



Attachment 1 Hazard Investigation Report H1-11222022

RTD Maintenance of Way

19th & Stout – Risk Assessment is High, Catastrophic and Probable without mitigation. Rail is in an Unacceptable Condition, Corrective Action Required. Recommend a 3MPH Slow Zone in this area until rail is replaced.

19th & Stout – Condemned Rail

- Gauge widening and negative superelevation measurements prompted removal of a flangeway section for further investigation.



19th & Stout – Condemned Rail

- Flangeway removed 11/15/22 for inspection, confirming suspected Base-corroded rail.
- Base-corroded rails: Rail corrosion consists of deterioration and disintegration of the rail steel starting at its surface, due to chemical reactions, oxidation and electrolysis effects in the presence of water containing salts or other impurities. Rail corrosion could lead to rail breaks and signal system failures.



19th & Stout – Condemned Rail

- **Severe Base Corrosion.** Base of rail completely missing in portions. Greater than ¼” of base-corrosion is considered severe.
- **Severe Base-corroded rail is a Priority 1 defect requiring minimum remedial action of rail replacement (RTD MOW Track Safety Standards, Pg. 42, Table 11c)**



19th & Stout – Condemned Rail

- E-Clip(s) which hold the rail in place are severely corroded and missing.
- Maintaining rail gauge is no longer viable significantly increasing probability of derailment.



19th & Stout – Condemned Rail

- Rail Head Loss: 1-11/16” is new rail compared to current measurement of approximately 3/4”.
- A loss of 1/2” of the Rail Head or a measurement of less than 1-3/16” requires rail replacement as the remedial action.



19th & Stout Rail Condition

- Head of rail 1/2" below restraining rail. Indicative of settling or head loss.



19th & Stout – Condemned Rail

- Rolling contact fatigue causing flaking on rail head at gauge corner.



March 1, 2023



19th & Stout – Condemned Rail

- **Flowed head:** Rolling out of the metal on the head of the rail toward the sides.
- **Detail Fracture:** A progressive fracture originating at or near the surface of the railhead.



19th & Stout – Condemned Rail

- **Flowed head:** Rolling out of the metal on the head of the rail toward the sides.
- **Detail Fracture:** A progressive fracture originating at or near the surface of the railhead.



19th & Stout – Condemned Rail

- **Flowed head:** Rolling out of the metal on the head of the rail toward the sides.
- **Detail Fracture:** A progressive fracture originating at or near the surface of the railhead.



19th & Stout – Condemned Rail

- **Flowed head:** Rolling out of the metal on the head of the rail toward the sides.
- **Detail Fracture:** A progressive fracture originating at or near the surface of the railhead.



19th & Stout – Condemned Rail

- **Flowed head:** Rolling out of the metal on the head of the rail toward the sides.
- **Detail Fracture:** A progressive fracture originating at or near the surface of the railhead.



19th & Stout – Condemned Rail

- Rail head separation and corrugation.
- Train wheels are riding on rubber flangeway, causing arcing due to loss of wheel contact.



19th & Stout – Condemned Rail

- Rail head separation and corrugation.



19th & Stout – Condemned Rail

- Rail head flow and separation.



19th & Stout – Risk Analysis at MAS

TABLE I: SEVERITY CATEGORIES
 Enter Severity Category: _____ 1 - Catastrophic _____

CATEGORIES		
Description	Severity Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding \$10M.
Grave	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding \$1M but less than \$10M.
Significant	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding \$100K but less than \$1M.
Modest	4	Could result in one or more of the following: injury or occupational illness not resulting in a lost work day, minimal environmental impact, or monetary loss less than \$100K.
Negligible	5	Could result in one or more of the following: no injuries or occupational illness, no environmental impact, minor public inconvenience, or nuisance or monetary loss less than \$25K.

19th & Stout – Risk Analysis at MAS

TABLE II: PROBABILITY LEVELS

Probability is defined as the likelihood of the number of times that a specific event will occur during the planned life expectancy of a system. A risk probability may be derived from the analysis of a transit system's operating experience, evaluation of RTD safety historical data, or the analysis of reliability and failure data. Probability is categorized as Frequent, Probable, Remote, Improbable or Highly Improbable.

Enter Probability Level: _____ B - Probable _____

LEVELS			
Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item	Continuously experienced.
Probable	B	Will occur several times in the life of an item	Will occur frequently.
Remote	C	Likely to occur sometime in the life of an item	Will occur several times.
Improbable	D	Unlikely, but possible to occur in the life of an item	Unlikely, but can reasonably be expected to occur
Highly Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.

