

Pump Monitoring & Rebuild Program

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BAYWORK

March 19, 2019



Facts About SCVWD

Pump & Motor Rebuild Program - Condition Monitoring

- ▶ 10 Dams & Reservoirs
- ▶ 114 Miles Raw & Treated Pipelines
- ▶ **3 Portable Water Treatment Plants**
- ▶ **1 Recycled Water Treatment Plant**
- ▶ **3 District Pump Stations**
- ▶ Serves 2 million people
- ▶ 756 Employees
 - ▶ Engineering Maintenance Support
 - ▶ Mechanical (2)
 - ▶ Electrical (6)



Santa Clara Valley
Water District



Pumps Units Selected

Pump & Motor Rebuild Program - Condition Monitoring

- ▶ Critical Pumps = 77
- ▶ Sizes 50 hp $\geq$ 2000 Hp
- ▶ Centrifugal
 - ▶ Vertical & Horizontal



Motivation for Change

Pump & Motor Rebuild Program

- ▶ Cost
- ▶ Long rebuild process
- ▶ Failures



Santa Clara Valley
Water District



Pump & Motor Rebuild Program

Pump and Motor Rebuild Program Components



When to Rebuild – Predictive Maintenance

Pump & Motor Rebuild Program - Condition Monitoring

▶ **Contact Wear**

- ▶ Vibration (Motor & Pump)
 - ▶ Bearing Impacts
 - ▶ Overall Vibration (ANSI HI, ISO, EASA/NEMA)
 - ▶ Shaft Vibration Displacement (ISO 20816-5)
 - ▶ Shaft Deflection (API 610/ ANSI ASME B73.1)
 - ▶ Setting Warning and Alarms levels

▶ **Progressive Wear**

- ▶ Hydraulic Performance
- ▶ Motor Testing
- ▶ Temperature

Vibration – Assigned Risk Indicators

Pump & Motor Rebuild Program - Condition Monitoring

► Pilot Program

► **DFI:** Vibration velocity limits

► **Roller Bearing Wear:** Vibration acceleration

DFI L1 < ANSI/HI LIMIT	DFI L2 ≥ HI Limit, < 1.5x ANSI/HI Limit	DFI L3 = ≥ 1.5x ANSI/HI Limit, < 2x ANSI/HI Limit	DFI L4 = ≥ 2x ANSI/HI Limit
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		Dynamic Force Indicator (DFI) Level			
		1	2	3	4
Bearing Wear Stage (B)	ARI				
	1	1.41	2.24	3.16	4.12
	2	2.24	2.83	3.61	4.47
	3	3.16	3.61	4.24	5
	4	4.12	4.47	5	5.65

Assigned Risk Indicator (ARI)

Pump & Motor Rebuild Program - Condition Monitoring

► Assigning Risk Indicator (ARI)

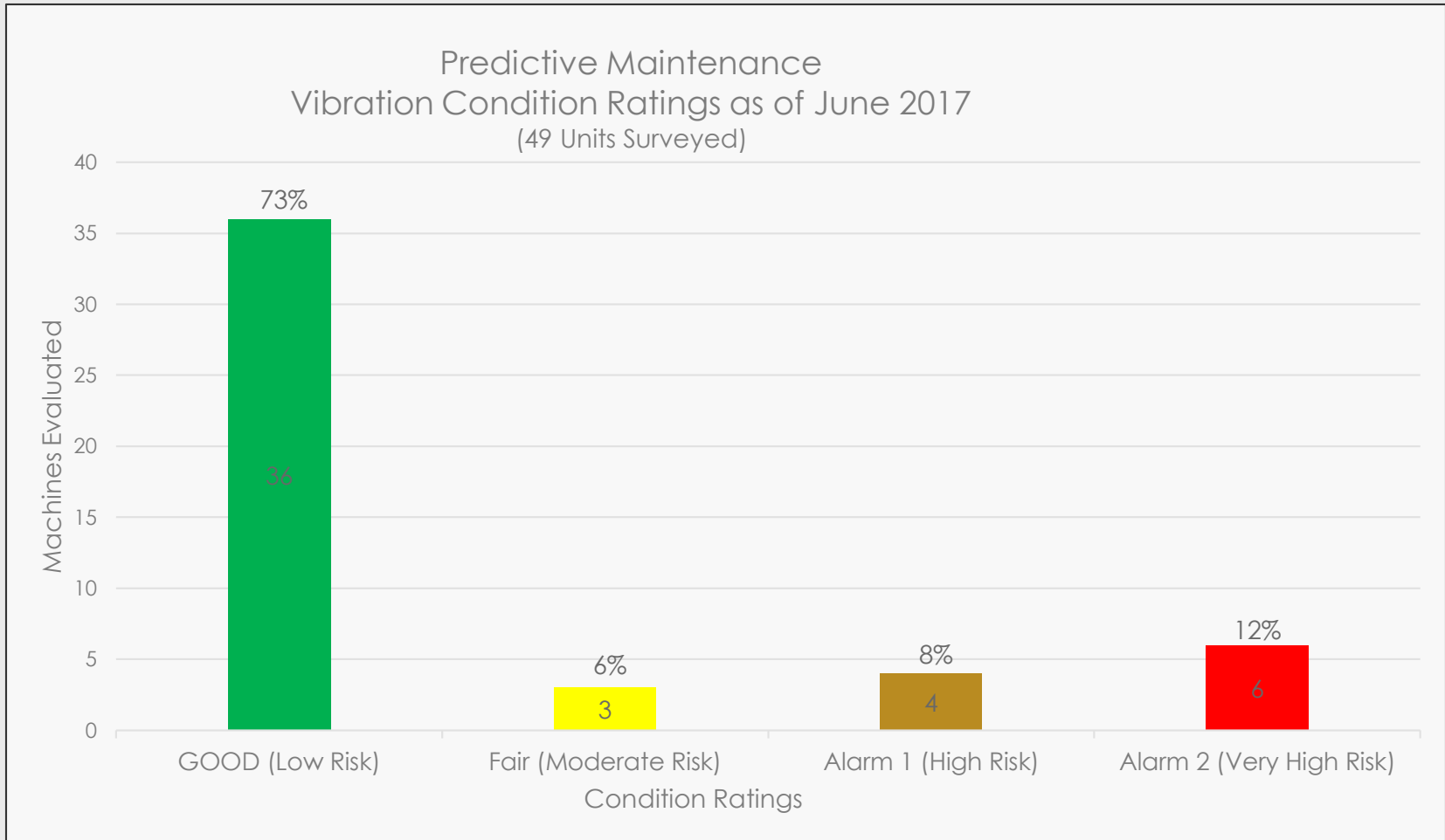
- ≤ 2 = Low Risk of Failure  (Normal)
- $2 > 3$ = Moderate Risk of Failure  (Next Planned Maintenance)
- $3 > 4$ = High Risk of Failure  (Repair in 30 Days)
- $4 >$ = Very High Risk of Failure  (Repair Immediately)

