VEHICLE RECOVERY

Purpose

Prevention is better than cure.

It is better to have it and not need it than need it and not have it.

It is better to be safe than sorry

- http://www.youtube.com/watch?v=yDYzWRpX37A&feature=related
- http://www.youtube.com/watch?v=8WBMTfLQtE8&NR=1

Prevention

- Knowledge of your vehicle
- Drive within your boundaries
- Understand the terrain
- Understand the risks
- Plan for contingencies

Knowledge of your vehicle

Traction

- Tires
- Ground clearance
  - IFS/IRS vs. solid axle
- Approach angle
- Break over angle
- Departure angle
- Suspension Articulation
  - Body roll
  - Side slope ability

Knowledge of your vehicle cont.

- 4WD System
  - Full time
  - Part time
- Traction Aids
  - ETC
  - Lockers
    - Center differential lock
    - Axle differential lock(s)

Knowledge of your vehicle cont.

Drive within the design constraints of your vehicle

- Engine
- Gearing
- Center of mass w.r.t. “area of influence”
- Understand how loading or lifting your vehicle changes the center of mass
- Maximum climb angle
  - 100% = 45° based on traction perfect flat surface
- Roll-Over angle
  - > 40° good, < 35° poor

Drive within your boundaries

- Know your limits
  - I know how to drive!
  - This isn't my first rodeo you know!
  - Hey ya'll watch this!
  - Hirrit!
- Attitude
  - Drive defensively and courteously
  - Check your ego!
  - Hope for the best but plan for the worst
- Risk assessment
- Recovery assessment

Understand the Terrain

- Terrain and its influence on the driver, the vehicle, and the consequent risk of requiring recovery and the complexity of recovery
  - Dirt roads – false sense of security!
    - Speed
      - Cornering
        - Steering
        - Sliding
      - Braking distance

Understanding the Terrain cont.

  - Following distance
  - Visibility
    - Dust
- Potential threats w.r.t. recovery.
  - “High speed” rolls
  - Sliding off the road
  - Driving off the road
  - Head on collisions
  - Rear end collisions
- Significant personal injury
- Significant immediate vehicle damage
- Complex recovery involving critical care (time constraint) and damaged vehicle(s)

Understanding the Terrain cont.

- Rock Crawling
  - Pushing vehicle beyond its capabilities
    - Roll over angles
    - Ground Clearance
    - Component strength
- Potential threats w.r.t. recovery.
  - “Low Speed” rolls
  - Vehicle breakage
  - Stuck vehicle
- Potential for personal injury
- Potential for vehicle damage
- Less complex recovery potentially involving additional vehicle damage and vehicle repair
- Usually under less time pressure

Understanding the Terrain cont.

- Sand and Beach Driving
  - Speed
  - Cornering
    - Braking
    - Steering – trapped in tracks
  - Changing floatation
  - Subsurface objects
- Potential threats w.r.t. recovery.
  - “Medium speed” rolls
  - Head on collisions
  - Rear end collisions
  - Stuck vehicle
- Significant personal injury:
- Significant vehicle damage
- Less complex recovery potentially involving additional vehicle damage and loss
- Potential for significant time pressure

http://www.youtube.com/watch?v=pSwqobLE-dk&NR=1http://www.youtube.com/watch?v=pSwqobLE-dk&NR=1

Understanding the Terrain cont.

- Other terrain types (Covered in detail in our Driving Skills Courses)
  - Muddy Trails
  - Fording and Wading
  - Snow and Ice
  - Grasslands
  - Side Slopes
  - Ridges and Troughs
  - Gullies
  - Salt Pans
  - Corrugations / wash board

Understand the Risks

- Personal Injury
  - Immediate
  - Subsequent
- Vehicle Damage
  - Immediate
  - Subsequent
- Environmental Damage
- Corporate Injury

Plan for Contingencies

- First Aid capability
- First Aid equipment
- Mechanical ability
- Vehicle spares and tools
- Communication equipment
- Food and water
- Travel in groups
- More extensively covered in our Expedition Courses

Recovery Equipment

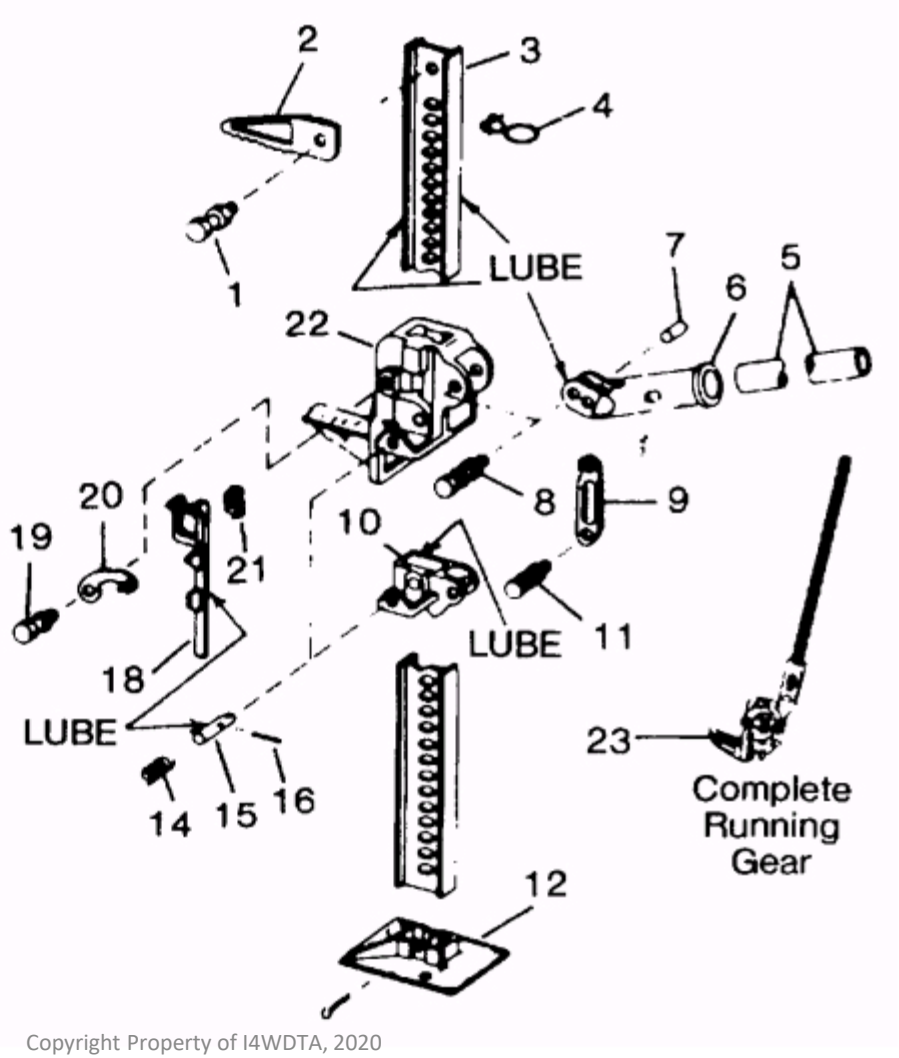
- Hand powered
- Vehicle powered
- Vehicle mounted
- Vehicle secured
- Anchors
- At a minimum, carry and have the equipment you think you will need based on the type of terrain you expect to encounter.

Hand Powered Recovery Equipment.

