MACCAFERRI

Start designing the change with our new software!

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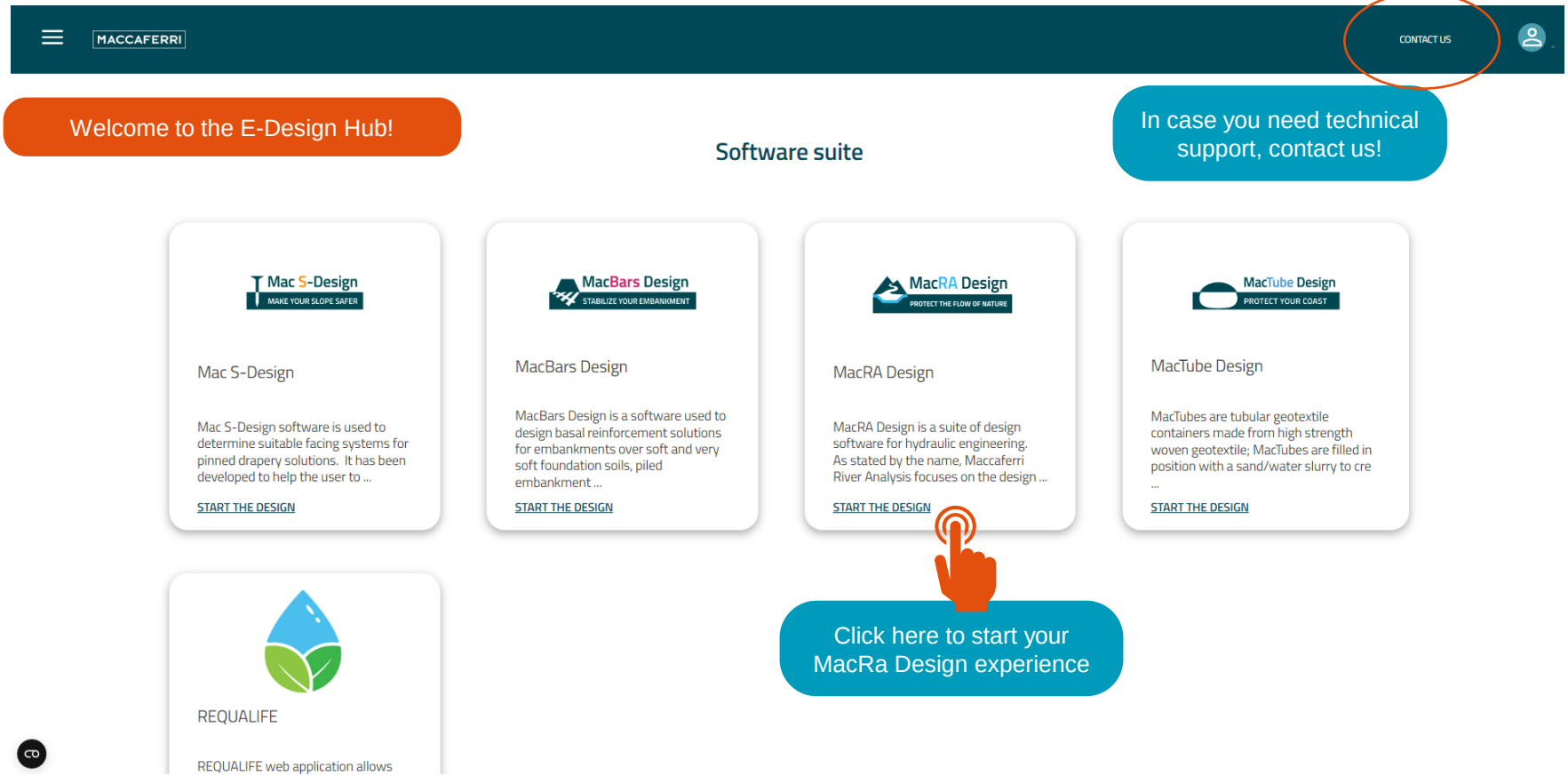
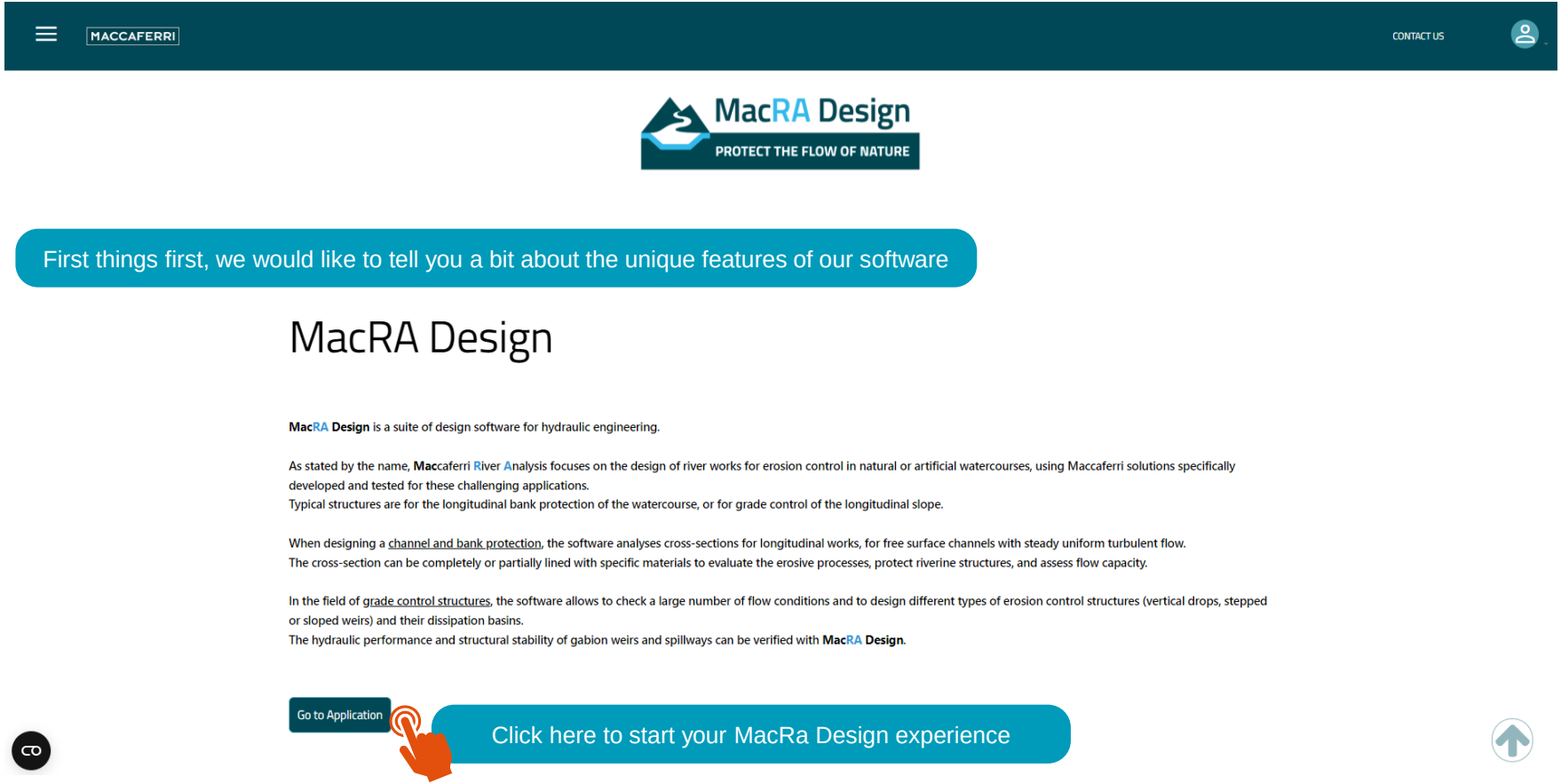
E-DESIGN HUB


MACCAFERRI
CONTACT US
Welcome to the E-Design Hub!
In case you need technical support, contact us!
Software suite
Mac S-Design
MAKE YOUR SLOPE SAFER
Mac S-Design
Mac S-Design software is used to determine suitable facing systems for pinned drapery solutions. It has been developed to help the user to ...
START THE DESIGN
MacBars Design
STABILIZE YOUR EMBANKMENT
MacBars Design
MacBars Design is a software used to design basal reinforcement solutions for embankments over soft and very soft foundation soils, piled embankment ...
START THE DESIGN
MacRA Design
PROTECT THE FLOW OF NATURE
MacRA Design
MacRA Design is a suite of design software for hydraulic engineering. As stated by the name, Maccaferri River Analysis focuses on the design ...
START THE DESIGN
MacTube Design
PROTECT YOUR COAST
MacTube Design
MacTubes are tubular geotextile containers made from high strength woven geotextile; MacTubes are filled in position with a sand/water slurry to cre ...
START THE DESIGN
REQUALIFE
REQUALIFE web application allows
Click here to start your MacRa Design experience