$$ARI = \sqrt{DFI^2 + B^2}$$

P. Graney and Ken Starry,
"Rolling Element Bearing Analysis", 2011

FY17 Results

Pump & Motor Rebuild Program – Condition Monitoring

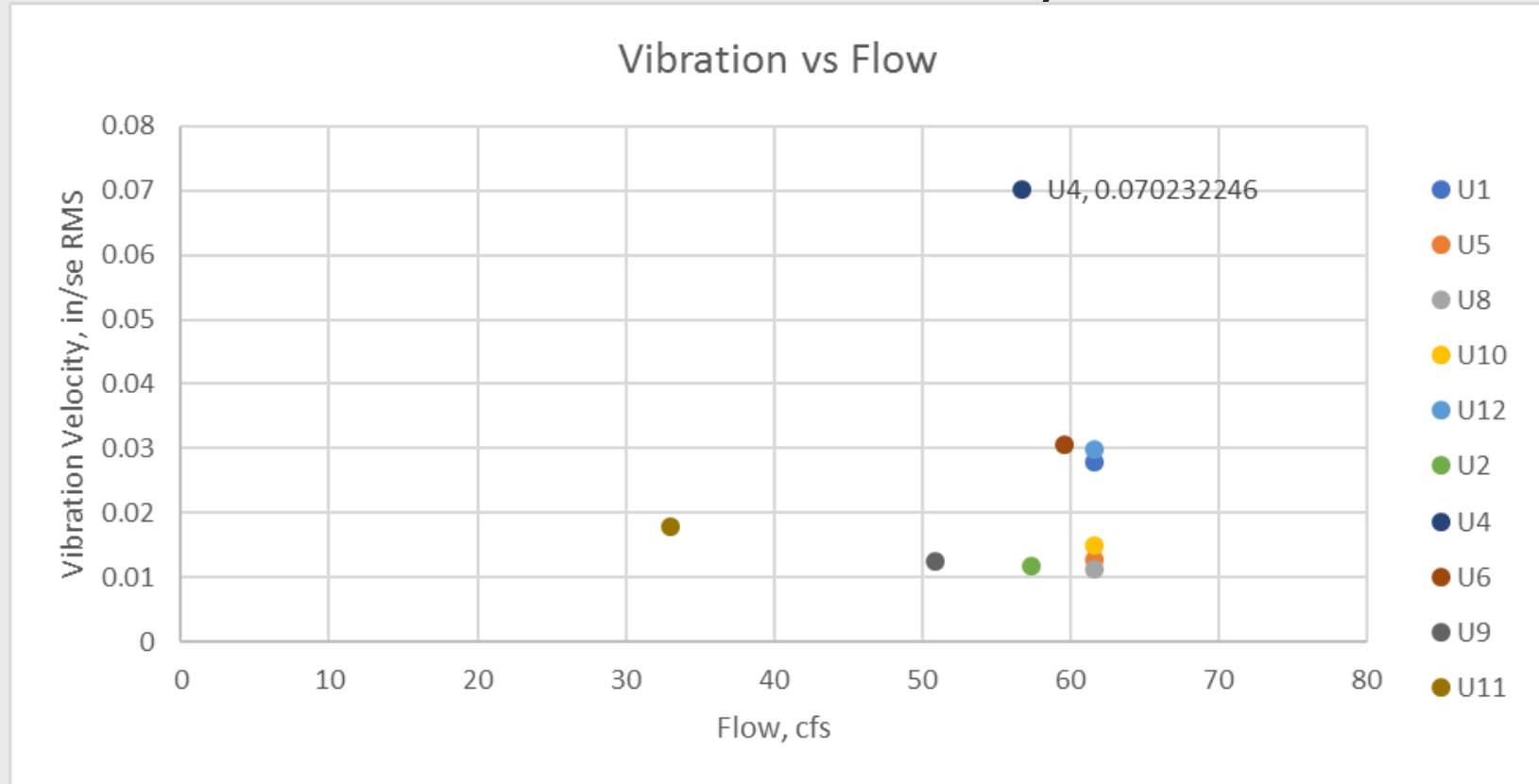


Pump Monitoring Report (PG. 1)

