Minnesota Pollution Control Agency

Air Quality Construction Permits Six Sigma Improvement Process

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History of Six Sigma

- **1980s marked many different approaches to improved quality in an effort to compete with Japanese products and services**
  - Statistical Process Control (SPC)
  - Total Quality Management (TQM)
  - Just-in-Time Manufacturing (JIT)
- **Malcolm Baldrige award created to award company-wide quality initiatives**

History of Six Sigma

- **Motorola created continuous improvement and reduced variability focus which led to measuring processes by "Sigma" or "σ"**
  - 6σ is roughly 3.4 defects per million opportunities (DPMO)
- **Other companies learned of Motorola's success with continuous improvement and adopted the practice**
  - AlliedSignal
  - Texas Instruments

History of Six Sigma

- **1995 – CEO of GE, Jack Welch, implemented Six Sigma and reformed some of the methodology to what most companies use today**
  - DMAIC for existing process improvement
  - DMADV for new products
- **Other users: 3M, Honeywell, Samsung, Black & Decker, DuPont, American Express, Boston Scientific, IBM, Ford, Johnson & Johnson**

Six Sigma Overview

- Six Sigma is an improvement method that uses data to define and analyze the performance of a business process
- Six Sigma requires that assumptions (our “gut feeling”) about what might improve a process be proven with data, so that chosen solutions address the key problems within a process
- Six Sigma aims for breakthrough improvement, not small incremental gains

Long-term Commitment

- **Six Sigma requires a long term commitment to a continuous improvement philosophy.**
- **The final step in each improvement project is "Control", where gains are documented and maintained.**

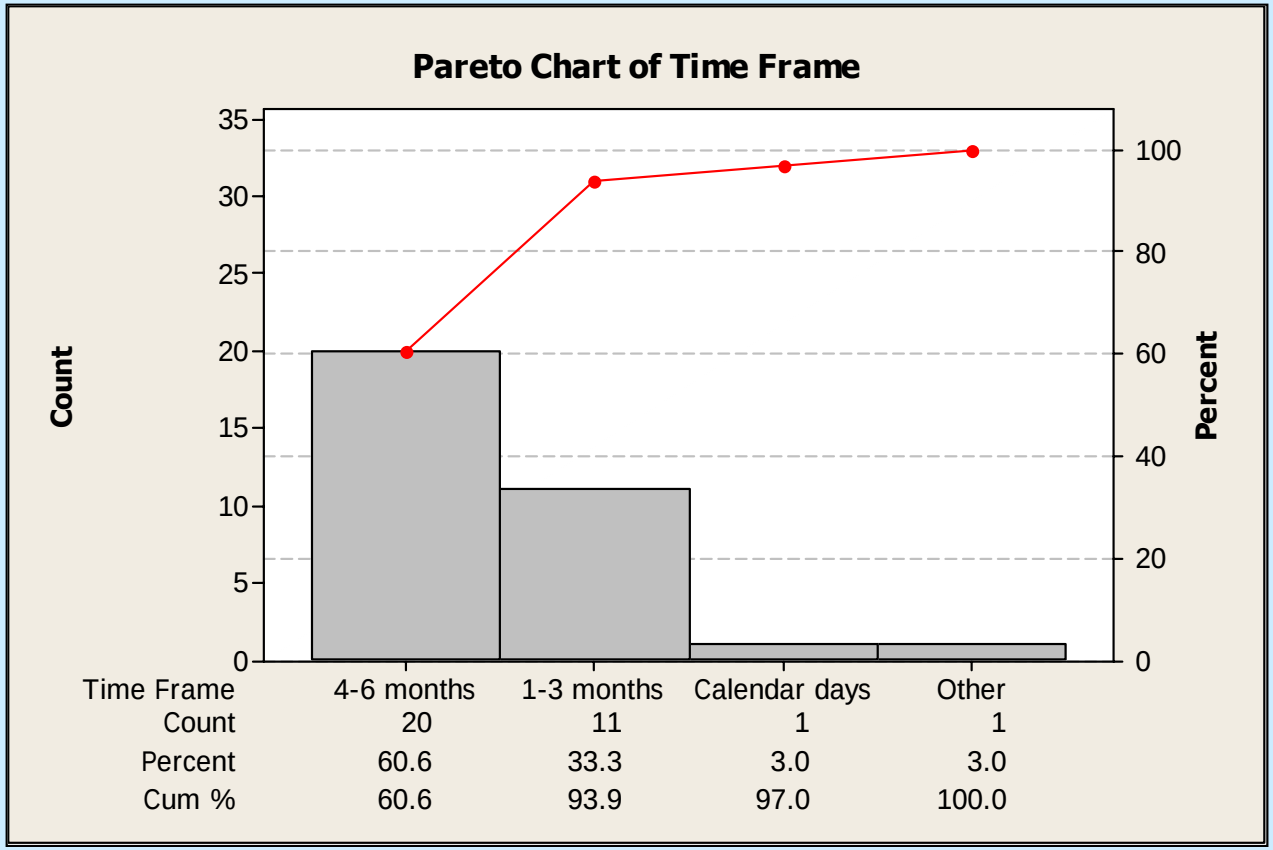
Six Sigma Improvement Steps

- **Define-** Use data to understand what users of the process need and expect
- **Measure-** Use data to understand how the current process performs
- **Analyze-** Use data to test theories of why a process under-performs and determine root causes
- **Improve-** Develop steps that will consistently achieve improved performance by focusing on root causes
- **Control-** Develop measures that make transparent whether the improved process is performing up to the project objective

Why 6σ at the MPCA?