MACRA DESIGN



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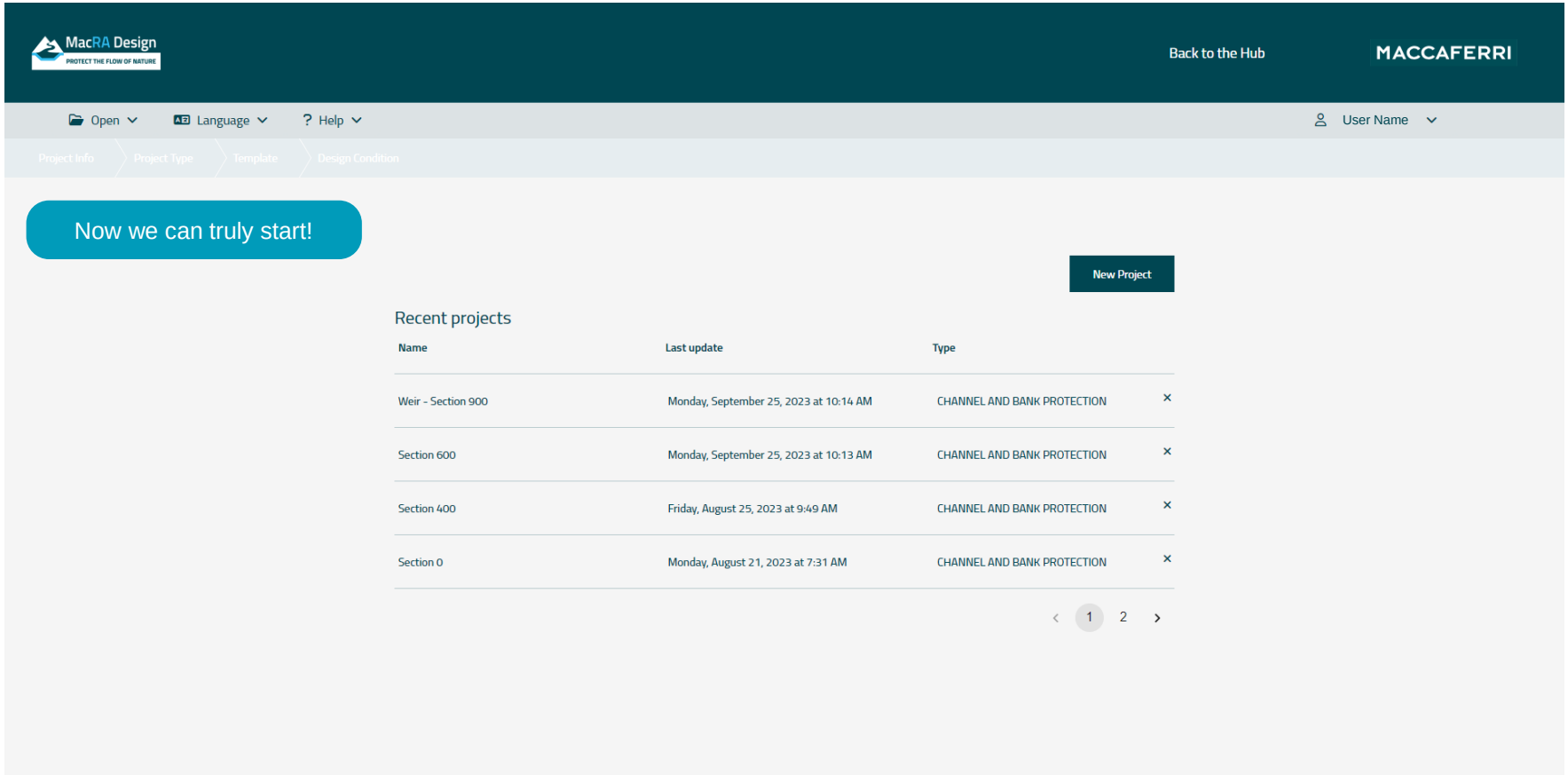
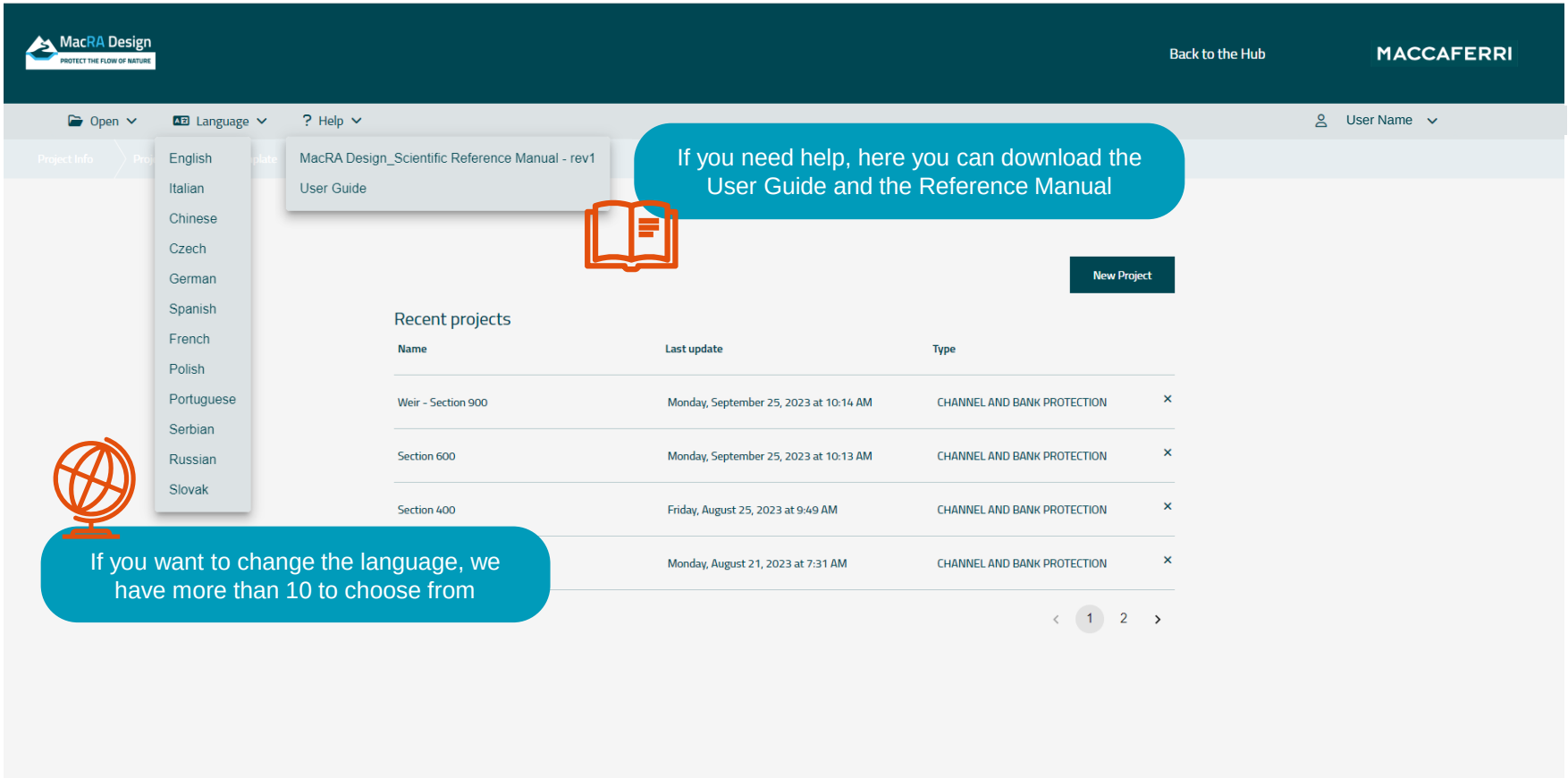
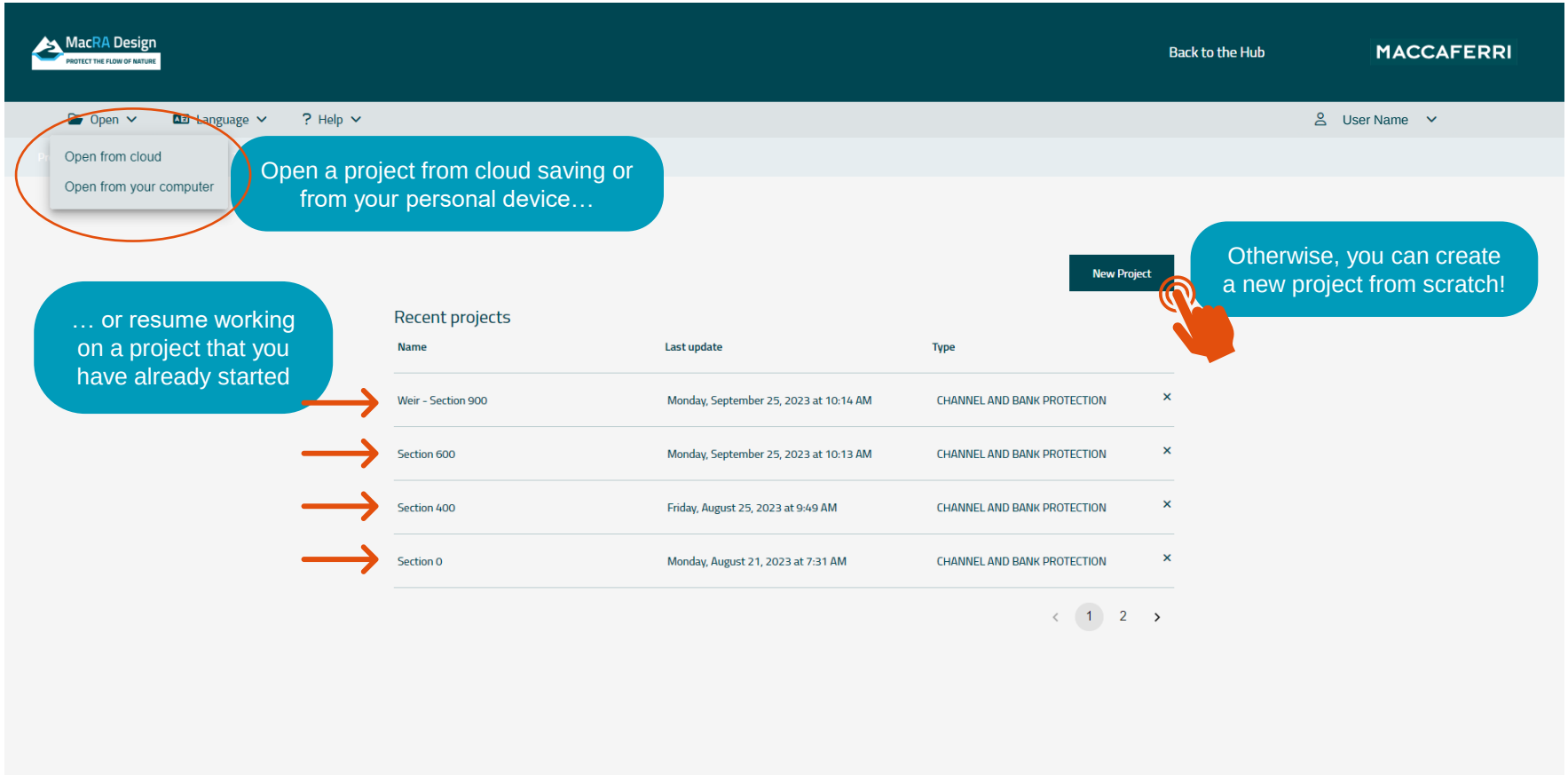