2000 Hp Pump – Sleeve Bearings

Pump & Motor Rebuild Program – Condition Monitoring

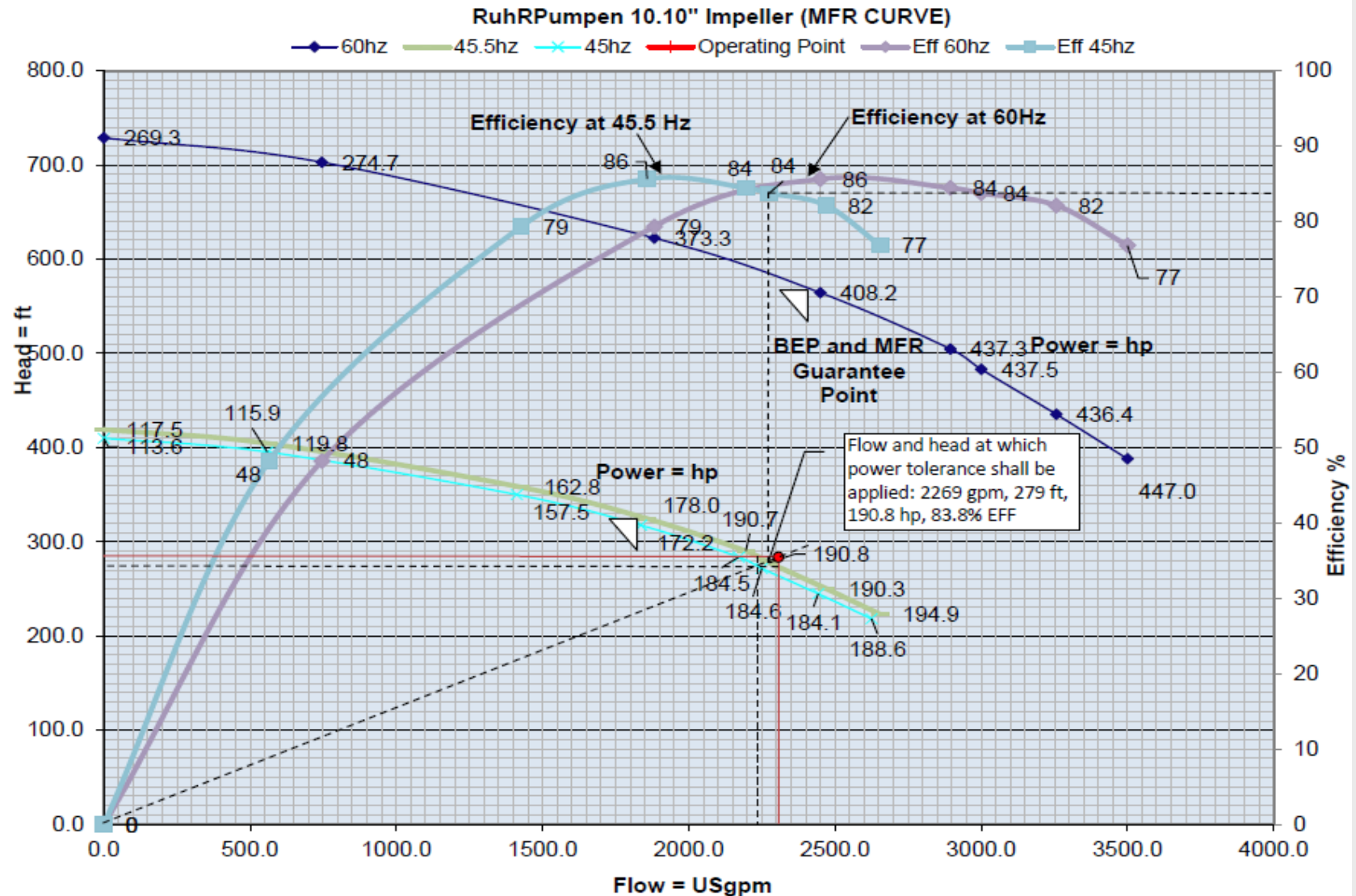
► Overall Vibration Velocity



Hydraulic Performance

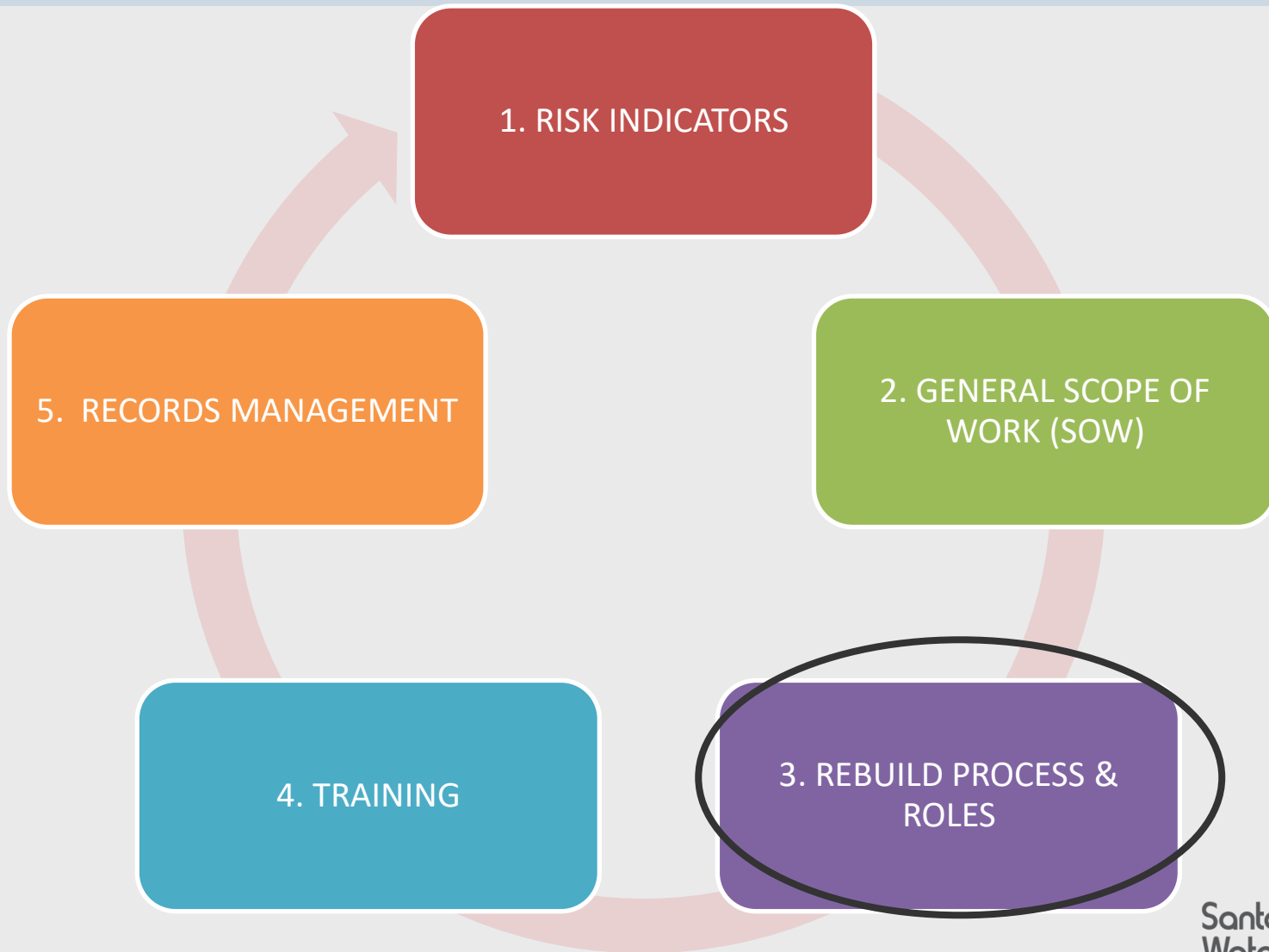
Pump & Motor Rebuild Program - Condition Monitoring

► Baselines



Pump & Motor Rebuild Program

Pump and Motor Rebuild Stages

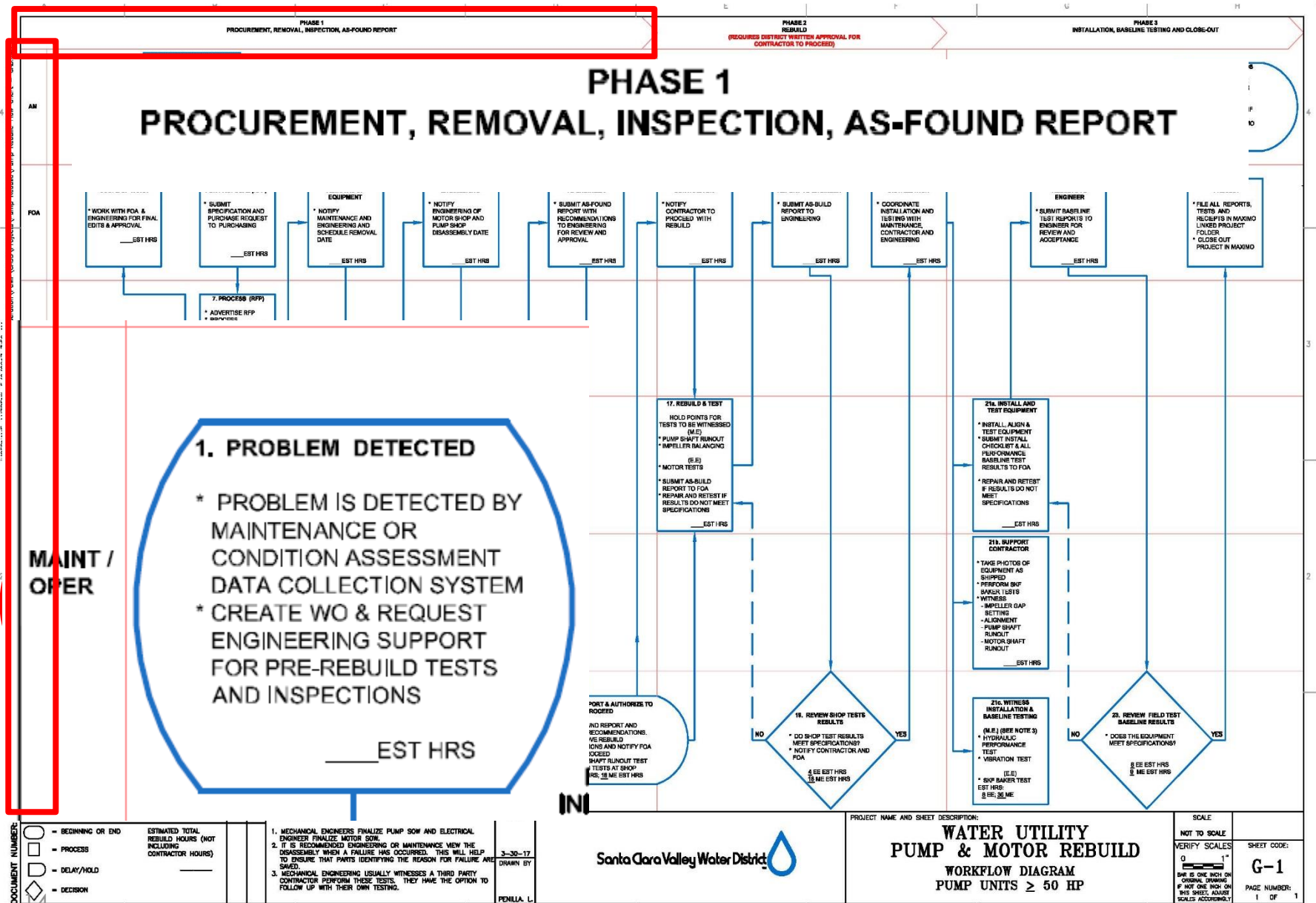


Team: Roles & Responsibilities

Pump and Motor Rebuild Team

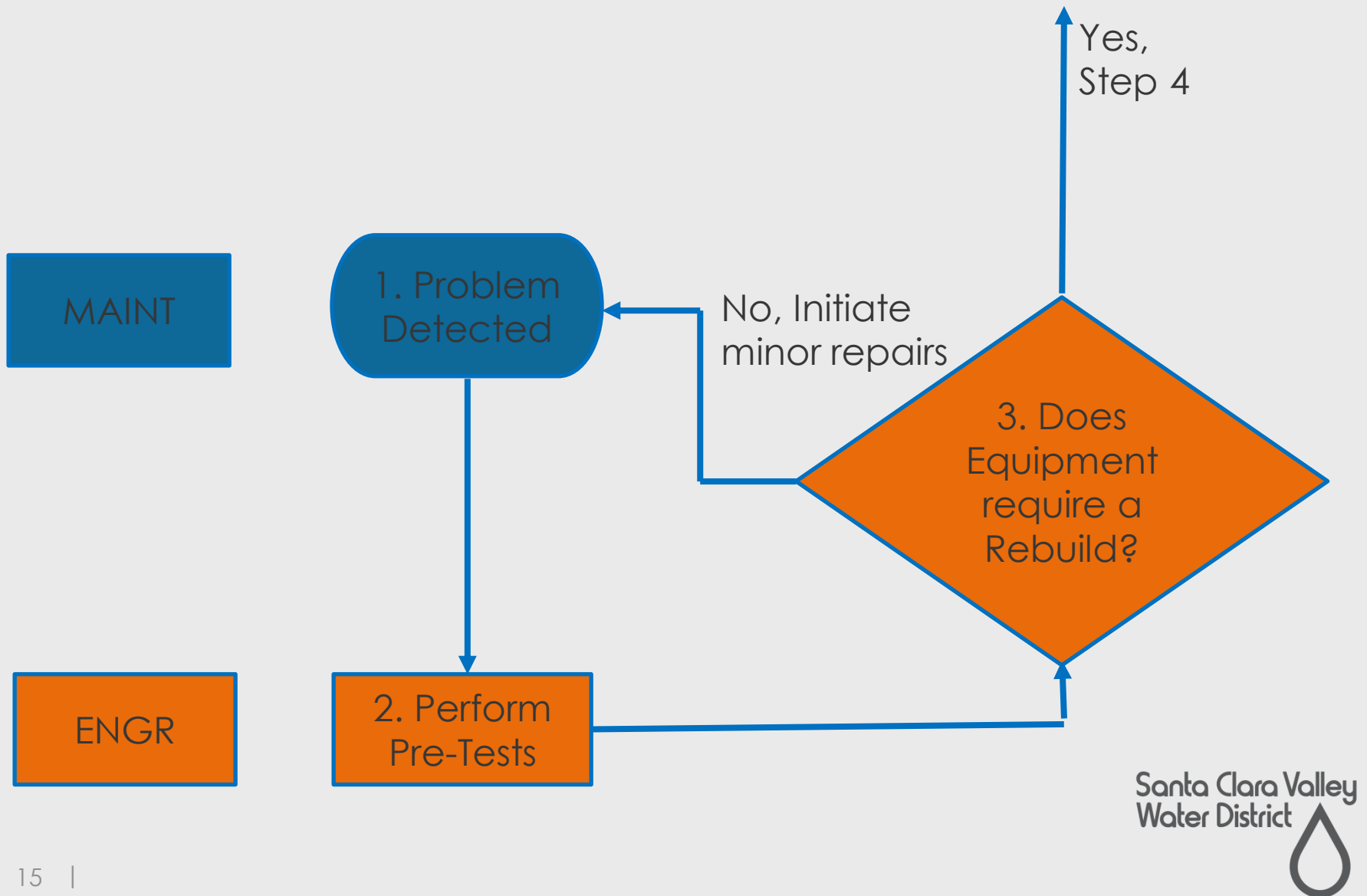
- ▶ Maintenance & Operations (MAINT)
- ▶ Field Operations Administrator (FOA)
- ▶ Purchasing Dept (PURCH)
- ▶ Contractor (CONTR)
- ▶ Engineering (MECH & ELEC)
- ▶ Asset Management (AM)

