

QuadGuard® Elite

Product Description Manual



TRINITY
HIGHWAY

Ahead of the Curve™

QuadGuard® Elite

Product Manual



2525 Stemmons Freeway
Dallas, Texas 75207



Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the QuadGuard® Elite system. These instructions are for standard assemblies specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Trinity Highway representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway at (888) 323-6374 or download copies from the website below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest QuadGuard® Elite system information available to Trinity Highway at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway to confirm that you are referring to the most current instructions.

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Customer Service Contacts

Trinity Highway is committed to the highest level of customer service. Feedback regarding the QuadGuard® Elite system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Energy Absorption Systems, Inc. dba Trinity Highway

Telephone:	(888) 323-6374 (USA) (312) 467-6750 (International)
E-mail:	product.info@trin.net
Website:	www.trinityhighway.com

Important Introductory Notes

Proper assembly of QuadGuard® Elite system is critical to achieve performance that has been evaluated and accepted by the Federal Highway Administration (FHWA) per NCHRP Report 350. These instructions should be read in their entirety and understood before assembling the QuadGuard® Elite system. These instructions are to be used only in conjunction with the assembly of the QuadGuard® Elite system and are for standard assemblies only as specified by the applicable highway authority. If you need additional information, or have questions about the QuadGuard® Elite system, please contact the highway authority that has planned and specified this assembly and, if needed, contact Trinity Highway's Customer Service Department. This product must be assembled in the location specified by the appropriate highway authority. If there are deviations, alterations, or departures from the assembly protocol specified in this Manual, the device may not perform as it was tested and accepted.

This system, like other Trinity Highway systems, has been crash tested pursuant to NCHRP Report 350 mandated criteria



Important: DO NOT use any component part that has not been specifically crash tested and/or approved for this system during the assembly or repair of this system.

This product has been specified for use by the appropriate highway authority and has been provided to that user who has unique knowledge of how this system is to be assembled. No person should be permitted to assist in the assembly, maintenance, or repair of this system that does not possess the unique knowledge described above. These instructions are intended for an individual qualified to both read and accurately interpret them as written. These instructions are intended only for an individual experienced and skilled in the assembly of highway products that are specified and selected by the highway authority.

A manufacturer's drawing package will be supplied by Trinity Highway upon request. Each system will be supplied with a specific drawing package unique to that system. Such drawings take precedence over information in this Manual and shall be studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any product assembly.



Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® Elite system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. Such failure also compromises the acceptance of this system by the FHWA. Please keep up-to-date instructions for later use and reference by anyone involved in the assembly of the product.



Warning: Ensure that all of the QuadGuard® Elite system Danger, Warning, Caution, and Important statements within the QuadGuard® Elite Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the QuadGuard® Elite system. Additional copies of this Manual are immediately available from Trinity Highway by calling (888) 323-6374 or by email at product.info@trin.net. Please contact Trinity Highway if you have any questions concerning the information in this Manual or about the QuadGuard® Elite system. This Manual may also be downloaded directly from the website listed below.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or the QuadGuard® Elite system components. Work gloves, safety goggles, safety-toe shoes, and back protection should be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this QuadGuard® Elite Manual. Read the Manual for complete safety and assembly information.

Symbol

Meaning



Safety Alert Symbol: Indicates Danger, Warning, Caution, or Important. Failure to read and follow the Danger, Warning, Caution, or Important indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the QuadGuard® Elite system.



Danger: Failure to comply with these warnings could result in increased risk of serious injury or death in the event of a vehicle impact with a system that has not been accepted by the Federal Highway Administration (FHWA).



Warning: Do not assemble, maintain, or repair the QuadGuard® Elite system until you have read this Manual thoroughly and completely understand it. Ensure that all Danger, Warning, Caution, and Important statements within the Manual are completely followed. Please call Trinity Highway at (888) 323-6374 if you do not understand these instructions.



Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site.



Warning: Use only Trinity Highway parts that are specified herein for the QuadGuard® Elite for assembling, maintaining, or repairing the QuadGuard® Elite system. **Do not utilize or otherwise comeingle parts from other systems even if those systems are other Trinity Highway systems.** Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.



Warning: DO NOT modify the QuadGuard® Elite system in any way.



Warning: Ensure that the QuadGuard® Elite system and delineation used meet all federal, state, specifying agency, and local specifications.



Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards.



Warning: Ensure that there is proper site grading for the QuadGuard® Elite system placement as dictated by the state or specifying agency, pursuant to Federal Highway Administration (FHWA) acceptance.



Warning: Use only Trinity Highway parts on the QuadGuard® Elite system for assembly, maintenance, or repair. **The assembly or comingling of unauthorized parts is strictly PROHIBITED.** The QuadGuard® Elite and its component parts have been accepted for state use by the FHWA. However, a comingled system has not been accepted within the applicable criteria.



Important: Trinity Highway makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the local highway authority and its engineers to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this Manual have been strictly followed.



Warning: Ensure that this assembly conforms with the guidance provided by the AASHTO Roadside Design Guide, including, but not limited to, those regarding placement on or adjacent to curbs.

Limitations and Warnings

Trinity Highway, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) “Recommended Procedures for the Safety Performance of Highway Safety Features”, contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The QuadGuard® Elite system has been approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350. These tests typically evaluate product performance defined by Report 350 involving a range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]). A product can be certified for multiple Test Levels. The QuadGuard® Elite is certified to the Test Level(s) as shown below:

Test Level 2: 70 km/h [44 mph]

Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP Report 350 as approved by FHWA.

Trinity Highway neither represents nor warrants that the impact results of these federally established test criteria prevent or reduce the severity of any injury to person(s) or damage to property. These tests only demonstrate the occurrence of certain results following an impact within NCHRP Report 350 criteria. Every departure from the roadway is a unique event.

The QuadGuard® Elite system is intended to be assembled, delineated, and maintained within specific state and federal guidelines. It is important for the highway authority specifying the use of a highway product to select the most appropriate product configuration for its site specifications. The customer should be careful to properly select, assemble, and maintain the product. Careful evaluation of the site lay out, vehicle population type; speed, traffic direction, and visibility are some of the elements that require evaluation in the selection of a highway product. For example, curbs could cause an untested effect on an impacting vehicle.

After an impact occurs, the debris from the impact should be removed from the area immediately and the specified highway product should be evaluated and restored to its original specified condition or replaced as the highway authority determines as soon as possible.

System Overview

The QuadGuard® Elite is a potentially reusable, redirective, non-gating impact cushion for roadside obstacles ranging in width from 610 mm to 2285 mm (24" to 90"). It consists of high molecular weight, high density polyethylene (HMW/HDPE), energy-absorbing cylinders surrounded by a framework of Quad-Beam™ panels.

The QuadGuard® Elite utilizes two (2) types of Cylinders in a "staged" configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site.

Measuring the Width

The nominal width of the Tension Strut Backup is the width between Side Panels behind the Backup (see Figure 1). The outside width of the system is approximately 150 mm [6"] to 230 mm [9"] wider than this measurement.

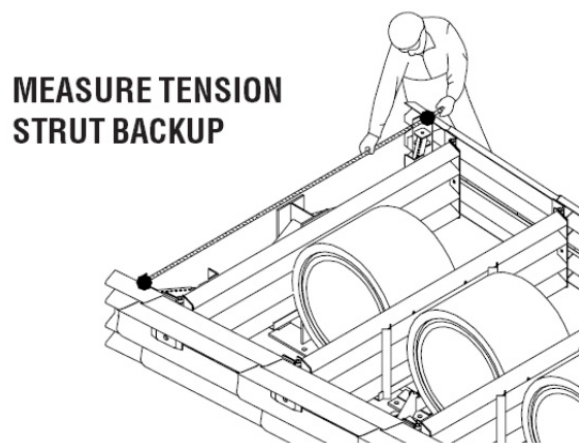


Figure 1
Tension Strut Backup Width

Counting the Number of Bays

One bay consists of one Diaphragm, two Fender Panels, etc. The Nose section is not considered a bay (see Figure 2)

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the system facing the roadside feature. Your left is the system's left and your right is the system's right (see Figure 3).

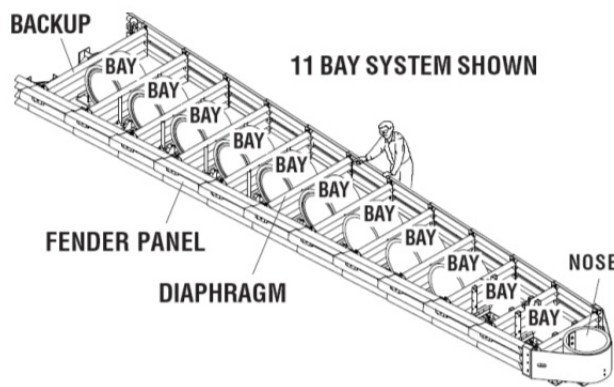


Figure 2
Number of Bays

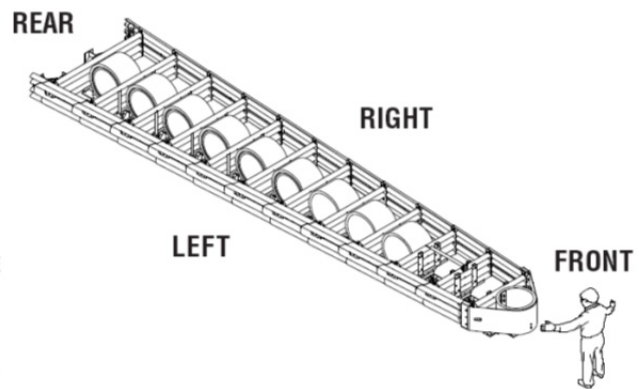


Figure 3
Left/Right

Impact Performance

The 5 bay and 7 bay EC QuadGuard® Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 2 tests with both the light car and pickup at speeds of up to 70 km/h [43 mph] at angles up to 15 degrees.

The 8 bay and 11 bay EC QuadGuard® Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 15 degrees.

The “EC” designation stands for “Extra Capacity”. This system has additional energy absorbing capacity.

The 14 bay 24”, 30” and 36” wide QuadGuard® Elite have successfully been tested with the pickup at speeds up to 115 km/h [70 mph].

During head-on impacts, within the applicable NCHRP Report 350 criteria, the QuadGuard® Elite has been shown to telescope rearward to absorb the energy of impact. During those same in-criteria impacts, when impacted from the side, the system has been shown to redirect the vehicle back toward its original travel path and away from the roadside feature.

Design Criteria

FHWA Criteria

The 5 bay and 7 bay QuadGuard® Elite systems have passed the requirements stipulated in NCHRP Report 350, Test Level 2 tests with both the light car and pickup at speeds of up to 70 km/h [43 mph] at angles up to 20°.

The 8 bay and 11 bay QuadGuard® Elite systems are capable of passing the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20°.

Establish Basic System Specifications

The specification of a QuadGuard® Elite system for a particular site must always include system width and system length.

1) Specification of System Width

The QuadGuard® Elite system is available in five nominal widths (see Figure 8 on p. 13).

610 mm [24"]

760 mm [30"]

915 mm [36"]

1755 mm [69"]

2285 mm [90"]

As a general rule, selection of the narrowest width that adequately shields the roadside obstacle is recommended.

2) Specification of System Length

System length is specified by the number of bays the system includes. The number of bays required is a function of the design speed of the roadway. The system nose is not considered to be a bay.

Backup Structure for the System

The Tension Strut backup drawings are available at the back of this Manual on pages 26 & 33 and are appropriate for use on grade or deck.

Establish Required System Footing

The system must be anchored. MP-3[®] polyester anchor bolts will be supplied for all required anchorages in concrete. Refer to QuadGuard[®] Elite system Installation Manual, or MP-3[®] kits for detailed assembly instructions.

- 1) **Existing concrete** – Concrete must be at least 150 mm [6"] thick, reinforced 28 MPa [4000 psi] Portland cement concrete (P.C.C.), or 200 mm [8"] thick non-reinforced measuring at least 3.66 m [12' – 0"] wide by 15.24 m [50' – 0"] long. The concrete should be in good condition and be free of major cracks.
- 2) **New concrete** – If existing concrete does not meet these criteria, a new concrete foundation must be placed to properly secure the system.
- 3) **Cross-slope**– if there is a cross-slope of more than 8% (5 deg.), or if the cross-slope varies (twists) more than 2% (1 deg.) over the length of the system, a concrete leveling foundation may be required (see Figure 4).
- 4) **No Cross-slope** – If the cross-slope is within the range described above, the leveling foundation is not required:
 - **Transversal slope $\leq 8\%$**
 - **Longitudinal slope $\leq 2\%$**

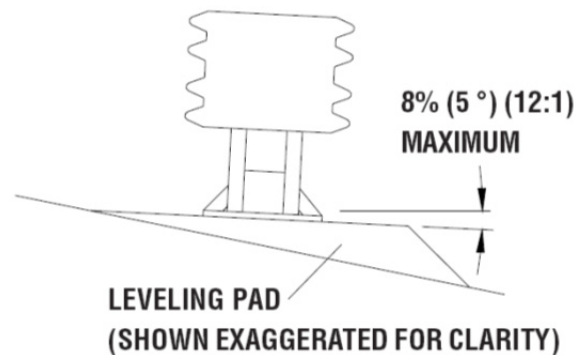


figure 4
Cross-Slope

Special Site Conditions

Contact the Trinity Highway Customer Service Department if you are a representative of the highway authority and would like input with your application. You will need to answer the following questions:

1. Are curbs, islands, or elevated objects (delineators or signs) present at the site? What height and width are they? All curbs and elevated objects 100 mm [4"] high should be removed. If possible, curbs less than 100 mm [4"] high should be removed approximately 15 m [50'] in front of the QuadGuard® Elite system and as far back as the system's backup. Any curbs that must remain should be 100 mm [4"] maximum and be mountable.
2. If the deployment site is a gore area, (place where two roads diverge), what is the angle of divergence?
3. What is the general geometry of the site? Include the roadway for 150 m [500'] in front of highway feature so traffic patterns can be visualized.
4. When there is an existing guardrail or median barrier at the site, the backup of the QuadGuard® Elite system should tie into it when possible.
5. Will there be traffic approaching from the rear of the system? Is the system in a two-way traffic situation, with traffic going in opposite directions on either side of the system? Or, is the system on the side of the road in a location where crossover traffic is a concern? If so, a transition from the back of the system to the fixed object is necessary to prevent vehicle snagging (see "Transition Panel Types" on next page).
6. See next section if there are any other unique features at the site that may affect positioning or performance of the QuadGuard® Elite system?



Caution: The potentially restorable nature of the cylinders could provide for possible rebounding of an impacting vehicle into pathways beyond the reserve area under certain impact conditions. Consideration of a system for a particular site should include an assessment of this factor.

Other Factors That May Affect Your Design:

1. The existence of drain inlets.
2. Junction boxes or other appurtenances located near the roadside feature.
3. Insufficient space for the length preferred.
4. The location and movement of expansion joints. Contact Trinity Highway Customer Service Department before proceeding with your design (see p. 3).

Transition Panel Types

If a system is placed in a location where traffic will be approaching from the rear, a Transition Panel is necessary. Figures 5, 6 & 7 show the standard panel types. There are variations for each panel type. The specific Panel needed will depend on system and site conditions. Therefore, it is important to send site specific data to the customer service department for a recommendation for exact Panel needed for your application.