MACRA DESIGN – MAIN PAGE



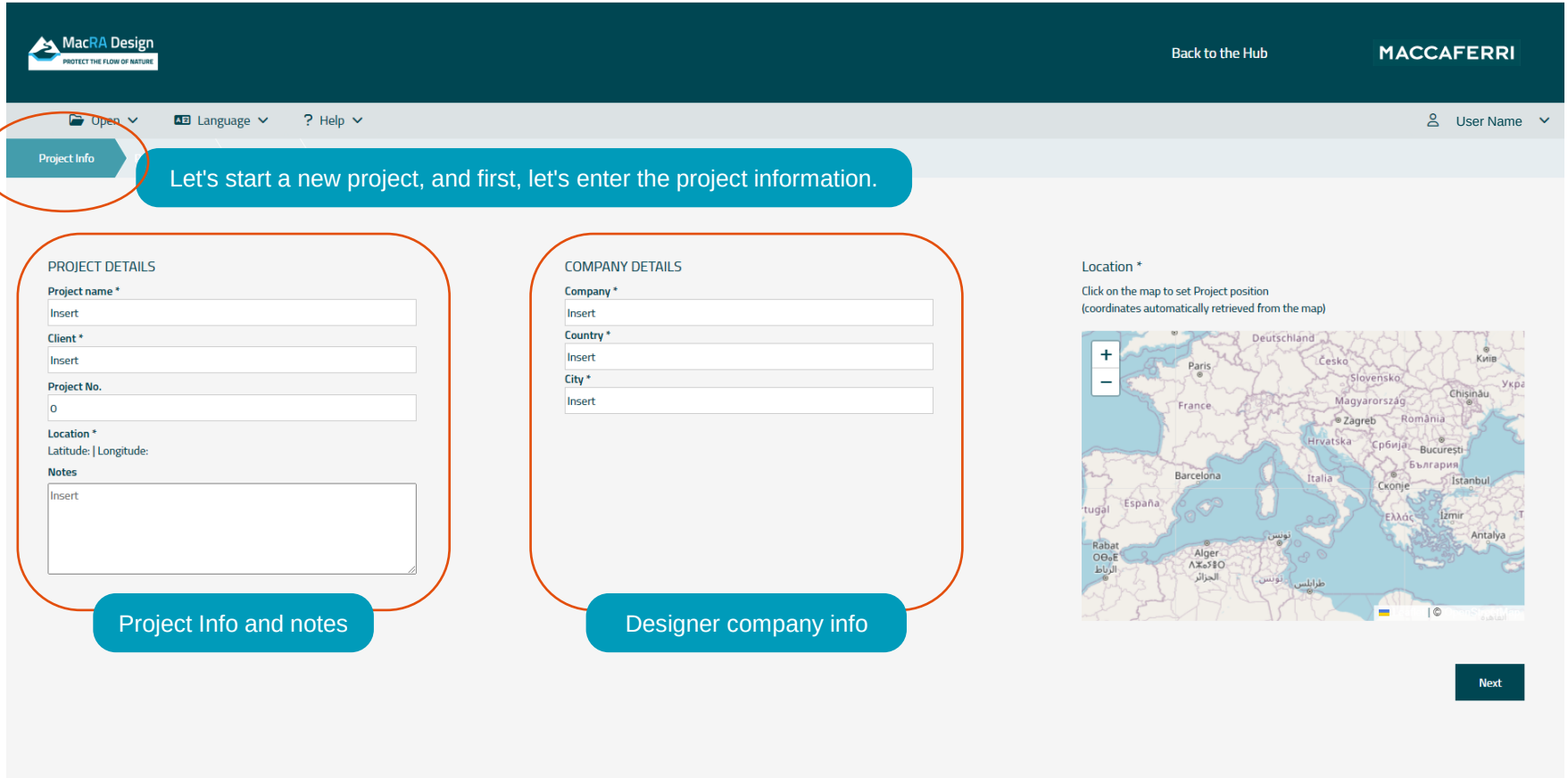
MACRA DESIGN – MAIN PAGE



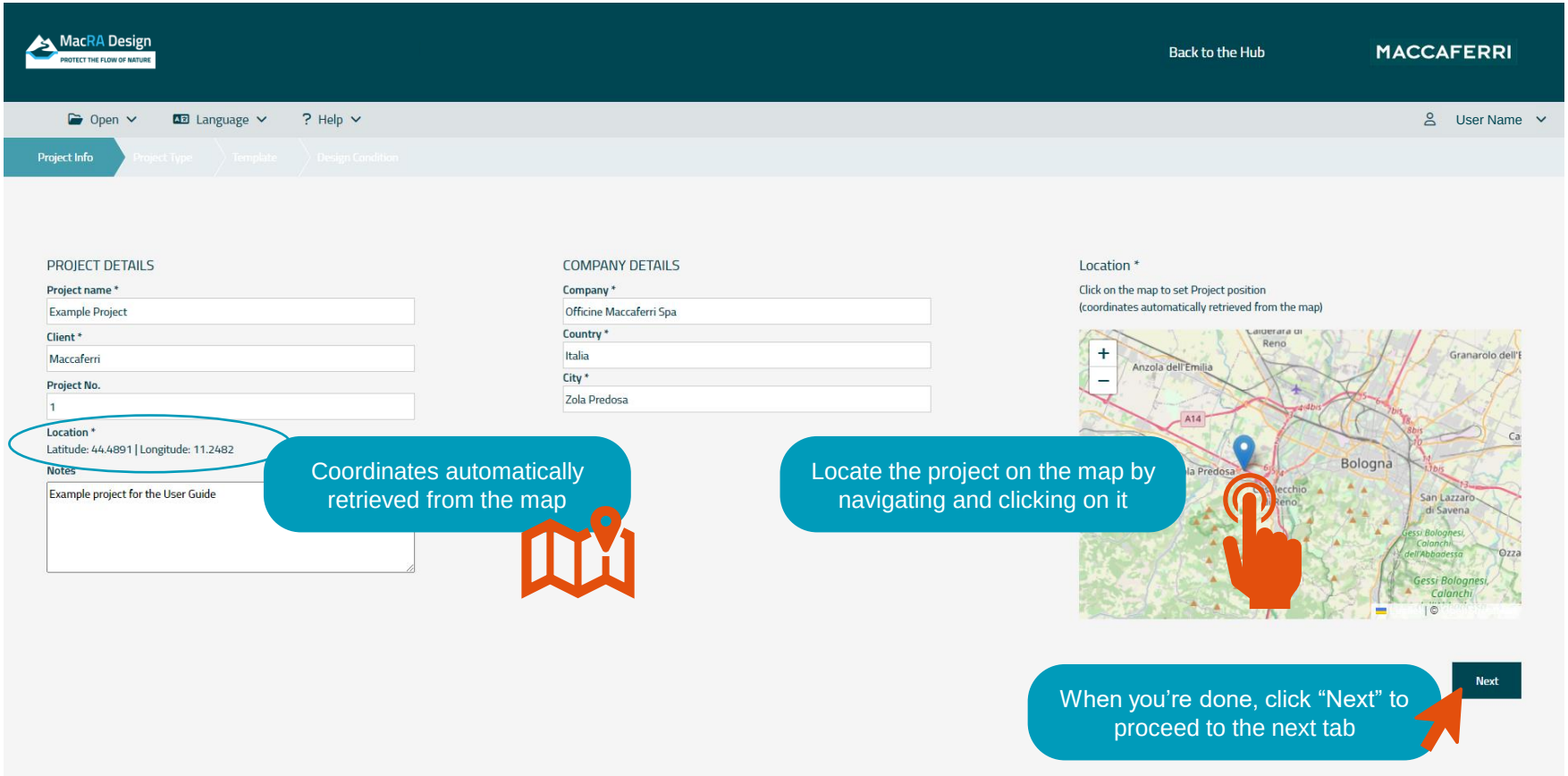
MACCAFERRI

CREATION OF A NEW PROJECT

1.1 CREATION OF A NEW PROJECT – PROJECT INFO



1.1 CREATION OF A NEW PROJECT – PROJECT INFO



1.2 CREATION OF A NEW PROJECT – PROJECT TYPE

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PROTECT THE FLOW OF NATURE

Back to the Hub

MACCAFERRI

Open | Language | Help | User Name

Project Info | Project Type | Template | Design Condition

Here you can choose between two main project types

CHANNEL AND BANK PROTECTION

Cross section analysis for longitudinal works: free surface channels with steady uniform turbulent flow. The cross-section can be completely or partially lined with specific materials to evaluate the erosive processes, protect riverine structures, and assess flow capacity.

GRADE CONTROL STRUCTURES

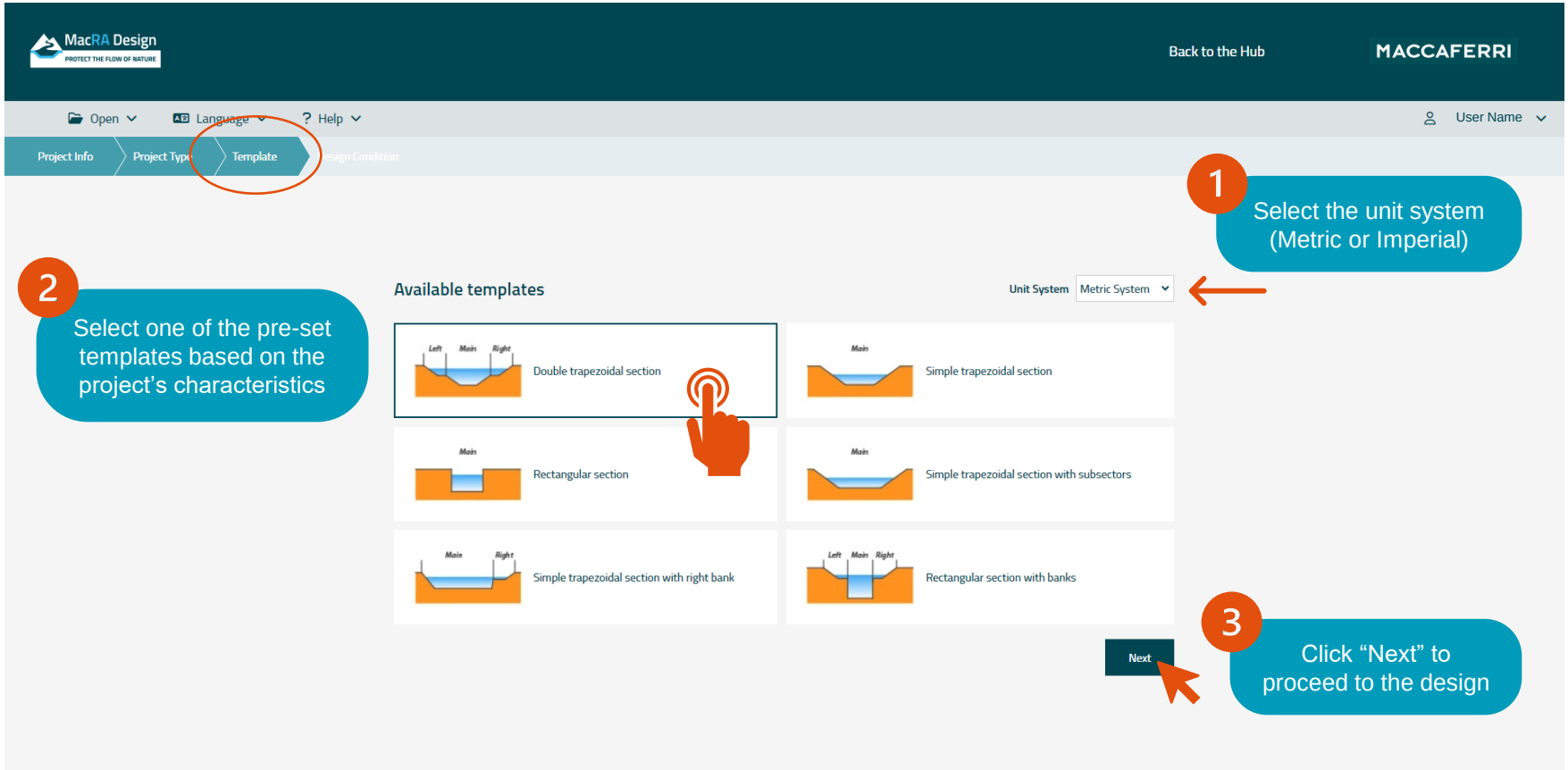
Check many flow conditions and design different types of erosion control structures (vertical drops, stepped or sloped weirs) and their dissipation basins. Evaluate hydraulic performance and structural stability of gabion weirs and spillways.