Procurement, Removal, Shop Inspection, As-Found Report



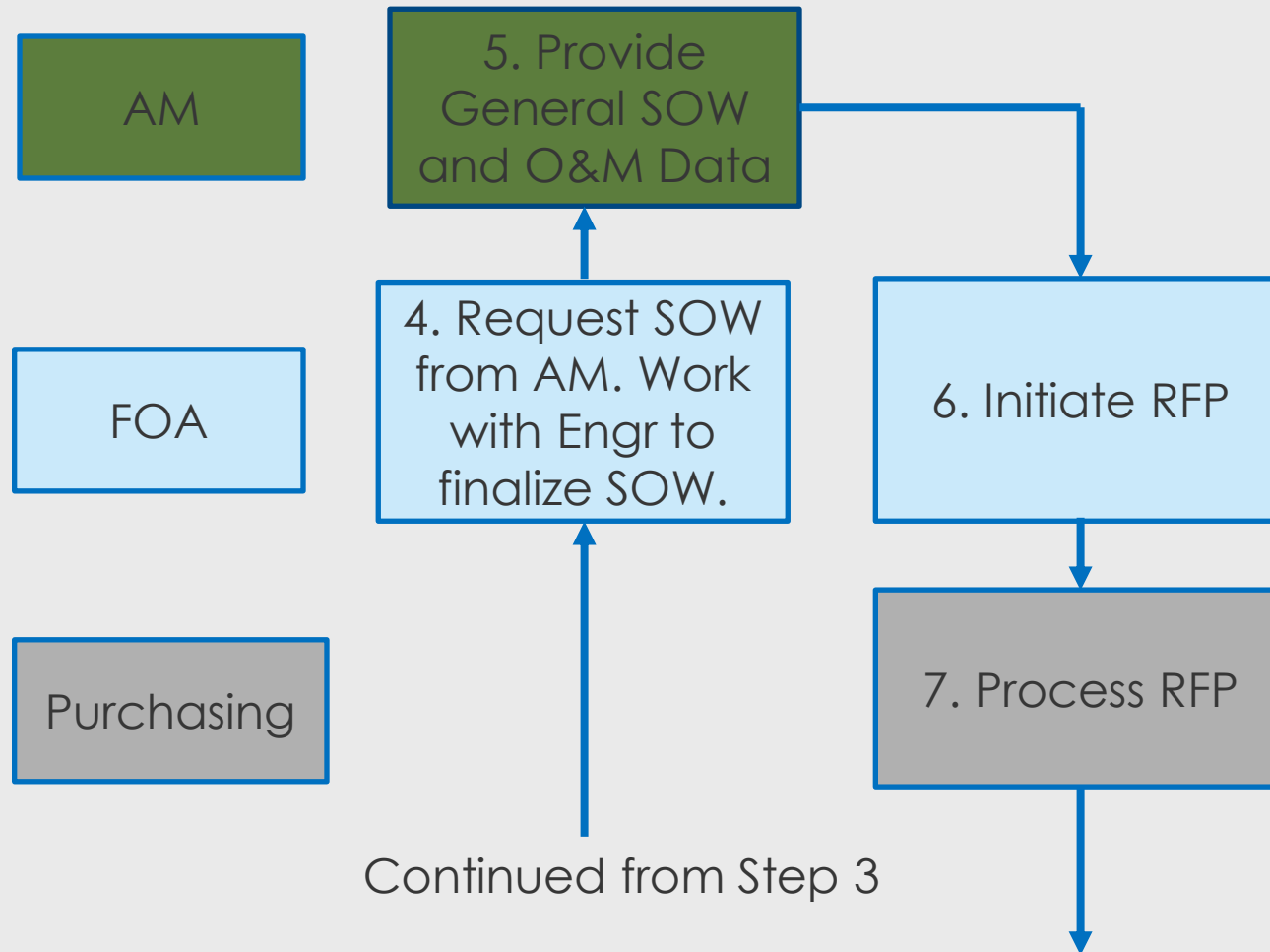
Rebuild Phase 1: Steps 1-3

Pump and Motor Rebuild Process



Rebuild Phase 1: Steps 4-7

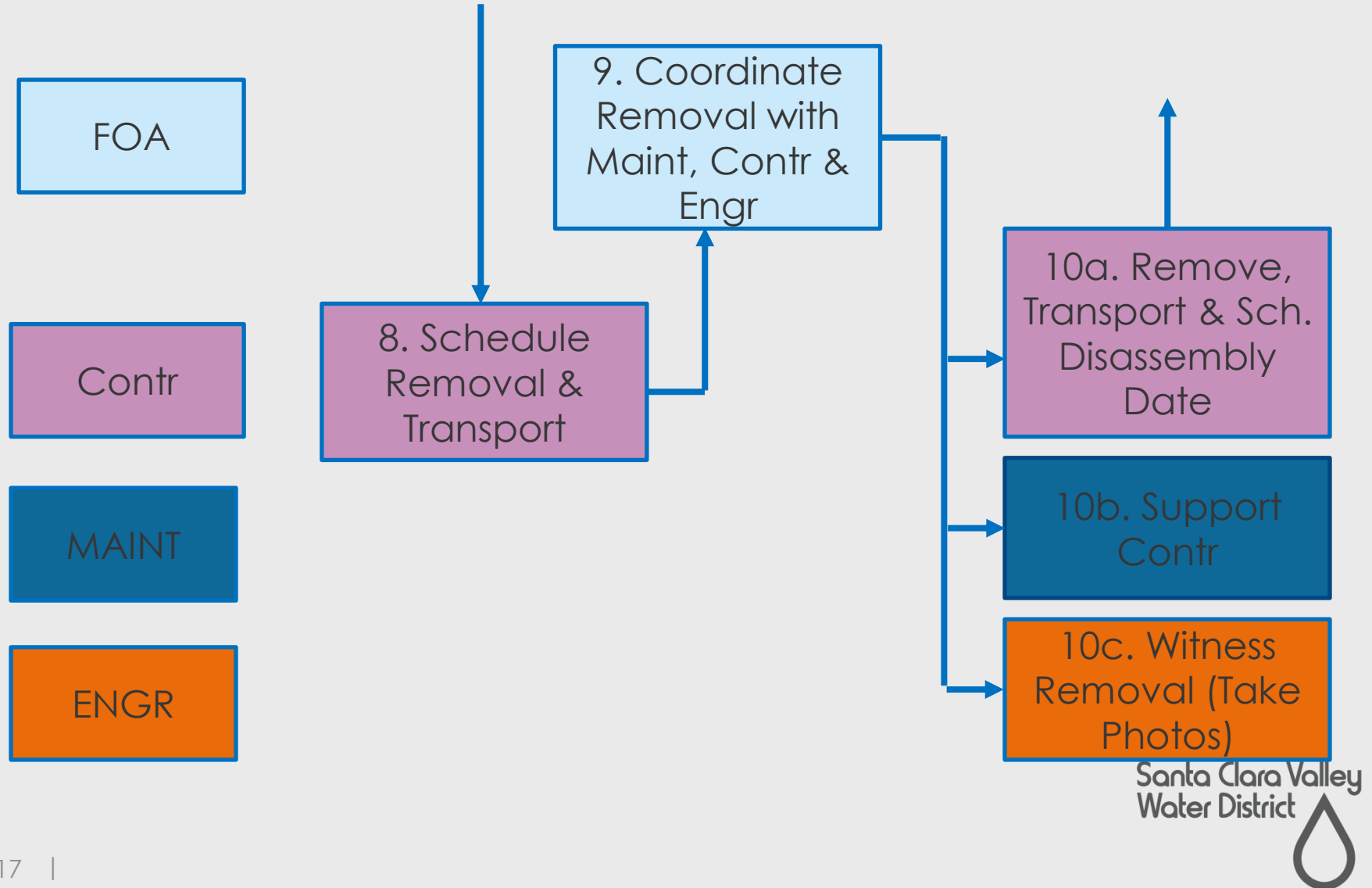
Pump and Motor Rebuild Process



Rebuild Phase 1: Steps 8-10

Pump and Motor Rebuild Process

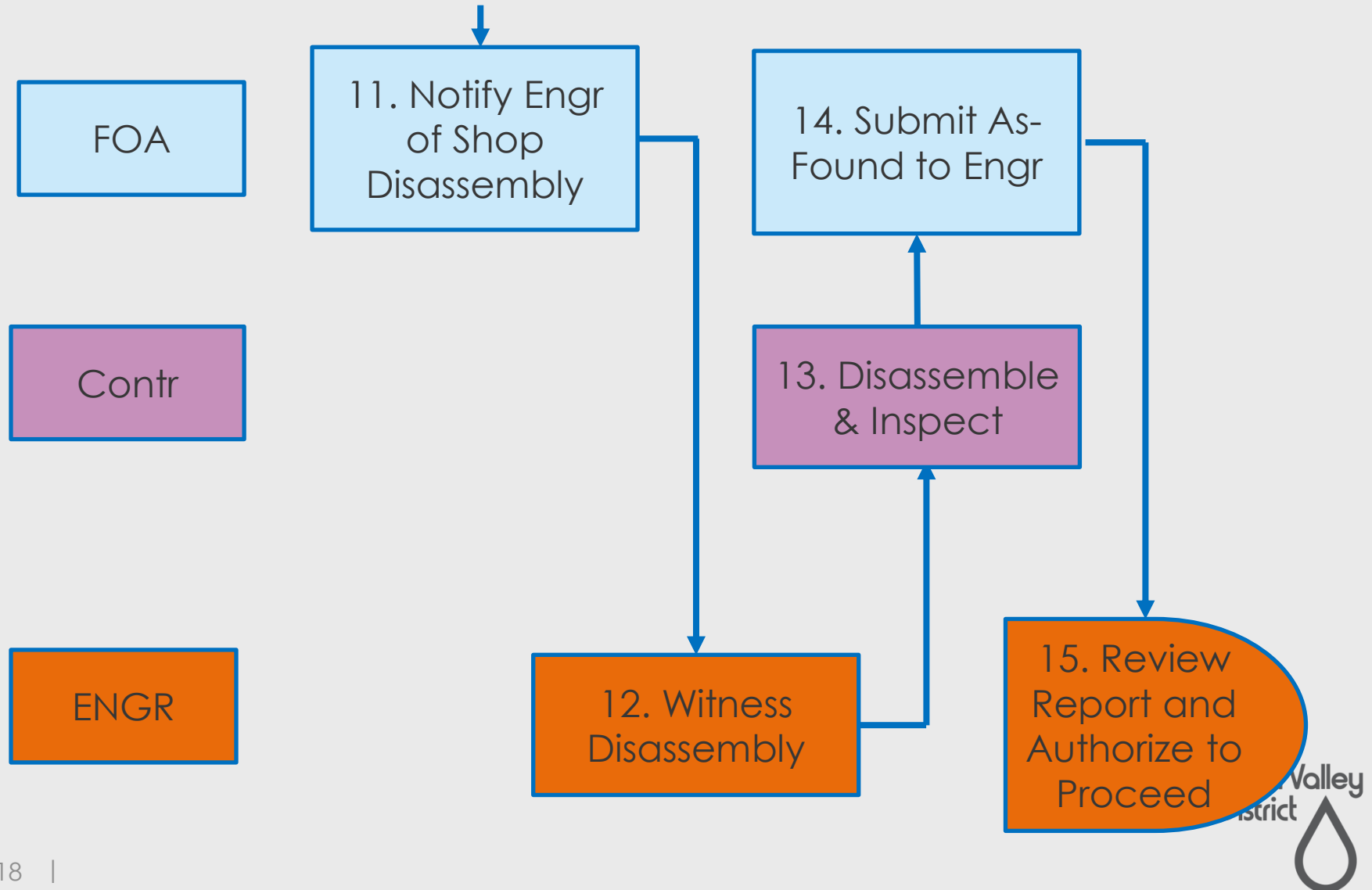