- Jacks
  - High-lift Jacks
    - Steel / cast
    - All cast
    - Extreme
    - Consult www.hi-lift.com for more information
    - Also knows as Farm jack, multiple manufacturers including Larin
    - Accessories See http://www.hi-lift.com/accessories/index.html
      - Covers, mounts, handle keepers, protectors, repair kits
      - Lift Mate
      - Base
      - Bumper lift
      - Off Road Kit – enables High-lift to be used as a winch
      - Handle All Kit see http://www.okoffroad.com/stuff-hilift-handle-all.htm
      - Parts Reference http://www.hi-lift.com/hi-lift-jacks/parts-services.html

High-Lift Jack

1	Top Clamp-Clevis Bolt
2	Top Clamp-Clevis
3	Steel Standard (Bar)
4	Handle Spring Clip
5	Steel Handle w/ Cotter Pin
6	Handle Socket
7	Pitman Pin
8	Hex Bolt
9	Pitman
10	Small Runner
11	Hi-Lift® Shear Bolt
12	Foot Piece w/ Cotter Pin
14	Climbing Pin Spring (2 required)
15	Climbing Pin (2 required)
16	Cross Pin (2 required)
18	Reversing Switch Cam Bar and Spring
19	Cap Screw w/ Washer
20	Reversing Latch
21	Reversing Switch Spring
22	Large Runner
23	Running Gear (assembled)
	Safety Label also available.



High-Lift Handle All Kit

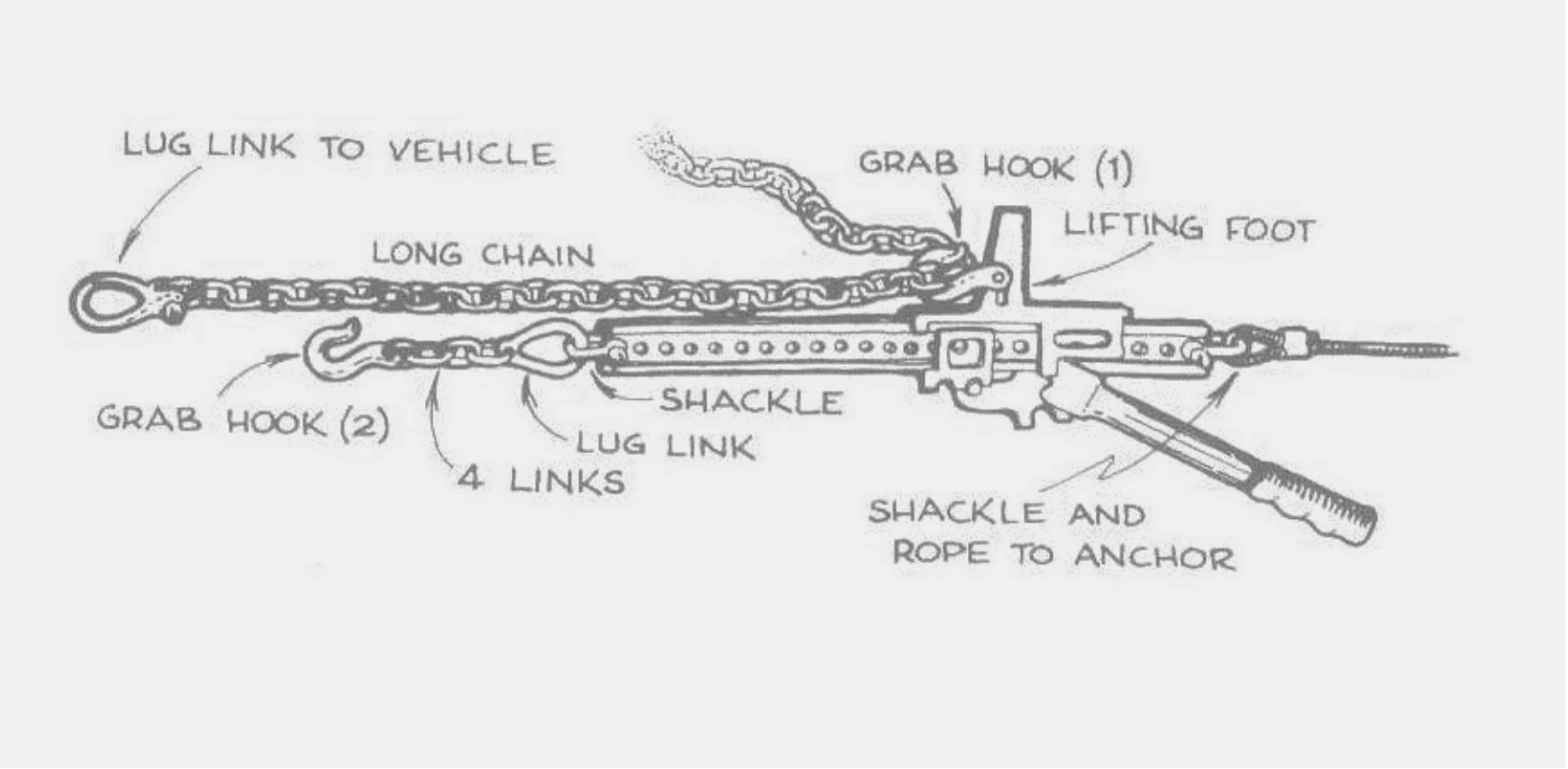
Tools

Jackmate

- Jaws of life

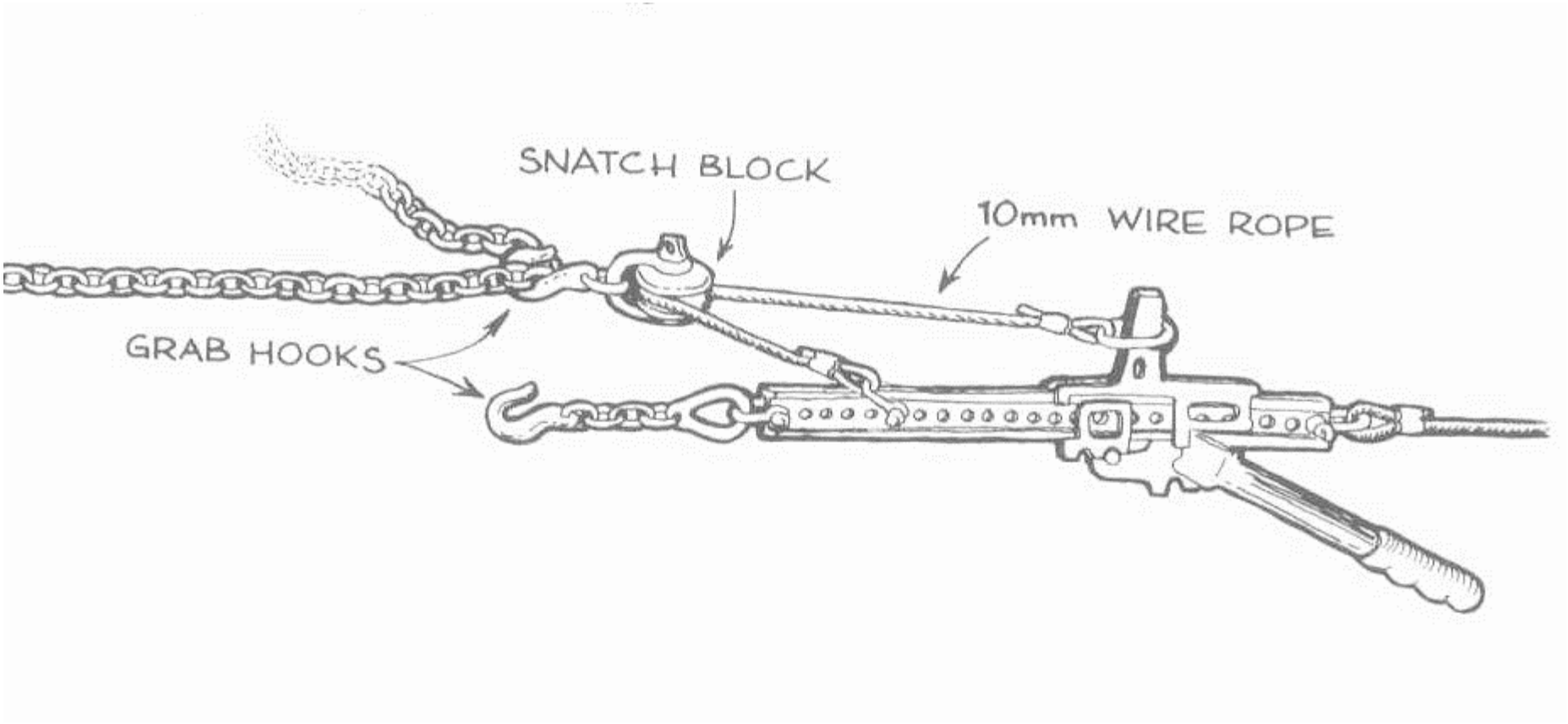
- Spade/shovel combination tools
  - Max Ax tool see
  - http://www.youtube.com/watch?v=p1iHKXBKPdA&NR=1
    - T Lift

High-Lift as a Winch



- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 207 and 208 Personal copy.

