The Hydro-Potential (HP) Value:

A Rock Classification Technique For Estimating Seepage Into Excavations

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Excavations with Potential Seepage Problems

- Tunnels
- Dams
- Mines
- Rockslopes
- Foundations

Tunnels

- Rimrock Tunnel US12, WA
  - Groundwater seepage
  - Rockfall
  - Ice Seepage
  - Ice Mounding

Dam Foundations

- Swift Reservoir, Lewis River, SR503 WA
  - Piping
  - Seepage
  - Failure

Mines

- Utah Kennecott Copper Bingham Pit
  - Groundwater seepage through wall
  - Contaminated water
  - Unstable slopes

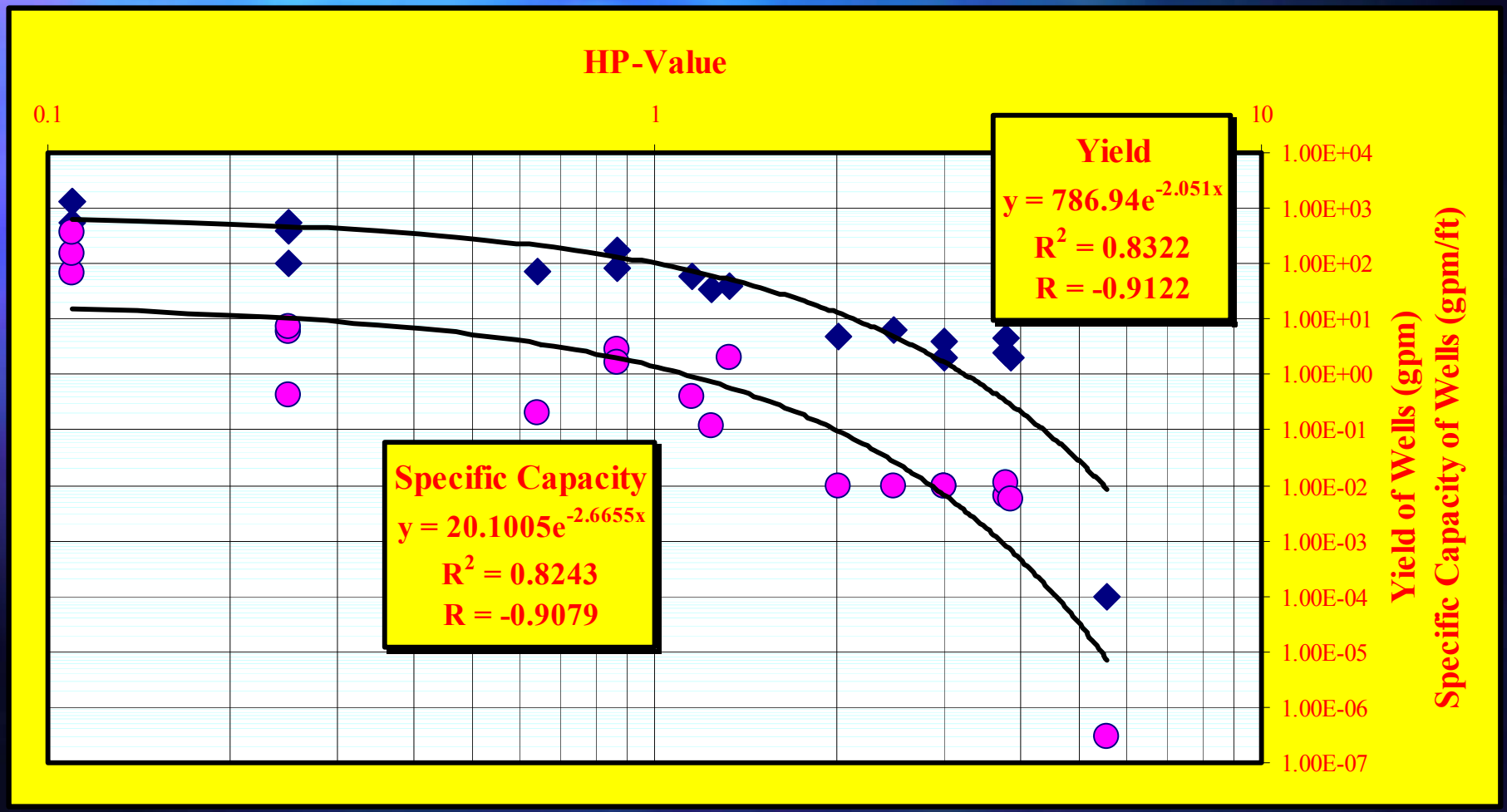
Rockslopes

- Ruby Creek Rockslide, SR97, WA
  - Unstable Slope
  - Ice Development

HP-Value Technique

- **Proven rockmass classification semi-quantitative technique employed to evaluate development of groundwater in bedrock terrain.**
- **Adapted to estimate groundwater seepage into excavations in bedrock.**