Continued from Step 7



Rebuild Phase 1: Steps 11-15

Pump and Motor Rebuild Process

Continued from Step 10

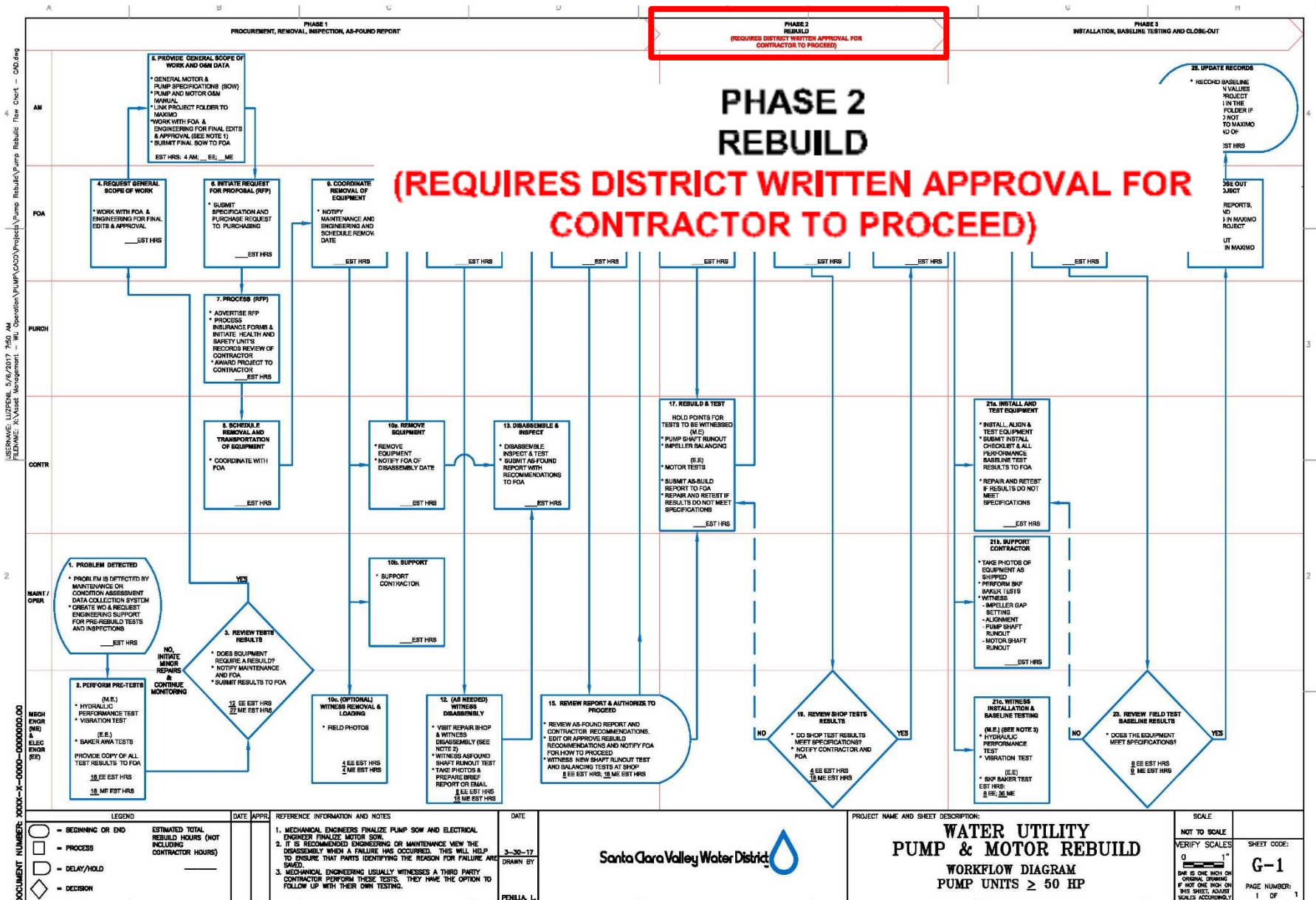


Rebuild Phase 1 - Summary

Pump and Motor Rebuild Process

- ▶ Pre-Tests
- ▶ Procurement
- ▶ Removal (FOA, Maint, Contr)
- ▶ Shop Inspection (Engr/Maint, Contr)
- ▶ As-Found Report