Click “Next” to proceed to the Template selection

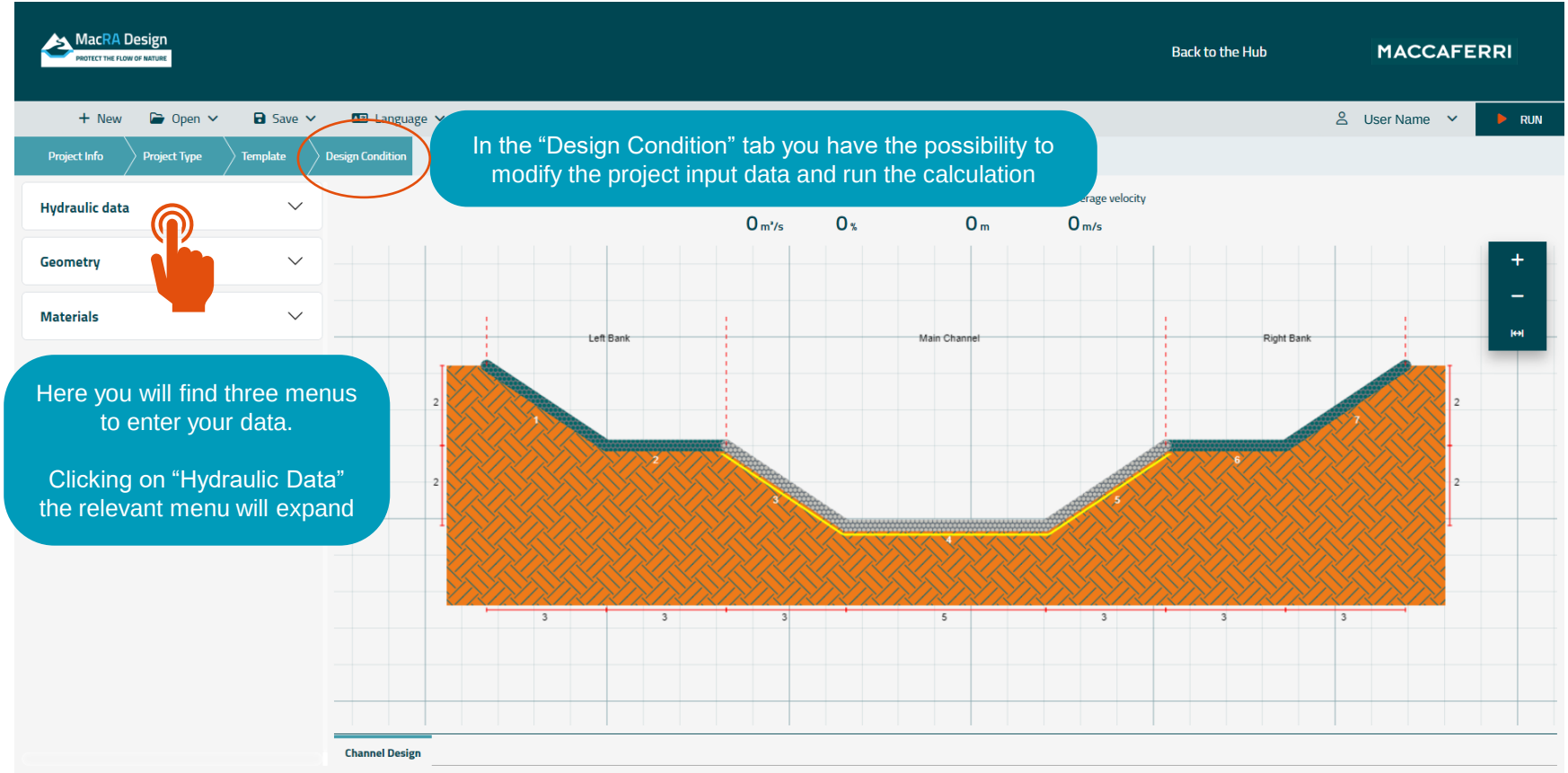
Next

CHANNEL AND BANK PROTECTION

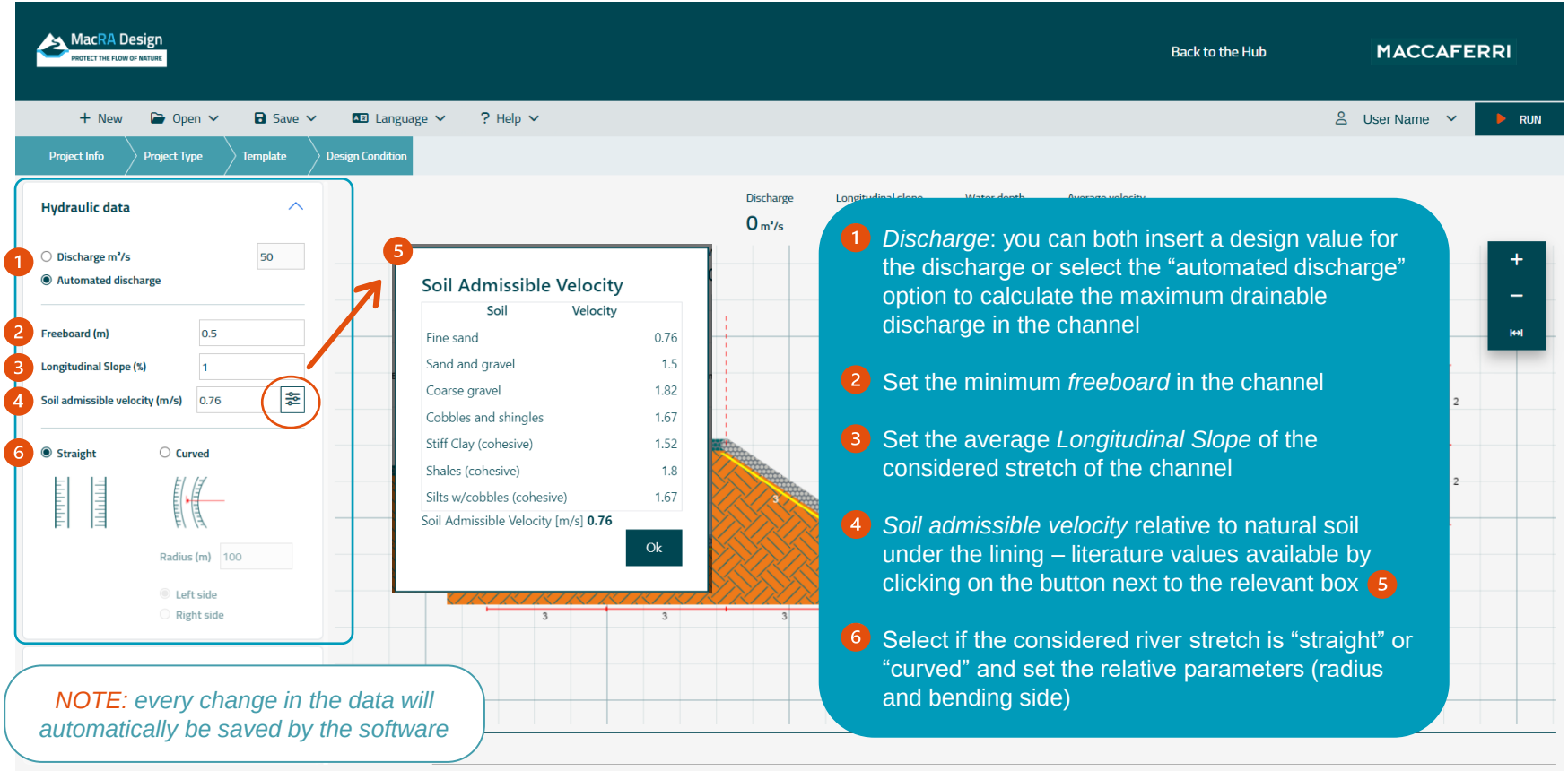
2.1 CHANNEL AND BANK PROTECTION – TEMPLATE