High-Lift as a Winch



- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 207 and 208 Personal copy.

High Lift Jack use

- http://www.youtube.com/watch?v=1ezumvHnvQ0&feature=related
  - Models
- http://www.youtube.com/watch?v=NIeASvjxDtU&feature=related
  - Maintenance
- http://www.youtube.com/watch?v=d9mqMTS8C_8&feature=related
  - Off Road Kit
- http://www.youtube.com/watch?v=Egi9e5fUZs4&feature=related
  - Load Specifications
- http://www.youtube.com/watch?v=MrfbR4REV-s&feature=related
  - Use as a Jack to raise and lower
- http://www.youtube.com/watch?v=xldBPnzohtI&feature=related
  - Use as a winch
- http://www.youtube.com/watch?v=zOygogTEsHE&NR=1
  - Use as Jaws of Life – Jake Mate
- http://www.youtube.com/watch?v=y4wQGYYcwZA&feature=related
  - Spreading, Clamping and Extrication

Hand Powered Recovery Equipment.

- Spade/shovel
- Axe, pick, etc.
- Bushman's winch
  - See *The New Zealand 4 Wheel Drive Handbook* by Ken Sibly page 184 ISBN 1-877251-24-0
- Tirfor type winch – Tuff Pull Hand Winch
- Come along
- More power puller
- Strong arm – NEVER HANG ON A VEHICLE!
- More effort but less forces applied

Vehicle Powered Recovery Equipment

- Air jack – exhaust powered
  - See Easy Lift for example
    - http://www.air-jack.com/
    - http://www.youtube.com/watch?v=M0HOQJ0Molw&feature=related
      - Use of Air Jack

Vehicle Powered Recovery Equipment

Air Jack vs. High-lift Jack

Air Jack	High-lift
Used when engine is running	Used without engine running
Used on almost any vehicle	Needs accessories or jacking points
Wont sink in soft ground	Needs base to prevent sinking
More stable less versatile	Less stable very versatile
Cannot be used as a winch	Can be used as a winch
Cannot be used as to jack and push	Can be used to jack and push
Dust and sand does not affect operation	Dust and sand can jam mechanism
Useless if punctured	Reliable if properly maintained
Small punctures may be patched	Spares available

Vehicle Powered Recovery Equipment

- Winch – for when you are ***REALLY*** stuck
  - Electric
  - PTO
  - Hydraulic
  - Worm Gear
  - Planetary Gear
  - Capstan
  - Wheel Winch
    - http://www.youtube.com/watch?v=JY4cKc4FKSM&feature=related

Vehicle Powered Recovery Equipment

Electric Winches

- Performance [use 1.5 times GVWR]

16.5ti SPECS
Part Number: 68801 (12V)
Rated Line Pull: 16,500 lbs. (7484 kgs) single-line
Intended Use/Application: Vehicle Recovery / For Heavier Trucks and SUVs
Duty Cycle Rating: BEST — GOOD (LONGER)
Motor: 12V 4.6 hp, Gen II, Series Wound
Remote Control: Remote, 12' (3.7m) lead, thermometric indicator, S2 elements, integrated flashlight
Geartrain: 3-Stage Planetary
Gear Ratio: 315:1
Lubrication: Molylube #1 or Aeroshell #17
Clutch (freespooling): Rotating Ring Gear
Brake: Automatic Direct Drive Cone
Wire Rope: 90', 7/16" diameter (27m, 11mm diam.)
Fairlead: Roller
Recommended Battery: 650 CCA minimum for winching
Battery Leads: 2 gauge, 72" (1.83m)
Finish: High-gloss powder coat over primer undercoating
Drum Diameter/Length: 3.5"/8.2" (9cm/21cm)
Weight: 138 lbs. (63 kgs.)

Vehicle Powered Recovery Equipment

Electric Winches

- Rated line pull – per layer
- Pull as much rope as possible

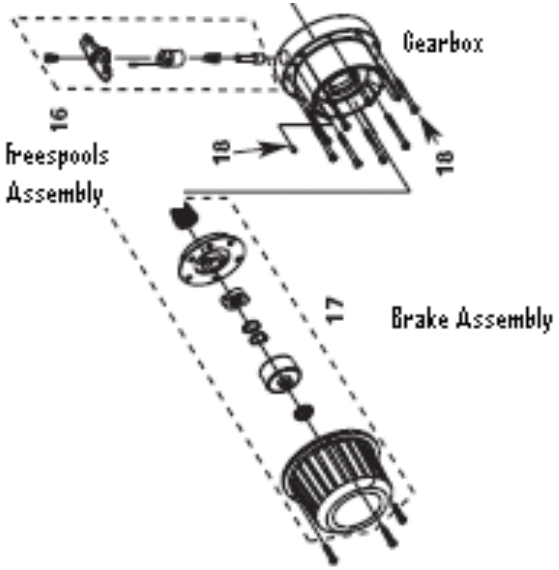
12V DC PERFORMANCE SPECS			
Line Pull Lbs.(Kgs.)	**Line Speed FT./min(M/min.)**	**Motor Current**	**Pull by layer layer/Lbs(Kgs.)**
0	23.6(7.20)	68 amps	1/16500(7484)
2000(907)	12.07(3.68)	138 amps	2/15279(6930)
4000(1814)	9.22(2.81)	189 amps	3/12672(5748)
6000(2721)	7.37(2.25)	240 amps	4/10824(4910)
8000(3628)	6.08(1.85)	291 amps	
10000(4536)	5.12(1.56)	342 amps	
12000(5443)	4.40(1.34)	393 amps	
14000(6350)	3.86(1.18)	444 amps	
16000(7257)	3.38(1.03)	494 amps	
16500(7484)	3.24(0.99)	507 amps	

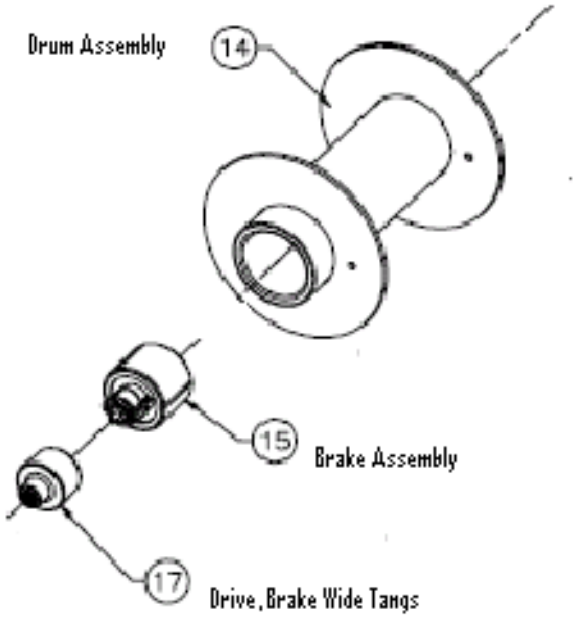
Above performance specs are based on first layer of drum

Vehicle Powered Recovery Equipment

Electric Winches

- Brake Assembly: **why you should minimize powering out and not use the winch as a tow rope**
- Warn 16.5ti brake diagram
- 12K to 16.5K use same brake





- Superwinch EP9.0 brake diagram

Winch Lines

Steel cable

- Corrosion resistance
  - Standard, galvanized - stiffer, stainless – springier
  - Use roller fairlead
  - Extremely dangerous when it breaks
  - Use kerosene to clean wire cable
  - Outer wrap with independent core
    - Steel core
    - Fiber core
  - Wire rope is identified by two numbers 7X19
    - First # [7] indicates the number of strands wrapped around the core.
    - Second # [19] indicates the individual wires in a strand

Winch Lines cont.