HP-Values Vs Yield & Specific Capacity



HP-Value ⇒ Six fracture characteristics of the rock mass

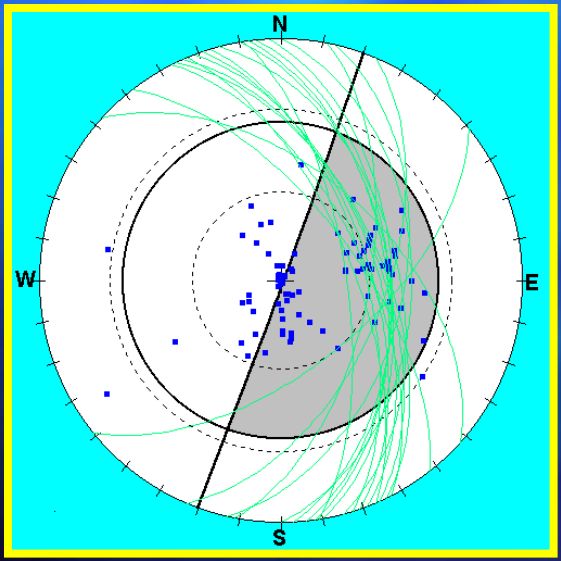
1. Rock quality designation (RQD)
2. Joint number (J_n)
3. Joint roughness (J_r)
4. Joint hydraulic conductivity (J_k)
5. Joint aperture factor (J_{af})
6. Joint water factor (J_w)

$$HP_{value} = \left(\frac{RQD}{J_n}\right)\left(\frac{J_r}{(J_k)(J_{af})}\right)(J_w)$$

1st Quotient of Equation

$$\left(\frac{RQD}{J_n}\right)$$

- **Rock quality designation (RQD)**
- **Joint number (J_n)**

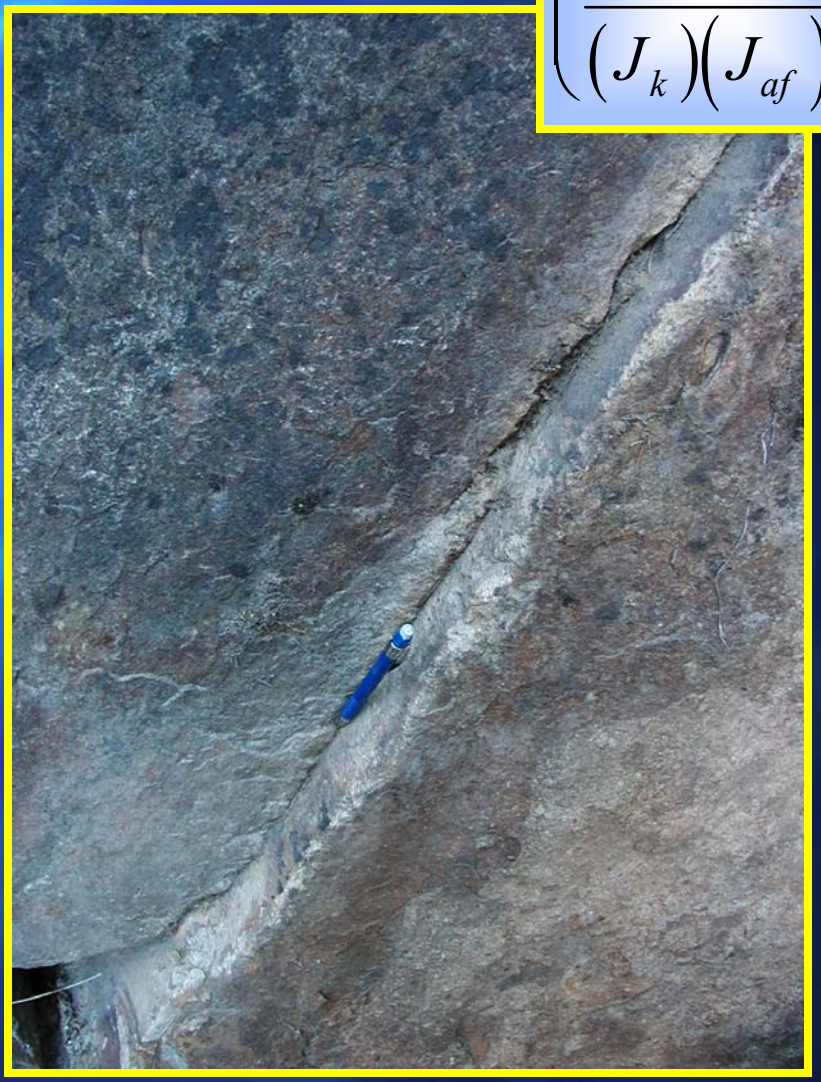


2nd Quotient of Equation:

Fluid Flow Resistance

$$\left(\frac{J_r}{(J_k)(J_{af})}\right)$$

- **Joint roughness (J_r)**
- **Joint hydraulic conductivity (J_k)**
- **Joint aperture factor (J_{af})**
  - Modified for Fractures ≤ 20mm
  - Rating 1 – 2.5



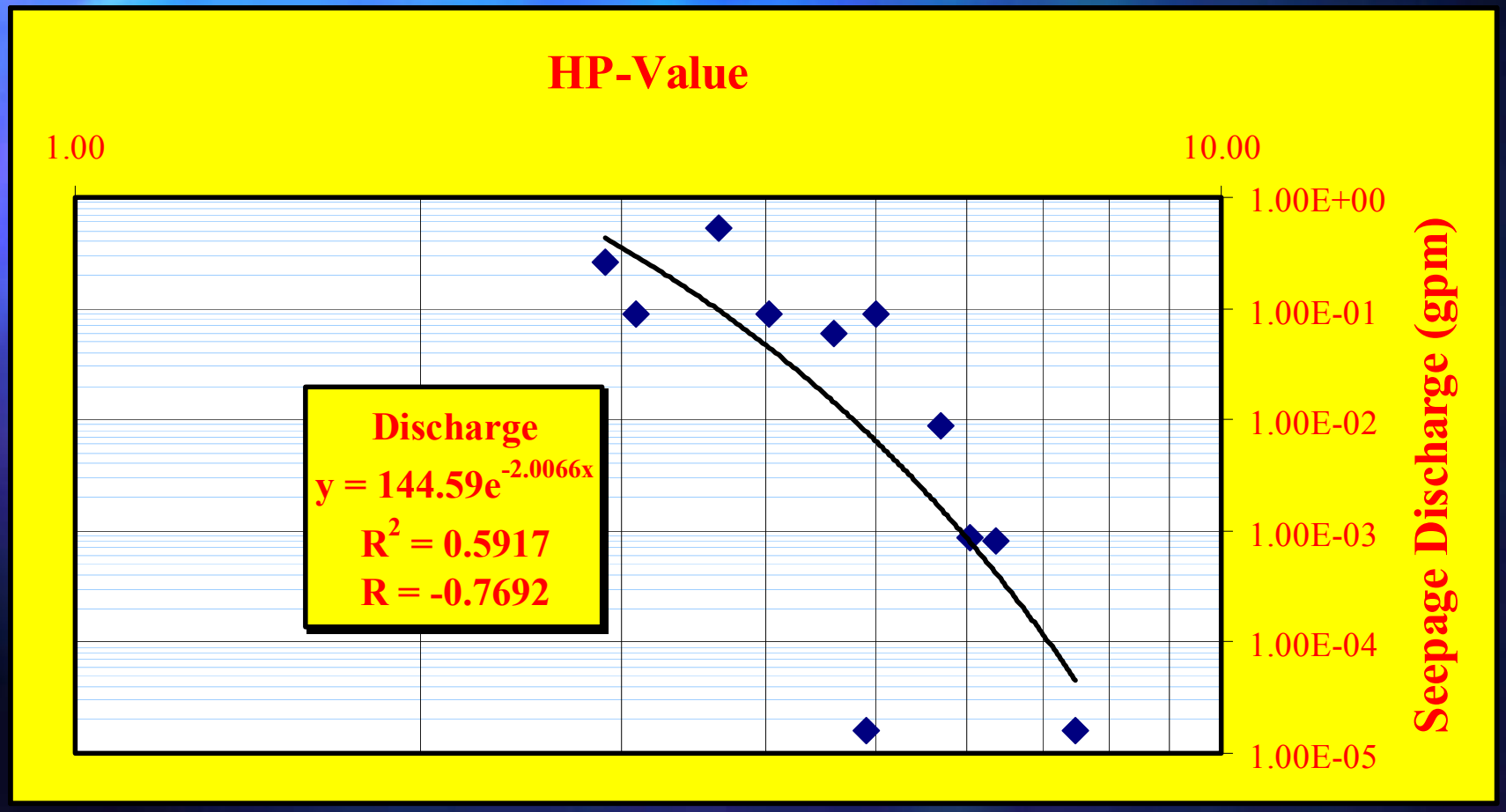
Joint Water Factor (J_w)

- Problems Collecting Samples
  - Representative Samples
  - Counting Drips
  - Horizontal Drains