2.2 CHANNEL AND BANK PROTECTION – DESIGN CONDITION



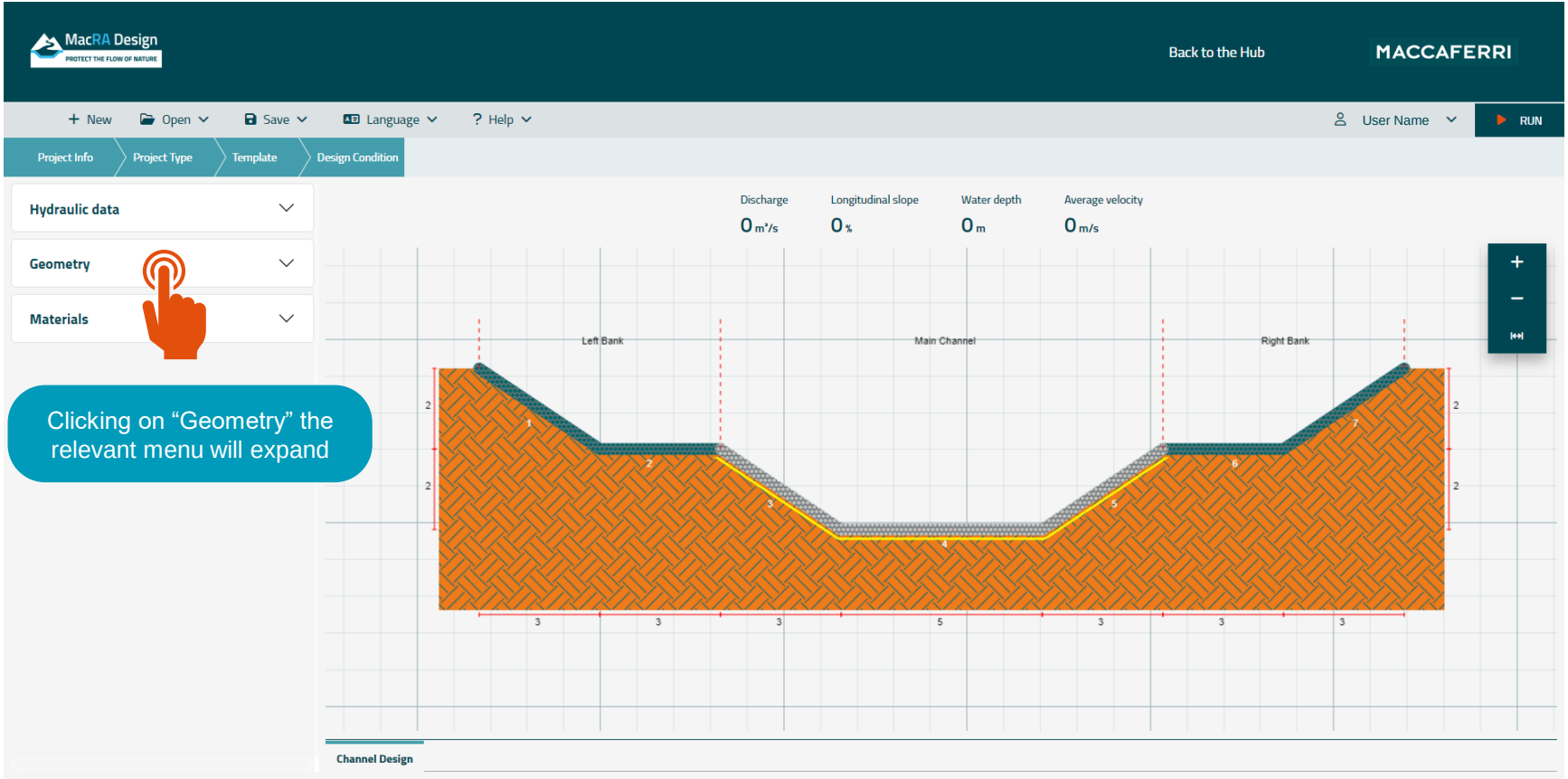
2.2.1 CHANNEL AND BANK PROTECTION – HYDRAULIC DATA



1. *Discharge*: you can both insert a design value for the discharge or select the "automated discharge" option to calculate the maximum drainable discharge in the channel
2. Set the minimum *freeboard* in the channel
3. Set the average *Longitudinal Slope* of the considered stretch of the channel
4. *Soil admissible velocity* relative to natural soil under the lining – literature values available by clicking on the button next to the relevant box 5
6. Select if the considered river stretch is "straight" or "curved" and set the relative parameters (radius and bending side)

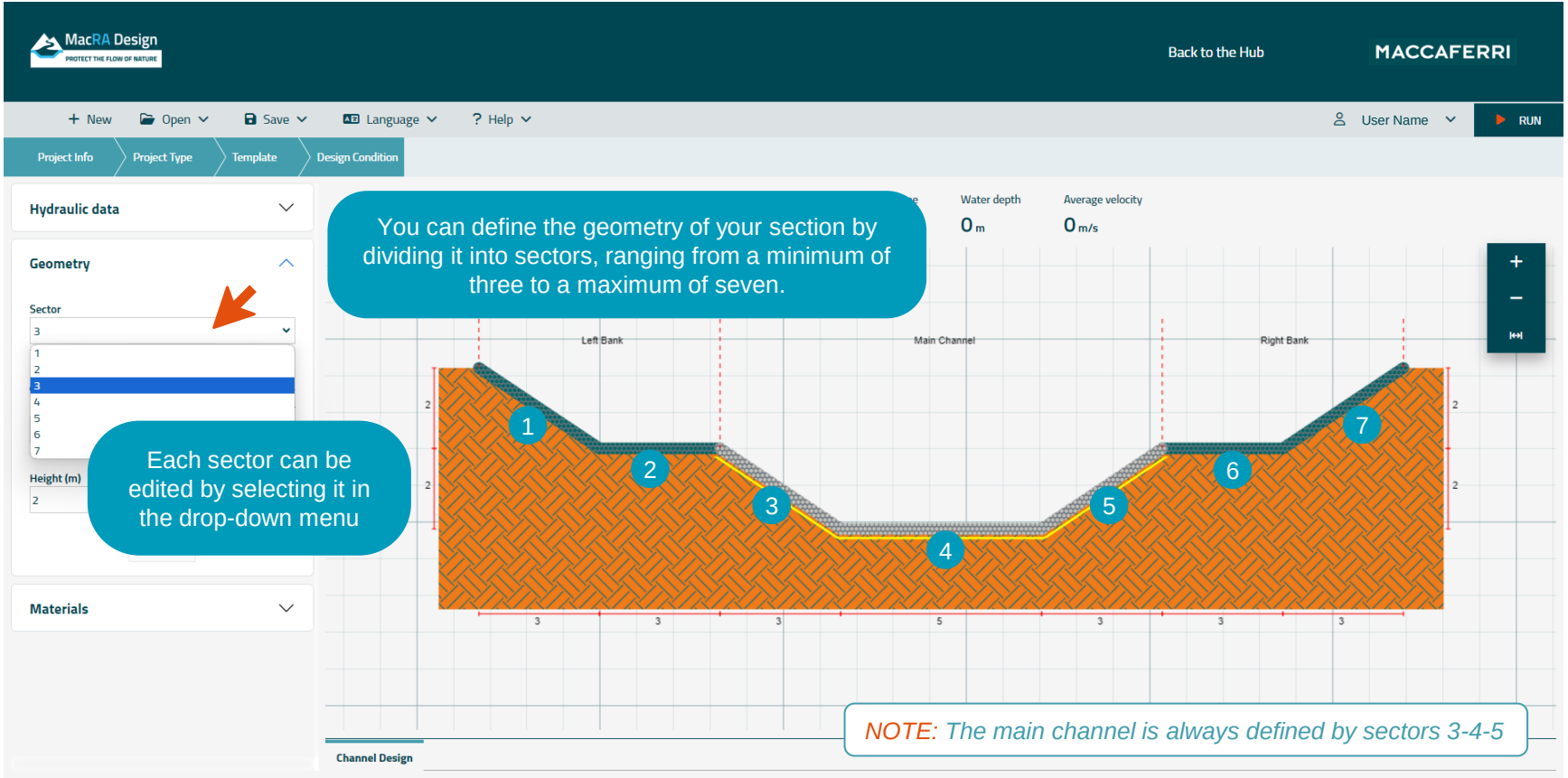
NOTE: every change in the data will automatically be saved by the software

2.2.2 CHANNEL AND BANK PROTECTION – GEOMETRY



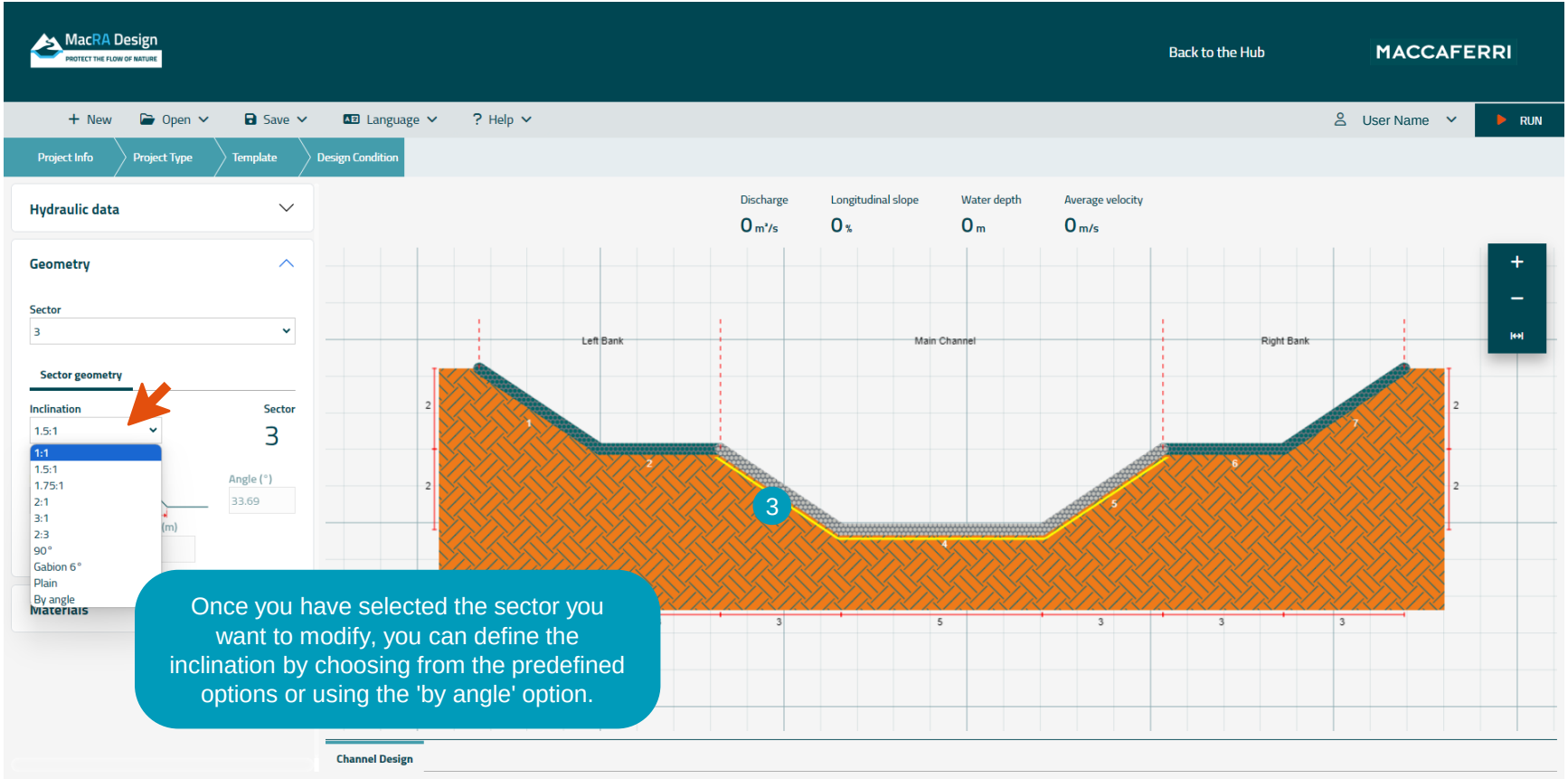
Clicking on “Geometry” the relevant menu will expand