Synthetic rope Amsteel Blue

- See http://www.amsteelblue.com/index.cfm
- See http://www.masterpull.com/cpage.cfm?cpid=197
  - Greater strength to weight ratio
  - Higher breaking strain that steel cable of the same diameter
  - Weighs about 1/6th of steel cable
  - Does not bind, kink, or spring like wire rope
  - Does not corrode like wire rope
  - Floats, does not conduct electricity
  - Does not develop sharp frays
  - Can join easily, has superior flex
  - Use Hawse fairlead [poly rollers or new rollers]
  - Releases a fraction of the energy when it brakes – safer
  - Same elongation, and elastic elongation to wire rope
  - Torque free
  - Less abrasion resistant than steel cable

Winch attachment

- To vehicle
  - Mounted
    - Bottom bolts and front bolts
    - Ensure bumper is securely attached to vehicle
    - Drum visibility
    - Solenoid placement
    - Hand control plug placement
    - “Remote” control
    - Weather protection required
  - Receiver hitch – portable
    - Receiver hitch pin rating – receiver clamp
    - Battery cable rating and length
    - Connector [SMH] rating

Winch attachment cont.

- Cable to drum –
  - Mark [paint or sleeve] first 8 wraps on drum
  - Five wraps considered the minimum
- “Hook” to cable – crush proof thimble
  - Types of hooks
    - Self-locking
    - Safety latch
    - Hammer-lock

Vehicle Mounted Recovery Equipment

- Vehicle mounted recovery equipment is equipment that is bolted to the vehicle and intended to be used where it is bolted on
  - Winch
  - Tow points – front and rear
  - Jack points – on all sides
- Tow point and Jack point attachment
  - Integrated in the bumpers
  - Weld on
  - Bolt on [preferred]

Vehicle Secured Recovery Equipment

- Vehicle secured recovery equipment is all other recovery equipment that is **secured** in an organized way to the vehicle.
- All vehicle contents but especially heavy recovery equipment MUST be properly stowed and secured.
- You don't want a D shackle wedged under the brake pedal!
- You do not want to get hit in the head by a snatch block!
- Vehicle organization and storage systems are covered in more detail in our Expedition Courses

Recovery Equipment

- http://www.youtube.com/watch?v=emBkIaMwXoU&feature=related
  - General description
- Shackles
  - Screw pin D shackles – used with chains
  - Screw pin Bow shackles – used with straps
  - Only use screw pin shackles as the screw pin prevents shackle spreading under load.
- Working Load Limit [WLL] is max load able to be applied
- Safe Working Load [SWL] is the max load that can be safely applied – breaking load divided by a safety factor
- Snatch blocks
- Chains with clevis grab hooks
  - Pin and split pin location
  - Use of handling – natural lay
  - G70 3/8” chain 6,600 lbs. WLL [1/2” chain 11,300 lbs WLL]
- Safety straps – safety loops to prevent missiles

Recovery Equipment cont.

- Tire chains and snow chains
  - Cable and link chains
  - Vehicle class w.r.t clearance for chains
- Recovery Kinetic/Snatch Straps and Ropes
  - 20% to 30% stretch depending of moisture and width
  - Moisture increases stretch & reduces strength by about 25%
  - Knots and cuts may reduce strength by up to 50%
- Tow Ropes and Straps
  - Typically do not stretch
  - Often have hooks attached
  - Should not be used for recovery
- Tree savers
  - Other methods
    - Sticks to spread the load
    - Carpet bandage, floor mat

Recovery Equipment cont.

- Natural anchors
  - Trees
    - Low attachment point
    - Firm footing and big enough
    - Should be alive
  - Rocks with use of chain
- Stay away from power lines, telephone lines, fences, etc.
- Alternative Anchors
  - Pull Pall see http://www.pullpal.com/
  - Steel stakes with steel strip [or safety strap]
  - Bury a wheel
  - Plough disc
  - Another vehicle – watch for strain on components
    - Anchor from same tow point under the anchor vehicle to another anchor
    - Put front wheels against a log
    - Put front wheels in a ditch

Recovery Equipment cont.

- Bridging and Sand Ladders
  - PSP – perforated steel plate
  - Trac mats
  - Rubber Mats
  - Plastic ladders
  - Steel sand ladders
  - Aluminum sand ladders
  - Fiber glass waffle boards / bridging ladders
- Generally bulky, heavy, and only used by the extreme expedition oriented.

Recovery Techniques

- Identify, Decide, Predict, Execute “IDPE”
- The first point is to do a stuck assessment
  - Ensure vehicle is stable – determine wheel weight distribution
  - Ensure vehicle is locked down, wheels are cocked
  - Evaluate what caused you to get stuck
- Determine where you need to get the vehicle to
- Develop your plan
  - Critically evaluate wheel path during recovery
  - Critically evaluate suspension load during recovery
  - Critically evaluate body roll during recovery
- Implement your plan

Recovery Techniques cont.

- Use of recovery equipment
- ENSURE SAFETY AT ALL TIMES
- SAFETY IS EVERYONES RESPONSIBILITY
- Check tire pressure – sometimes simply airing down can be enough
- Start with a Spade
  - Release of vacuum in mud – hose pipe pieces
- End with the winch
  - Slack in line prior to pull
  - SAFETY ZONE

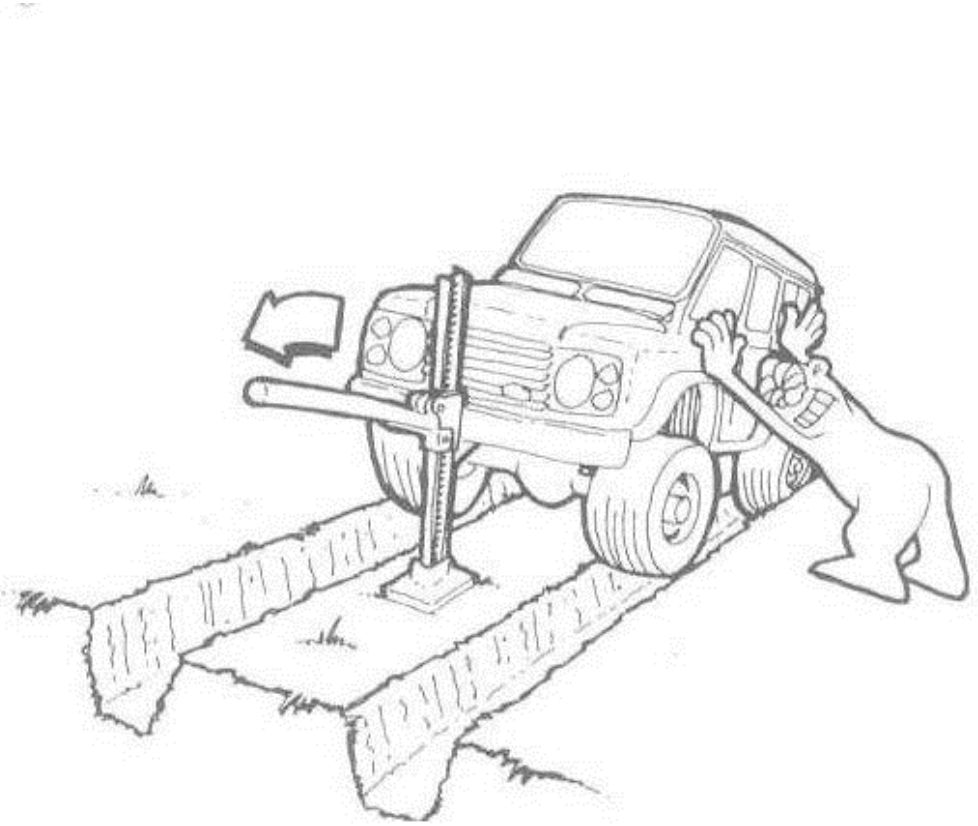
Recovery Techniques cont.