19th & Stout – Risk Analysis at MAS

RISK ASSESSMENT MATRIX

Enter Risk Assessment: 1B – High

Severity \ Probability	Catastrophic (1)	Severe (2)	Serious (3)	Limited (4)	Negligible (5)
Frequent (A)	High	High	Serious	Medium	Medium
Probable (B)	High	High	Serious	Medium	Moderate
Remote (C)	Serious	Serious	Medium	Moderate	Low
Improbable (D)	Medium	Medium	Moderate	Low	Low
Highly Improbable (E)	Medium	Moderate	Low	Low	Low

Risk Level	Acceptability	Resolution Requirement
High	Unacceptable	Correction required
Serious	Undesirable	Correction may be required, decision by management
Medium	Acceptable with review	With review and documentation by management
Moderate	Acceptable	With review
Low	Acceptable	No action needed

19th & Stout – Risk Analysis at 3MPH

TABLE I: SEVERITY CATEGORIES
 Enter Severity Category: _____ 3 - Significant _____

CATEGORIES		
Description	Severity Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding \$10M.
Grave	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding \$1M but less than \$10M.
Significant	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding \$100K but less than \$1M.
Modest	4	Could result in one or more of the following: injury or occupational illness not resulting in a lost work day, minimal environmental impact, or monetary loss less than \$100K.
Negligible	5	Could result in one or more of the following: no injuries or occupational illness, no environmental impact, minor public inconvenience, or nuisance or monetary loss less than \$25K.

19th & Stout – Risk Analysis at 3MPH

TABLE II: PROBABILITY LEVELS

Probability is defined as the likelihood of the number of times that a specific event will occur during the planned life expectancy of a system. A risk probability may be derived from the analysis of a transit system’s operating experience, evaluation of RTD safety historical data, or the analysis of reliability and failure data. Probability is categorized as Frequent, Probable, Remote, Improbable or Highly Improbable.

Enter Probability Level: _____ B to C- Probable to Remote _____

LEVELS			
Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item	Continuously experienced.
Probable	B	Will occur several times in the life of an item	Will occur frequently.
Remote	C	Likely to occur sometime in the life of an item	Will occur several times.
Improbable	D	Unlikely, but possible to occur in the life of an item	Unlikely, but can reasonably be expected to occur
Highly Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.

19th & Stout – Risk Analysis at 3MPH

RISK ASSESSMENT MATRIX

Enter Risk Assessment: 3B – 3C Medium to Serious

Severity \ Probability	Catastrophic (1)	Severe (2)	Serious (3)	Limited (4)	Negligible (5)
Frequent (A)	High	High	Serious	Medium	Medium
Probable (B)	High	High	Serious	Medium	Moderate
Remote (C)	Serious	Serious	Medium	Moderate	Low
Improbable (D)	Medium	Medium	Moderate	Low	Low
Highly Improbable (E)	Medium	Moderate	Low	Low	Low

Risk Level	Acceptability	Resolution Requirement
High	Unacceptable	Correction required
Serious	Undesirable	Correction may be required, decision by management
Medium	Acceptable with review	With review and documentation by management
Moderate	Acceptable	With review
Low	Acceptable	No action needed

19th & Stout – Downtown Loop Mitigation Options

Option 1:

- Cease train operation @ the Convention Center and utilize the existing bus service Route 43 for the Downtown Loop.

Option 2:

- Run inbound trains alternately. Train to run normal to 18th & California and reverse back to the Convention Center. Crossing back over to the outbound track via SWT25ACC & SWT25BCC crossover switches. Next inbound train cross over into the Convention Center via SWT30ACC & SWT30BCC and run reverse from the Convention Center to 18th & Stout and then head back outbound. Run train service from 20th & Welton to 30th & Downing.

Option 3:

- Cross over inbound trains into the Convention Center via SWT30ACC & SWT30BCC crossover switches. Use a train to shuttle from the Convention Center to 18th & Stout and back. Likewise, use a train to shuttle from the Convention Center to 18th & California and back. Run train service from 20th & Welton to 30th & Downing.

Option 4:

- 3MPH Slow Order, MOW to monitor and stop train movement if conditions degrade. Field Supervisors to step up speed enforcement in the area.