2.2.2 CHANNEL AND BANK PROTECTION – GEOMETRY



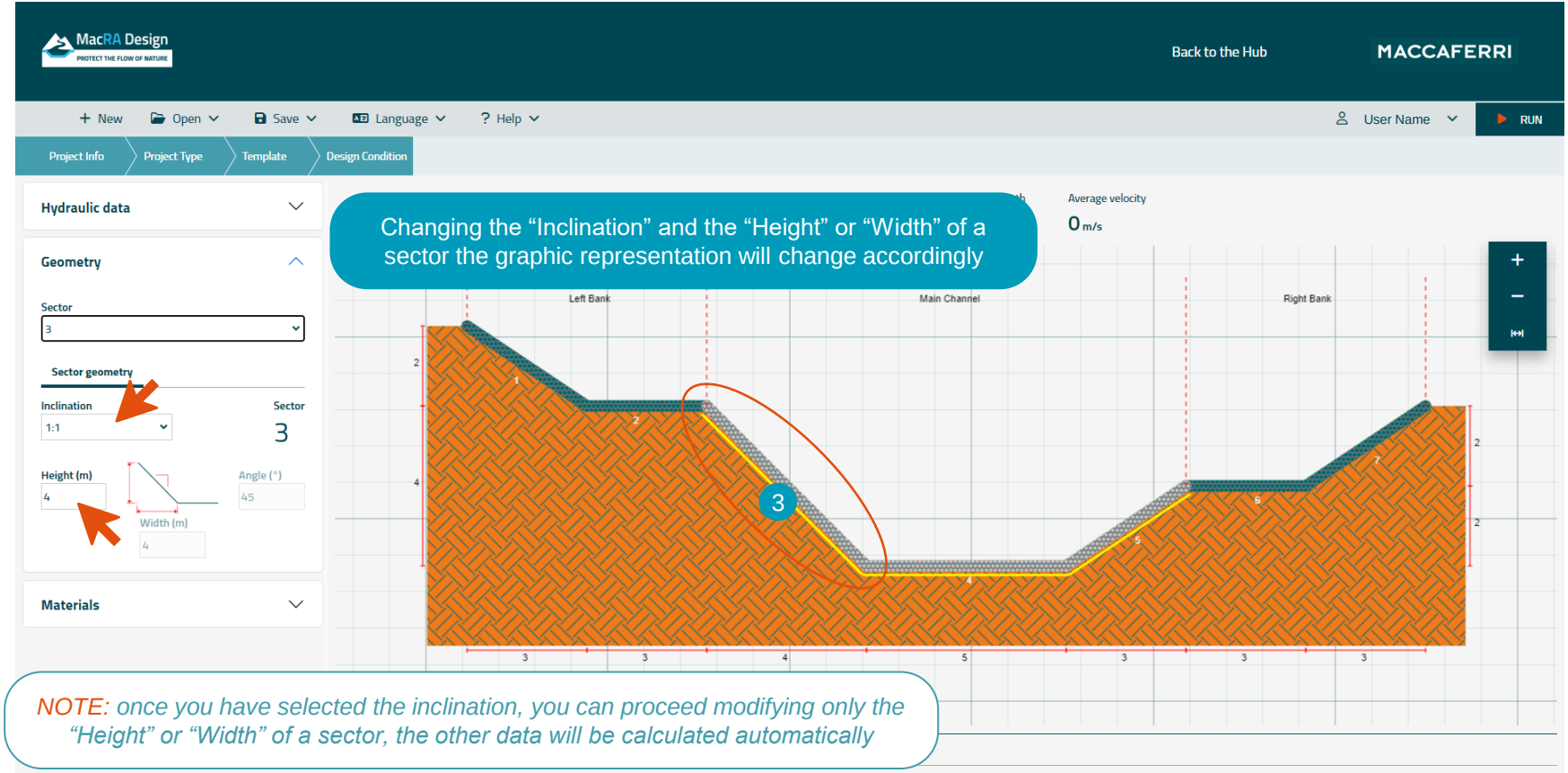
NOTE: The main channel is always defined by sectors 3-4-5

2.2.2 CHANNEL AND BANK PROTECTION – GEOMETRY



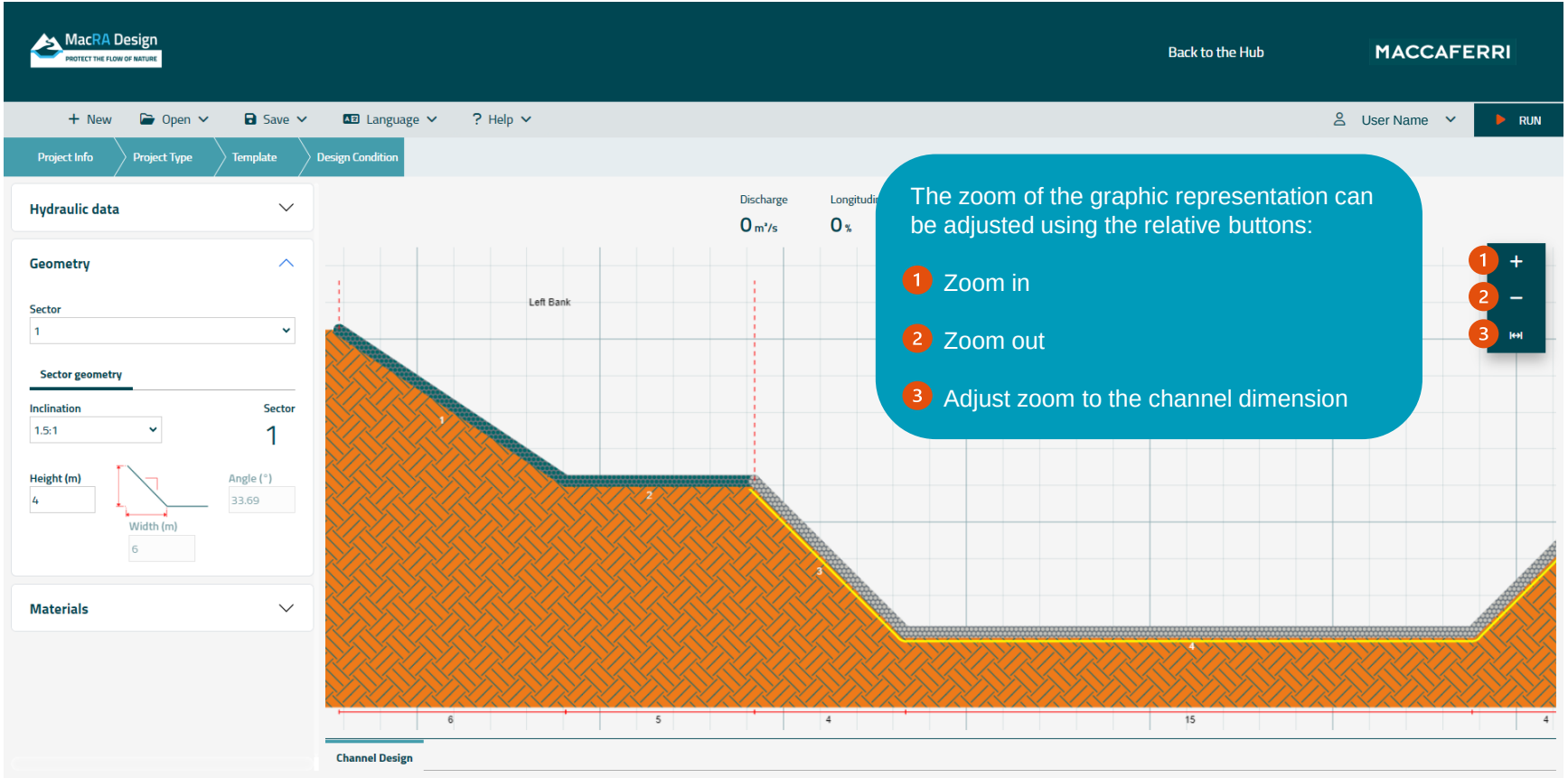
Once you have selected the sector you want to modify, you can define the inclination by choosing from the predefined options or using the 'by angle' option.

2.2.2 CHANNEL AND BANK PROTECTION – GEOMETRY

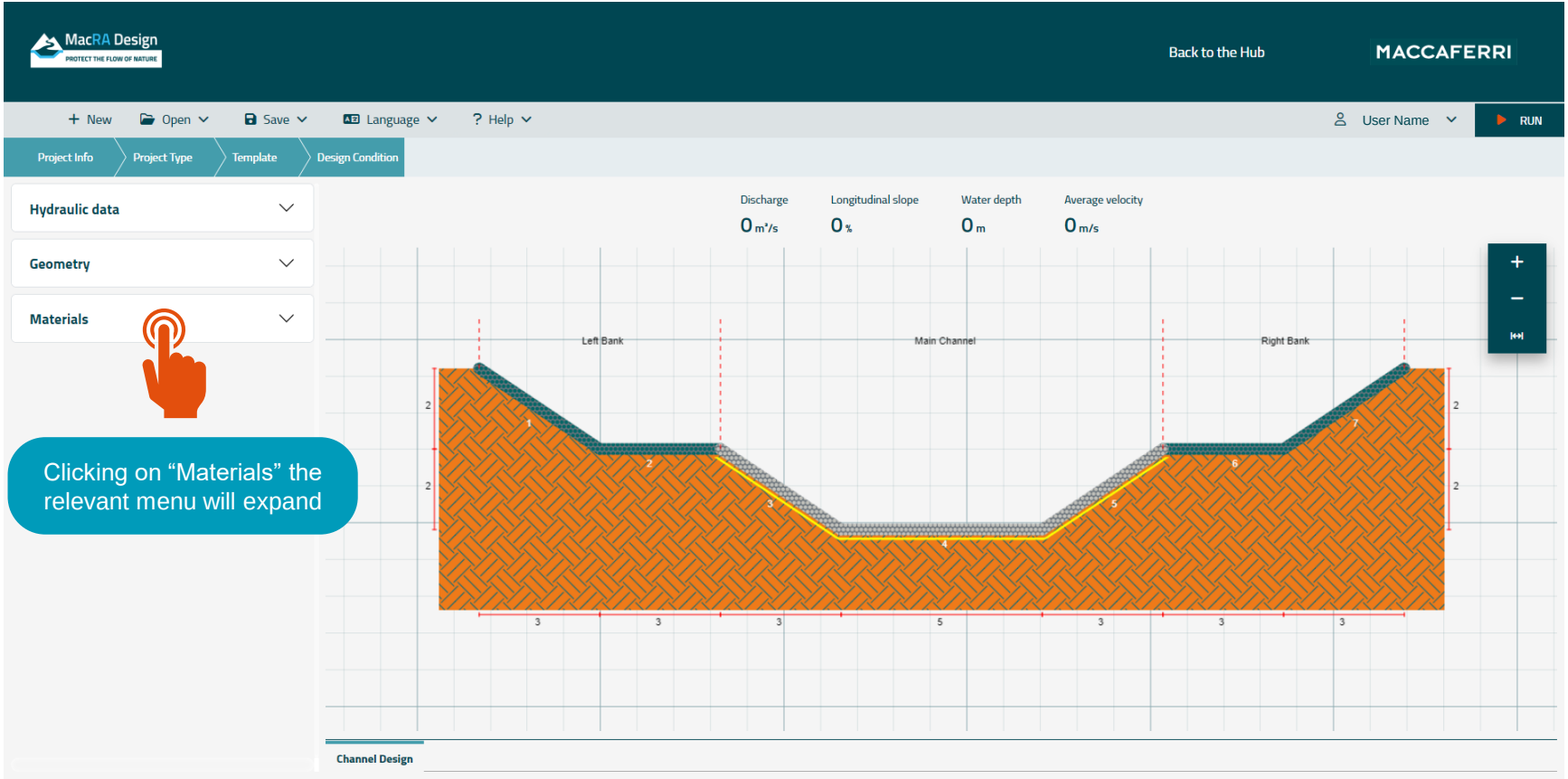


NOTE: once you have selected the inclination, you can proceed modifying only the “Height” or “Width” of a sector, the other data will be calculated automatically