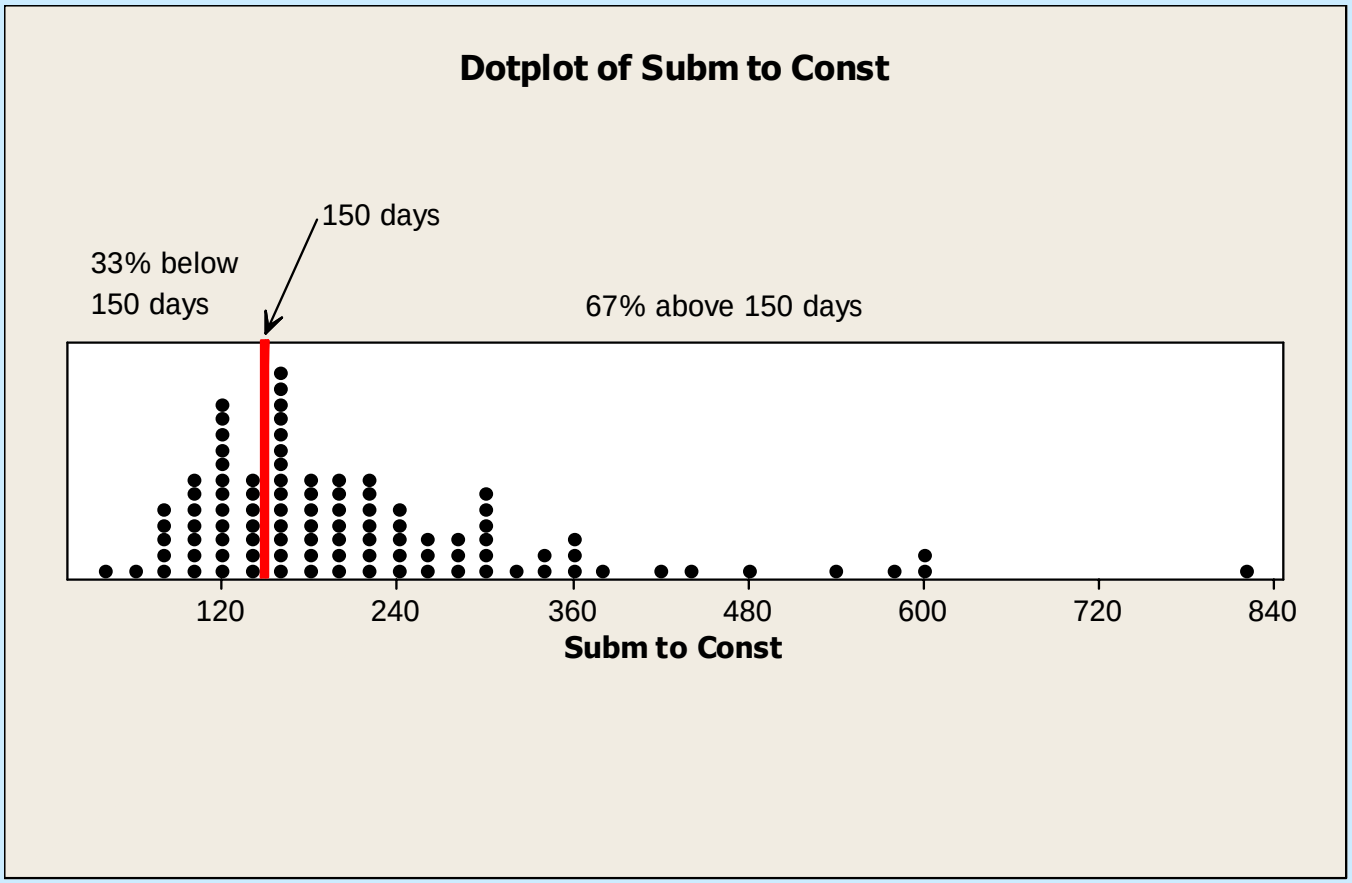
- New Commissioner used it successfully at 3M
- State agency, facing higher workload demand with constant or shrinking budget, needs to find efficiencies in key processes

DEFINE: What do permit applicants expect?



93.9% of permit applicants believe that a timely permit is one issued in under 6 months. 75% of applicants are most concerned with timeliness.

DEFINE: How does our current construction permit process perform?