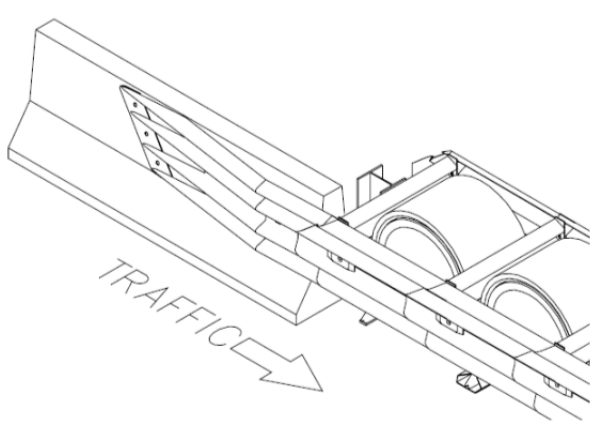


Figure 5
Quad-Beam™ to Safety Shape Barrier
Transition Panel

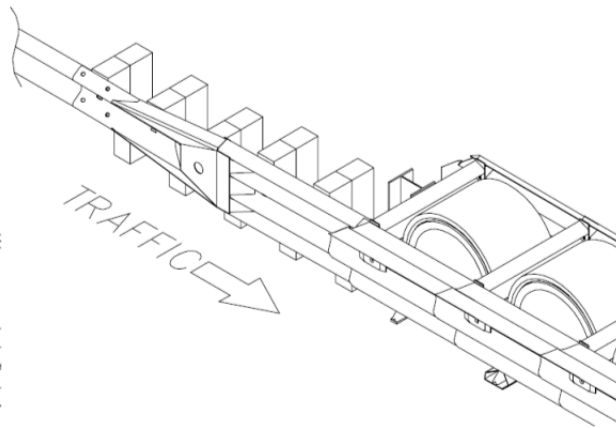


Figure 6
Quad-Beam™ to W-Beam Transition Panel

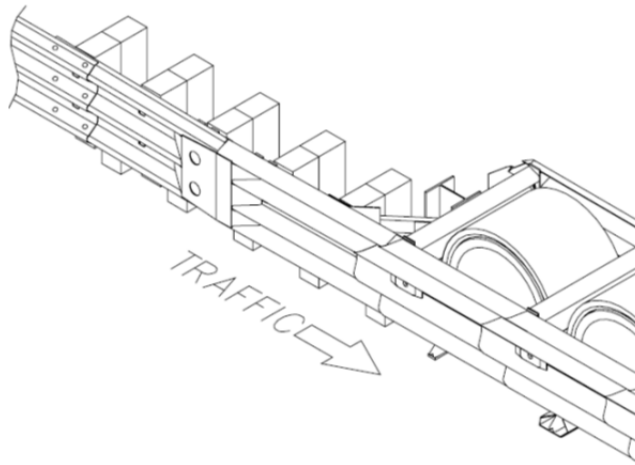


Figure 7
Quad-Beam™ to Thrie-Beam Transition Panel

System Width	5 Bay TL2 70 km/h [43 mph]	7 Bay EC TL2 85 km/h [53 mph]	8 Bay TL3 100 km/h [62 mph]	11 Bay EC TL3 105 km/h [65 mph]	14 Bay TL3 115 km/h [72 mph]
610 mm [24"]	QS2405E	QS2407E	QS2408E	QS2411E	QS2414E
760 mm [30"]	QS3005E	QS3007E	QS3008E	QS3011E	QS3014E
915 mm [36"]	QS3605E	QS3607E	QS3608E	QS3611E	QS3614E
1755 mm [69"]	QS6905E	QS6907E	QS6908E	QS6911E	Not Available
2285 mm [90"]	QS9005E	QS9007E	QS9008E	QS9011E	Not Available

Figure 8
QuadGuard® Elite System Model Numbers

Model Number Description

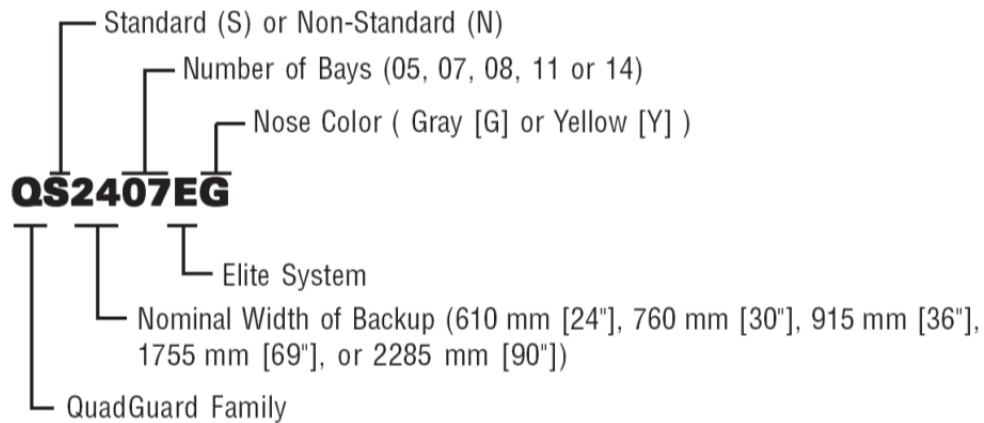
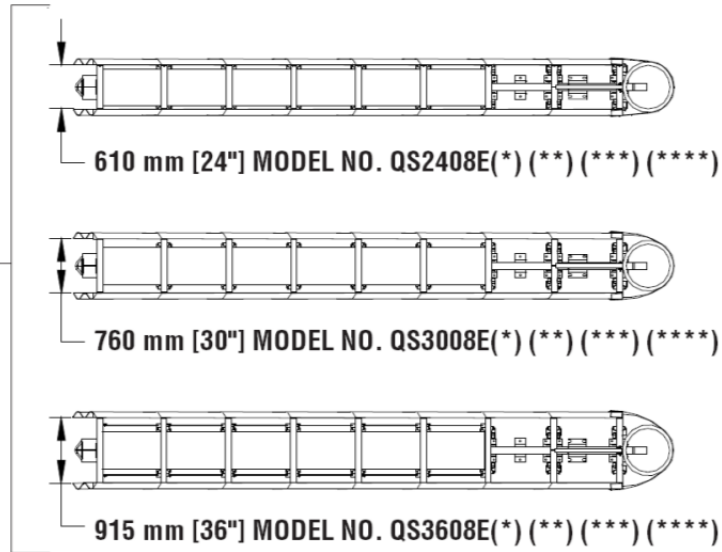
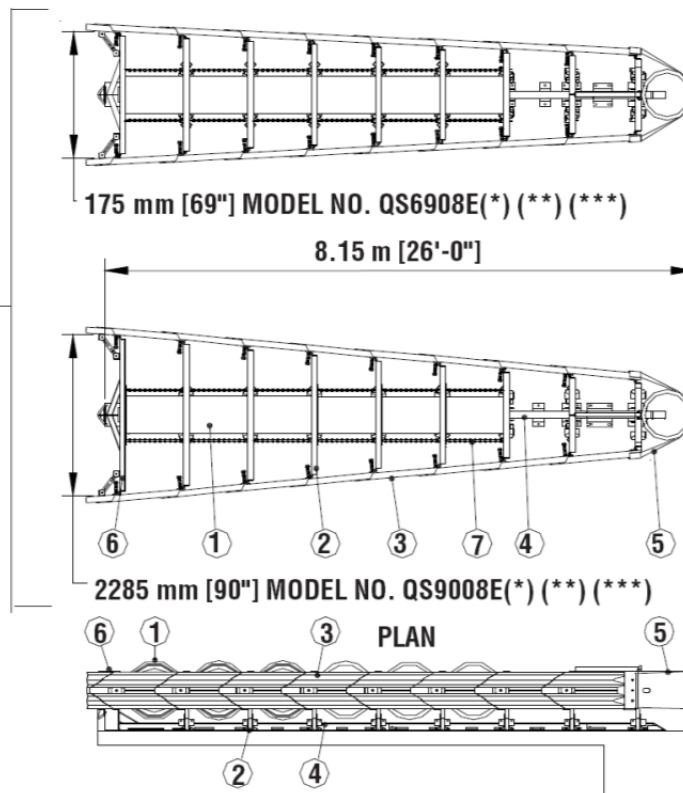


Figure 9
Model Number Key

QUADGUARD ELITE
FOR NARROW HAZARDS



QUADGUARD ELITE
FOR WIDE HAZARDS



Key

- 1) Energy-Absorbing Cylinder
- 2) Diaphragm
- 3) Quad-Beam™ Fender Panel
- 4) Monorail
- 5) Nose Cover
- 6) Backup
- 7) Chain Assembly

Elevation

- * Also Available in 5 Bay Lengths
- ** Also Available in 7 Bay Lengths (EC Model)
- *** Also Available in 11 Bay Lengths (EC Model)
- **** Also Available in 14 Bay Lengths

Figure 10
Plan & Elevation

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's Drawing Package

Personal Protective equipment

- Safety Glasses
- Gloves
- Apron for MP-3[®] application
- Safety-toe shoes

Cutting equipment

- Rotary hammer drill
 - Rebar cutting bit
 - Concrete drill bits – 22 mm [7/8"] (*Double-Fluted)
 - Grinder, Hacksaw, or Torch (optional)
 - Drill motor
 - Drill bits 1/16" through 7/8"
- * Trinity Highway recommends using double-fluted drills to achieve optimum tensile strength when installing the MP-3[®] anchoring system.

Hammers

- Sledgehammer
- Standard hammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/2" drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2" drive Deep sockets: 15/16", 1 1/4"
- 1/2" drive Ratchet and attachments
- 1/2" drive Breaker bar - 24" long
- 1/2" drive Torque wrench: 200 ft-lb
- Crescent wrench: 300 mm [12"]
- Allen wrench: 3/8
- Impact wrench: 1/2" drive

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Compressor (100 psi) and Generator 95 kW)
- Long pry bar
- Drift pin 300 mm [12"]
- Center punch
- Tape measure 7.5 m [25']
- Chalk line
- Concrete marking pencil
- Nylon bottle brush for cleaning 7/8" drilled holes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified site.



Caution: The assembly/maintenance information provided here is for planning and system selection purposes only. Do not attempt to deploy or maintain the QuadGuard® Elite system without the proper plans and Assembly/Maintenance Manual from the manufacturer. If you need additional information, or have questions, please contact the highway authority who has planned and specified this product and, if needed, call the Trinity Highway Customer Service Department at (888) 323-6374.

Site Preparation/Foundation

The QuadGuard® Elite system should be deployed only on an existing or freshly placed and cured concrete foundation (28 MPa [4000 psi] minimum). Location and orientation of the concrete foundation and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundation are provided in Trinity Highway concrete foundation drawings, supplied with the system. System may be deployed on concrete roadway (see p. 10). Deployment cross-slope shall not exceed 8% and should not vary more than 2% over the length of the system. The foundation surface shall have a light broom finish.



Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete Anchor Bolts.



Warning: Location of the backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the fender panels telescope toward and extend beyond the rigid backup as much as 635 mm [25"] from their pre-impact location. Position the backup so that the rear ends of the last fender panels are a minimum of 635 mm [25"] forward of objects that would otherwise interfere with movement of the panels. Failure to comply with this requirement will result in impaired system performance offering motorists less protection and cause component damage.

Estimated Time for Assembly

With the use of proper tools and trained crew of three workers, the estimated time for deployment on a fully cured foundation is six to eight hours depending on site conditions, traffic, size and experience of work crew, and quality of tools.

General Maintenance and Repair

The QuadGuard® Elite System is considered to be a potentially reusable system. The system must be inspected after each impact and must be manually pulled out to its original length if necessary. Depending on the impact, components may get damaged and need replacement.

Estimated time for Maintenance

An experienced two person crew with the proper tools and spare parts should be able to complete the work in one to three hours depending on the damage done to the system.

Life Expectancy

Environment

Except due to damage, it is anticipated that the cylinders may survive in a highway environment for a period ranging from five to fifteen years from the date of deployment.

Impact

Life expectancy is also affected by:

1. The number of impacts
2. The severity of the impacts
3. The temperature at the time of the impacts

Systems must be inspected after each impact. Any cylinder that is cracked or otherwise damaged should be replaced and the system should be pulled out to its original length.



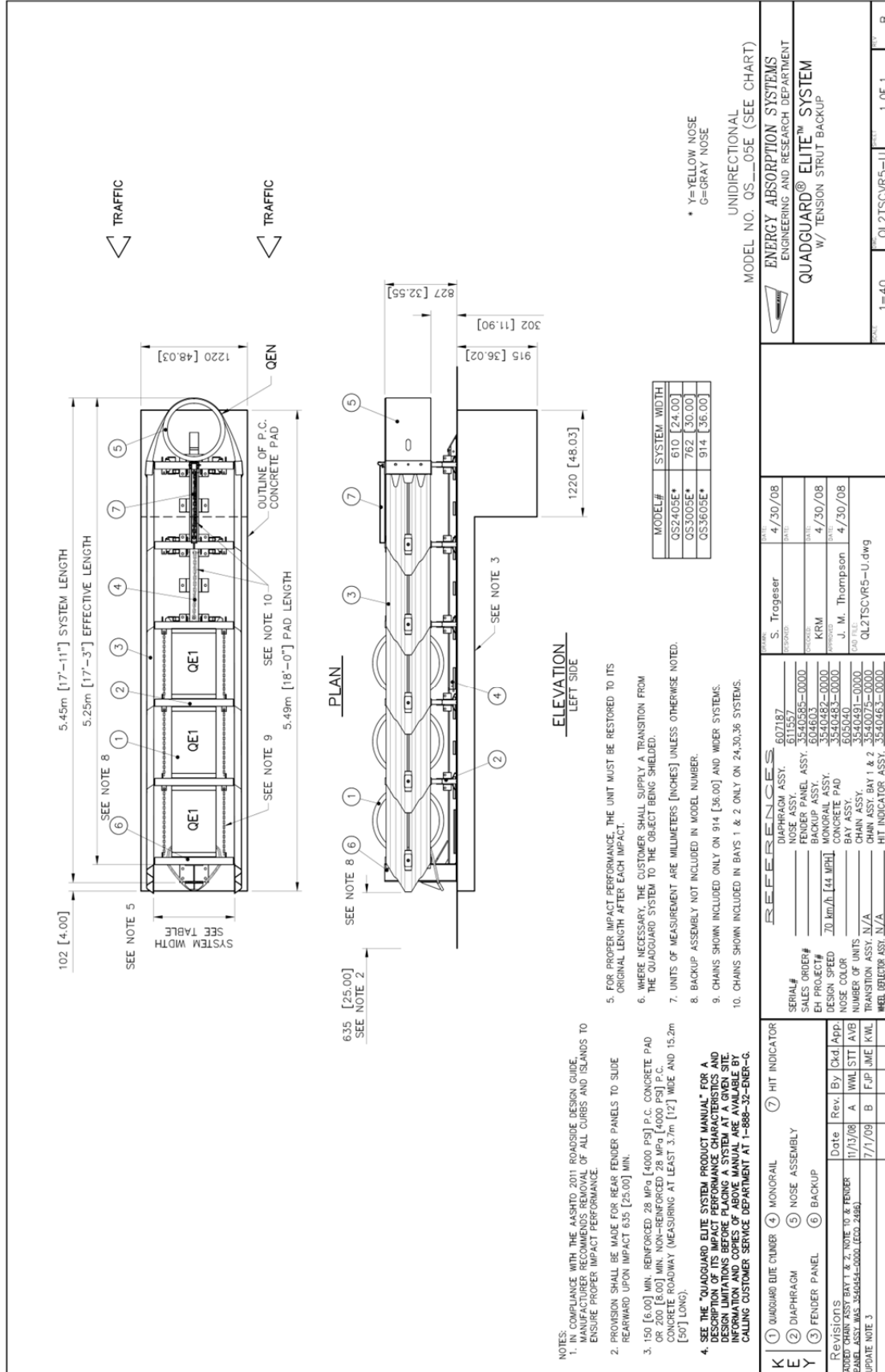
Caution: After an impact, always follow "Post-Impact Instructions" in the maintenance and repair section of the Assembly Manual.

Recycle Information

When parts need to be replaced, it is recommended that the old parts be recycled as follows:

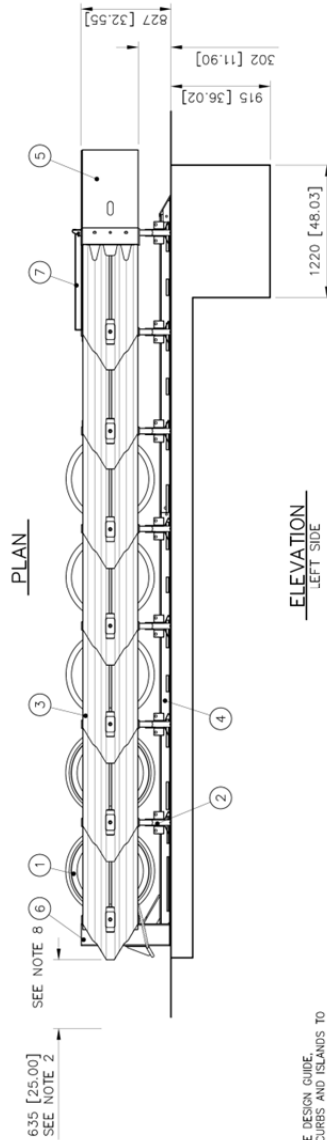
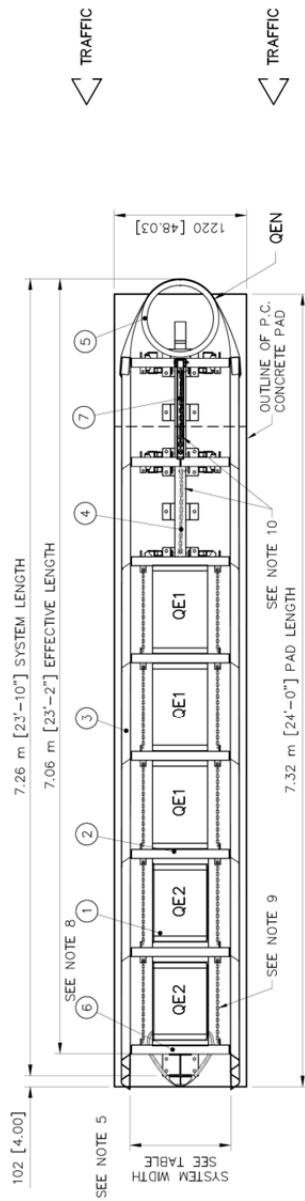
1. Steel should be sold as scrap to a local metal recycler.
2. Cylinders should be sold to a plastic recycler if available. If a recycler is unavailable, dispose of the material as plastic refuse.

