio. Two groups are fighting over how the land should be distributed. Group #1 wants the land to go to business and group #2 wants the land to go to nature. Group #1 was able to get Gavin Newsom to agree to give them at least 300 acres of the land for business. In addition to that the two groups came up with a set of compromises. They decided that at most 200 acres of the Hunter's Point Naval Shipyard and the AT&T parking lot land should go for nature. Their second compromise was that exactly 100 acres from the Presidio and Hunter's point needed to go for business.

The question is asking us to present Gavin Newsom with a proposal that divides up the land while fitting into the compromises made by the two groups. **The proposal has to give the amount of land that goes to each group from each part of the city that will give Gavin Newsom the most profit with the least amount of cost for him.** We also have to come up with a plan for the land distribution that doesn't fit the compromises, or constraints, that we think is the best idea and why we think that.

To do this problem, the math I will need to know is:
How to write out constraints into equations
How to cancel out constraints that will create parallel lines
How to comprise a list of constraint combinations
How to write out matrices
How to multiply matrices on the calculator
How to figure out if answers fit into constraints
How to multiply the amount of acres by the amount per acre to figure out the cost
How to use my answers to make conclusions
What matrices are:
A matrix, plural matrices, is a way to organize numbers in a rectangle. There are rows of numbers going up and down and from side to side called rows and columns. You can add and multiply matrices but you cannot subtract or divide them. In this project I will be multiplying them as if they were linear equations. The way that works is you have a number matrix (A), a variable matrix (X), and an answer matrix (B). This allows you to multiply many linear equations at once. Also, by using the inverse which is like raising your number matrix to the power of -1, you can solve for the variable matrix (X).

PLAN-
Step 1: To do this problem I will need to write out equations for all the constraints and number them.

Step 2: Then I will have to cancel out equations that equal the same thing because I know they will make a straight line. That way I will have fewer combinations to test.
Step 3: Then I have to put each set of combinations in a matrix and mark whether or not it has each land variable.
Step 4: **Then I have to put those matrices into the calculator so I can multiply them by the inverse and then multiply that with the answer matrix. The equation is set up like this:**
(A) x (X) = (B) A= the combination matrix X=the variable matrix B=the answer matrix. We are trying to solve for the X matrix because that will give us the amount of land from each part of the city or that corresponds with each variable like LN (presidio land for nature) or PB (AT&T parking lots for business.) Basically, what I'm doing is putting the combination matrix in the calculator and then multiplying it by it's inverse and by the answer matrix (B) in order to solve for (X). When using matrices you can't divide, so you have to use the inverse, which is like raising the whole matrix to the power of -1 and that gives you the matrix with the values that you would need to multiply with the (A) combination matrix to get the (B) answer matrix.
Step 5: After I get all the answers, which are the amounts of land, I have to make sure that each one meets the constraints. If it doesn't, I can eliminate it.
Step 6: **Once I have eliminated amounts of land that don't fit the constraints, I can figure out which one costs the least by multiplying each amount of land acreage by the amount of money per acre the land costs.**
Step 7: Once I have that answer I can forget about the constraints and decide what I think is the best way to divide up the land.

Part II.
Work Section:

Constraints-

1. LN + LB=300
2. SN + SB=100
3. PN + PB=150
4. SN + LB=100
5. SN + PN≤200
6. LB + SB + PB ≥300
7. LN ≥0
8. LB ≥0
9. SN ≥0
10. SB ≥0
11. PN ≥0
12. PB ≥0

[**LN**=PRESIDIO LAND FOR NATURE **LB**=PRESIDIO LAND GOING FOR BUSINESS **SN**=HUNTER'S POINT NAVAL SHIPYARD FOR NSTURE **SB**=HUNTER'S POINT NAVAL SHIPYARD FOT BUSINESS **PN**=AT&T PARKING LOT LAND FOR NATURE **PB**=AT&T PARKING LOT LAND FOR BUSINESS]

Constraint Combinations-

1,2,3,4,5,6	1,2,3,4,6,8
1,2,3,4,5,8	1,2,3,4,6,10
1,2,3,4,5,10	1,2,3,4,6,11

Numbers 1,2,3, and 4 always have to be in the combi nations because they have an equals sign which means that they are equations not inequalities.