	N	Median
To Notice	129	130
To Approval	100	178.5

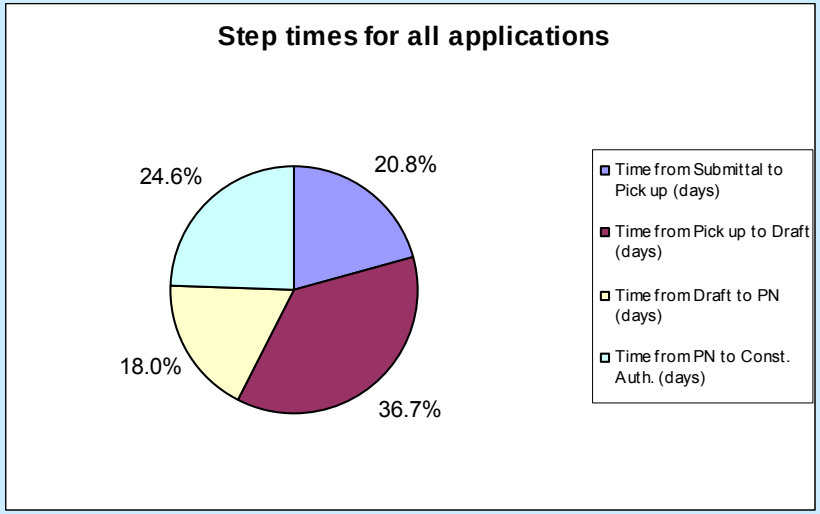
Between 2000 and 2003 only 33% of construction permit authorizations were issued in under 150 days.

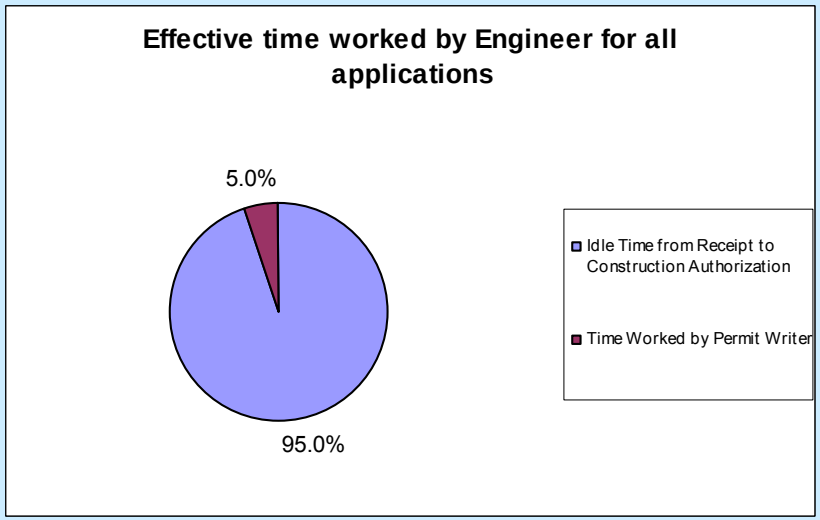
DEFINE: Project Objective

- Reduce the cycle time between receipt of an application and the date of construction authorization to below 150 days for 90% of the air quality construction permit applications (Majors w/construction), while maintaining high quality permit conditions (currently at 33%).
- *(Secondary objective)* Reduce the cycle time between receipt of an application and the date of Public Notice to below 120 days for 95% of the permit applications (currently at 45%).