2.2.2 CHANNEL AND BANK PROTECTION – GEOMETRY

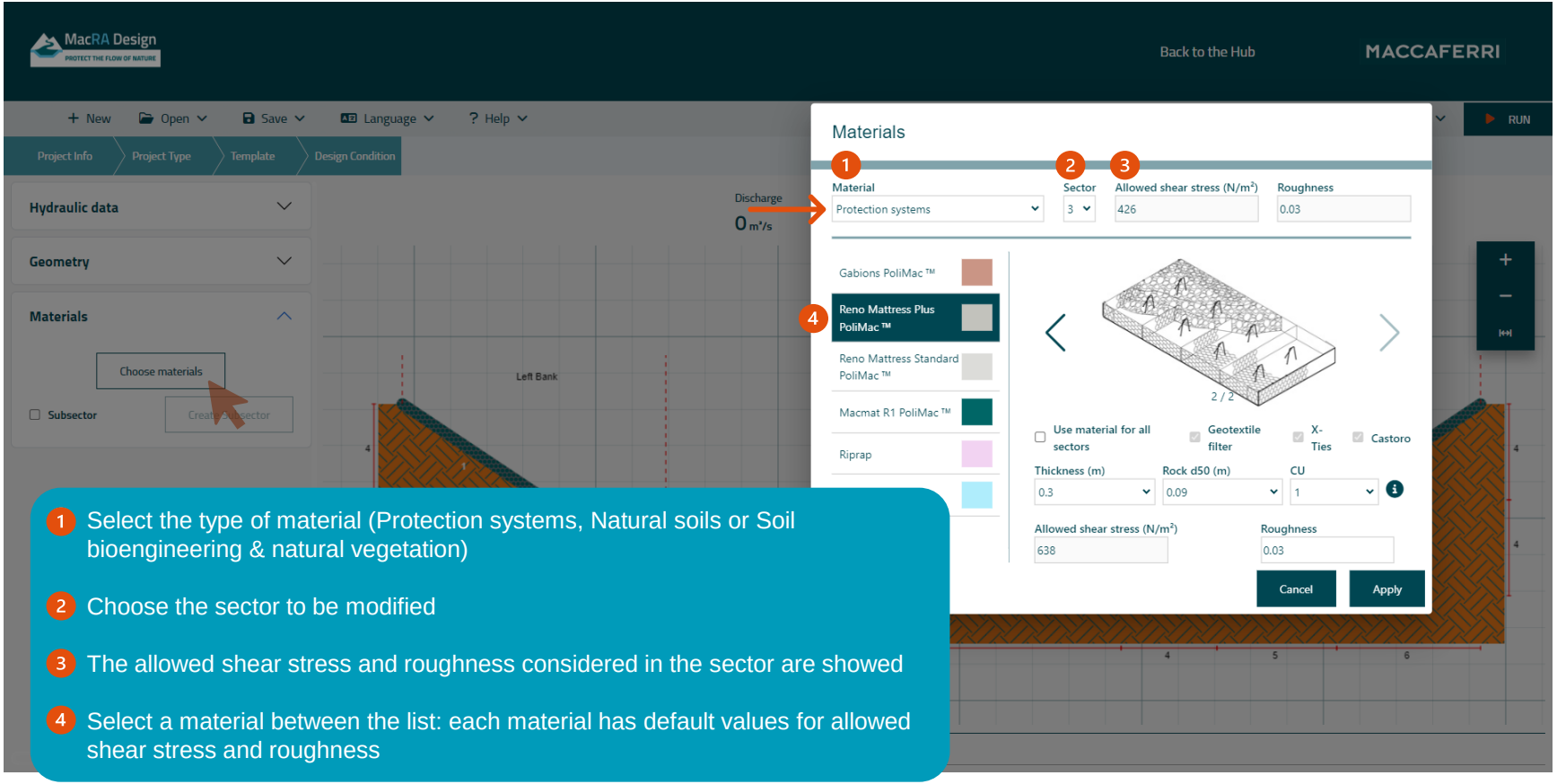


2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS



Clicking on “Materials” the relevant menu will expand

2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS



1. Select the type of material (Protection systems, Natural soils or Soil bioengineering & natural vegetation)
2. Choose the sector to be modified
3. The allowed shear stress and roughness considered in the sector are showed
4. Select a material between the list: each material has default values for allowed shear stress and roughness

2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS

NOTE: In "Protection systems" the value of "Allowed shear stress" cannot be directly modified. This value varies, depending on the material selected, according to:

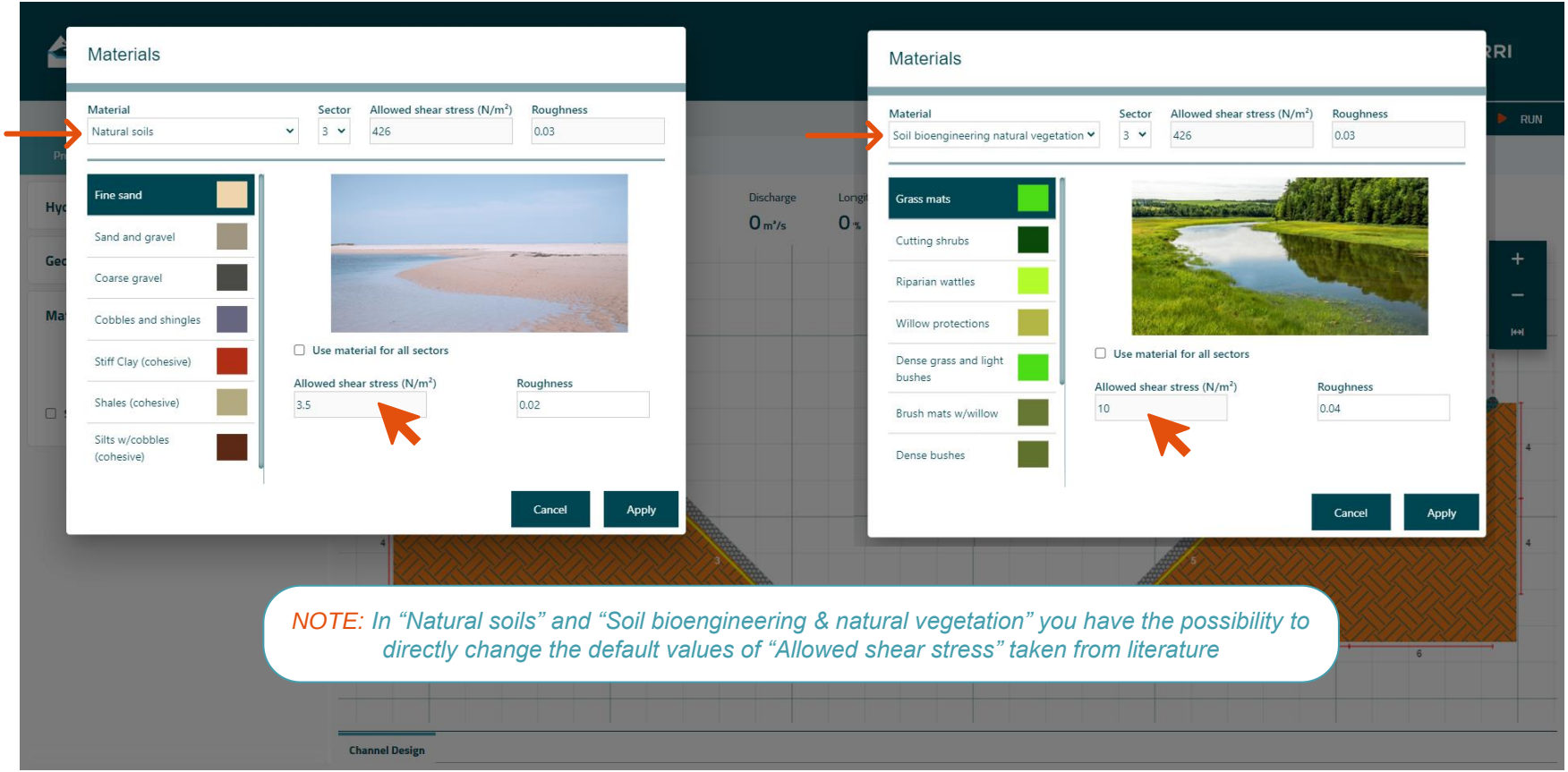
- *User input*
- *Database values*
- *Literature formulations*
- *Research test results*

On the other hand, the "Roughness" value can be modified.

To learn more about each material allowed shear stress you can click on the "info" button!