1,2,3,4,5,11 1,2,3,4,6,12 **Because they are equations, that means that they have fixed amounts that the variables have equal. The inequalities are much broader and can be less than/equal to a certain number/amount or greater than/equal to a certain number/amount. The equations have to be included in every combination because the outcomes have to stay the same and the same variables have to add up to only that amount.**
1,2,3,4,5,12 1,2,3,4,10,11

Which constraints can't be paired together-

7 and 8	8 and 11
9 and 10	8 and 12
11 and 12	9 and 11
8 and 9	10 and 12
8 and 10	

Any of these together would create parallel lines because they all have the same answers. Therefore, they couldn't work for this problem.

Matrices-

1,2,3,4,5,6

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		50
2	0	0	1	1	0	0		100		250
3	0	0	0	0	1	1	X	150	=	-150
4	0	1	1	0	0	0		100		250
5	0	0	1	0	1	0		200		350
6	0	1	0	1	0	1		300		-200

1,2,3,4,5,8

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		300
2	0	0	1	1	0	0		100		0
3	0	0	0	0	1	1	X	150	=	100
4	0	1	1	0	0	0		100		0
5	0	0	1	0	1	0		200		100
8	0	1	0	0	0	0		0		50

1,2,3,4,5,10

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		300
2	0	0	1	1	0	0		100		0
3	0	0	0	0	1	1	X	150	=	100
4	0	1	1	0	0	0		100		0

5	0	0	1	0	1	0		200		100
10	0	0	0	1	0	0		0		50

1,2,3,4,5,11

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		400
2	0	0	1	1	0	0		100		-100
3	0	0	0	0	1	1	X	150	=	200
4	0	1	1	0	0	0		100		-100
5	0	0	1	0	1	0		200		0
11	0	0	0	0	1	0		0		150

1,2,3,4,5,12

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		250
2	0	0	1	1	0	0		100		50
3	0	0	0	0	1	1	X	150	=	50
4	0	1	1	0	0	0		100		50
5	0	0	1	0	1	0		200		150
12	0	0	0	0	0	1		0		0

1,2,3,4,6,8

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		300
2	0	0	1	1	0	0		100		0
3	0	0	0	0	1	1	X	150	=	100
4	0	1	1	0	0	0		100		0
6	0	1	0	1	0	1		300		-150
8	0	1	0	0	0	0		0		300

1,2,3,4,6,10

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		300
2	0	0	1	1	0	0		100		0
3	0	0	0	0	1	1	X	150	=	100
4	0	1	1	0	0	0		100		0
6	0	1	0	1	0	1		300		-150

10	0	0	0	1	0	0		0			300

1,2,3,4,6,11

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		225
2	0	0	1	1	0	0		100		75
3	0	0	0	0	1	1	X	150	=	25
4	0	1	1	0	0	0		100		75
6	0	1	0	1	0	1		300		0
11	0	0	0	0	1	0		0		150

1,2,3,4,6,12

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		150
2	0	0	1	1	0	0		100		150
3	0	0	0	0	1	1	X	150	=	-50
4	0	1	1	0	0	0		100		150
6	0	1	0	1	0	1		300		150
12	0	0	0	0	0	1		0		0

1,2,3,4,10,11

	LN	LB	SN	SB	PN	PB				
1	1	1	0	0	0	0		300		300
2	0	0	1	1	0	0		100		100
3	0	0	0	0	1	1	X	150	=	150
4	0	1	1	0	0	0		100		100
10	0	0	0	1	0	0		300		0
11	0	0	0	0	1	0		0		0

Explanation:
Each of the number tables above are matrices. Above them and labeled down the side are the combinations of constraints that are listed and numbered at the very top of the work section. The “LB” LN” “SN” “SB” etcetera, are the variables in the constraints which also correspond to the parts of the land Gavin Newsom is dividing up. The ones and zeros mark how many of each variable combination come up in each constraint equation. The first matrix and the second matrix get plugged into the calculator and then you take the inverse of the first matrix by pressing the -1 exponent button and multiply it with the second matrix and that gives you the third matrix which is the answer. In order to see which of these will work and which of them won’t, you have to test them against the constraints. If you look at constraints 7-12 they tell you that you cannot have negative answers therefore, any combinations with negative answers can be eliminated.