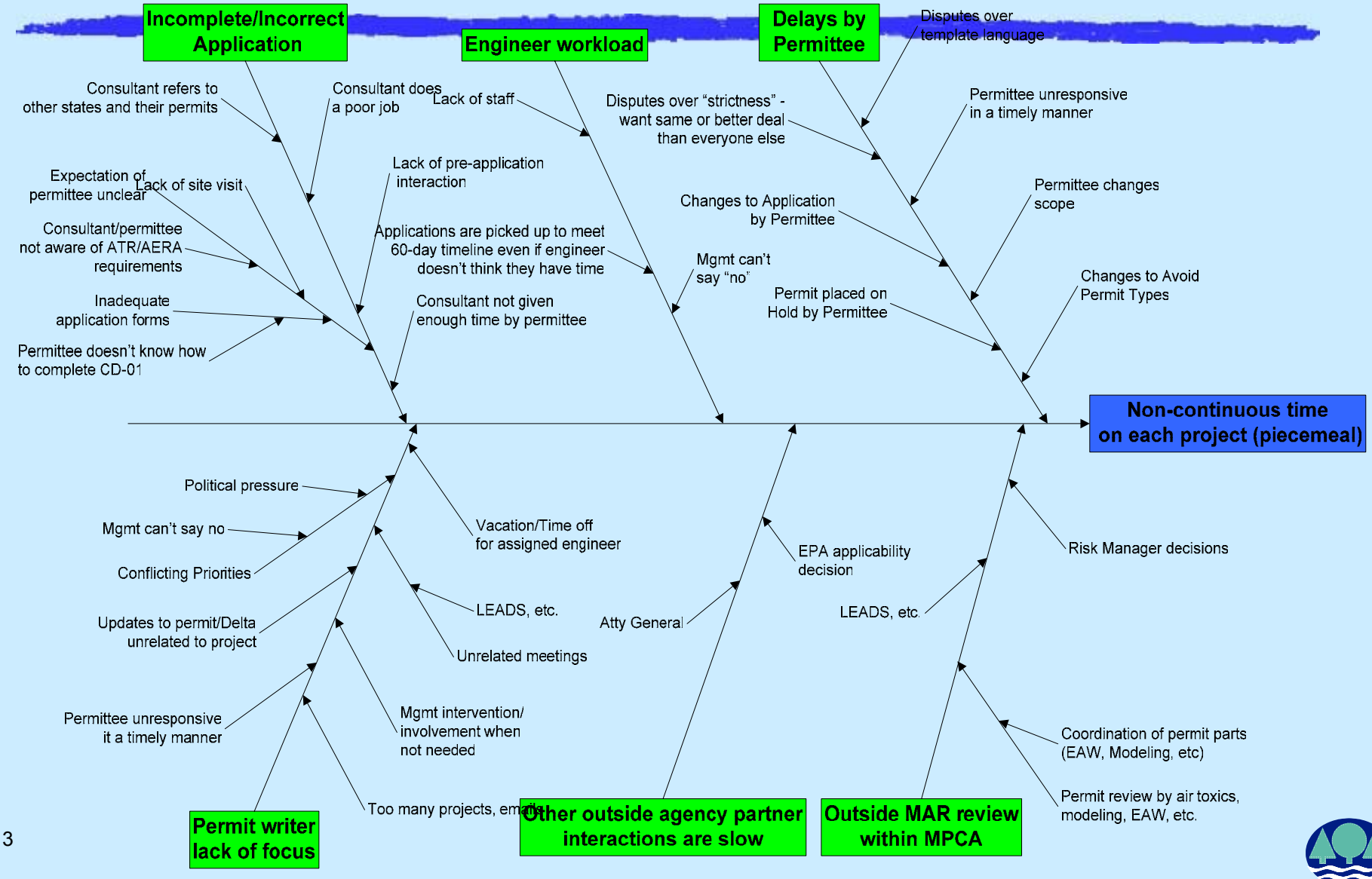
MEASURE: Where does the cycle time (days elapsed) go on permits?

- A majority of the time an application is at the MPCA, it is not being actively worked on by a permit writer
- Pattern is typical of service processes
- To improve, must reduce the idle time (stops and starts)





MEASURE: Brainstorm theories of what could cause the idle time



MEASURE: Failure Mode Effects Analysis Results Evaluate Theories

- **21 Theories judged on:**
  - Severity (effect to customer if occurs)
  - Occurrence (likeliness that cause will occur)
  - Detection (likeliness failure will be detected)
- **Risk Priority Number=(SEV) x (OCC) x (DET)**
- **6 Theories were found to have the most improvement potential**

ANALYZE: Which of the Six Most Promising Theories is Proven by Data?

Theory 1 - Do more complete applications reduce idle time?

Application Completeness	N	Median
G	15	146.0
I	55	132.0
P	9	156.0
	79	

P = 0.526

As the p-value is higher than 0.1, **the data does not show that application completeness leads to less idle time**

Theory 2 - Do more complete applications lead to less hours of engineer effort to issue a permit?

Application Completeness	N	Median
G	20	6.050
I	71	6.300
P	13	8.800
	104	

P = 0.215

As the p-value is higher than 0.1, **the data does not show that application completeness leads to less engineer effort to issue a permit**

ANALYZE: Which of the Six Most Promising Theories is Proven by Data?

Theory 3 - Do more responsive permittees lead to less idle time?

Permittee Responsiveness	N	Median
G	31	116.0
I	41	154.0
P	7	156.0
Overall	79	

P = 0.014

As the p-value is lower than 0.1, **the data supports the theory that permittee responsiveness is related to less idle time**

Theory 4 - Is total cycle time mainly due to waiting within the MPCA or to waiting for a permittee to respond?

Pearson correlation of **idle time** and **external waiting** = -0.184

P = 0.635

Pearson correlation of **idle time** and **internal waiting** = 0.847

P = 0.004

Total cycle time is strongly correlated with internal waiting (p<0.1) and not with external waiting (p>0.1)

ANALYZE: Which of the Six Most Promising Theories is Proven by Data?

Theories 5 and 6 - Does the MPCA allocate enough permit writer hours to sufficiently handle application demand?

2 Sample t-test for quarters hours from 2000 to 2003

	N	Median
Demand	16	1694.8
Allocated	16	1257.9

P = 0.0001

As the p-value is lower than 0.1, **there is enough data to conclude that the hours of work demanded are higher than the hours allocated to write permits**