- http://www.youtube.com/watch?v=Q8lMxYnGIrw&feature=related
- Analysis Use of spade?
  - Releasing the vacuum?
  - Winching?
  - “Kinetic Rope?” pulling backwards
  - Tommy to the rescue! – “I know the procedure”
  - Spectator control?
  - Snatch Strap – joining with shackle?
  - Reversing – could reverse over snatch strap
  - Stuck vehicle assist?
  - Attached to tow ball on both vehicles?
  - Communication?
  - Deadly events?
- http://www.youtube.com/watch?v=XJEgRN4em8w&feature=related
- http://www.youtube.com/watch?v=Wc993Pmn87A&NR=1
  - What is the mistake?

Recovery Techniques cont.

- Manual work
  - Use your spade to clear obstructions
  - Try and reverse out
  - Road building
  - Use of carpets, floor mats, clothing, sleeping bags, branches, rocks, no live plants!
  - Remove all “traction aids” once unstuck
- Use of high-lift jack
  - Jack and push technique
  - Jack and pack technique
  - Use high-lift as a winch

Jack and Push

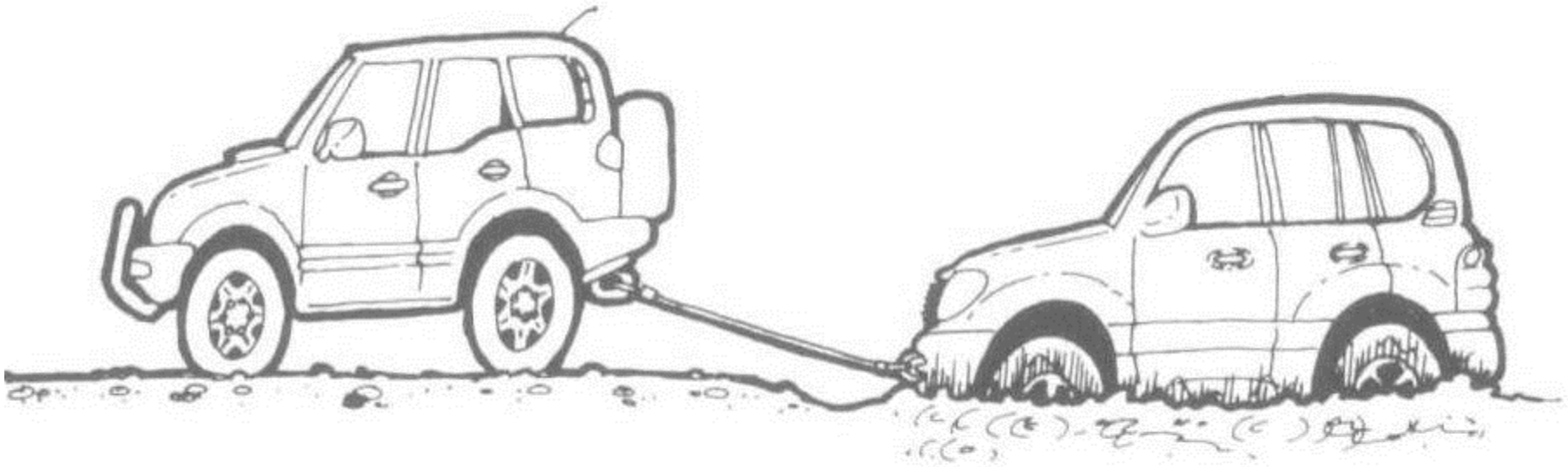


- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 183 Personal copy.

Recovery Techniques cont.

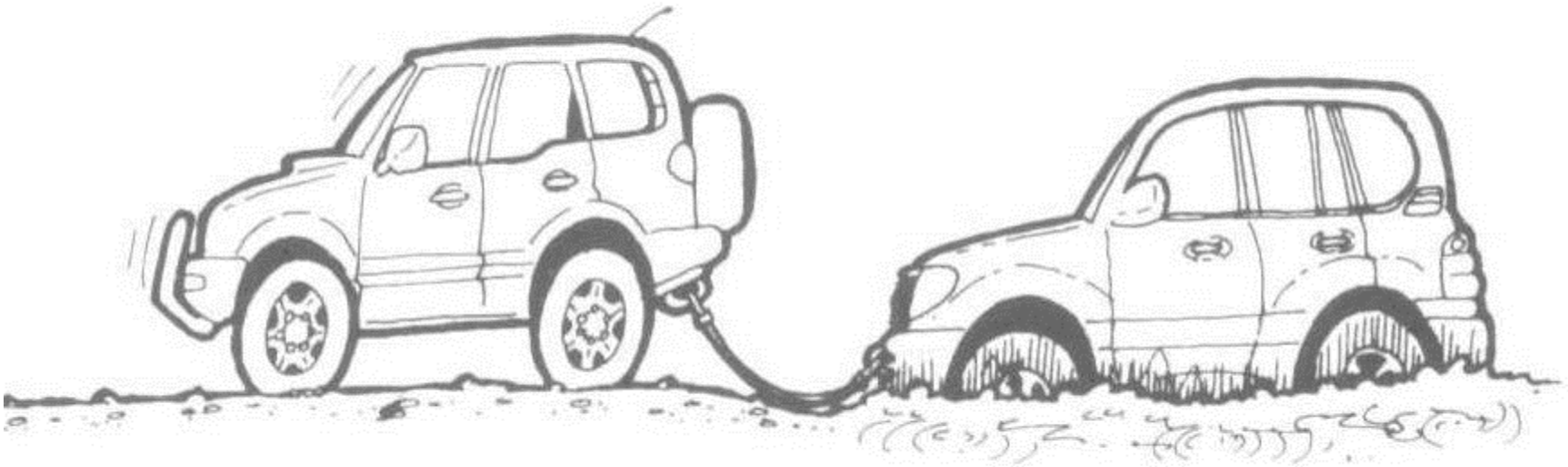
- http://www.youtube.com/watch?v=2JBnxSqpuCM&feature=related
  - John Rich
- Snatch Straps
  - First pull – light load - test
  - Second pull – back up 1/3 yank
  - Third pull – back up 2/3 yank
  - Ensure all on-lookers are out the danger zone
  - Yank driving forwards – avoid yanking driving backwards
  - Use of two yank vehicles
    - **http://www.youtube.com/watch?v=wuBkxUP2Aho&feature=related**