1st Eliminated Combinations:

1,2,3,4,5,6 1,2,3,4,6,10 These all have negative numbers in the answer
1,2,3,4,5,11 1,2,3,4,6,12 column.
1,2,3,4,6,8

We can then eliminate more of the remaining combinations by going through all the answer columns and testing the numbers by putting them in the place of the variables in the equations.

2nd Eliminated Combinations:

1,2,3,4,5,8 violates constraint number 6
1,2,3,4,5,10 violates constraint number 6
1,2,3,4,5,12 violates constraint number 6
1,2,3,4,10,11 utterly unsolvable gives error on calculator.

There is only one combination left after all the eliminations, and it is:
1,2,3,4,6,11!!!!!!! Yay!
The most profitable way to divide the land is:
LN = 225 SN = 25 PN = 0
LB = 75 SB = 75 PB = 150
The prices for each of these are:
LN =$50/acre 50 x 225=$11250 LB = $500/acre 500 x 75=$37500
SN=$200/acre 200 x 25=$5000 SB = $2000/acre 2000 x 75=$150000
PN=$100/acre $100 x 0= $0 PB = $1000/acre 1000 x 150=$150000
Total: $353,750.00

Part III.
Answer Section:

The only way to split up the land while still meeting the constraints is by giving 225 acres of the Presidio land to the nature group and the other 75 acres to the business group. Of the Hunter's Point Naval Shipyard land, 25 acres should go to nature and 75 acres should go to business. Finally, none of the land from the AT&T parking lots can go to nature. All 150 acres have to go to business. This allotment of land would cost Gavin Newsom $353,750.00 all together and it is the only combination of the land allotments that will meet all the constraints brought up in the compromise groups 1 and 2 made. **I know this because once I went through the process of raising each of the constraint combination matrices (A) by -1 to find the inverse, and multiplying the inverse by the corresponding answer matrices (B) which is basically like dividing it, I solved for the (X) matrix which gave me the amounts of land for each variable. Once I had that, I could replace the variables in the constraint equations with the numbers that I came up with for each combination to figure out which one fit into all of them. I found that only one combination fit all the constraints. Once I knew that, it was very easy to determine which combination was the most cost effective because it was the only combination that met all the constraints. The combination was 1,2,3,4,6,11 and when it was put through the matrix multiplying process to solve for the (X) matrix, the results that came out met every constraint and the fact that it was the most cost effective solution was irrefutable.**

The last section the answer was based on what allotment of land met the constraints. However, if there were no constraints I would split it up differently. The majority of AT&T parking lot land would go to nature because that neighborhood has hardly any parks. I would suggest that 100 acres of that land go to making parks and natural things. The other 50 acres should go to business because that neighborhood is prime real estate for businesses and it would make a lot of profit there. As far as the Hunter's Point Shipyard, I don't think that any business should be built there because it's a toxic waste site. Parks aren't a good idea either because people probably shouldn't spend much time there at all. But in the interest of the problem, I would say that it should be 75 acres for nature and 25 acres for business. This is because the neighborhood has a lot of residents who would probably prefer parks and places to play to big office buildings or condominiums.

The last place that needs to be split up for the different factions is the Presidio. The presidio is already a very natural place with trees and things and it's an important part of San Francisco to preserve. For that reason, I think that all 300 acres of it should go to nature. The presidio is a nice place to walk and bike ride and it would be a good place to have events like festivals and concerts. The city could probably end up making quite a bit of profit off of keeping it natural and letting the people of San Francisco have it. That concludes my proposal. Now you have both the most feasible and diplomatic way to split up the land, and the logical perspective of someone who lives in San Francisco.

Part IV.
Reflection:

To do this project I had to first, familiarize myself with the problem itself and what it was asking me to do. I read over the paper a few times and then wrote a summary of it in my own creative way. I didn't know that you were supposed to use the same situation as is on the problem description sheet, so I took some artistic license and made it into a problem about a little old lady named Eleanor Rigby who's husband left her a lot of land when he died. The story is mostly quoted from Beatles songs' but I used all the same numbers as in the original problem. Unfortunately, that wasn't what I was supposed to do so I re-wrote it in a more official way. Even though this annoyed me greatly, I feel like it really got the problem into my head. Besides my initial problem with the problem statement, I didn't really encounter any other problems. I was able to stick to my plan throughout the whole thing.