ANALYZE: Conclusions

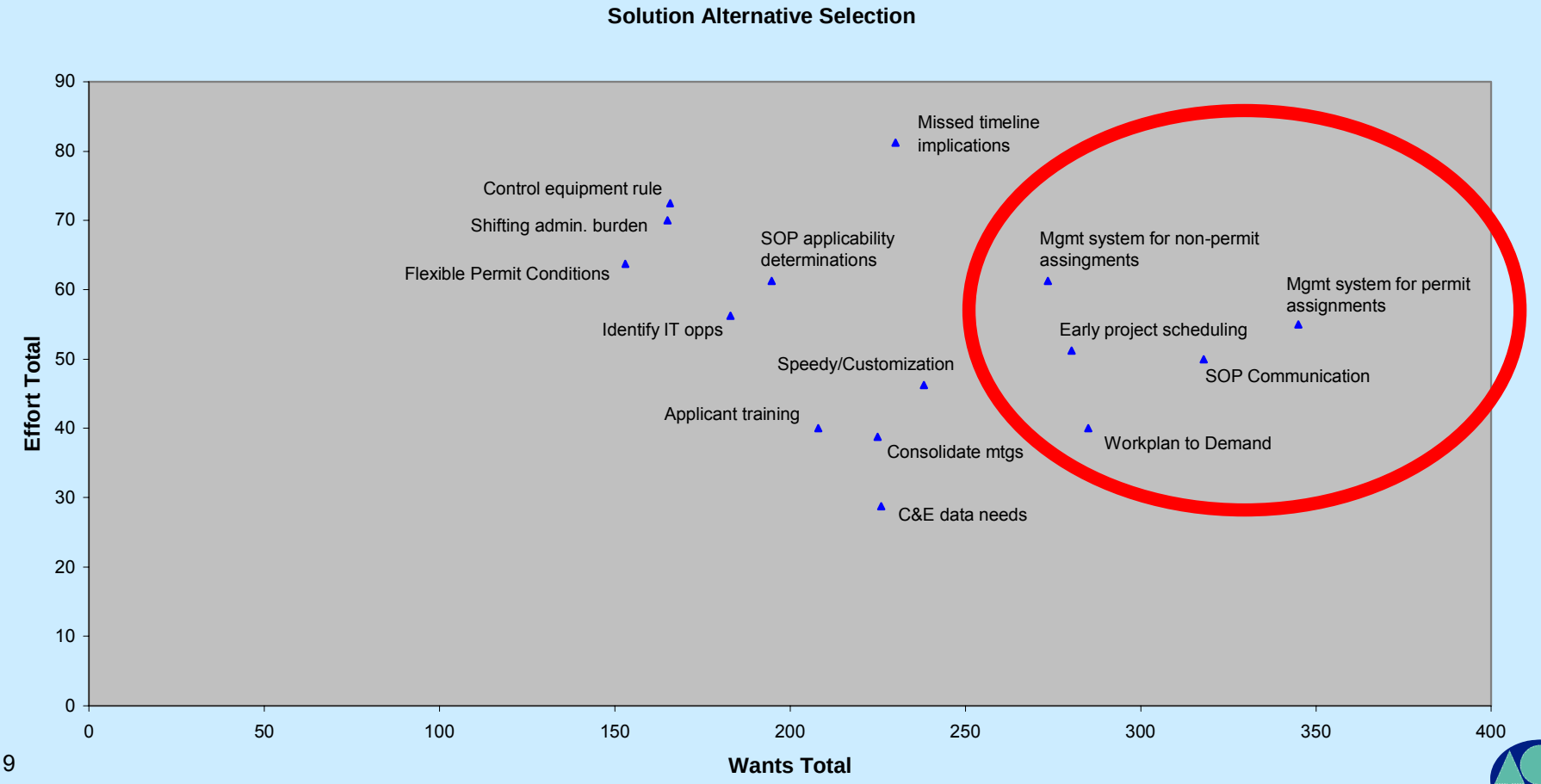
- **Need to significantly increase the number of available hours to write permits in the Air Quality Construction Permits Program by finding ways to:**
  - Increase the number of hours per year a permit writer spends writing permits

    and/or
  - Spend less hours per type of construction permit application

    and/or
  - Improve applicant responsiveness to requests from the MPCA to reduce permit writing time

IMPROVE: Brainstorming by MPCA staff, managers, permittee groups, and 6σ team

Brainstormed possible solutions to root causes (proven theories 3, 4, 5, 6). Solutions evaluated using weighted criteria for effectiveness and effort.