Snatch Straps: TEST



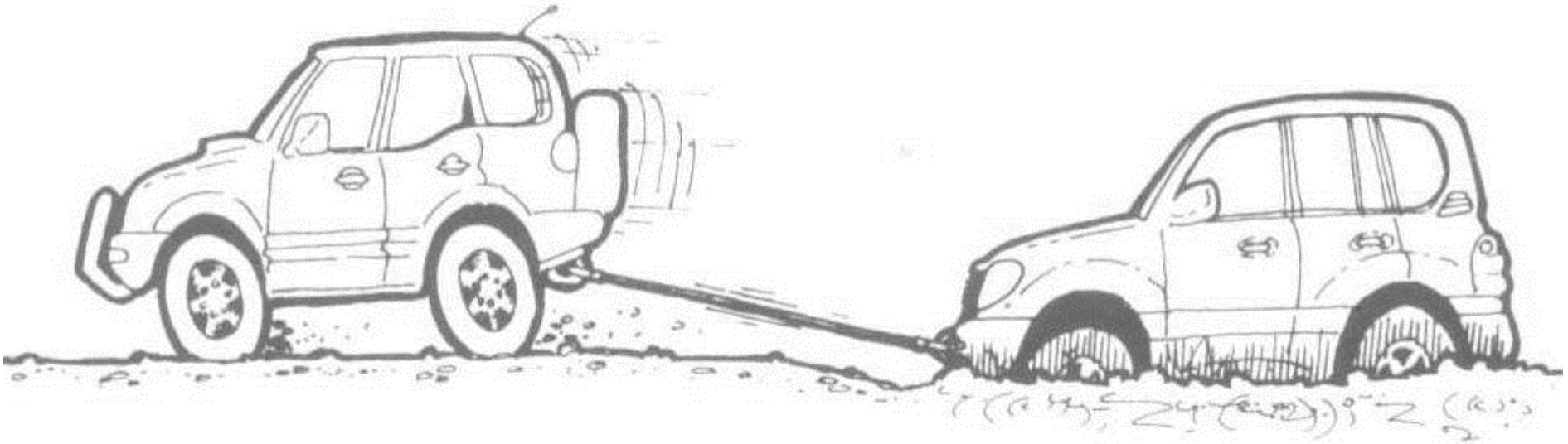
- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 186 and 187 Personal copy.

Snatch Straps: REVERSE



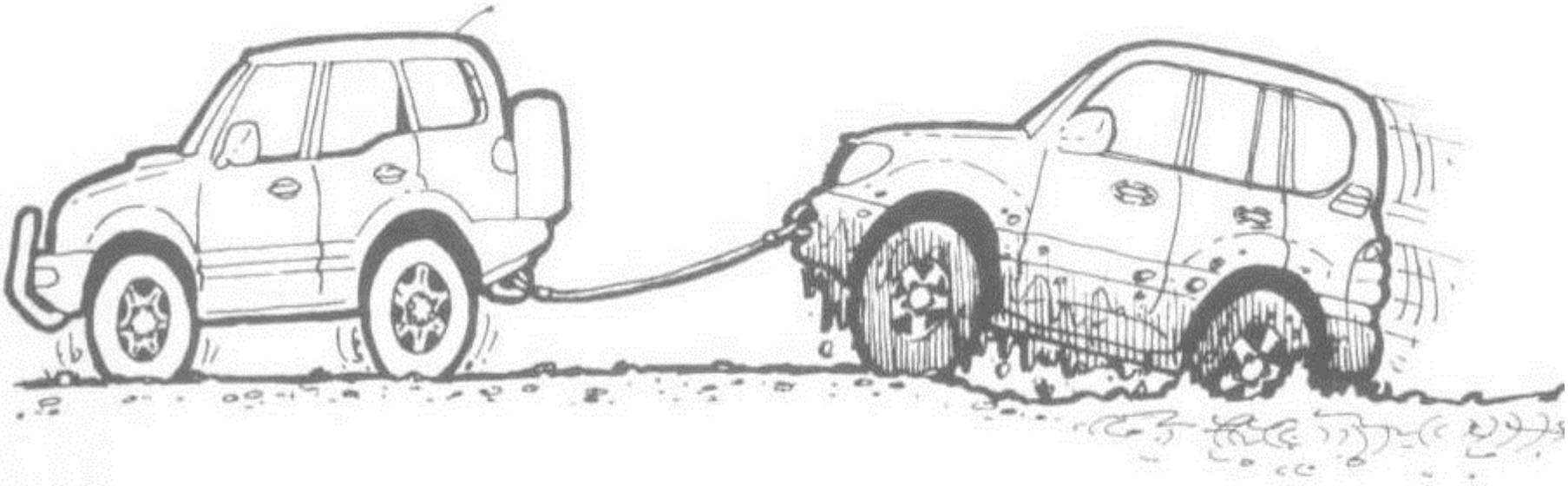
- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 186 and 187 Personal copy.

Snatch Straps: PULL



- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 186 and 187 Personal copy.

Snatch Straps: EXTRACT



- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 186 and 187 Personal copy.

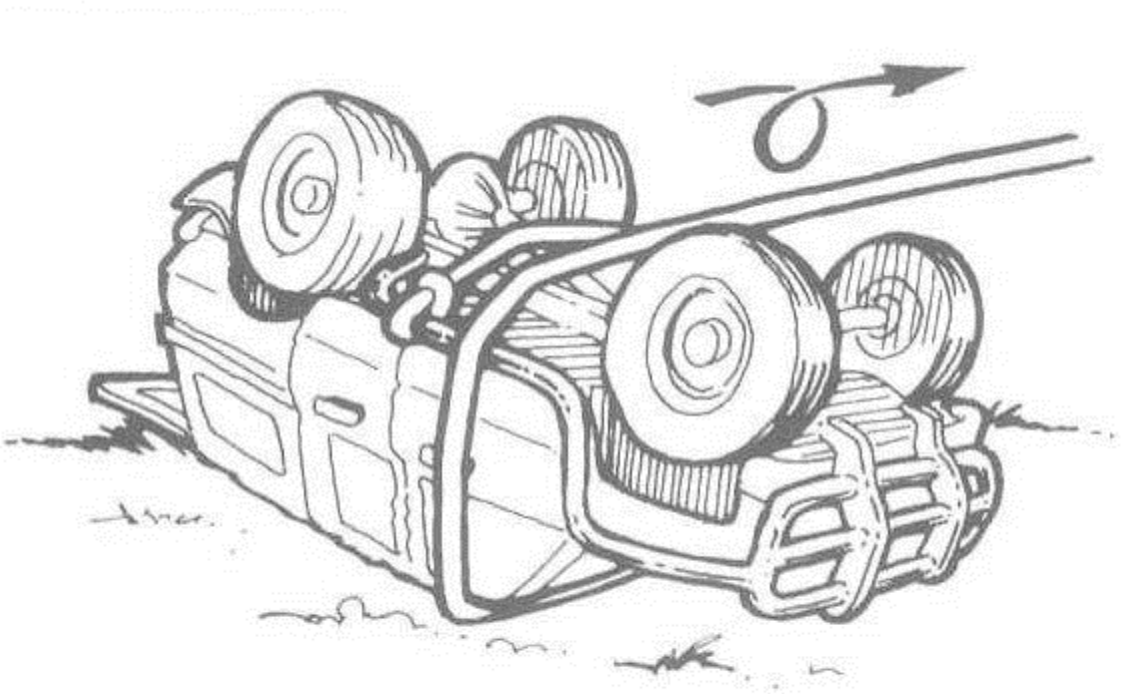
Recovery Techniques cont.

- http://www.youtube.com/watch?v=HEtuO-Mh9Lg&feature=related
- http://www.youtube.com/watch?v=YR22oP1WRtY&feature=related
- Snatch Straps
  - Joining snatch straps
  - Repairing broken straps
  - Shortening snatch straps / winch extension lines
  - Maintenance and cleaning of snatch straps

Recovery Techniques cont.