Once I understood the problem better, it was easier for me to understand what the constraints/compromises were about and which ones I could pair up together and which ones I couldn't. Once I narrowed down the list, I was able to move on to the next mathematical step, which I know had something to do with matrices. Unfortunately I missed the in-class time that we got to work on the matrices and I was really lost. But I stayed in at lunch and Aaron Alvarez helped me. Once I understood how to make the Matrices, and what the formula was, it was easy as pie. I was jut slow because I was writing out 6x6 matrices over and over again but changing one or two numbers slightly, and it got confusing.

Once I got all the answers to the matrices I had to go through and eliminate the ones that I knew didn't meet the constraints, like all of the negative ones because all the constraints required that the numbers be greater than or equal to zero. Once I did that I had to eliminate a second round of them by testing each number out by putting it in the place of its corresponding variable. After I went through and tested each of the answers from the matrices, there was only one option that worked and that was my answer. I was expecting to have to go through all the costs and figure out which one gave the most profit, but I didn't have to.

This math with matrices and constraints can be used to solve real world problems like how to spend the least amount of money on materials for house while still being able to purchase everything you need. In a situation like that, you can write up constraints about the minimum amounts of things you need to build the house with and the prices of those things. You could also have a budget constraint. Then you could make equations out of that information so that you could put it into matrix form and multiply it. Another real World example of how to use these matrices is if a school is planning on buying textbooks for the students. Say there are two different kinds of textbooks with different prices and they have to figure out how many of each kind they can buy for the students to take home how many to leave at school. In that sort of problem there would be constraints on how many books they needed so that each student could take one home, how many needed to be at school, how much the school could spend on it etc. There are a lot of real life situations where people need to find out how to spend the least amount of money they can while fulfilling their needs.

One change that could be made to this problem that would significantly change my answer is if I switched a variable in one of the constraint equations. For example, if I changed the constraint equation LN + LB = 300 to PN to LB = 300. If I did that, none of my answers would add up to the right things. **So, it's important not to get confused by the variables because they are very important. LN corresponds with only the amount of land in the presidio that can be kept for nature and PN can only be the amount of land from the AT&T parking lots that can be kept for nature. It is very specific and by changing the variables in the constraints the amounts of land will be totally thrown off.** Well, that's all I can say about this problem. I feel that my math work was thorough and complete and that my proposal for the "better" choice was very logical and well thought out. I hope that this proposal helps Gavin Newsom decide what to do with the 550 acres of land he was given.

San Francisco's Land: Greenbacks or Greenspace?

The City of San Francisco's Department of Public Works had just received a huge amount of land from various people and organizations.

George Lucas had decided to move his company, LucasArts, down to Los Angeles, in hopes it will make him more successful. He has left his 300-acres in the Presidio to the city to do whatever they wish with it.

Then the Navy, due to too much lawsuit "mumbo-jumbo", decided to close their Hunter's Point Shipyard and donated the 100-acres of land to the city to use in any way they wanted to.

Finally, the 150 acres of land that the city had leased to the SF Zoo 99 years ago came to the end of the lease. Because the zoo has had so many protesters in the past 10 years about the condition of the animals' lives at the zoo, they decided to close and move all the animals back to their natural habitats. This land became available to the city with no restrictions.

So that's 550 acres of land that the city could use however they wanted. The problem was that, as you know, people in a city have many different opinions. The two biggest and most vocal groups had opposing views. One group wanted to use as much of the land as they could for *development*—that is, for stores, businesses, and housing. The other group wanted to use as much of the land as possible for *recreation*—that is, hiking trails, picnic areas, and park land.

After much deliberation and many City Council meetings, one conclusion was reached. The City Council agreed that at least 300 acres would be designated for development. The business-minded people were ecstatic—they saw this as a huge success!