DWG QL2SCVR5-U



QuadGuard® Elite System w/ Tension Strut Backup TL-2

DWG QL2SCVR-U



MODEL#	SYSTEM WIDTH
QS2407E*	610 [24.00]
QS3007E*	762 [30.00]
QS3607E*	914 [36.00]

* Y=YELLOW NOSE
G=GRAY NOSE

UNIDIRECTIONAL
MODEL NO. QS--07E (SEE CHART)

ENERGY ABSORPTION SYSTEMS
ENGINEERING AND RESEARCH DEPARTMENT
QUADGUARD® ELITE™ SYSTEM
w/ TENSION STRUT BACKUP

DESIGNER	S. VAN OGLE	DATE	11/12/98
CHECKER	R. BLASKI	DATE	11/12/98
APPROVER	KRM	DATE	7/14/99
REVISOR	RBB	DATE	7/15/99
FILED	QL2TSCVR-U.dwg		

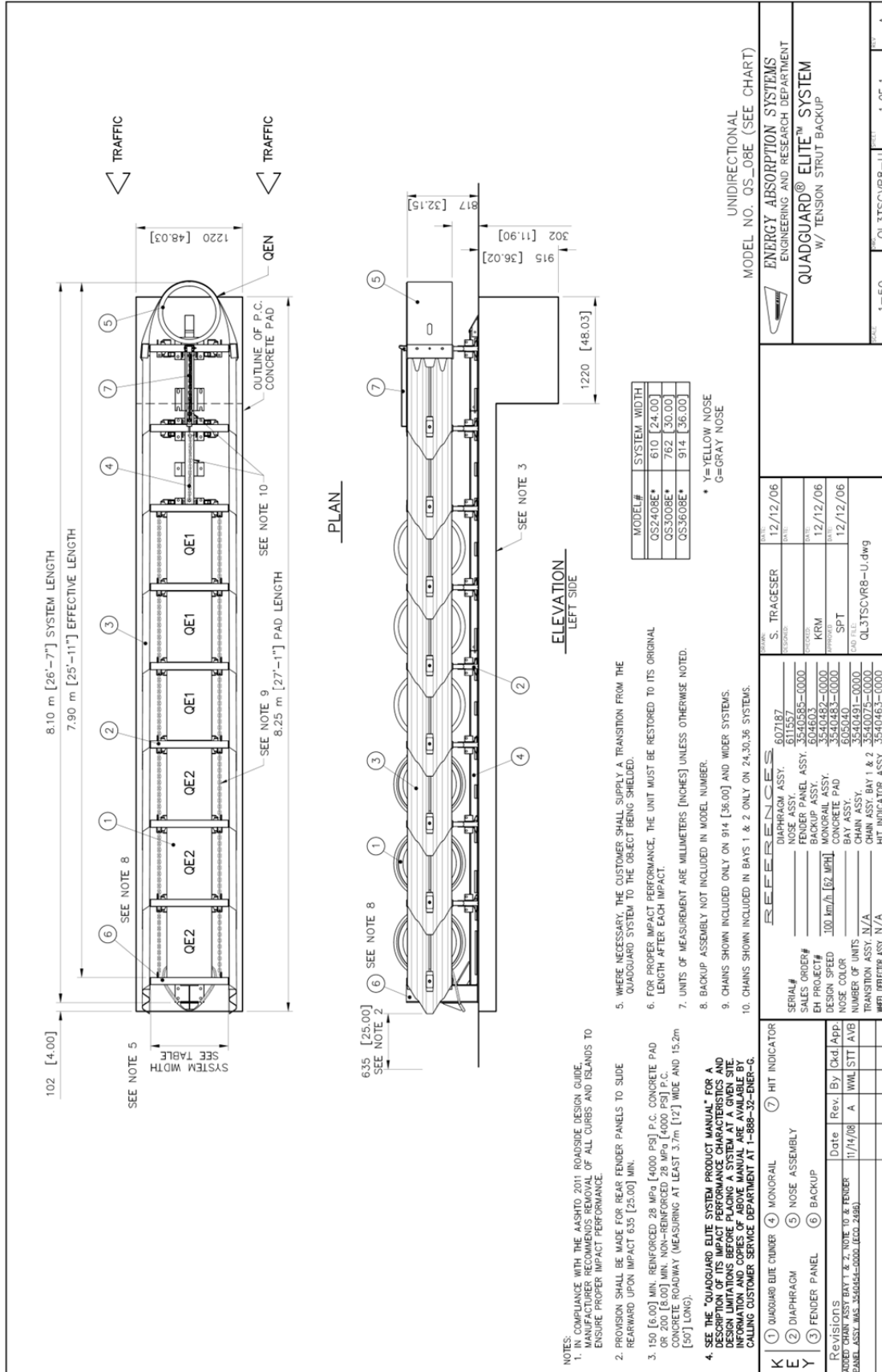
SERIAL#	607187
SALES ORDER#	611557
EH PROJECT#	3540487-0000
DESIGN SPEED	70 km/h [44 MPH]
NOSE COLOR	3540487-0000
NOSE TYPE	CONCRETE PAD
NUMBER OF UNITS	605040
TRANSITION ASSY. N/A	CHAIN ASSY. BAY 1 & 2
WHEEL INDICATOR ASSY. N/A	HIT INDICATOR ASSY. 3540463-0000

KEY	1	QUADGUARD ELITE CONER	4	MONORAIL	7	HIT INDICATOR
KEY	2	DIAPHRAGM	5	NOSE ASSEMBLY		
KEY	3	FENDER PANEL	6	BACKUP		
Revisions	Date	Rev.	By	Chd	App.	
DIAPHRAGM ASSY WAS 3540487-0000	08/23/02	A	LWC	DMO	STT	
AASHTO WAS 1996	11/20/02	B	SDC	STT	ACF	
ADDED CHAIN ASSY BAY 1 & 2; NOTE TO FENDER	11/14/08	C	WWL	STT	AVB	
FENDER ASSY WAS 3540463-0000 (REV. 4/98)						

- NOTES:
- IN COMPLIANCE WITH THE AASHTO 2011 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
 - PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 6.35 [25.00] MIN.
 - 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY (MEASURING AT LEAST 3.7m [12'] WIDE AND 15.2m [50'] LONG).
 - SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENERG.
 - FOR PROPER IMPACT PERFORMANCE, THE UNIT MUST BE RESTORED TO ITS ORIGINAL LENGTH AFTER EACH IMPACT.
 - WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
 - UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 - BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.
 - CHAINS SHOWN INCLUDED ONLY ON 914 [36.00] AND WIDER SYSTEMS.
 - CHAINS SHOWN INCLUDED IN BAYS 1 & 2 ONLY ON 24,30,36 SYSTEMS.

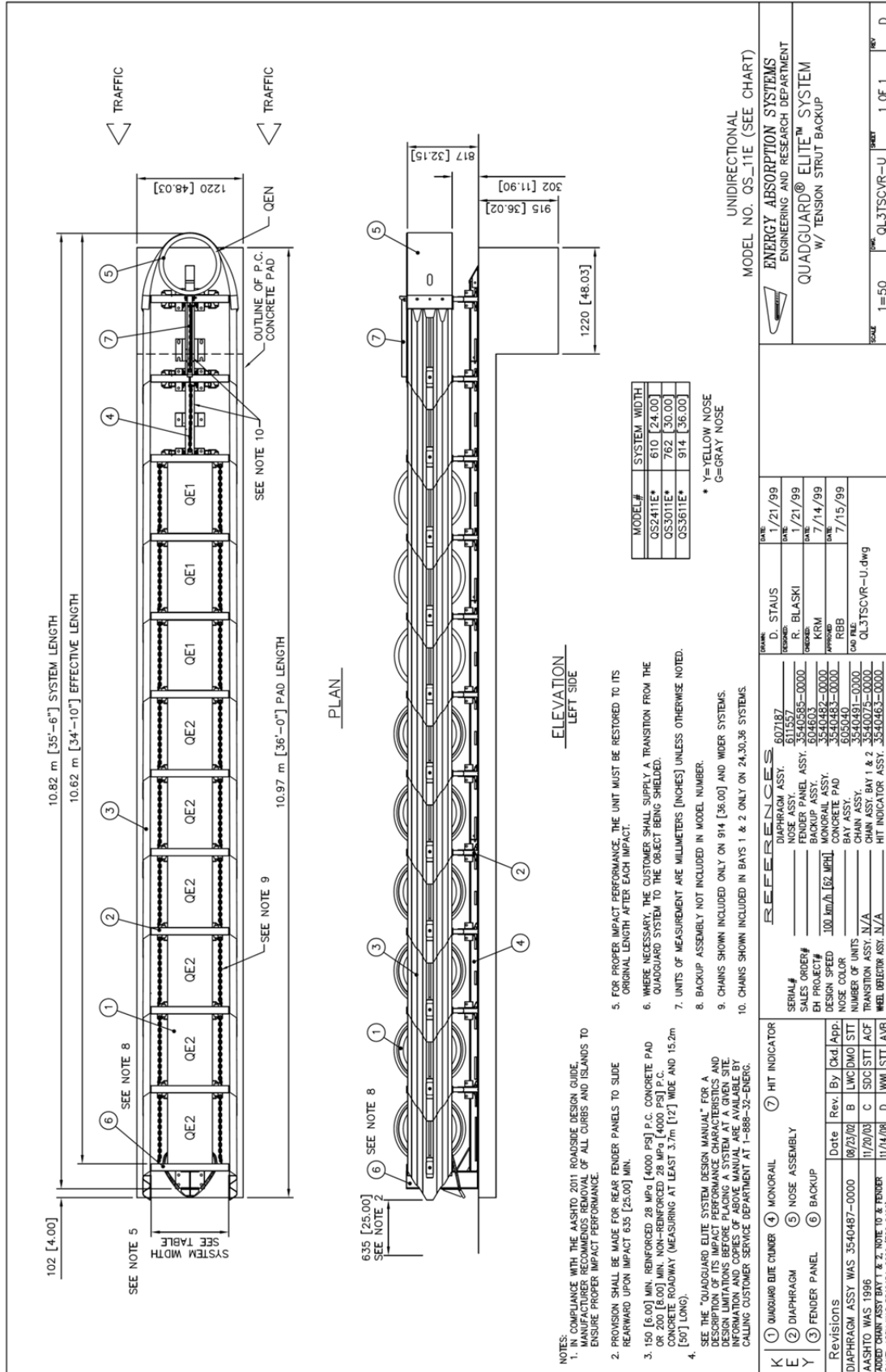
QuadGuard® Elite System w/ Tension Strut Backup TL-2 (EC Model)

DWG QL3TSCVR8-U



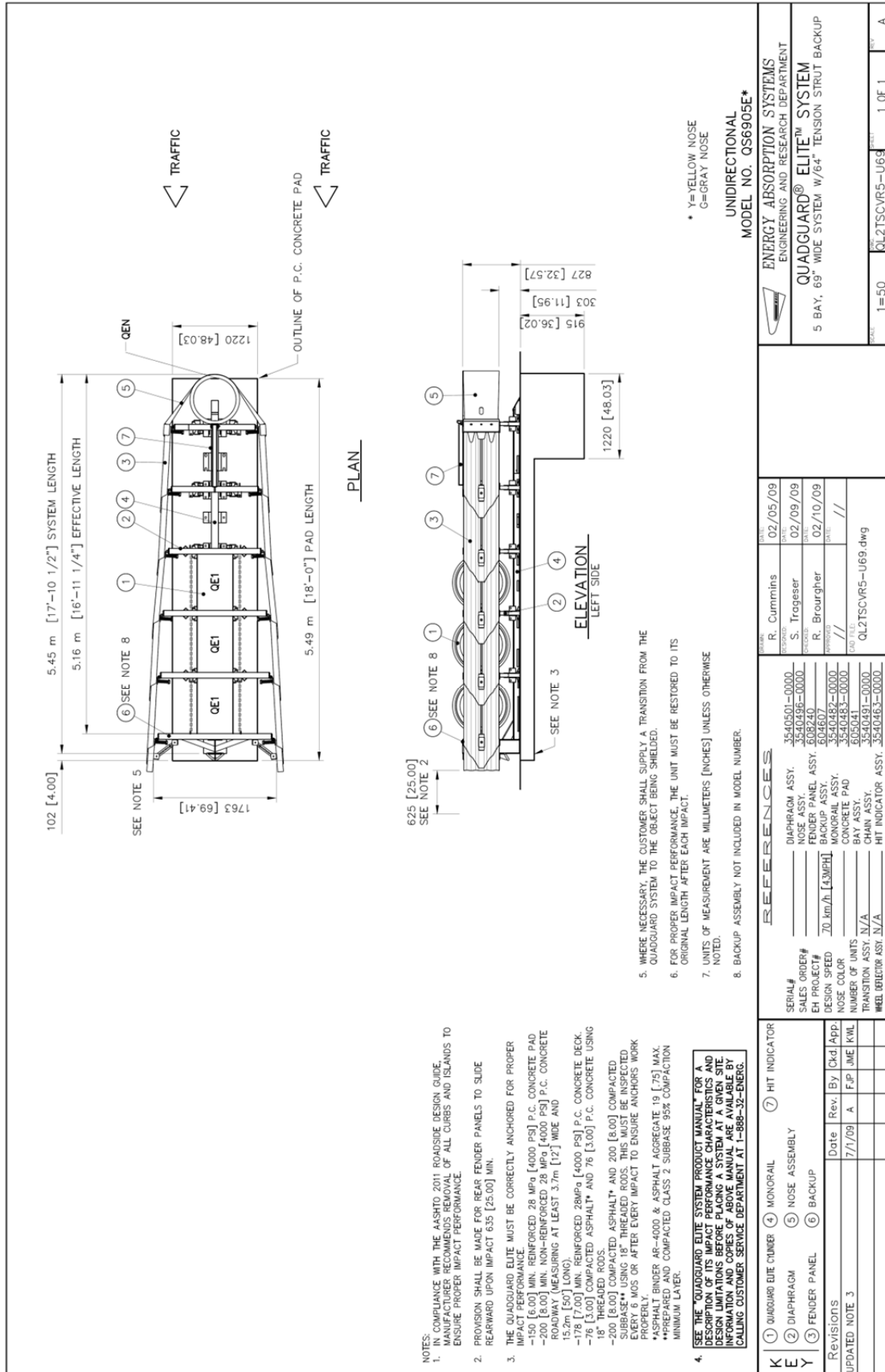
QuadGuard® Elite System w/ Tension Strut Backup TL-3

DWG QL3TSCVR-U



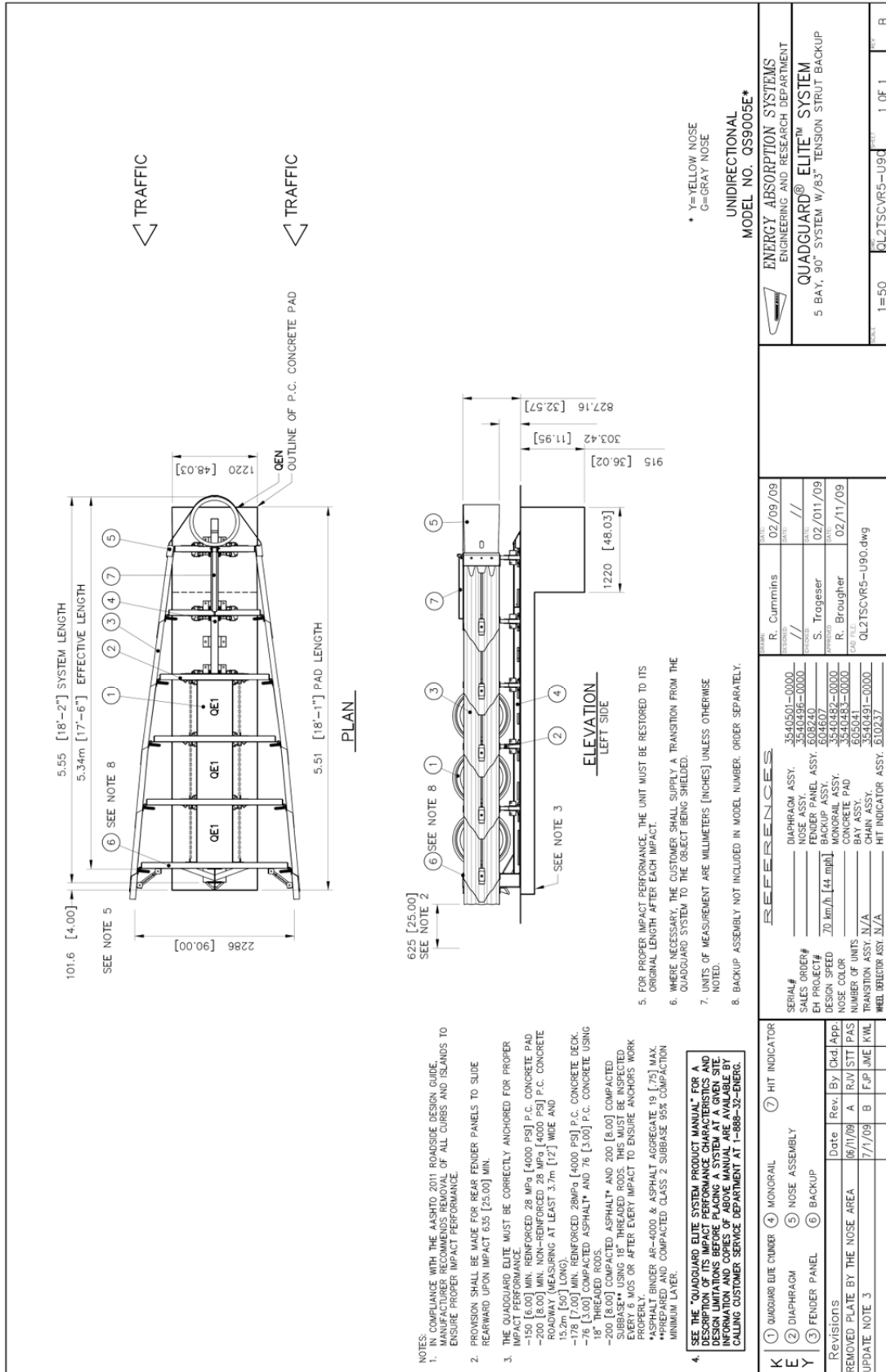
QuadGuard® Elite System w/ Tension Strut Backup TL-3 (EC Model)