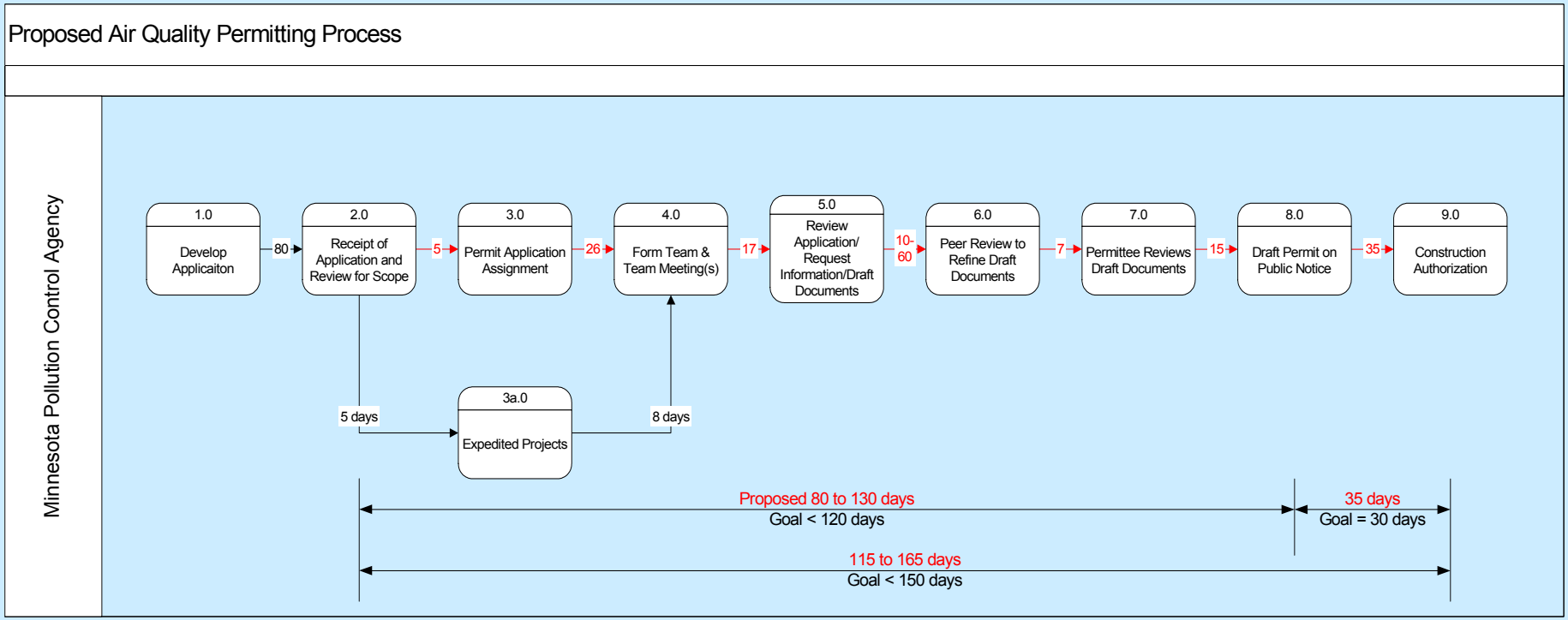
IMPROVE: Proposed Solutions

- **Five improvements rated to have best potential:**
  - Early project scheduling
  - Standard procedure for communication and decision-making (applicant and MPCA)
  - Match work planning budgeted hours to predicted demand for construction permits
  - Management system for permit assignments
  - Management system for non-permit assignments

IMPROVE: Specific Solutions

- Written schedule and communication procedure document signed by permit writer, supervisor, and permittee
- Application screening document designed to give each project a complexity and priority level facilitating the project assignment procedure used by AQ supervisors
- A new DELTA-based AQ project tracking screen and activity log allowing all AQ staff a transparent look at current project status and permit writer workload
- Work planning document meant to aid supervisors in budgeting AQ staff hours for specific tasks. Improved time tracking codes will allow easy measurement of time spent in areas such as construction, special projects, training, etc.
- Standard procedure for prioritizing work for permitting and non-permitting tasks to be derived and used for budgeting purposes

IMPROVE: Revised Overall Process Map



- Steps 2, 3, 4, and 5 have new detailed process maps
- Proposed step times based on most-likely critical path scenarios for each individual step
- Range due to inherent uncertainty of review process