The two groups also came to a compromise about the remaining land, as they both wanted their houses and parks on attractive land with nice views and surroundings. Their compromise said that at most 200 acres of the Naval Shipyard and the SF Zoo could go to recreation. In addition, the amount of Naval Shipyard land used for recreation and the amount of Presidio land used for development had to total exactly 100 acres.

The city manager made a chart of the costs for both development and recreation. The City of San Francisco wants to keep its cost to a minimum since it might be losing revenue because the 49ers are sell-outs and moving to Santa Clara!

Land	Improvement costs per acre for recreation	Improvement costs per acre for development
LucasArts—Presidio	$50	$500
Shipyard—Hunter's Point	$200	$2000
SF Zoo—Golden Gate Park	$100	$1000

The city manager had the exciting job of deciding how to split the land so that the cost to the city was minimized, but also so all of the conditions agreed on by the city council were met. She had no idea how to do this, so she called me up and I said my students would be happy to help her out! ☺

Greenbacks or Greenspace? Proposal

You have been chosen as a consultant for Mayor Newsom's office to help in the decision of how to split up the land to best serve the needs of the San Francisco community. Your task is to write up a **formal proposal** summarizing your findings. This proposal must be typed with a cover page and turned in by **Thursday, June 7th**.

Section 1: Current Situation (Due Thursday, May 24th)

In this section, describe, in detail, the information you have been given as a consultant. Keep in mind that all San Francisco residents will have access to this document, so it needs to be understandable to the average person. This includes, but is not limited to, **written and mathematical descriptions** of the

- Different pieces of land that have been donated to the city and
- Stipulations that must be met in order for everyone in the city to be happy

This section should also include a preview of what you will do in the report to solve the city's problem. Your plan should include:

- A general strategy for solving a linear programming problem of this magnitude
- Justifications of how you will analyze the possible solutions and how you will know which is most efficient.

Section 2: Investigation (Due Thursday, May 31st)

In this section, you will show, in an **organized and logical** fashion, ALL work you have done to inform the Mayor's Office of the most cost-efficient division of land. This includes, but is not limited to:

- A detailed explanation of the basics of matrices and how they can help solve the problem
- Detailed explanations about why combinations of constraints are examined or ignored
- All matrices used with labels for rows and columns
- A detailed description of what the inverse is and how it helps you solve a matrix equation
- A detailed explanation of matrix multiplication used to solve a matrix equation
- All matrices are solved and solutions are evaluated (if they violate a constraint, list which one(s))
- Costs for each possible solution

Section 3: Recommendation (Due Monday, June 4th)

In this section, you must clearly describe

- How the land should be allocated based on the given constraints and what the cost to the city will be
- A justification of your recommendation
- An alternate solution of how you would allocate the land based on your opinion of what is needed in San Francisco (only the 1st constraint applies)
- Evidence to support this allocation even though it might not be the most cost-effective

Section 4: Reflection (Due Wednesday, June 6th)

In this section, reflect on the following questions:

- Where could errors have altered the solution? How would each error affect it?
- How did you use and grow on the leadership skills being assessed (Solve Problems Resourcefully and Communicate with Clarity and Precision)? What do you still need to work on for next year?
- What was difficult about the problem solving process? What did you do to overcome the difficulties?
- How have you felt about math this year? What things helped you succeed? What was missing from the class?

CHECKLIST—USE THIS!

Section 1: Current Situation (Due Thursday, May 24th)

- ❑ My description of the situation is accessible/understandable to a non-math person.
- ❑ I have described each of the different pieces of land and assigned an appropriate variable to each.
- ❑ For each constraint, I have explained why it is needed and which agreement it refers to.
- ❑ Anything written in "math" is translated or described in English
- ❑ I have described in steps a general strategy to solve a linear programming problem.
- ❑ I have explained how I will know which land allocation is the most cost-efficient.

Section 2: Investigation (Due Thursday, May 31st)

- ❑ I have described what a matrix is, how it can help solve the problem and how each constraint can be changed into a row of a matrix.
- ❑ I have included all possible combinations of constraints and explained why certain combinations are not included or considered.
- ❑ All considered combinations of constraints have been translated into matrix equations.
- ❑ All of the matrices have rows and columns labeled.
- ❑ I have described what the inverse matrix is and how it can help solve a matrix equation.
- ❑ I have explained the meaning of matrix multiplication and how it works.
- ❑ I have solved each matrix equation.
- ❑ I have evaluated each solution to determine whether it is best.