DWG QL3TSCVR-U69



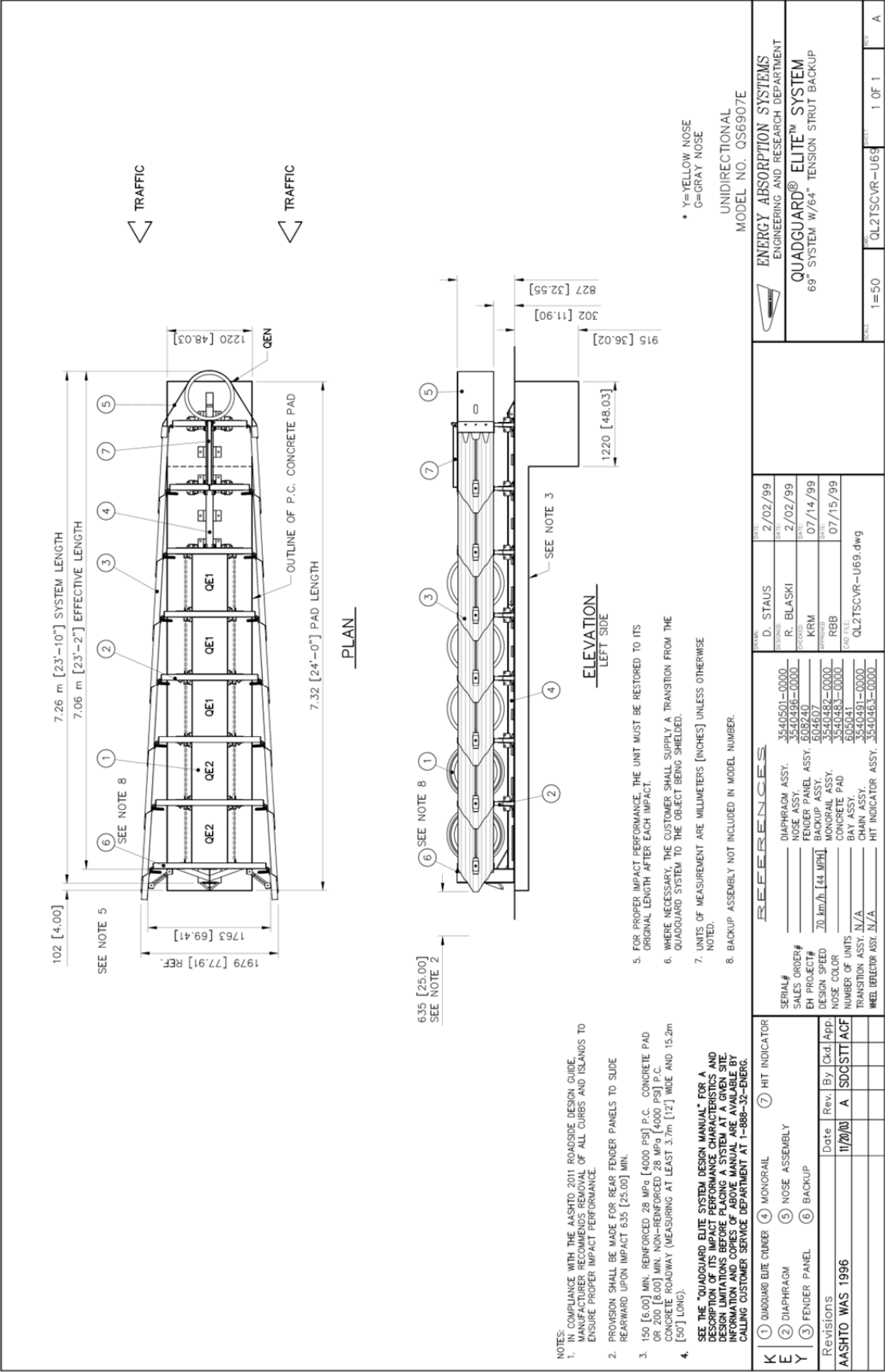
69" 5 Bay QuadGuard® Elite System w/64" Tension Strut Backup TL-2

DWG QL2TSCVR5-U90



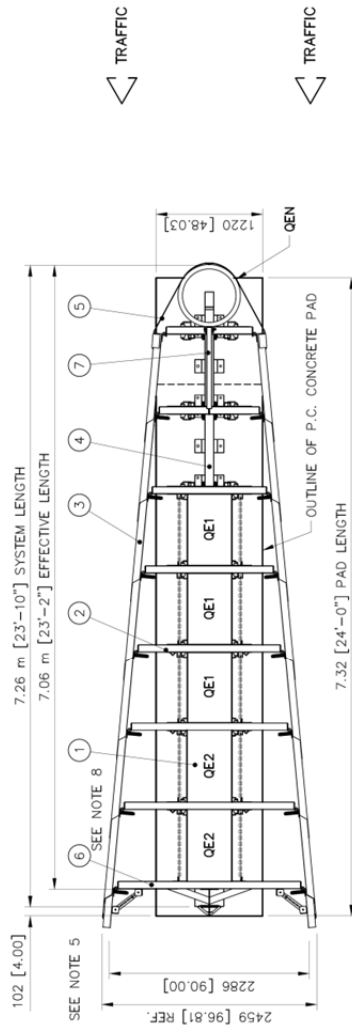
90" 5 Bay QuadGuard® Elite System w/83" Tension Strut Backup TL-2

DWG QL2TSCVR-U69

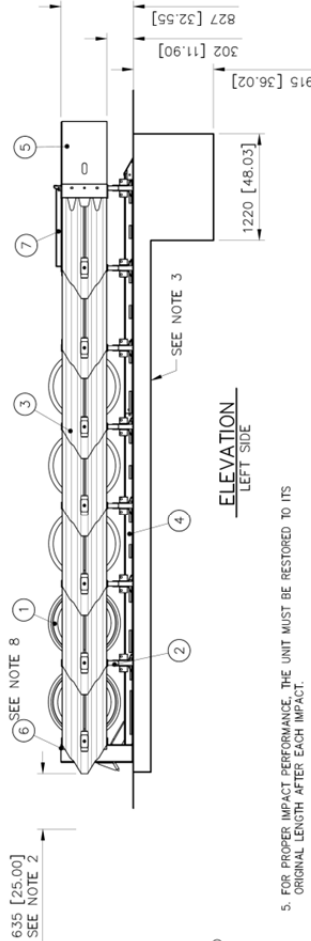


69" 7 Bay QuadGuard® Elite System w/ Tension Strut Backup TL-2

DWG QL2TSCVR-U90



PLAN



- NOTES:
1. IN COMPLIANCE WITH THE AASHTO 2011 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
 2. PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 635 [25.00] MIN.
 3. 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY (MEASURING AT LEAST 3.7m [12'] WIDE AND 15.2m [50'] LONG).
 4. SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DETAILED DESCRIPTION OF THE SYSTEM AND ITS DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENERG.
 5. FOR PROPER IMPACT PERFORMANCE, THE UNIT MUST BE RESTORED TO ITS ORIGINAL LENGTH AFTER EACH IMPACT.
 6. WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
 7. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 8. BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.

KEY	1	QUADGUARD ELITE SYSTEM	4	MONORAIL	7	HIT INDICATOR
	2	DIAPHRAGM	5	NOSE ASSEMBLY		
	3	FENDER PANEL	6	BACKUP		
Revisions	Date	Rev. By	Chd. App.			
AASHTO WAS 1996	11/7/90	A	ISDCSTT ACF			

REFERENCES

SERIAL#	3540501-0000
SALES ORDER#	3540496-0000
EH PROJECT#	608240
DESIGN SPEED	70 km/h [44 mph]
NOSE COLOR	MONORAIL ASSY. 3540491-0000
NUMBER OF UNITS	BACKUP PAD 3540483-0000
TRANSITION ASSY. N/A	CHAIN ASSY. 605041
WHEEL DEFLECTOR ASSY. N/A	HIT INDICATOR ASSY. 3540493-0000

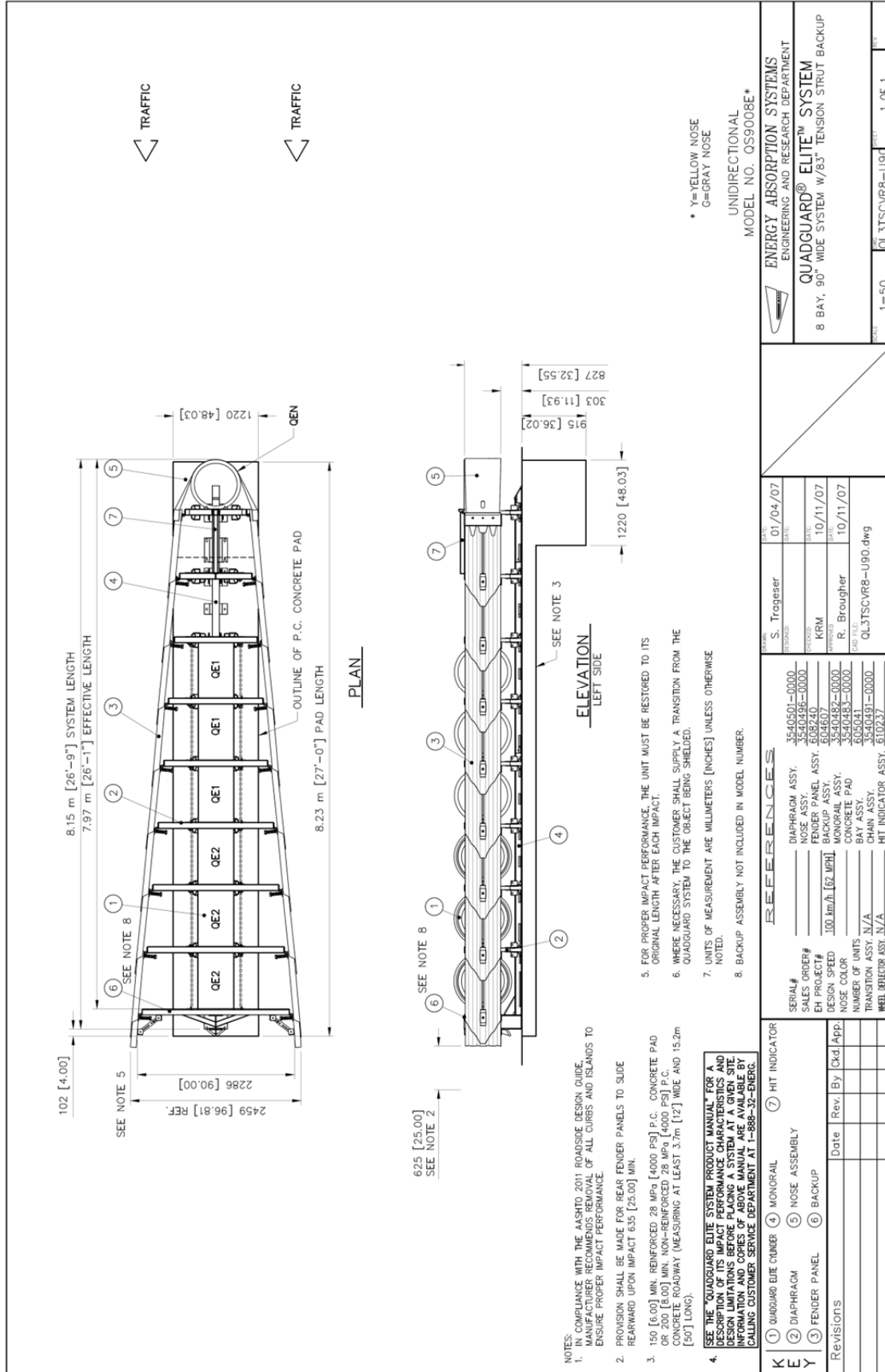
DESIGNED BY	D. STAUSS	DATE	2/02/99
CHECKED BY	R. BLASKI	DATE	2/02/99
APPROVED BY	KRM	DATE	7/14/99
DESIGNED BY	RBB	DATE	7/15/99
FILE	QL2TSCVR-U90.dwg		

ENERGY ABSORPTION SYSTEMS ENGINEERING AND RESEARCH DEPARTMENT	1=50	QL2TSCVR-U90	1 OF 1	A
QUADGUARD® ELITE™ SYSTEM 90° SYSTEM W/83" TENSION STRUT BACKUP				

90° 7 Bay QuadGuard® Elite System w/83" Tension Strut Backup TL-2

69" 8 Bay QuadGuard® Elite System w/64" Tension Strut Backup TL-3

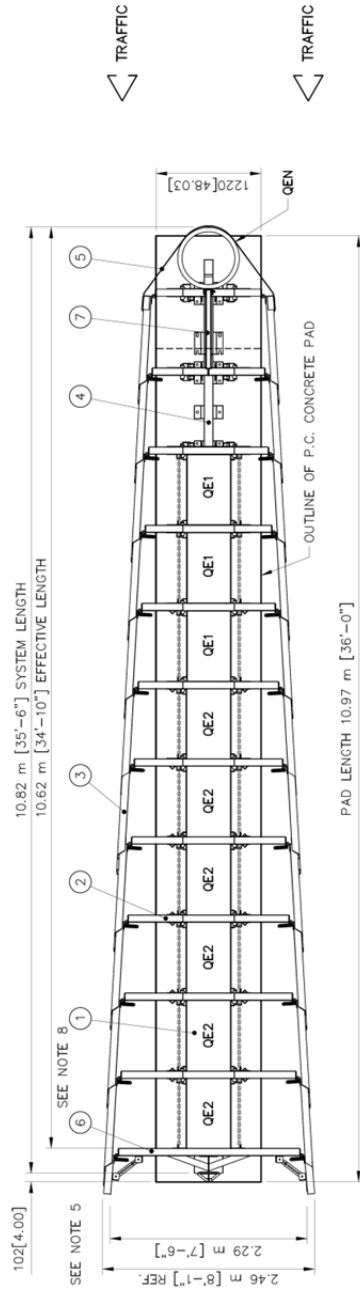
DWG QL3TSCVR8-U90



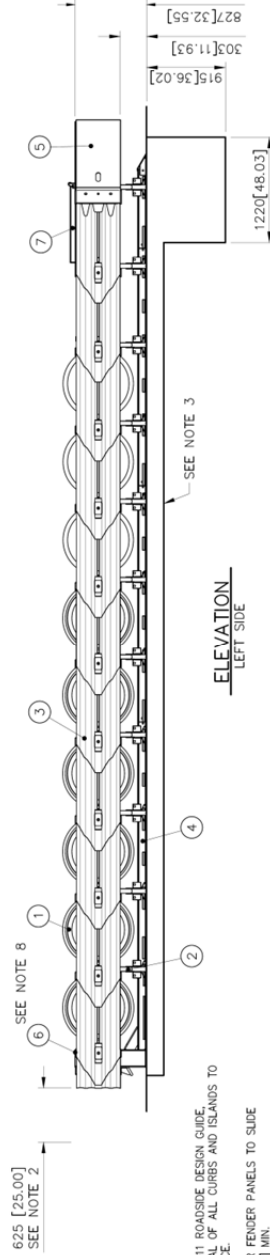
90" 8 Bay QuadGuard® Elite System w/83" Tension Strut Backup TL-3