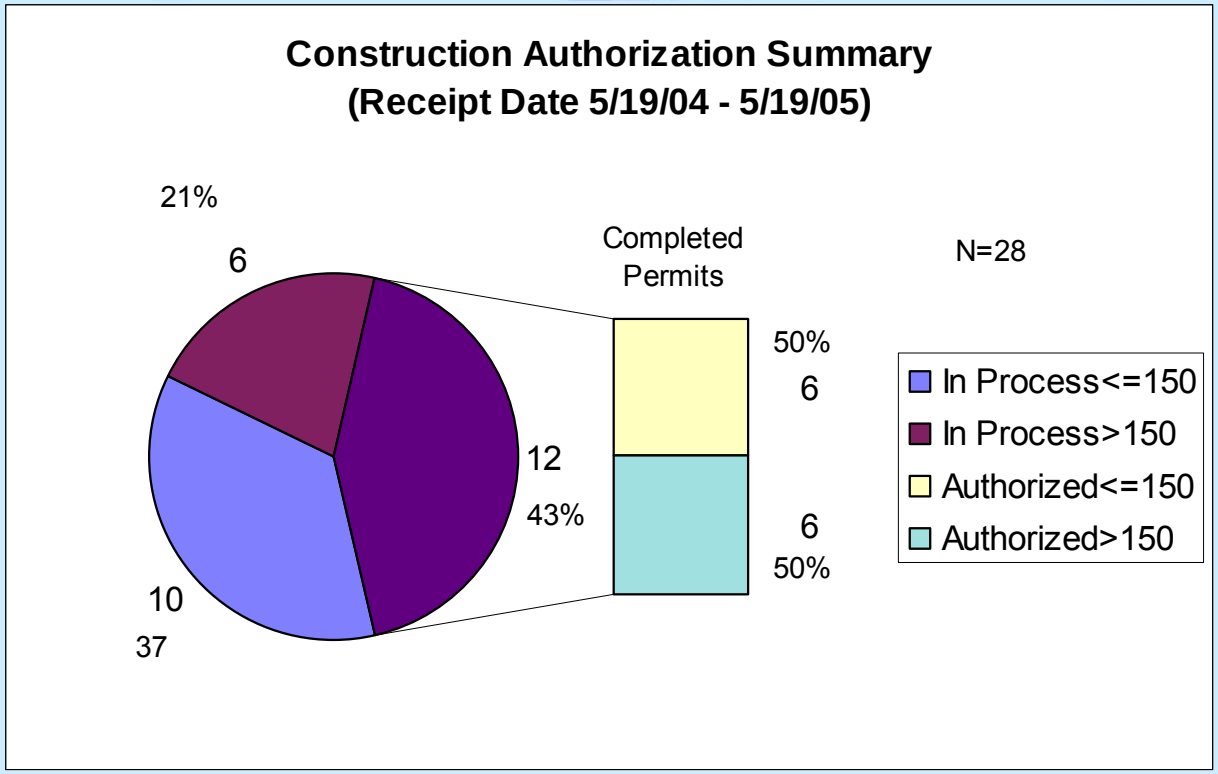
Permit Applications

- "Clock" starts when application is received
- Applications are assumed to be complete
- Applications on "hold" for extended periods of time will need to start at the beginning of the process

CONTROL: Monitor and hold the gains

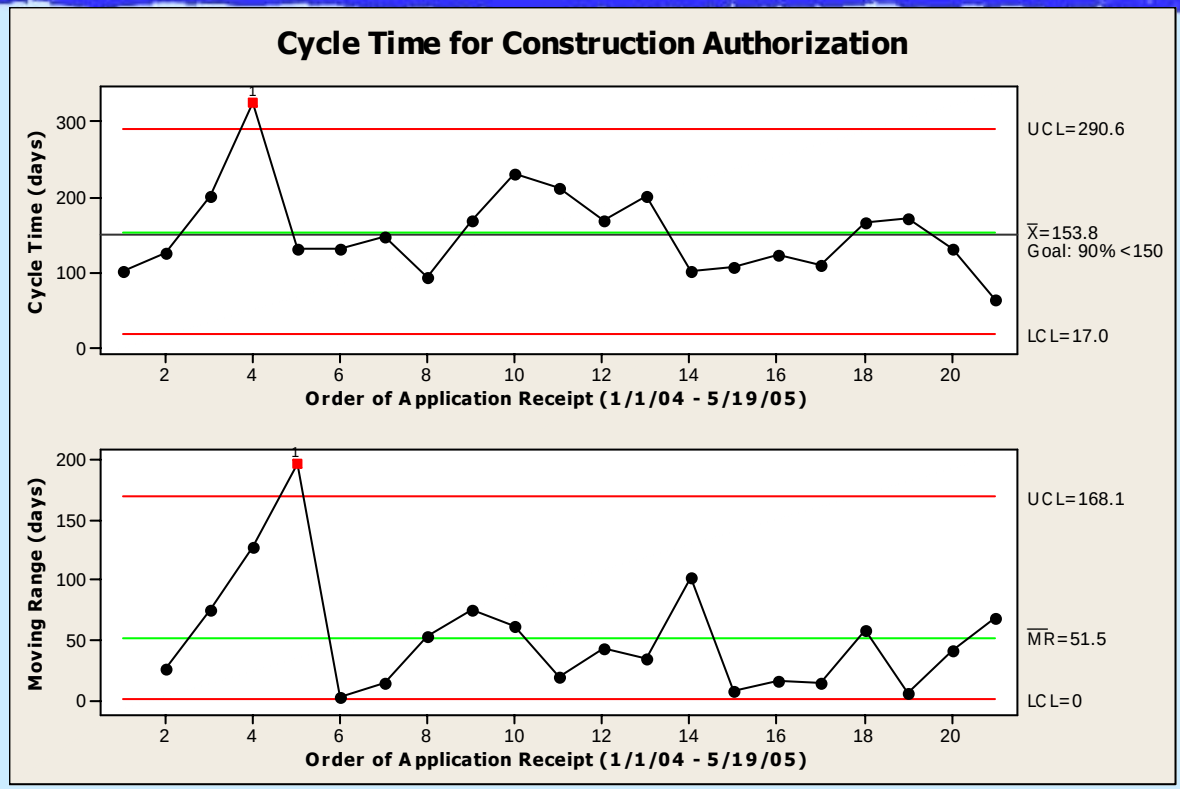
- Frequently measure new processes to verify that the solutions are consistently implemented and the project objective is being met
- Control Plan designs measures as well as contingency plan if a process is determined to be “out of control”
- Project “Dashboard” contains measures specific to the scope of the Six Sigma project, other measures are needed by AQ supervisors for management purposes
- Six Sigma team meets monthly with process owner and air quality permit supervisors to review dashboard and other measures, evaluate progress, take needed actions
- Process owner is Rich Sandberg, air quality permits manager