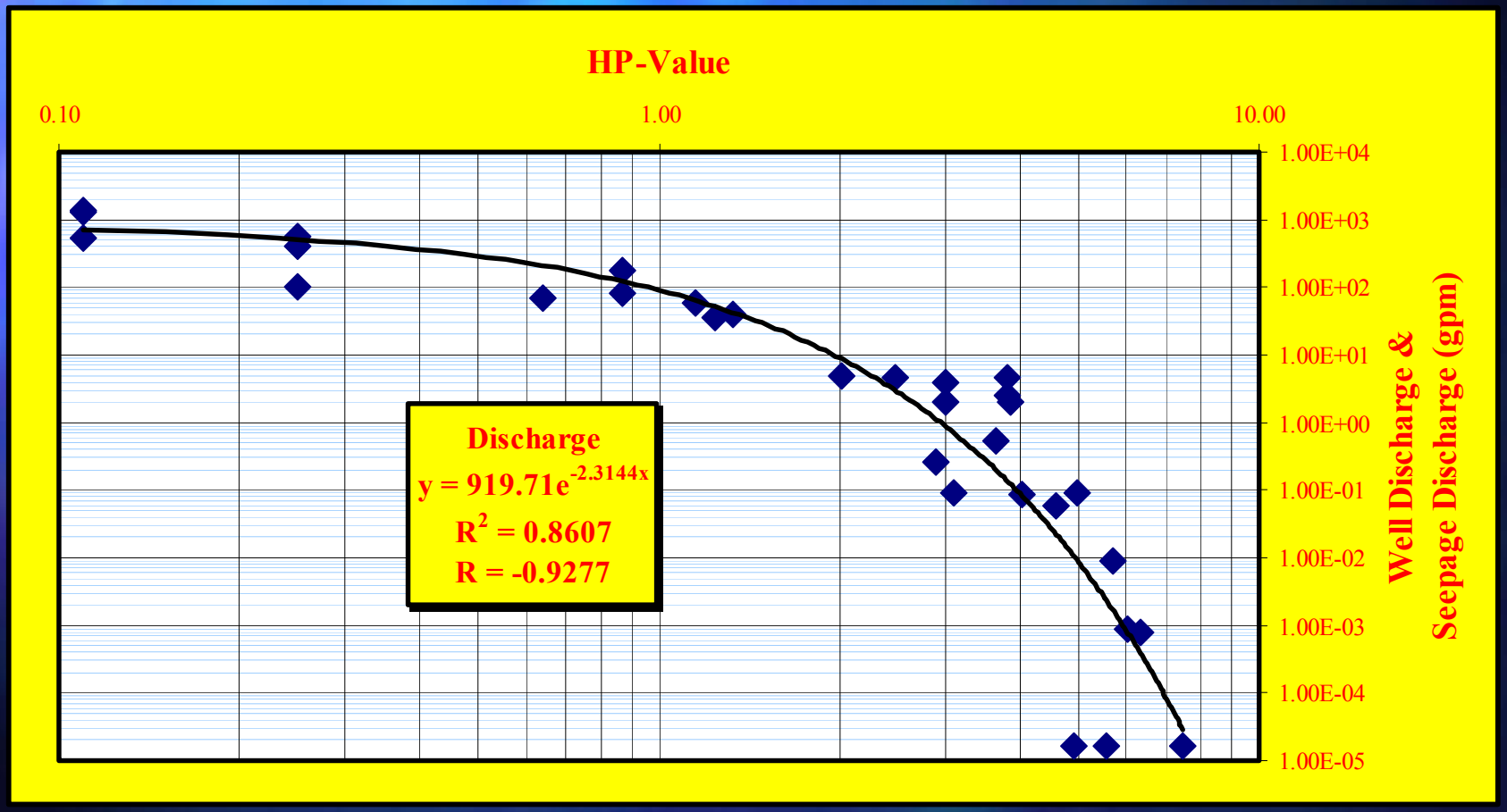
Joint Water Factor (J_w)

Description	Drops/Min	Gpm	Rating
Dry	<1	$<2x10^{-5}$	1
Damp	$1 \leq 10$	$2x10^{-5} \leq 2x10^{-4}$	0.94
Drops	$10 \leq 100$	$2x10^{-4} \leq 2x10^{-3}$	0.86
Dripping	>100	$2x10^{-3} \leq 2x10^{-2}$	0.76
Seeping		$2x10^{-3} \leq 2x10^{-2}$	0.66
Slight Flow		$0.16 \leq 1.6$	0.50
Mod. Flow		$1.6 \leq 16$	0.33
High Flow		>16	0.20

HP-Value vs. Discharge



HP-Value vs. Discharge



Conclusions

- HP-Value is a good tool to predict the following in bedrock:
  - Well Yield
  - Specific Capacity
  - Seepage
- Good tool to estimate seepage into construction sites.
- Always need more data points!