DWG QL3TSCVR-U90



PLAN



ELEVATION
LEFT SIDE

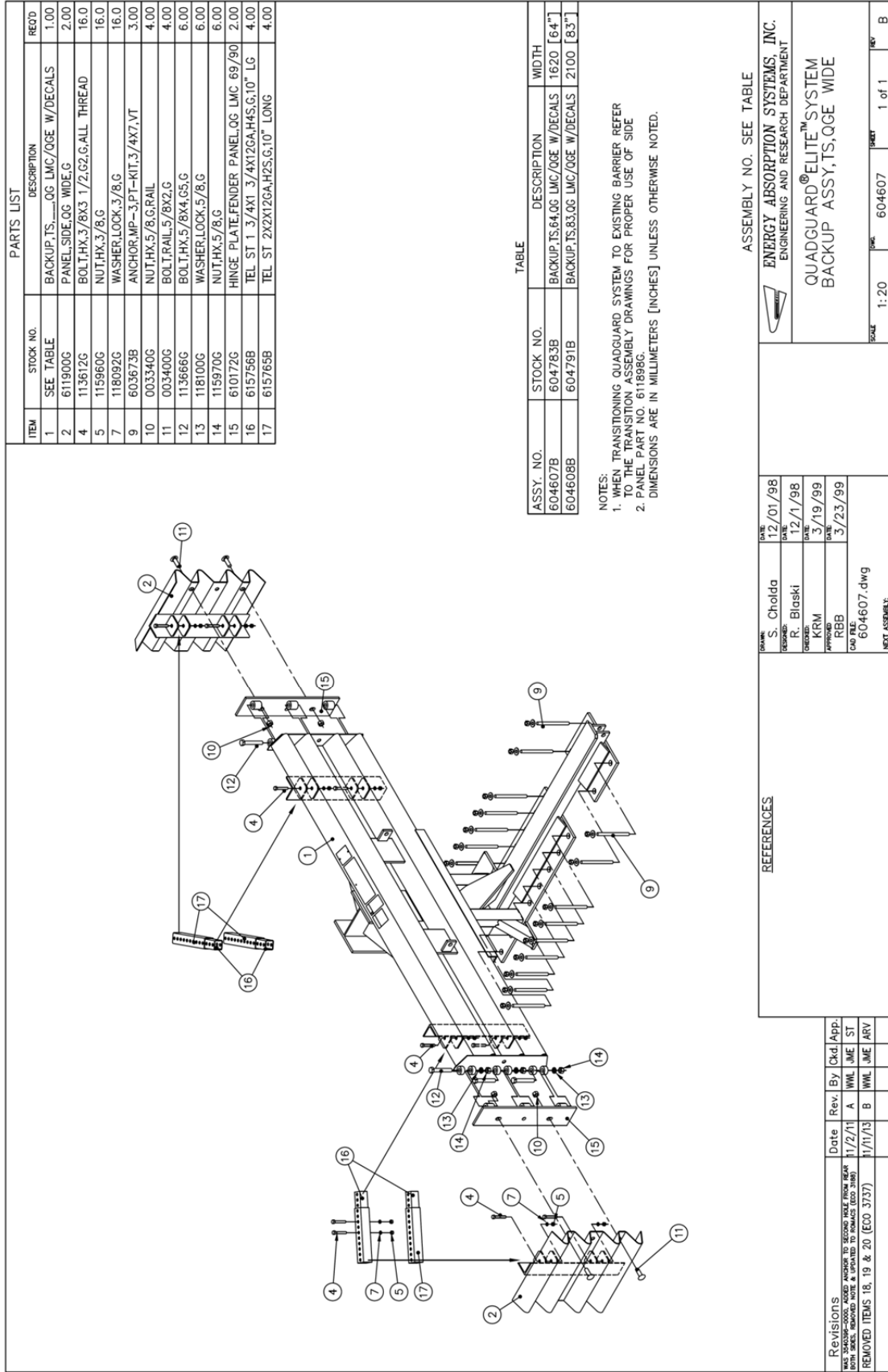
- NOTES:
1. IN COMPLIANCE WITH THE AASHTO 2011 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
 2. PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 635 [25.00] MIN.
 3. 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY (MEASURING AT LEAST 3.7m [12'] WIDE AND 15.2m [50'] LONG).
 4. SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENERG.
 5. FOR PROPER IMPACT PERFORMANCE, THE UNIT MUST BE RESTORED TO ITS ORIGINAL LENGTH AFTER EACH IMPACT.
 6. WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
 7. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 8. BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.

* Y=YELLOW NOSE
G=GRAY NOSE

UNIDIRECTIONAL
MODEL NO. QS9011E*

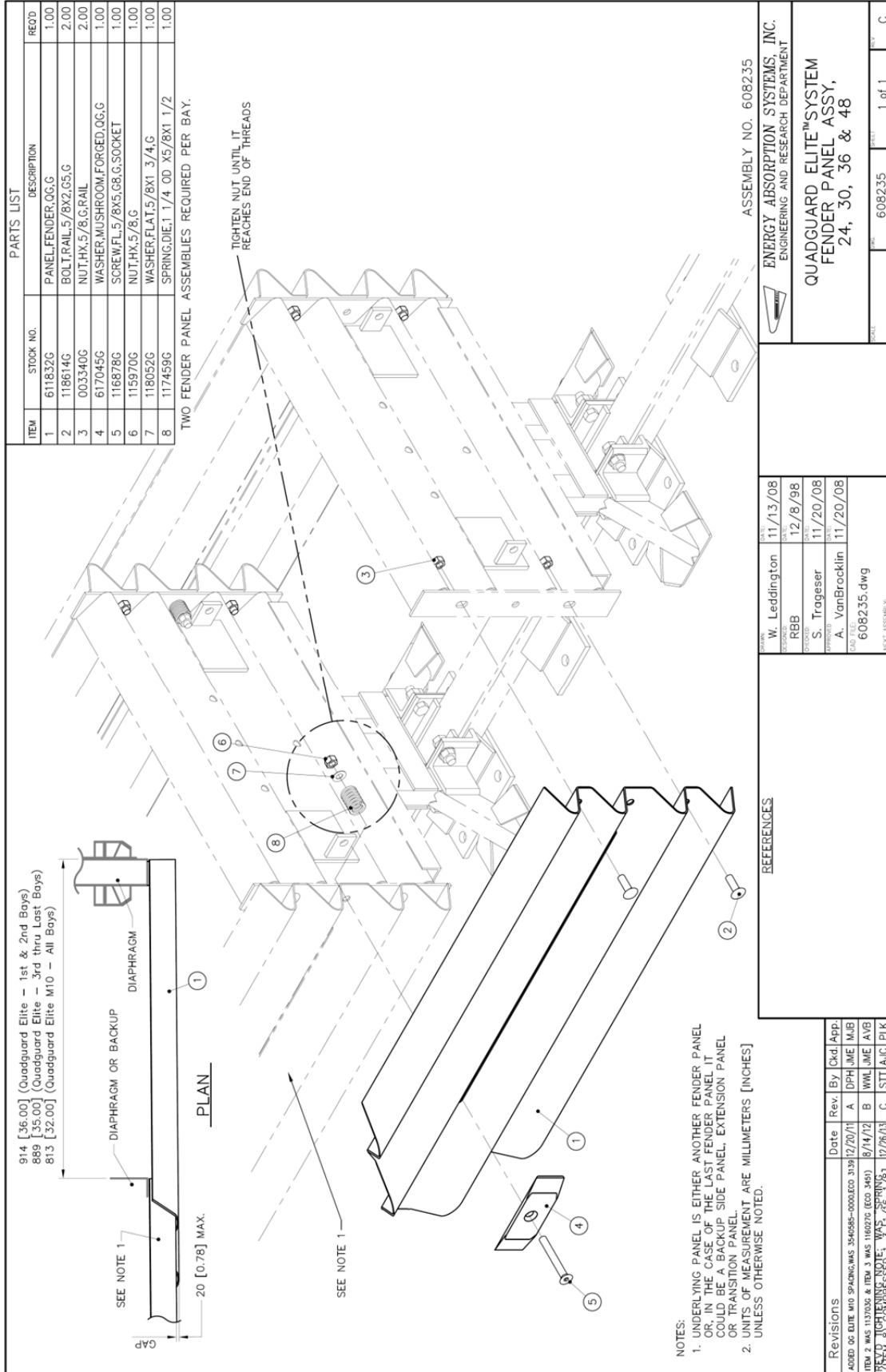
K E Y		① QUADRAQ ELITE CUMMER		④ MONORAIL		⑦ HIT INDICATOR		REFERENCES		S. VAN OGLE		11/13/98		ENERGY ABSORPTION SYSTEMS ENGINEERING AND RESEARCH DEPARTMENT	
Revisions		Date	Rev.	By	Chd.	App.			DIAPHRAGM ASSY.	3540501-0000	DATE	BY	QUADRAQ® ELITE™ SYSTEM 90° SYSTEM 4/83" TENSION STRUT BACKUP		
AASHTO WAS 1996		11/20/98	A	SDC	STI	ACF			NOSE ASSY.	3540496-0000	2/03/99	R. BLASKI			
									FENDER PANEL ASSY.	3540472-0000	07/14/99	KRM			
									BACKUP ASSY.	6046077-0000					
									MONORAIL ASSY.	3540482-0000					
									CONCRETE PAD	3540498-0000					
									BAY ASSY.	6050241-0000	07/15/99	RBB			
									CHAIN ASSY.	3540491-0000					
									TRANSITION ASSY.	3540463-0000					
									HIT INDICATOR ASSY.	3540463-0000					