Section 3: Recommendations (Due Monday, June 4th)

- ❑ I have described the land allocation that will be most cost-effective for the city of San Francisco.
- ❑ I have explained, in detail, why I know that this is the best allocation.
- ❑ I have described an alternate solution which I feel is the best solution based on the needs of San Francisco.
- ❑ I have given convincing details of what the needs of San Francisco are and why my land allocation will be more valuable (in the long term, even though it might not be the "right price".)
- ❑ I have included the cost for both solutions.

Section 4: Reflection (Due Wednesday, June 6th)

- ❑ I have described where errors could have occurred in the problem solving process.
- ❑ I have explained how these above errors would have changed the solution.
- ❑ I have evaluated where I have grown (and where I still need to grow) in both Leadership Skills being assessed.
- ❑ I have described the most difficult part of this assignment and how I overcame that difficulty.
- ❑ I have reflected on the whole year

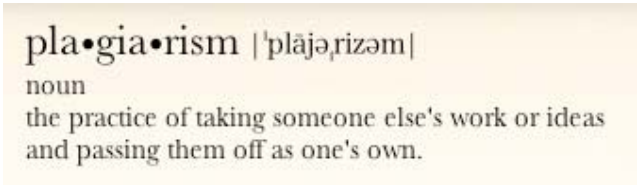
Overall Report (Due Thursday, June 7th)

- ❑ I have typed everything in my report (except matrix brackets).
- ❑ I have a cover page with a title and my name and date.
- ❑ I have included all four sections.
- ❑ I have checked my math and know it is correct.
- ❑ I have had someone edit my report.

Monday	Tuesday	Wednesday	Thursday	Friday
AM Work Party: 7:30-8:40 AM Computers: 7:30-8:40 PM Computers: 3:15-4:30		**23** IN CLASS: Consultant Report Assigned HW: Write Current Situation	**24** IN CLASS: Current Situation Due Peer Edit Work on Investigation HOMEWORK: Work on Investigation All Solved Matrix Equations Due Monday	**25** **NO CLASS**
28 **MEMORIAL DAY** **NO SCHOOL**	**29** **AM Work Party** IN CLASS: Matrix Equations Due Peer Edit Work on Investigation HOMEWORK: Finish Investigation	**30** **AM Work Party** **NO CLASS**	**31** **AM/PM Computers** IN CLASS: Investigation Due Peer Edit Work on Recommendations HOMEWORK: Finish Recommendations	**1** **NO CLASS**
4 **AM/PM Computers** IN CLASS: Recommendations Due Peer Edit Work on Reflection HOMEWORK: Finish Reflection	**5** **AM/PM Computers** **NO CLASS**	**6** **AM/PM Computers** IN CLASS: Reflection Due Work on Final Draft HOMEWORK: Finish compiling project	**7** **AM Computers** IN CLASS: Project Due (NO LATE PROJECTS!)	**8** **NO CLASS**

OTHER NOTES OF IMPORTANCE:

COMPUTERS
We will not have access to computers during class, but your report must be typed. I will have computers before and after school on the days noted. Please sign up if you are going to be there so I can have an idea.



Please make sure that the work you turn in is your own. If it is determined that you have plagiarized, you will receive a zero, fail the class, and be subject to disciplinary action.

GRADUATION PORTFOLIO
Next year, you will need to start collecting math evidence for your graduation portfolio. This project is designed to give you an idea of what that will look like. Treat this as a practice round! See the attached rubric for the aspects to be scored.

LEADERSHIP SKILLS

Solve Problems Resourcefully

- Identify relationships between problems
- Use new tools for solving problems.
- Propose, evaluate and select from multiple solutions
- Are comfortable taking risks, and are creative and flexible in our approach to problems.

Communicate with Clarity and Precision

- Understand principles of effective communication.
- Communicate appropriately to a range of audiences in a variety of formats.
- Listen carefully and request clarification or additional information as needed.