CONTROL: Dashboard Examples



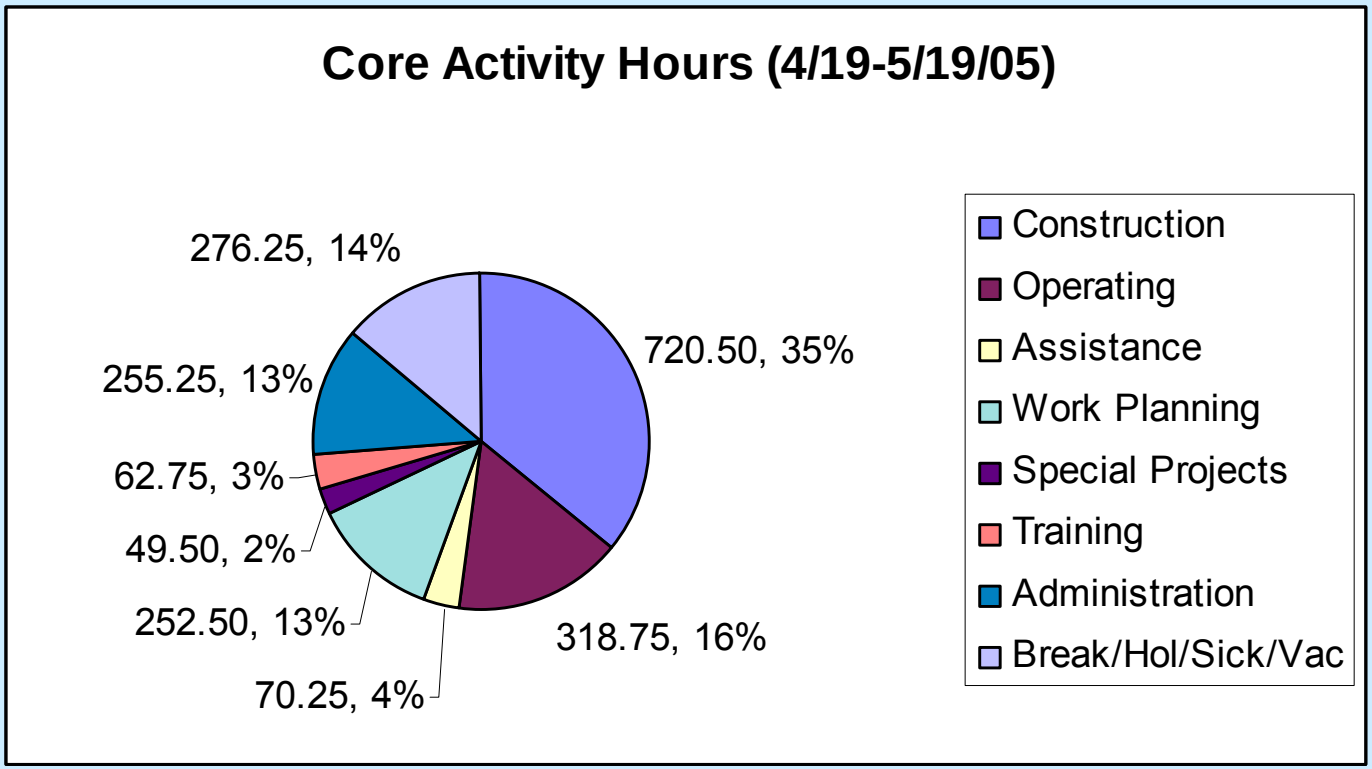
Pie charts of construction authorization and public notice cycle time will give snapshots of percent of projects that meet or can meet goal, and percent that have exceeded goal

CONTROL: Dashboard Examples



Individual and moving range charts will paint a picture of how the process values and variation are changing over time as improvements are implemented

CONTROL: Dashboard Examples



Compare time tracking database entries with work plan budgeting spreadsheet so that supervisors can verify demand for construction permit review is being met

CONTROL: Project Outlook

- New procedures apply to air quality construction permit applications received on or after January 1, 2005
- Goal is to have process in control by December 31, 2005
- Time tracking protocols and interim project tracking (manually) will begin on January 1, 2005
- DELTA project tracker and activity log will be implemented in February 2005
- Dashboard will be reviewed by Six Sigma team monthly starting in January 2005
- Project team expects that adjustments and further steps will be needed to reach objective
- New data streams created by this project will help target future improvement efforts

Additional Improvement Activities

- Registration Permits
- Capped Permits
- General Permits
- Contracting with consultants to write AQ permits
- Overtime initiative

AQ Six Sigma Investments

- Many hours of staff time required
- Large amount of data to track
- Data tracking system needed to be constructed
- Training so that data is precise
- Requires that staff be diligent data tracking practices
- Labor needed to run reports and "watch" the data
- Additional training (i.e. project management) may be needed as a result of the improved process

AQ Six Sigma Payoffs

- A system in place to record and analyze pertinent data
- Managerial decisions can be made based on data
- System in place for continuous process improvement
- Focus permit staff on writing permits
- More accountability internally and externally
- Better equipped to create annual and long-term workplans
- Impacts of any "fire drills" are better estimated and measured