DWG 604607

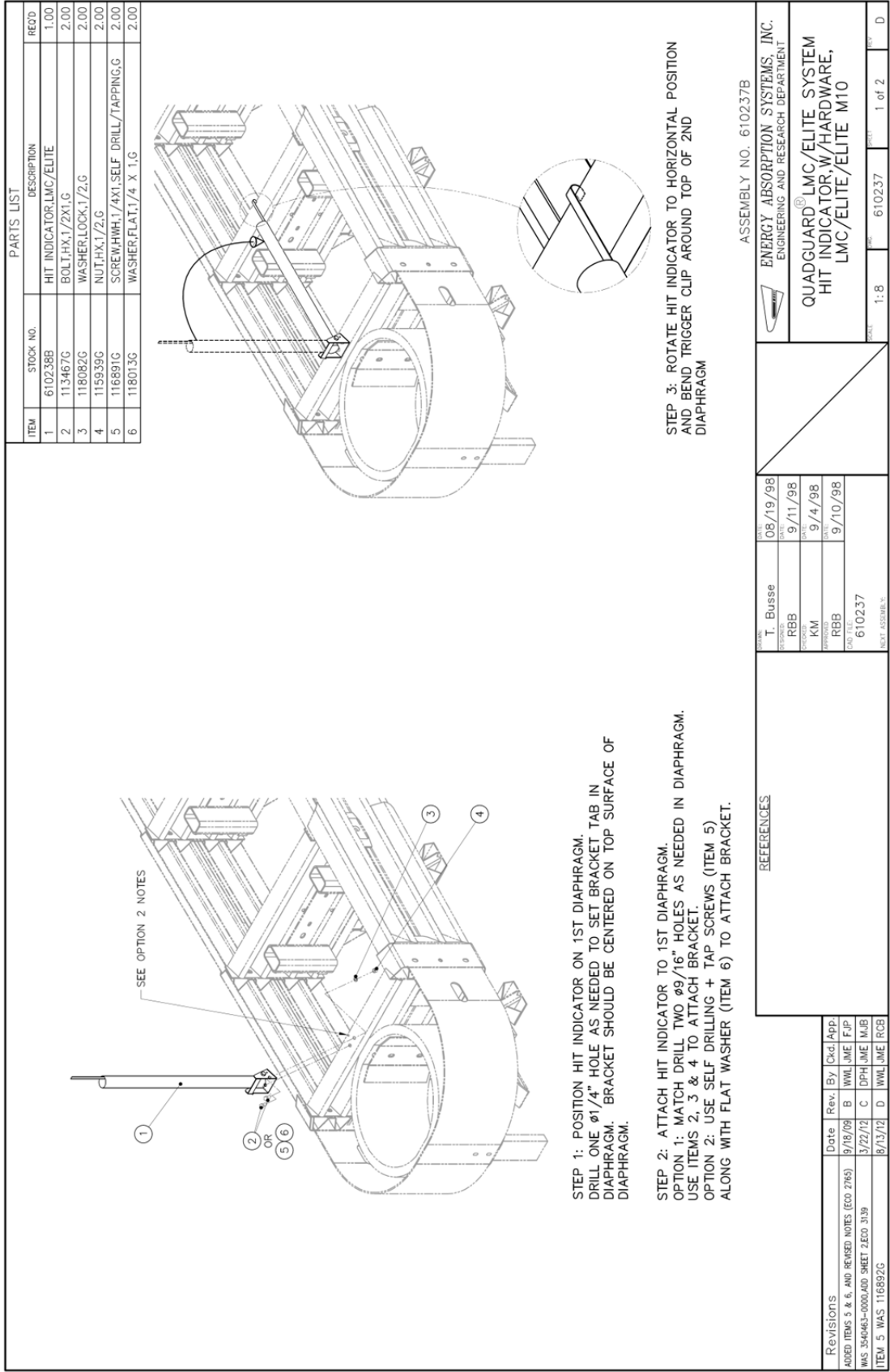


QuadGuard® Elite System Backup Assembly, Tension Strut, QGE Wide

DWG 608235



QuadGuard® Elite System Fender Panel Assembly, 24, 30, 36 & 48

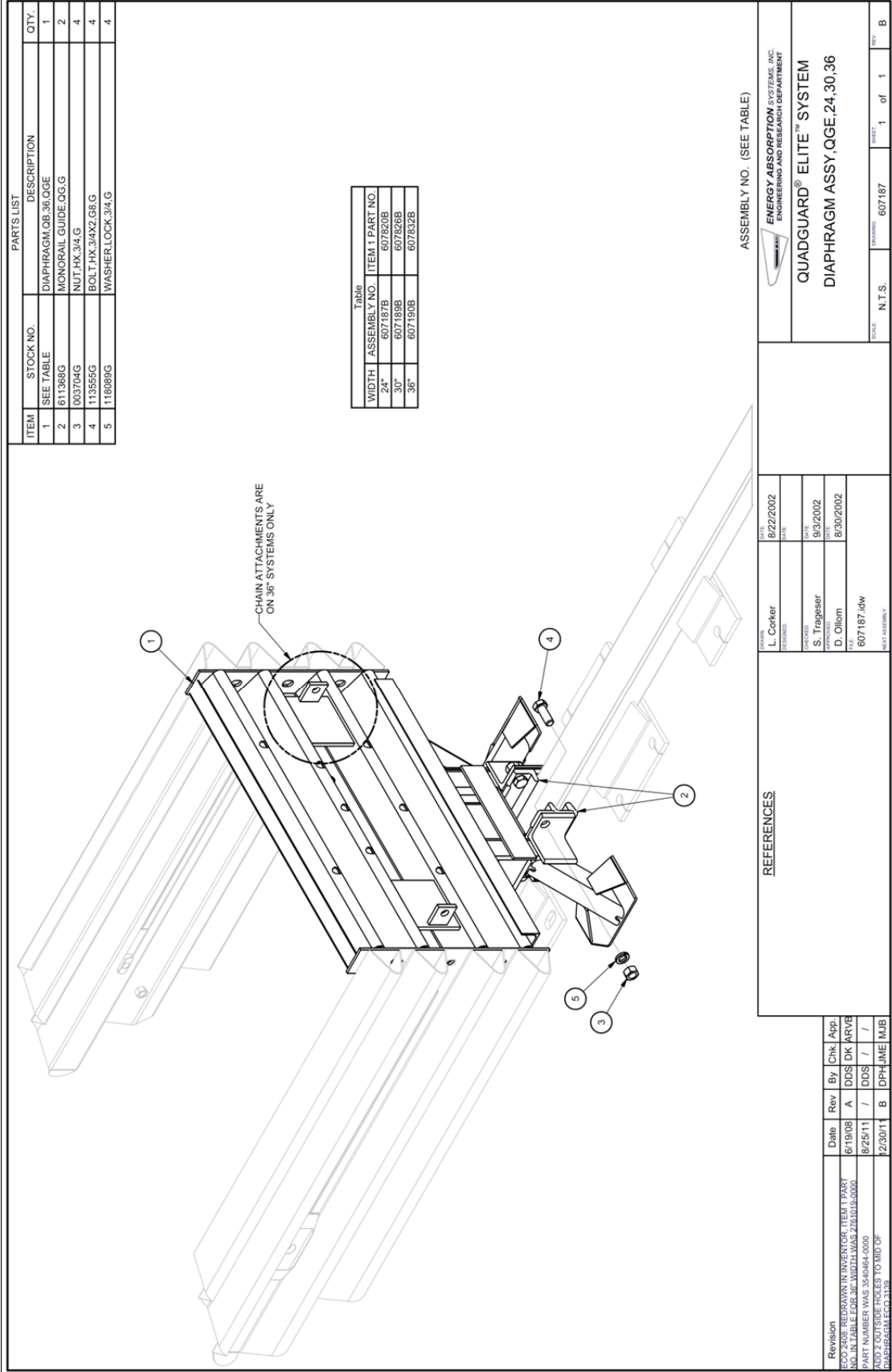


QuadGuard® Elite System Hit Indicator Assembly

DWG 610237 Sheet 2 of 2

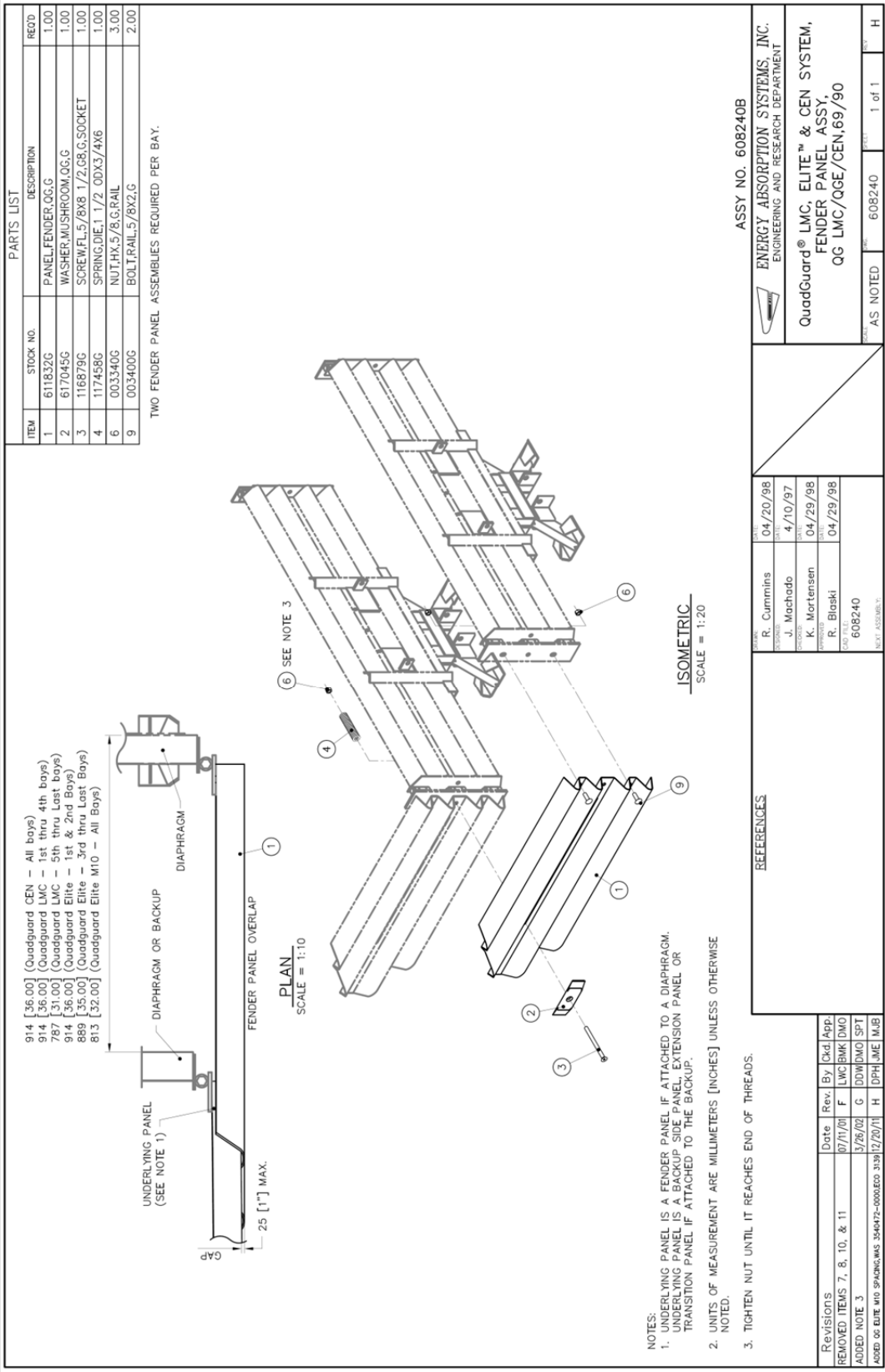
ITEM		STOCK NO.	PARTS LIST		DESCRIPTION	REV'D															
<p>STEP 1: POSITION HIT INDICATOR ON 1ST DIAPHRAGM. CENTER HIT INDICATOR (ITEM 1) 2 1/2" FROM EDGE OF DIAPHRAGM FOR 24" SYSTEMS. DRILL ONE Ø1/4" HOLE AS NEEDED TO SET BRACKET TAB IN DIAPHRAGM. BRACKET SHOULD BE CENTERED ON TOP SURFACE OF DIAPHRAGM.</p> <p>STEP 2: ATTACH HIT INDICATOR TO 1ST DIAPHRAGM. OPTION 1: MATCH DRILL TWO Ø9/16" HOLES AS NEEDED IN DIAPHRAGM. USE ITEMS 2, 3 & 4 TO ATTACH BRACKET. OPTION 2: USE SELF DRILLING + TAP SCREWS (ITEM 5) ALONG WITH FLAT WASHER (ITEM 6) TO ATTACH BRACKET.</p> <p>STEP 3: ROTATE HIT INDICATOR TO HORIZONTAL POSITION AND BEND TRIGGER CLIP AROUND TOP OF 2ND DIAPHRAGM</p>																					
<p>ASSEMBLY NO. 610237B</p> <p>ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT</p> <p>QUADGUARD LMC/ELITE SYSTEM HIT INDICATOR, W/HARDWARE, LMC/ELITE/ELITE M10</p>																					
<p>DATE: 08/19/98 BY: T. Busse RBB KM RBB 610237</p>		<p>DATE: 08/19/98 DATE: 9/11/98 DATE: 9/4/98 DATE: 9/10/98</p>		<p>SCALE: 1:8 SHEET: 2 of 2 REV: D</p>																	
<p>REFERENCES</p>																					
<p>Revisions</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Rev</th> <th>By</th> <th>Qtd</th> <th>App.</th> </tr> </thead> <tbody> <tr> <td>3/22/12</td> <td>C</td> <td>DPH</td> <td>JME</td> <td>MJB</td> </tr> <tr> <td>8/13/12</td> <td>D</td> <td>DPH</td> <td>/</td> <td>/</td> </tr> </tbody> </table> <p>ADDED SHEET/ECO 3139 SEE SHEET 1</p>							Date	Rev	By	Qtd	App.	3/22/12	C	DPH	JME	MJB	8/13/12	D	DPH	/	/
Date	Rev	By	Qtd	App.																	
3/22/12	C	DPH	JME	MJB																	
8/13/12	D	DPH	/	/																	

DWG 607187



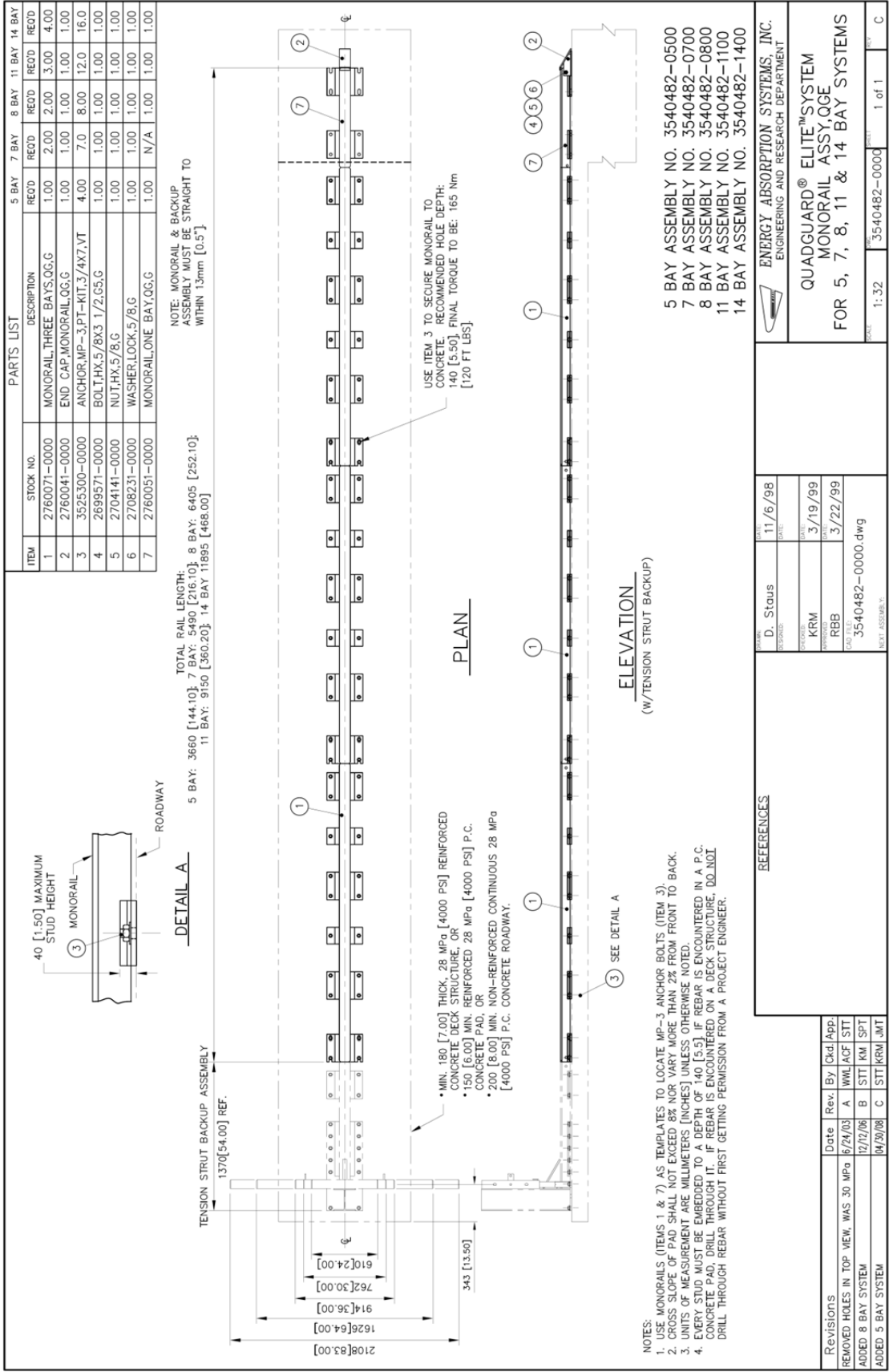
QuadGuard® Elite System Diaphragm Assembly, QGE, 24, 30, 36

DWG 608240



QuadGuard® Elite Fender Panel Assembly QG LMC/QGE/CEN, 69/90

DWG 3540482-0000

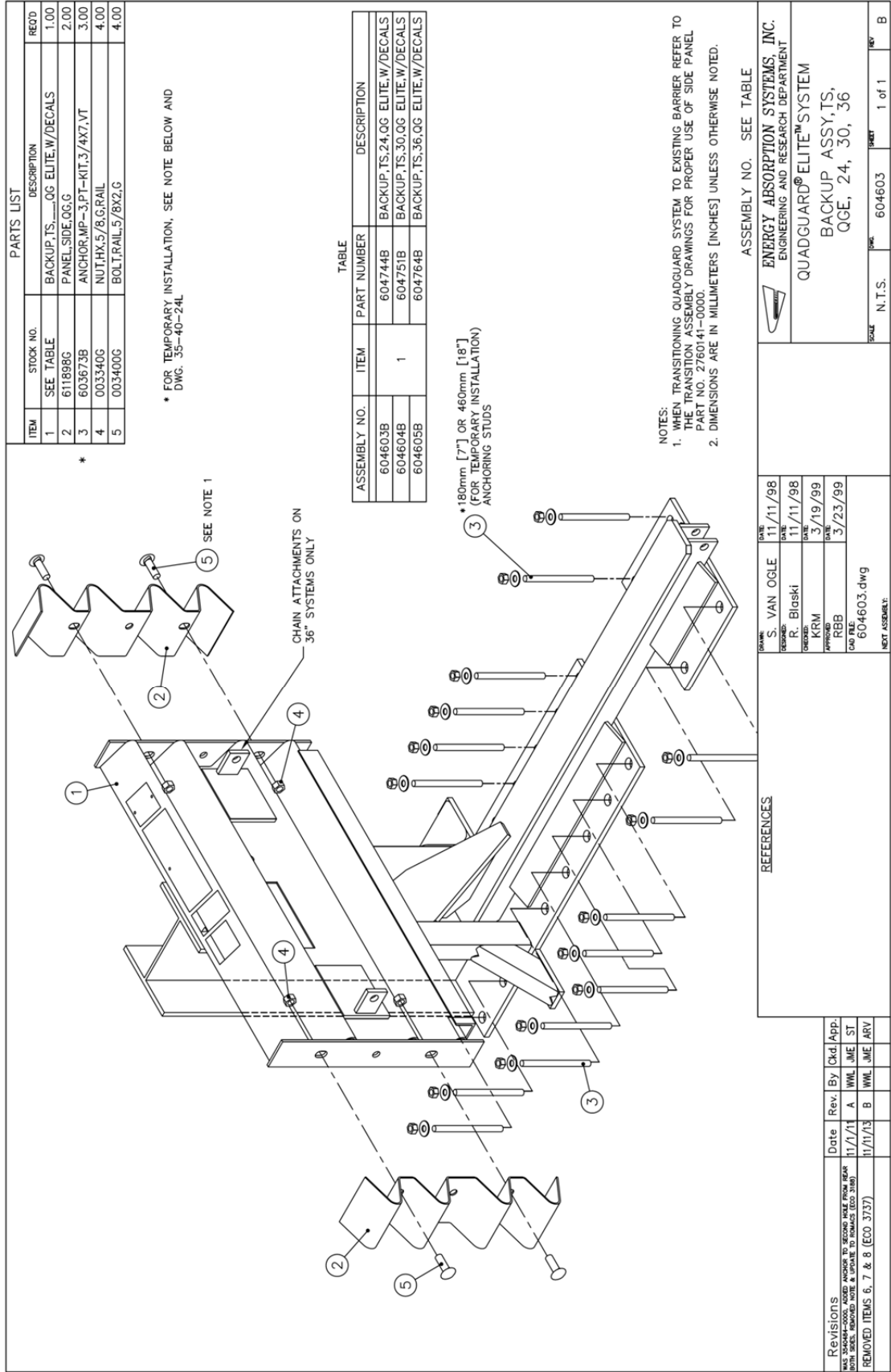


QuadGuard® Elite System Monorail Assembly, QGE for 5, 7, 8, 11 & 14 Bay Systems

QuadGuard® Elite System Concrete Foundation, QG Elite

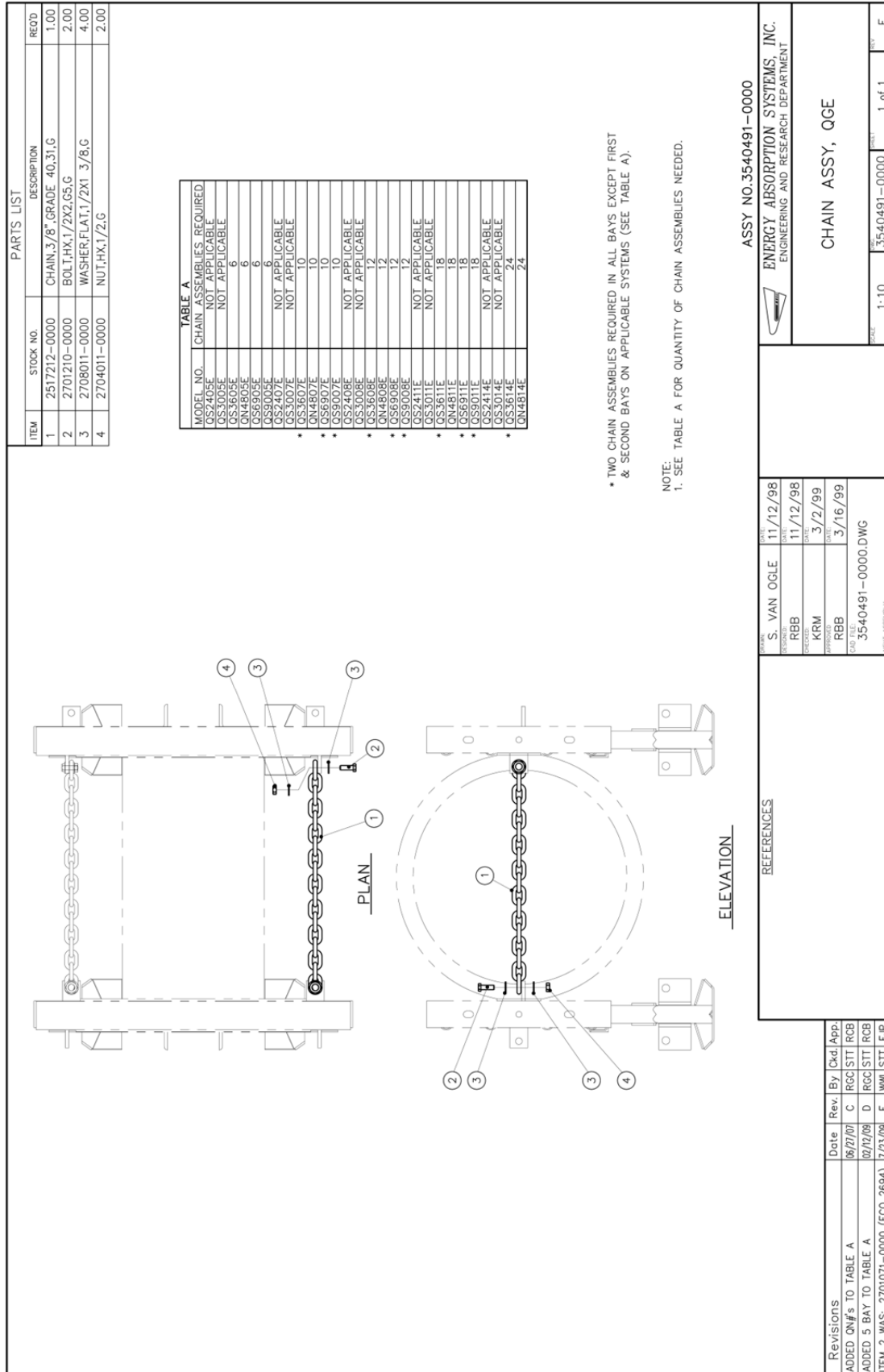
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DWG 604603