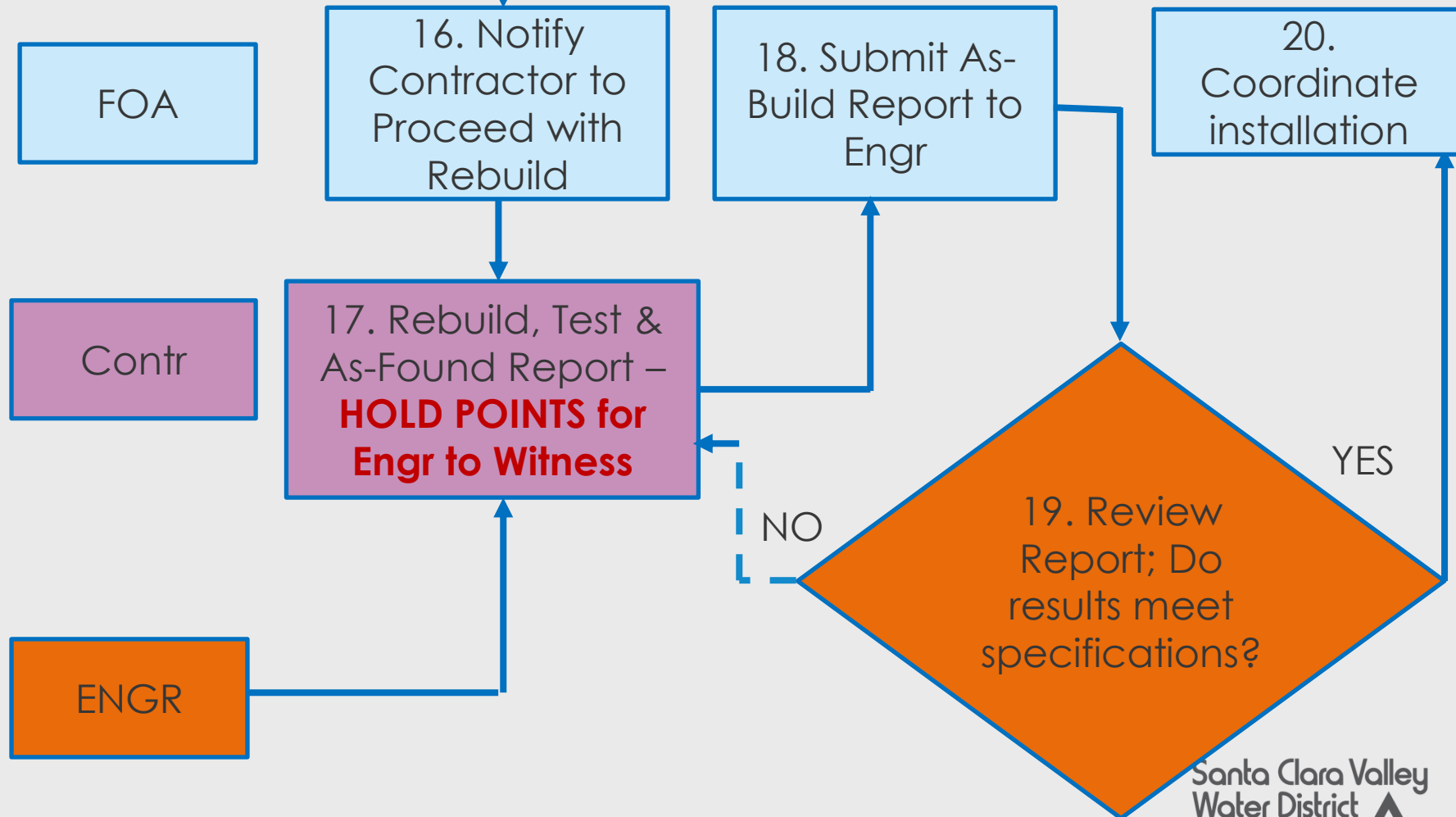
Rebuild Phase 2: Rebuild



Rebuild Phase 2: Steps 16-20

Pump and Motor Rebuild Process

Continued from Step 15



Stage 17: Rebuild, Shop Test & Report (CONTR)

Rebuild Process and Roles

► Hold Points for District staff



Phase 2 – Shop Test References & Tools

Pump and Motor Rebuild Process

► Pump Clearances/Balance

► Mfg. or API 610

► Motor

► IEEE 112, ANSI/EASA AR100

► O&M manual

► E.g. end play

► Vibration Analyzer



PHASE 1
PROCUREMENT, REMOVAL, INSPECTION, AS-FOUND REPORT

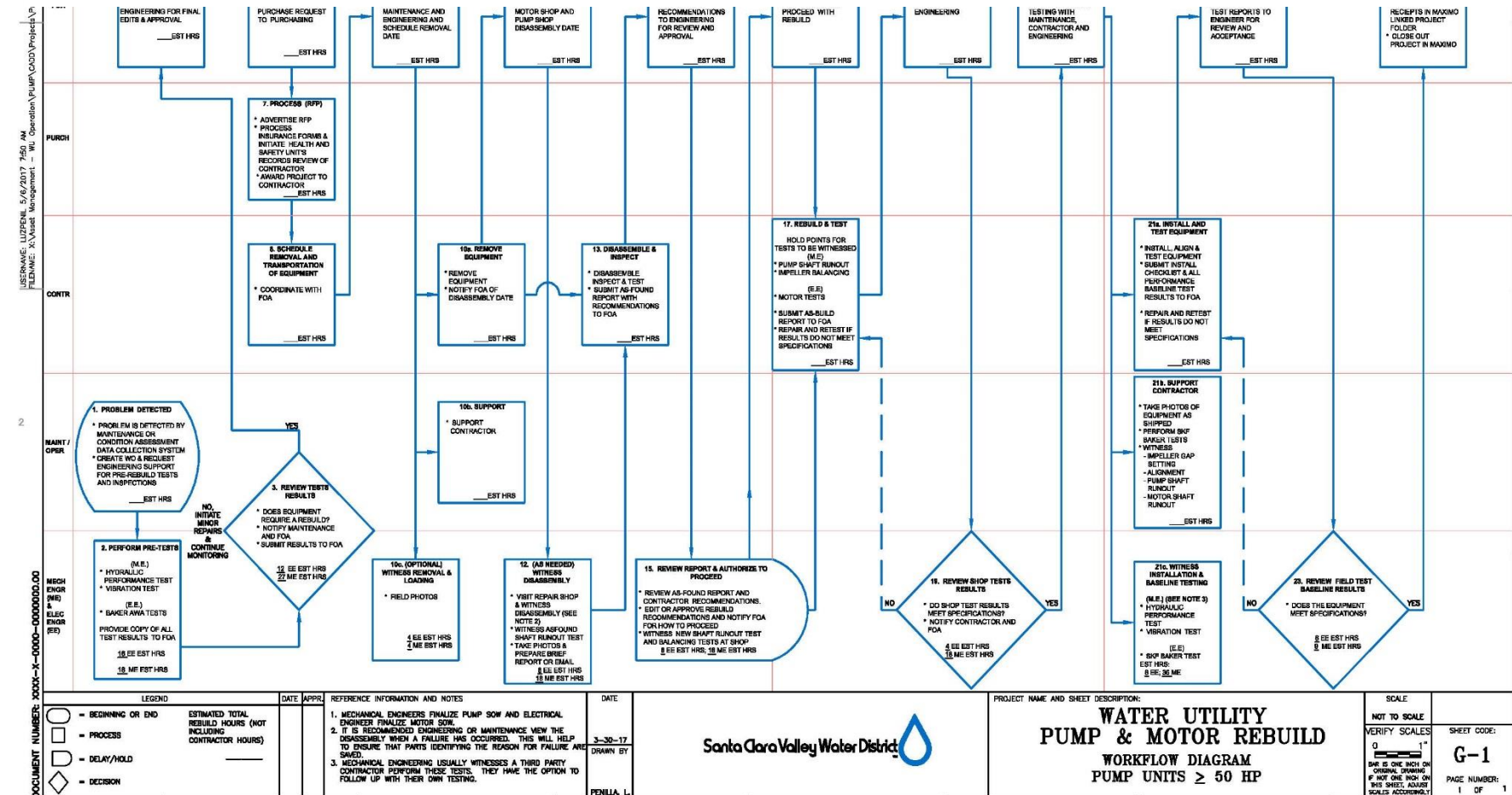
PHASE 2
REBUILD
(REQUIRES DISTRICT WRITTEN APPROVAL FOR CONTRACTOR TO PROCEED)