- http://www.youtube.com/watch?v=qP766RaCTFY&feature=related
  - Warn Winch
- Winch use in recovery
  - Single line pull forward
  - Double line pull forward – snatch [pulley] block
    - Creates a X2 mechanical advantage
    - Allows for change in direction
    - Pulley block needs to have double the winch rating
  - Pendulum pull – forward and sideways
  - Complex pulls – reverse, side ways
  - Righting a rolled vehicle
- Hand signals
- Self recovery
- Multiple vehicle recovery

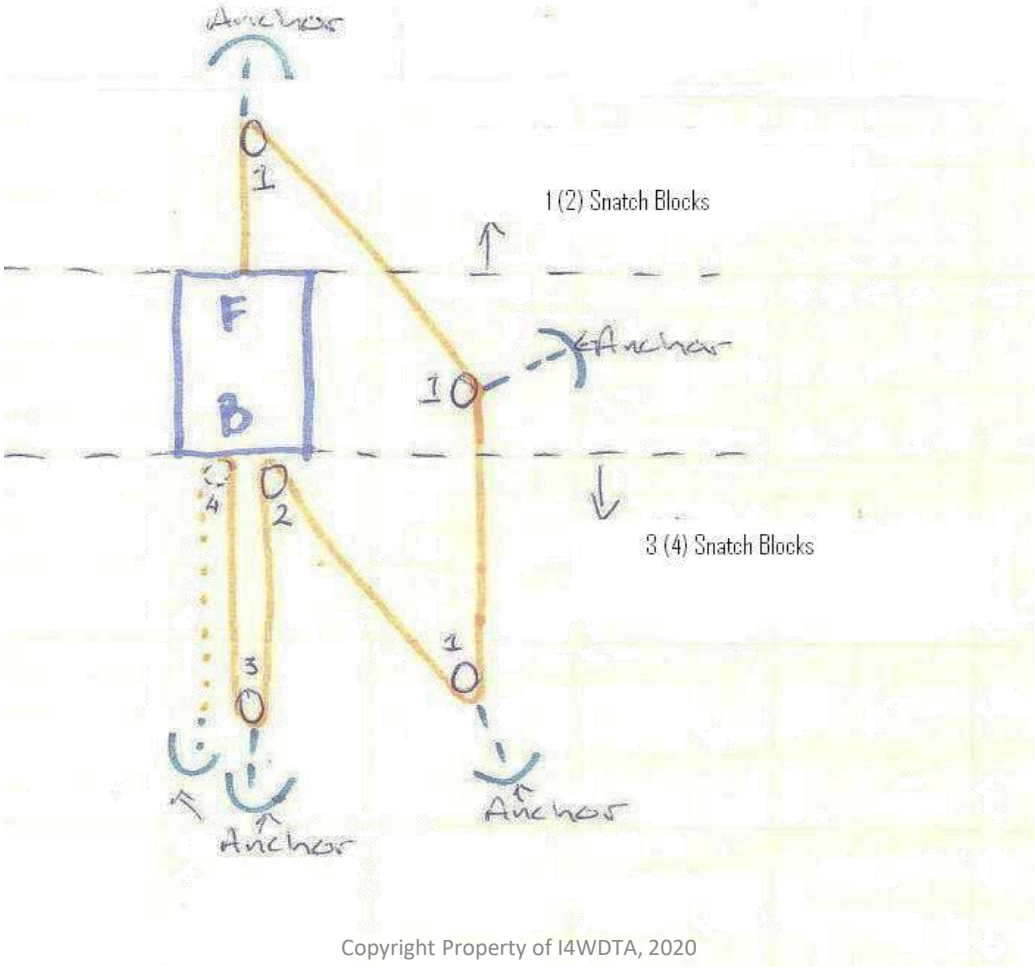
Getting Rubber Back Down



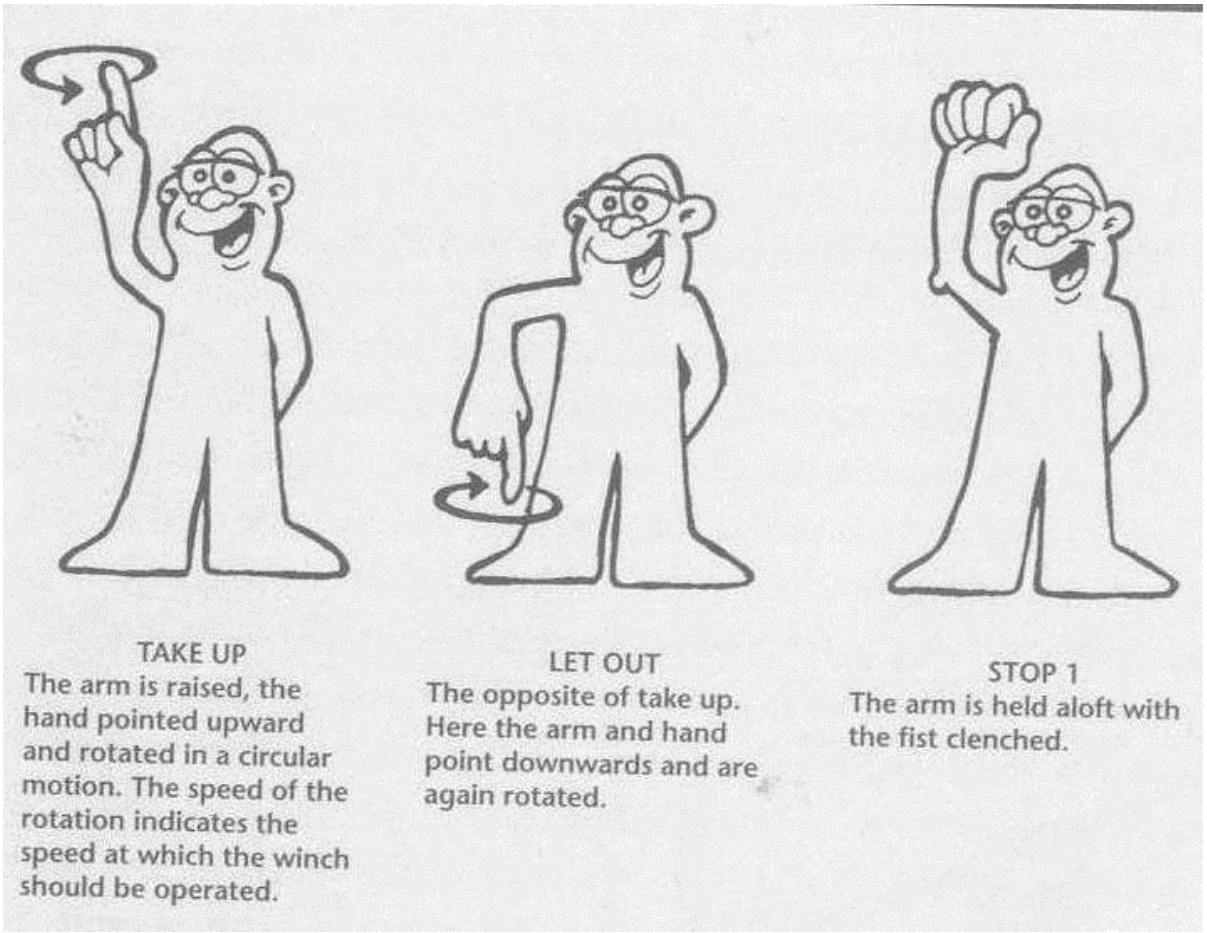
- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 211 Personal copy.

Recovery Techniques cont.

Winching backwards down hill?



Winch Hand Signals



TAKE UP
The arm is raised, the hand pointed upward and rotated in a circular motion. The speed of the rotation indicates the speed at which the winch should be operated.

LET OUT
The opposite of take up. Here the arm and hand point downwards and are again rotated.

STOP 1
The arm is held aloft with the fist clenched.

- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 198 Personal copy.

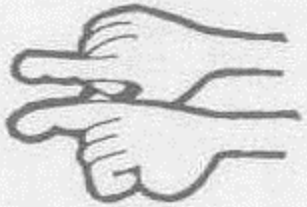
Winch Hand Signals

INTERMITTENT USE

The winch in and out signals can also be followed by touching the thumb and finger together, indicating to the remote control operator to use the trigger control intermittently.