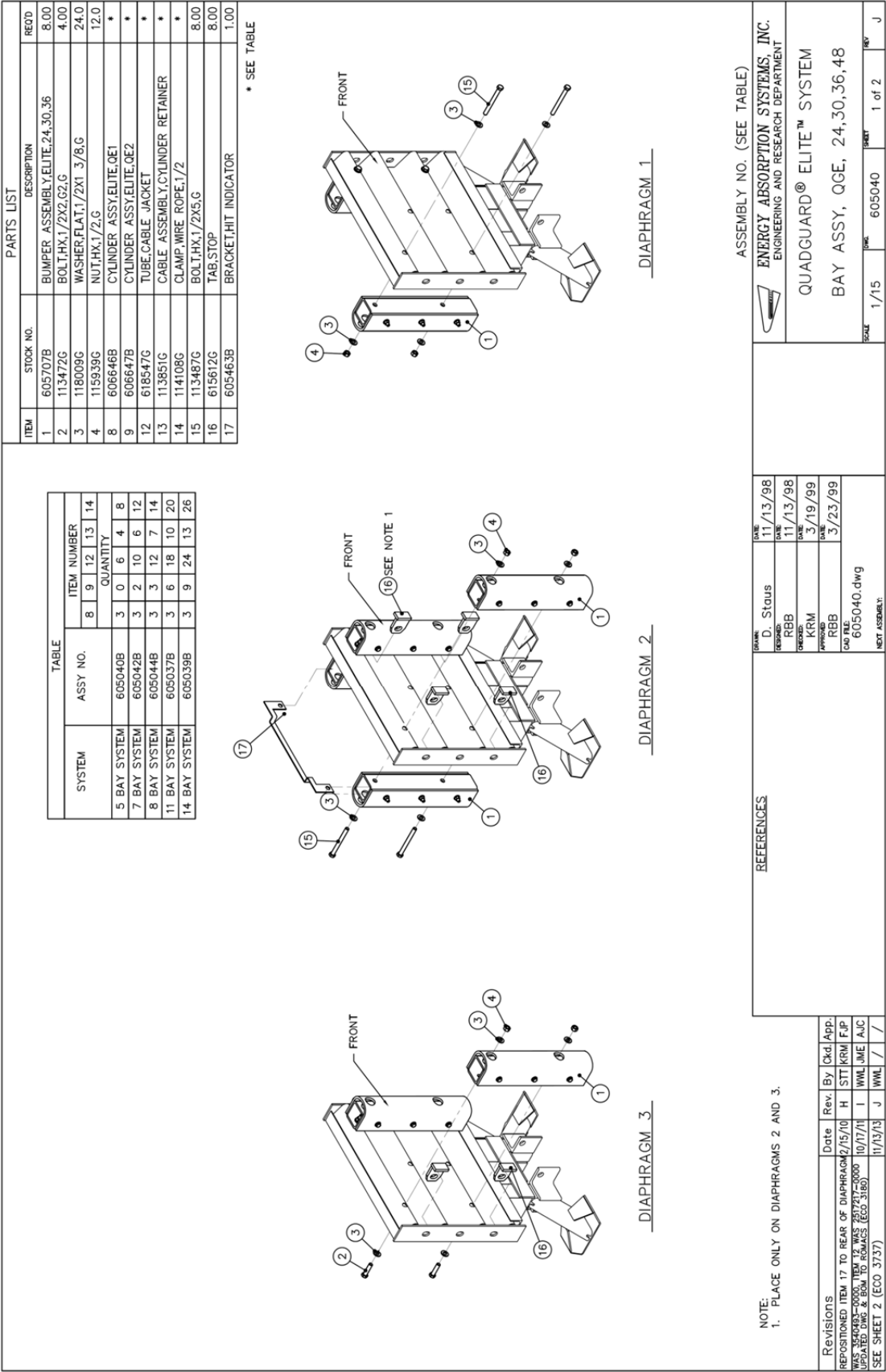


QuadGuard® Elite System Backup Assembly, Tension Strut, QGE, 24, 30, 36

SCALE	DRAWING	SHEET	REV
1=10	3540075-0000	1 of 1	A

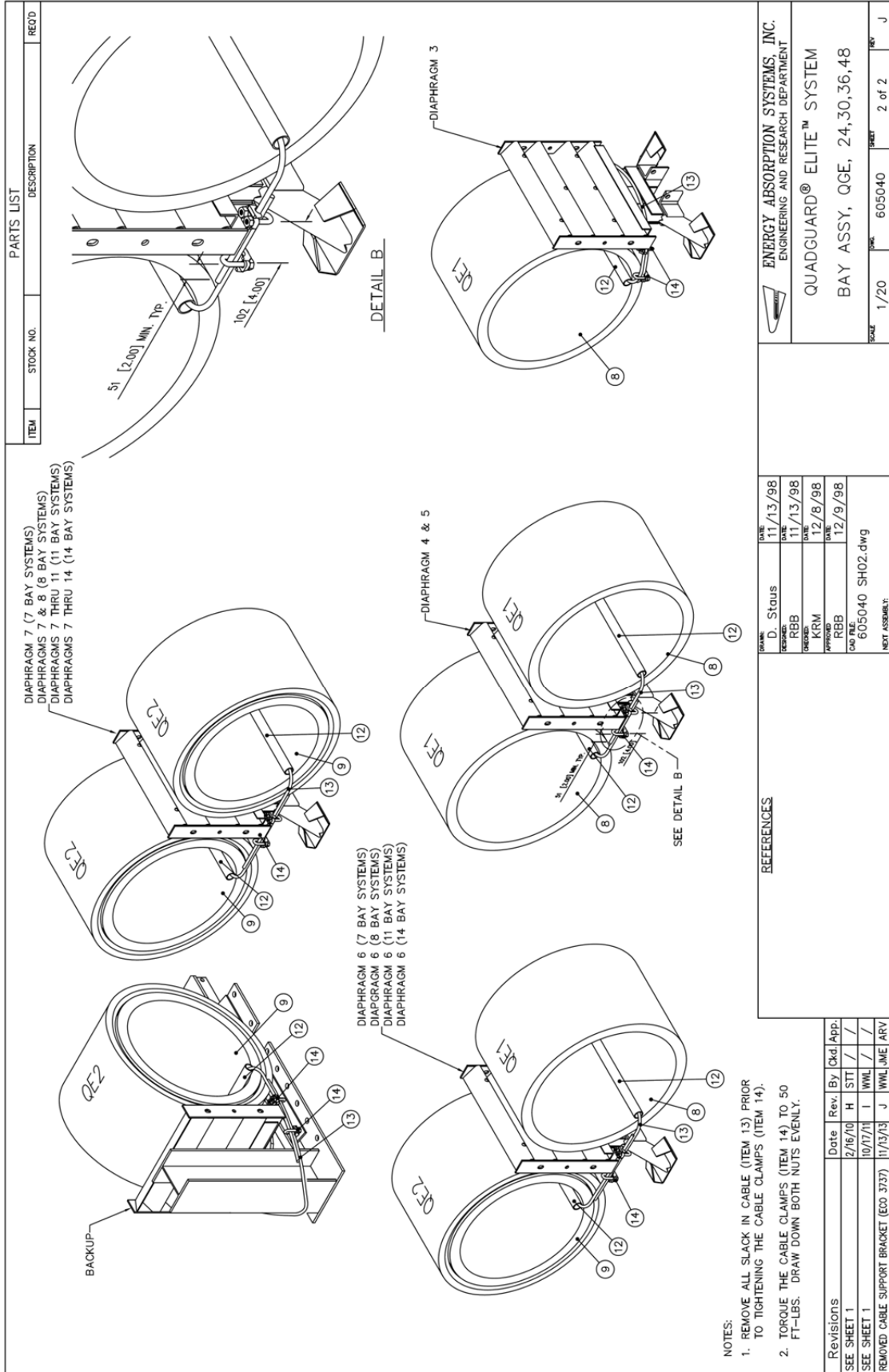


Chain Assembly, QGE



QuadGuard® Elite System Bay Assembly, QGE, 24, 30, 36, 48

DWG 605040 Sheet 2 of 2



DWG 605041 Sheet 1 of 2

SYSTEM	ASSY NO.	ITEM NO.							
		5	6	7	8	9	10	11	12
5 BAY SYSTEM	605041B	3	0	6	4	8			
7 BAY SYSTEM	605043B	3	2	10	6	12			
8 BAY SYSTEM	605045B	3	3	12	7	14			
11 BAY SYSTEM	605038B	3	6	18	10	20			

ITEM	STOCK NO.	DESCRIPTION	QUANTITY
1	605705B	BUMPER ASSY,QG	8.00
5	606646B	CYLINDER ASSY,ELITE,QE1	*
6	606647B	CYLINDER ASSY,ELITE,QE2	*
7	618547G	TUBE,CABLE JACKET	*
8	113851G	CABLE ASSEMBLY,CYLINDER RETAINER	*
9	114108G	CLAMP,WIRE ROPE,1/2	*
10	114108G	BOLT,HX,1/2X2,G2,G	4.00
11	118009G	WASHER,FLAT,1/2X1 3/8,G	24.0
12	115939G	NUT,HX,1/2,G	12.0
15	113487G	BOLT,HX,1/2X5,G2,G	8.00
16	605463B	BRACKET,HIT INDICATOR	1.00

* SEE TABLE

DIAPHRAGM 1

DIAPHRAGM 2

DIAPHRAGM 3

DATE	BY	CHKD	APP.
9/18/09	F	WML	JME FJP
10/18/11	G	WML	JME ALC
11/13/13	H	WML	/

ADDED ITEM 16 (ECO 2765)
WAS 1620484-0000, ITEM 7 WAS 267271-0000
WAS 1620484-0000, ITEM 7 WAS 267271-0000
(SEE DWG & BOM TO ROMACS (ECO 3186))
(SEE SHEET 2)

REFERENCES

DATE	BY	CHKD	APP.
11/13/98	RBB		
11/13/98	KRM		
3/19/99	RBB		
3/23/99	RBB		

605041.dwg
NOT ASSEMBLY

ASSEMBLY NO. (SEE TABLE)