PHASE 3
INSTALLATION, BASELINE TESTING AND CLOSE-OUT

6. PROVIDE GENERAL SCOPE OF WORK AND O&M DATA

28. UPDATE RECORDS

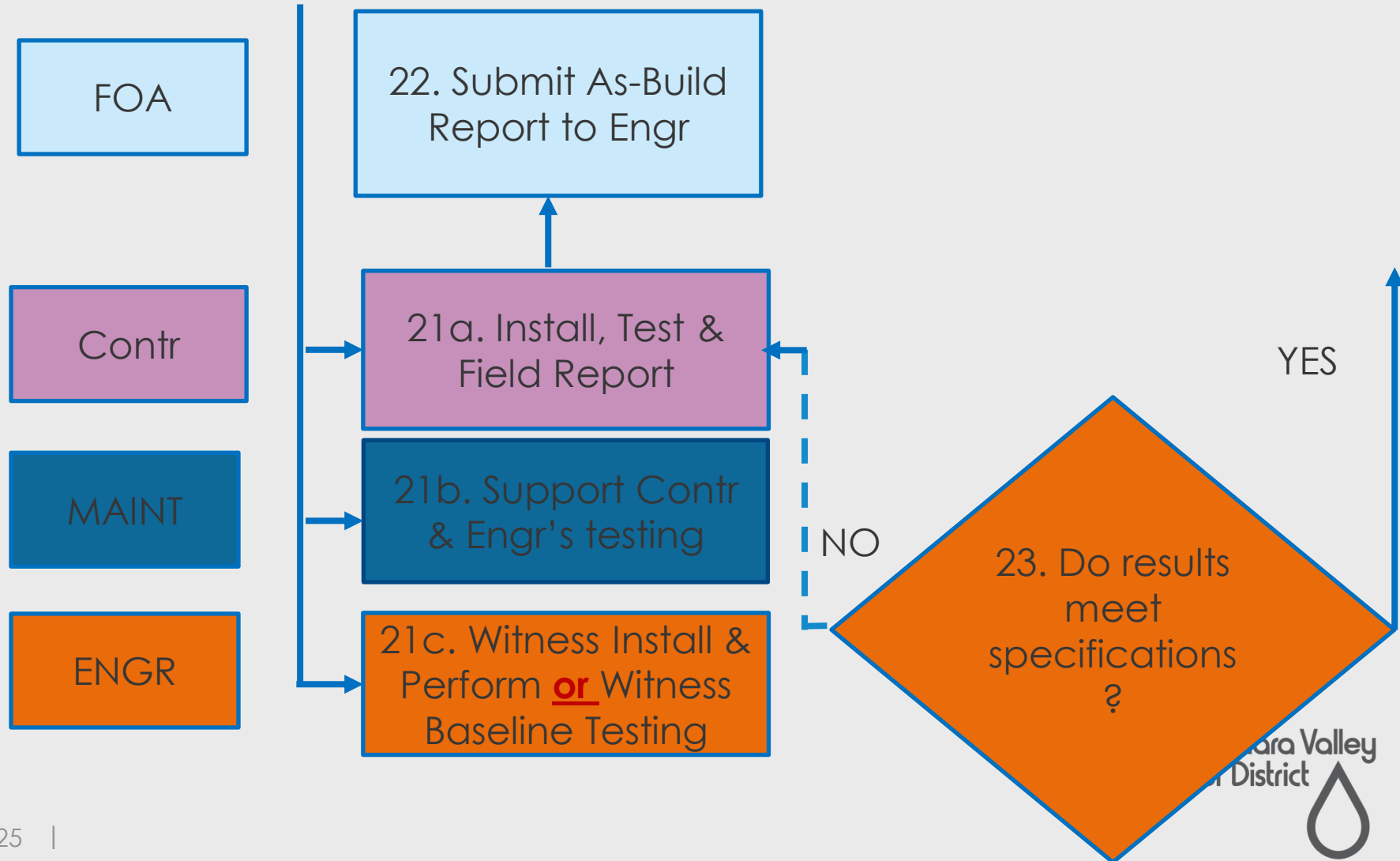
4. INSTALLATION, BASELINE TESTING AND CLOSE-OUT