HANDLING CABLE

Both hands side by side, facing downwards and pointing to the winch indicate that the person outside intends to handle the cable on the drum. The person controlling the winch should turn the controller so that the trigger control is facing away and cannot be used accidentally.

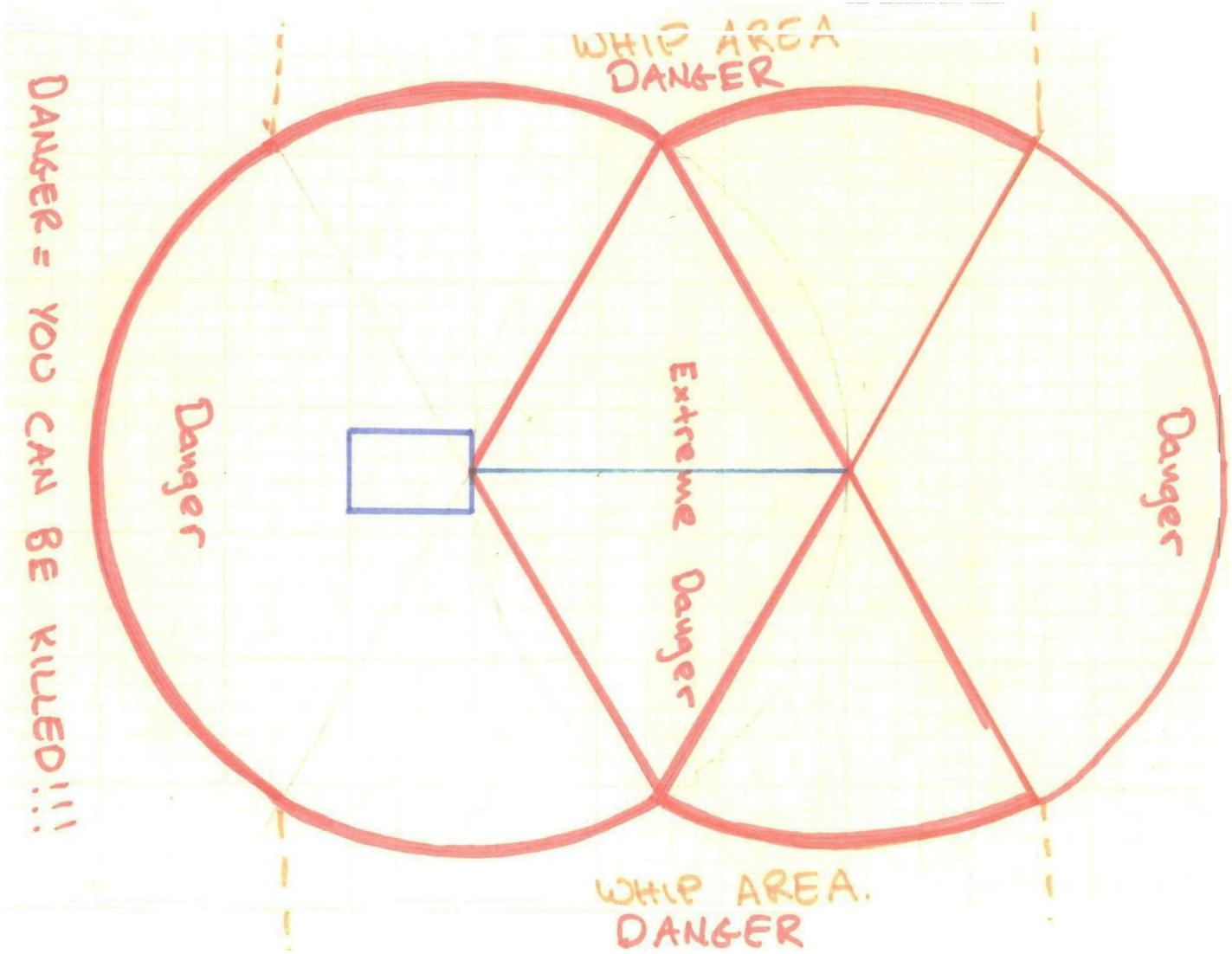


- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 198
- Personal copy.

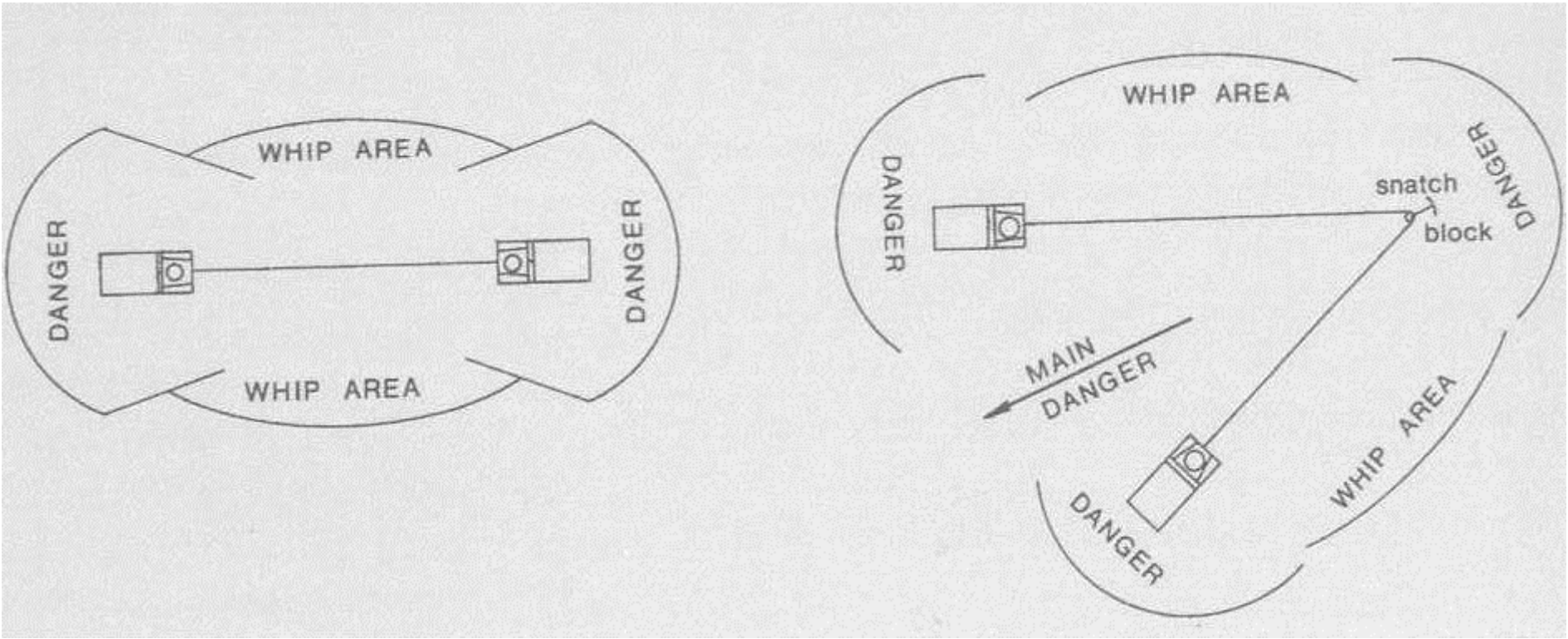
Winch Hand Signals

- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook*. Shoal Bay, 2004, page 198 Personal copy.

Danger Zone



Danger Zone cont.



- Reference: Ken Sibly *The New Zealand 4 Wheel Drive Handbook.* Shoal Bay, 2004, page 196 Personal copy.

Field Training

- SAFETY IS EVERYONES RESPONSIBILITY
  - Gloves
  - Watch Danger Zone
  - Hand Signals
  - Pinch areas
- SAFETY IS EVERYONES RESPONSIBILITY
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