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE™ SYSTEM

BAY ASSY,QGE,69/90

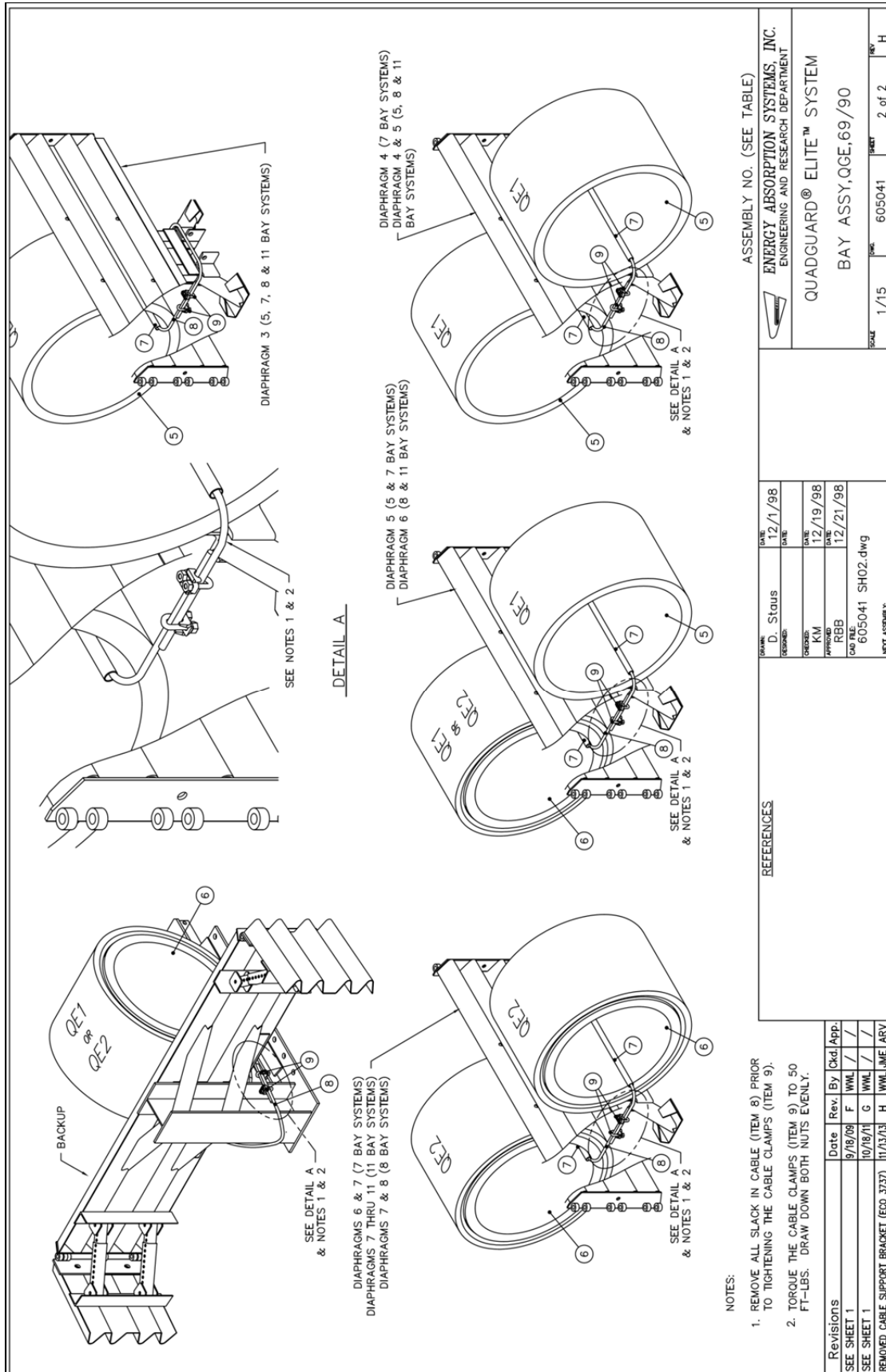
SCALE 1/15

DATE 605041

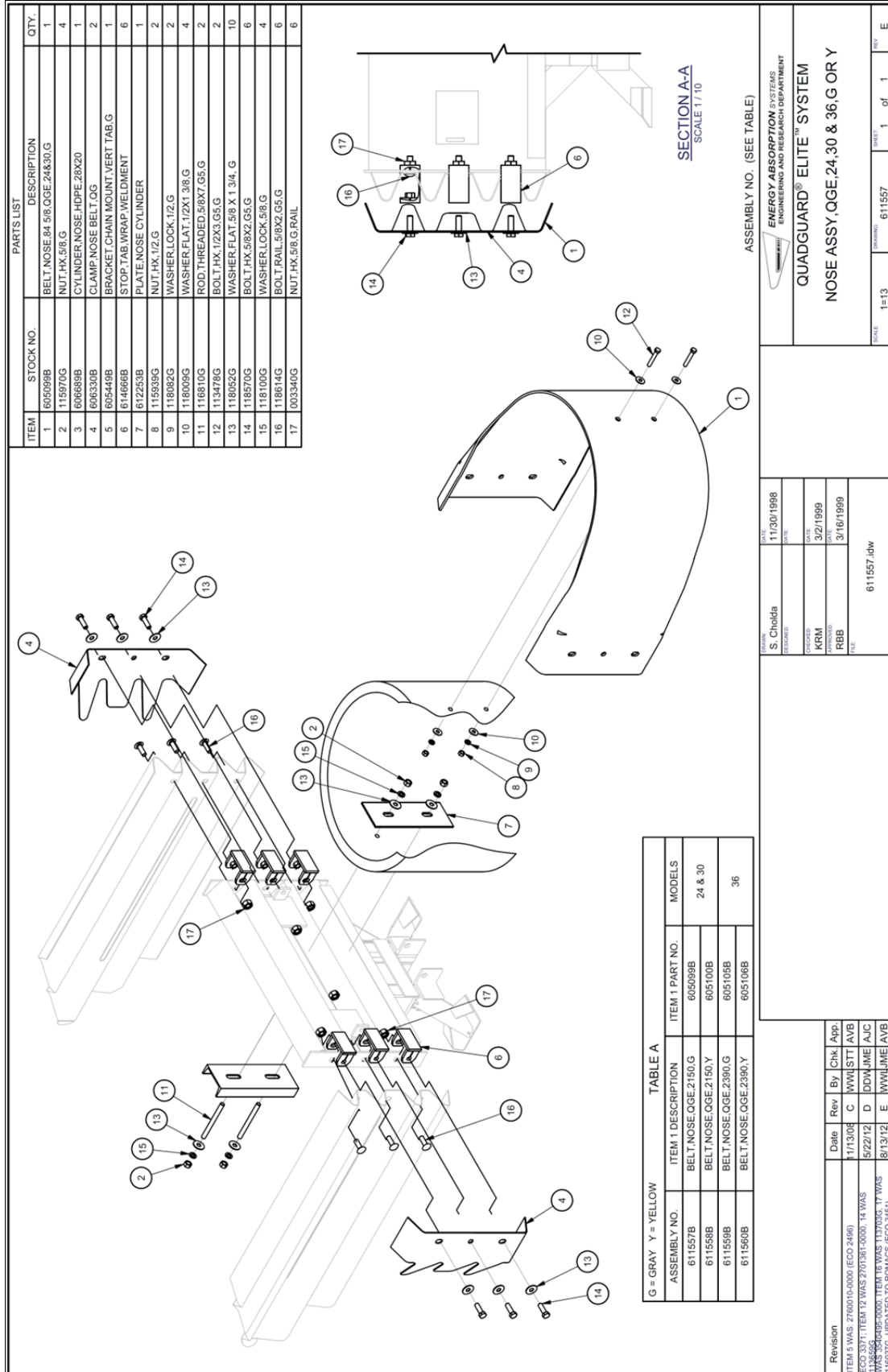
SHEET 1 of 2

REV H

QuadGuard® Elite System Bay Assembly, QGE, 69/90

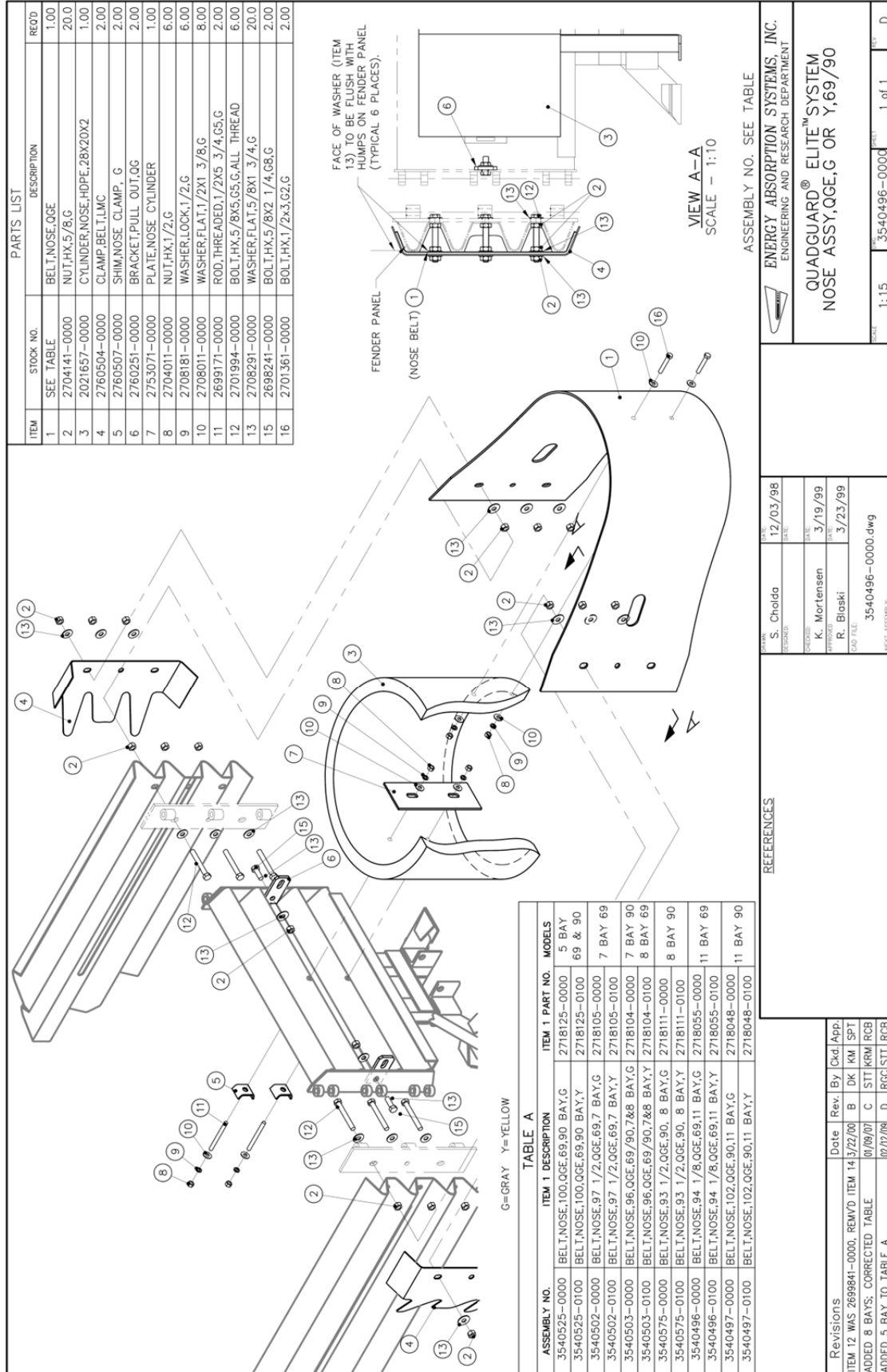


DWG 611557

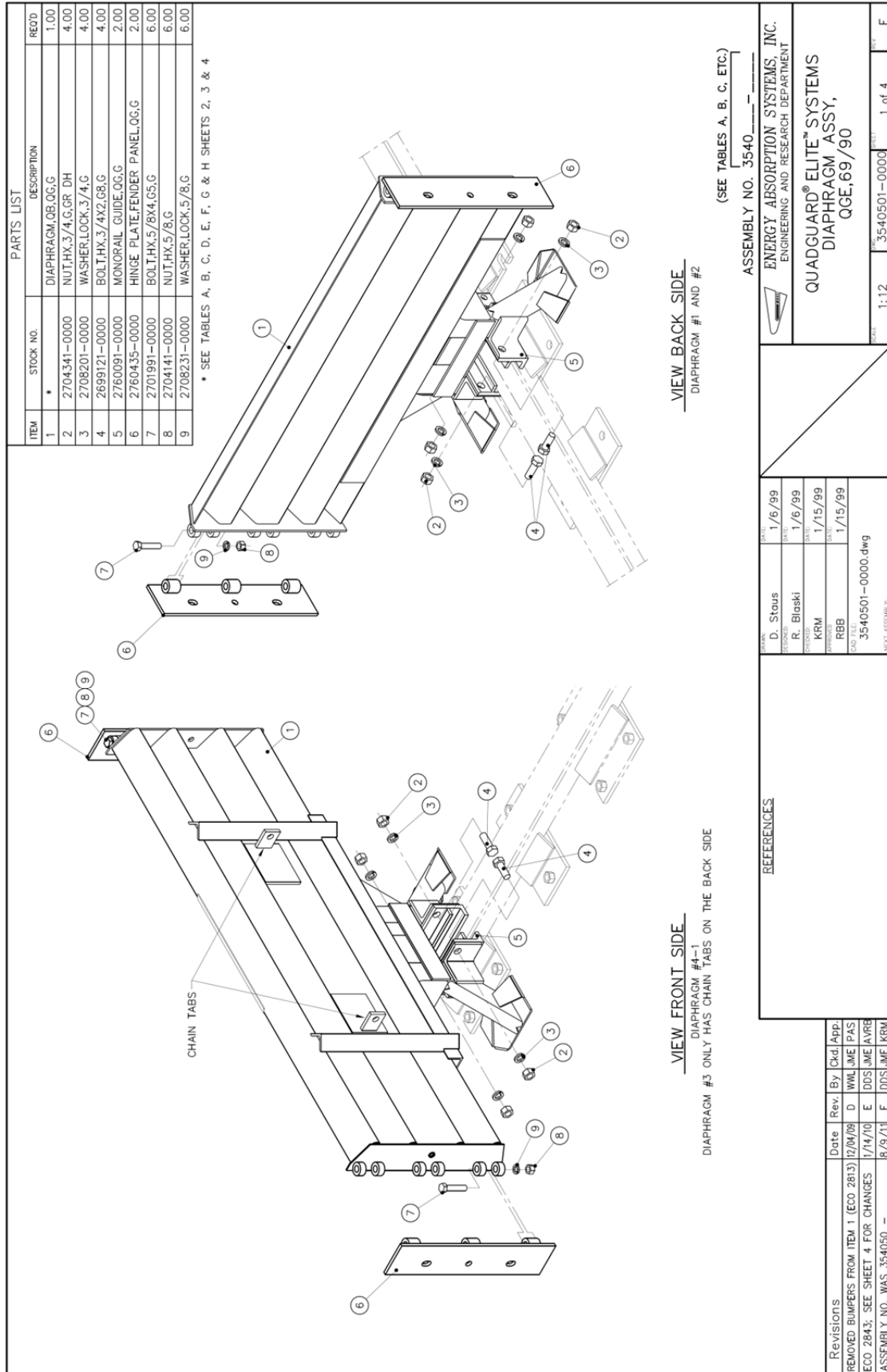


QuadGuard® Elite System Nose Assembly, QGE, 24, 30, & 36, G or Y

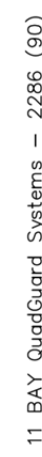
DWG 3540496-0000



QuadGuard® Elite System Nose Assembly, QGE, G or Y, 69/90



QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90

11 BAY QuadGuard Systems – 1753 (69)

NOTE: 1. DIMENSIONS ARE IN MILLIMETERS [INCHES]
UNLESS OTHERWISE NOTED.

SCALE	1=60	FILE NO.	3540501-0000	2 of 4	REV	F
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QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 11 Bay

DWG 3540501 Sheet 3 of 4

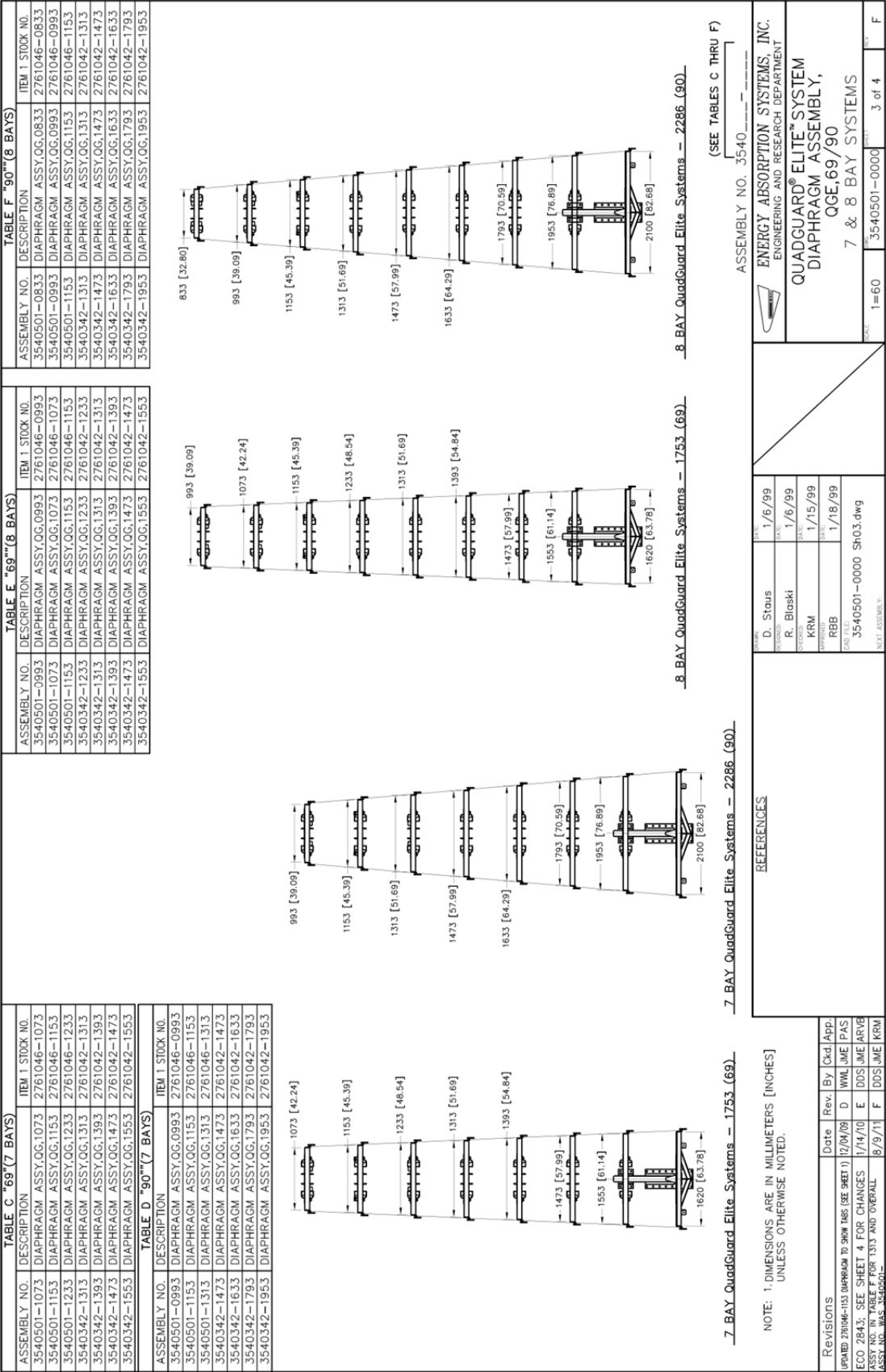
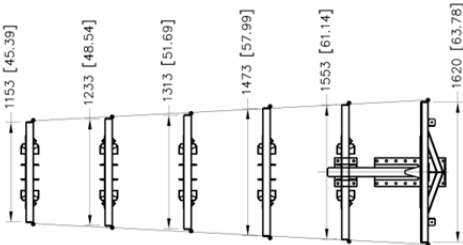
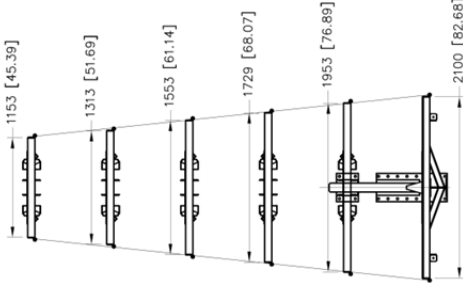


TABLE G "69"		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-1153	DIAPHRAGM ASSY.QG.1153	2761046-1153
3540501-1233	DIAPHRAGM ASSY.QG.1233	2761046-1233
3540501-1313	DIAPHRAGM ASSY.QG.1313	2761046-1313
3540342-1473	DIAPHRAGM ASSY.QG.1473	2761042-1473
3540342-1553	DIAPHRAGM ASSY.QG.1553	2761042-1553



5 BAY QuadGuard Systems — 1753 (69)

TABLE H "90"		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-1153	DIAPHRAGM ASSY.QG.1153	2761046-1153
3540501-1313	DIAPHRAGM ASSY.QG.1313	2761046-1313
3540501-1553	DIAPHRAGM ASSY.QG.1553	2761046-1553
3540342-1729	DIAPHRAGM ASSY.QG.1729	2761042-1729
3540342-1953	DIAPHRAGM ASSY.QG.1953	2761042-1953




5 BAY QuadGuard Systems — 2286 (90)

NOTE: 1. DIMENSIONS ARE IN MILLIMETERS [INCHES]
UNLESS OTHERWISE NOTED.

Revisions	Date	Rev.	By	Chk.	App.
SEE SHEET 1	12/04/08	D	WML	/	/
ECO 2843; UPDATED BOTH TABLES	1/14/10	E	DDJ/JME	ARVB	
ASSEMBLY NO. WAS 3540501-	8/9/11	F	DDJ/JME	KRM	

REFERENCES

DESIGNED BY	R. VENZON	DATE	06/11/09
CHECKED BY		DATE	
DESIGNED BY	S. TRAGESER	DATE	06/11/09
APPROVED BY	P. SEPULVEDA	DATE	06/11/09
CALCULATED BY	3540501-0000 SH04.DWG		
NEXT ASSEMBLY:			



ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE SYSTEMS™
DIAPHRAGM ASSEMBLY,
QGE,69/90
5 BAY

SCALE: 1=60

3540501-0000

4 OF 4

F

QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 5 Bay



TRINITY

HIGHWAY

Ahead of the Curve™

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