Rebuild Phase 3: Steps 21-23

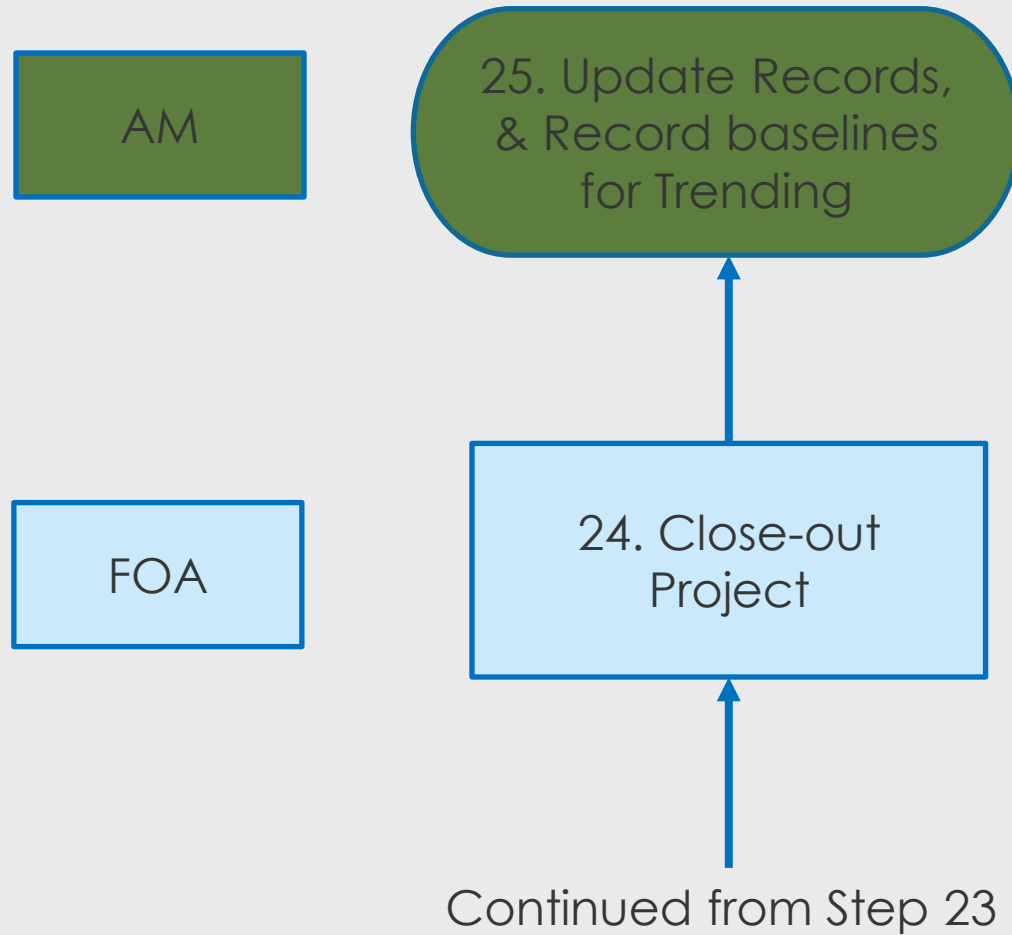
Pump and Motor Rebuild Process

Continued from Step 20



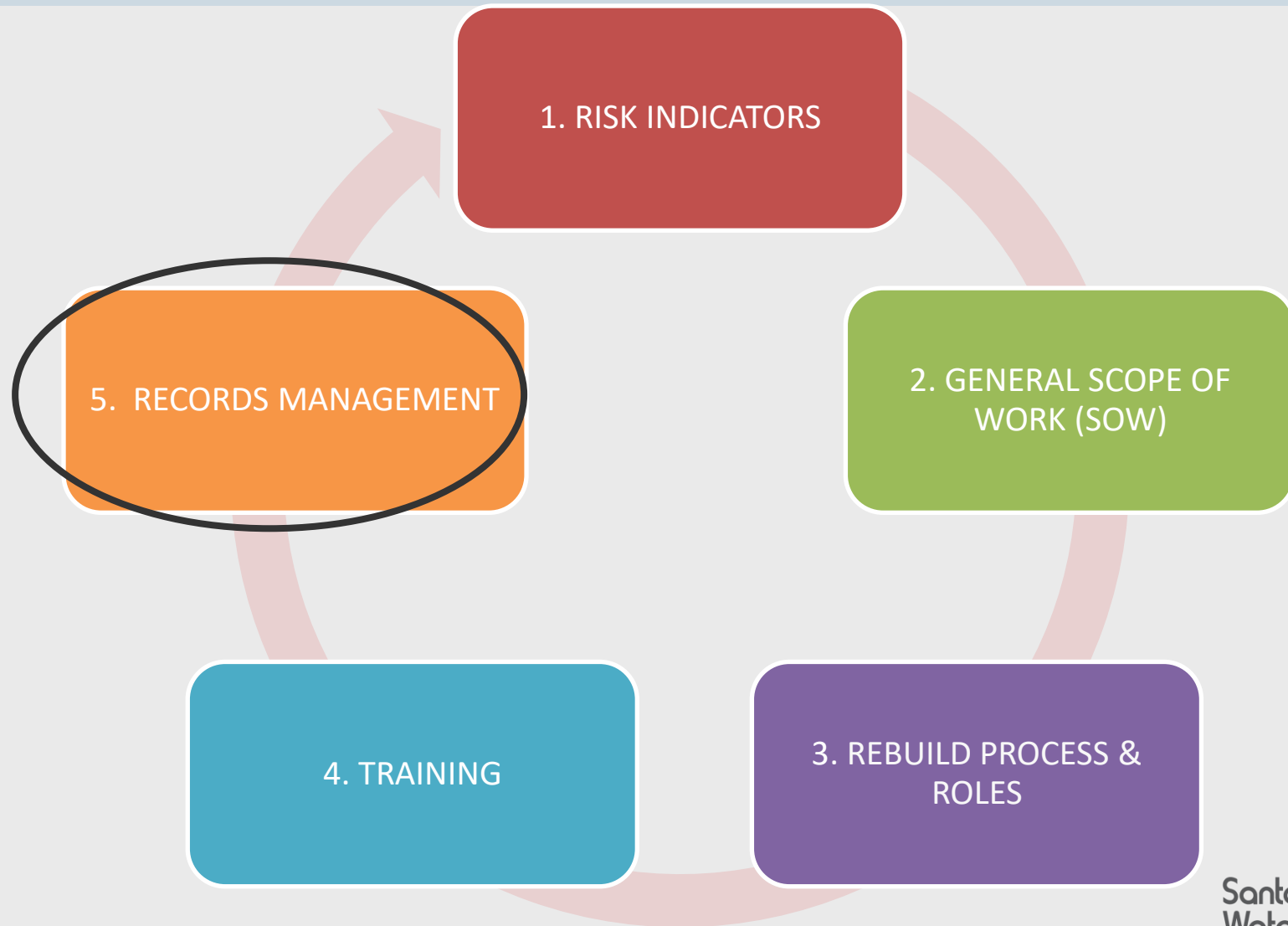
Rebuild Phase 3: Steps 24-25

Pump and Motor Rebuild Process



Pump & Motor Rebuild Program

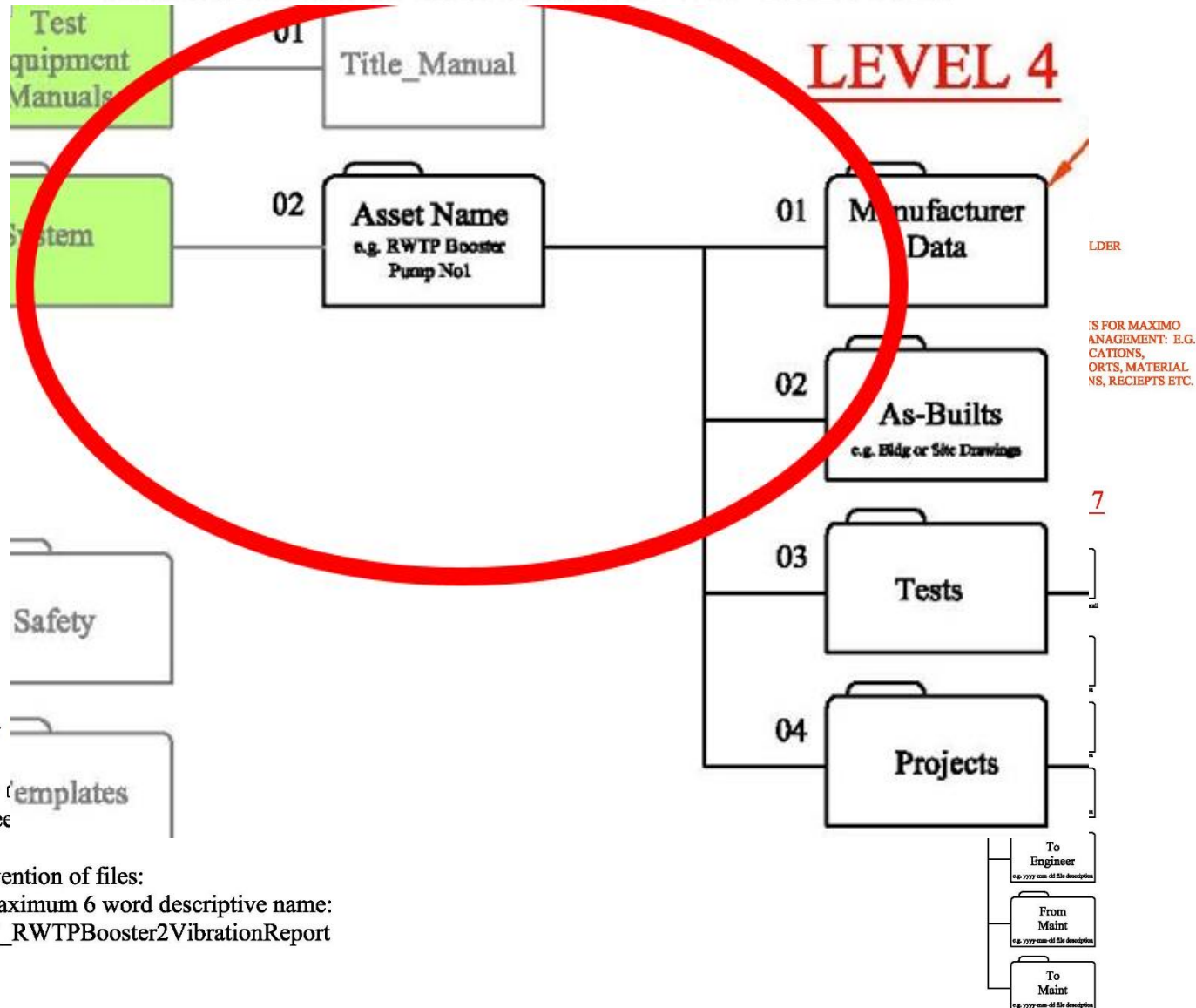
Pump and Motor Rebuild Stages



Pump & Motor Rebuild Program

Pump and Motor Rebuild Stages

ORGANIZATION OF MAINTENANCE WTP DIRECTORY



THANK YOU

Pump and Motor Rebuild Stages

What changes do you recommend?

What is your organization's process?

Biggest Challenge?