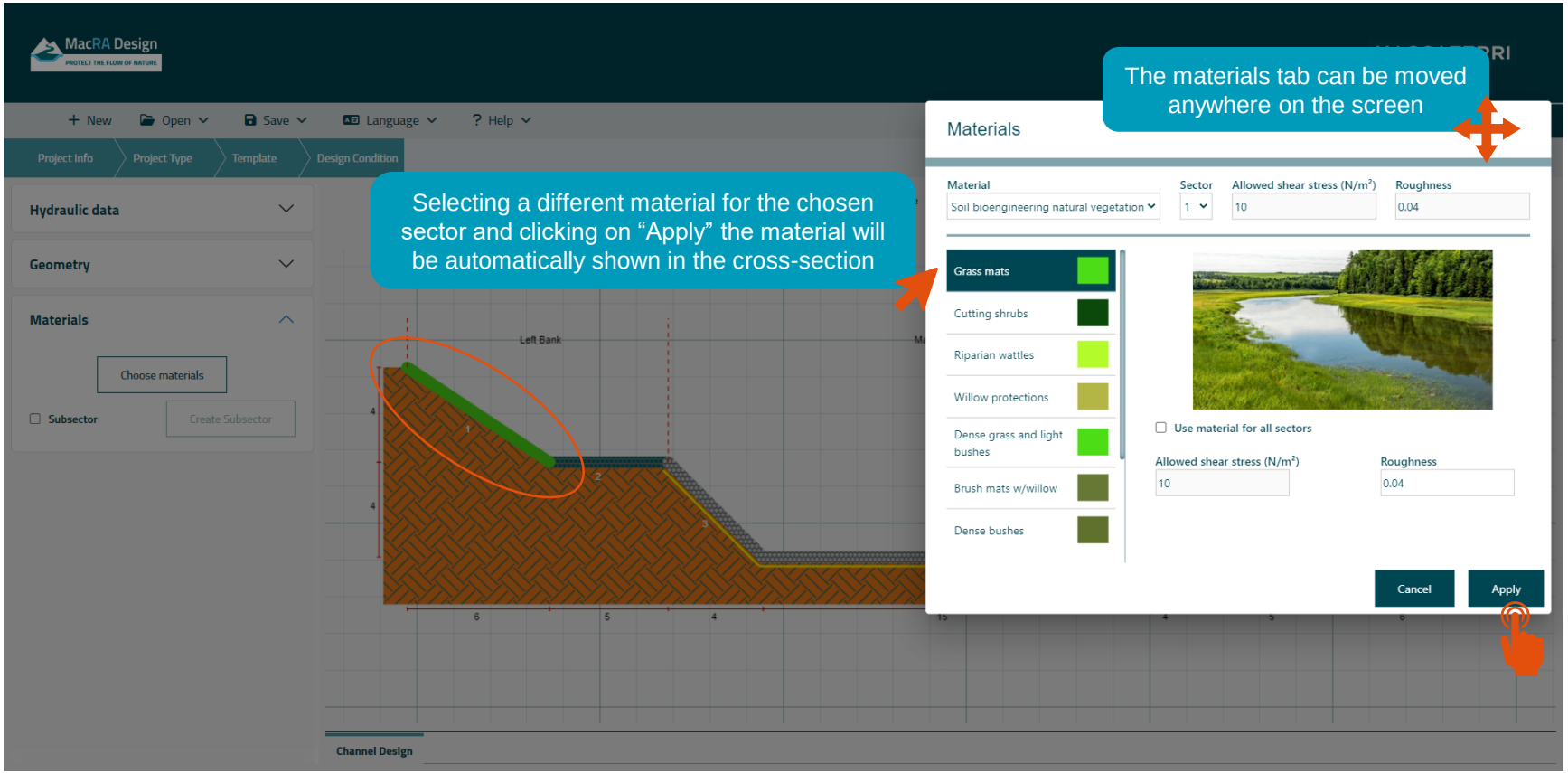
Click on "Apply" to save the selected material for the relevant sector

2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS



NOTE: In "Natural soils" and "Soil bioengineering & natural vegetation" you have the possibility to directly change the default values of "Allowed shear stress" taken from literature

2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS



2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS

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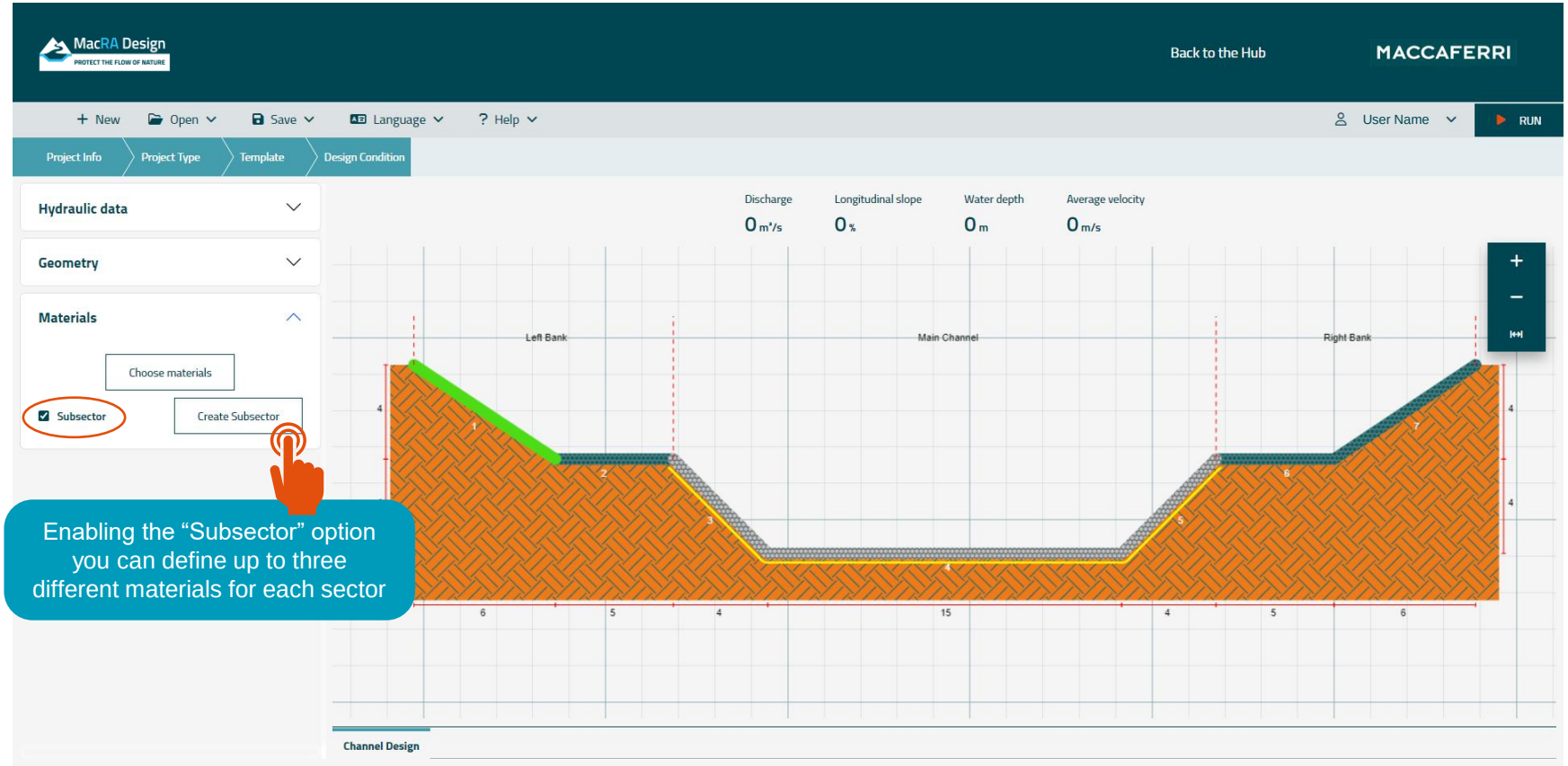
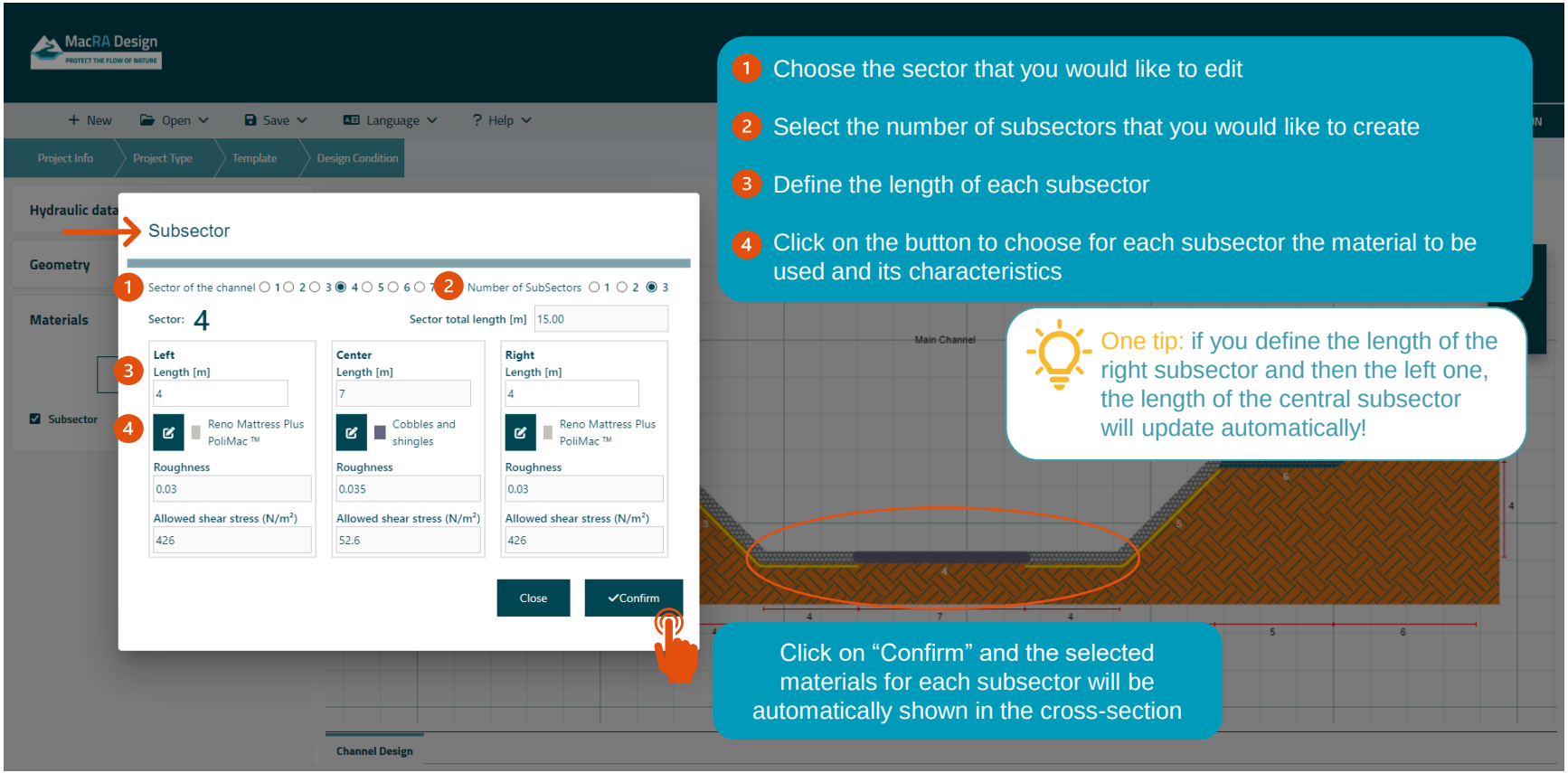


Enabling the “Subsector” option you can define up to three different materials for each sector

2.2.3 CHANNEL AND BANK PROTECTION – MATERIALS

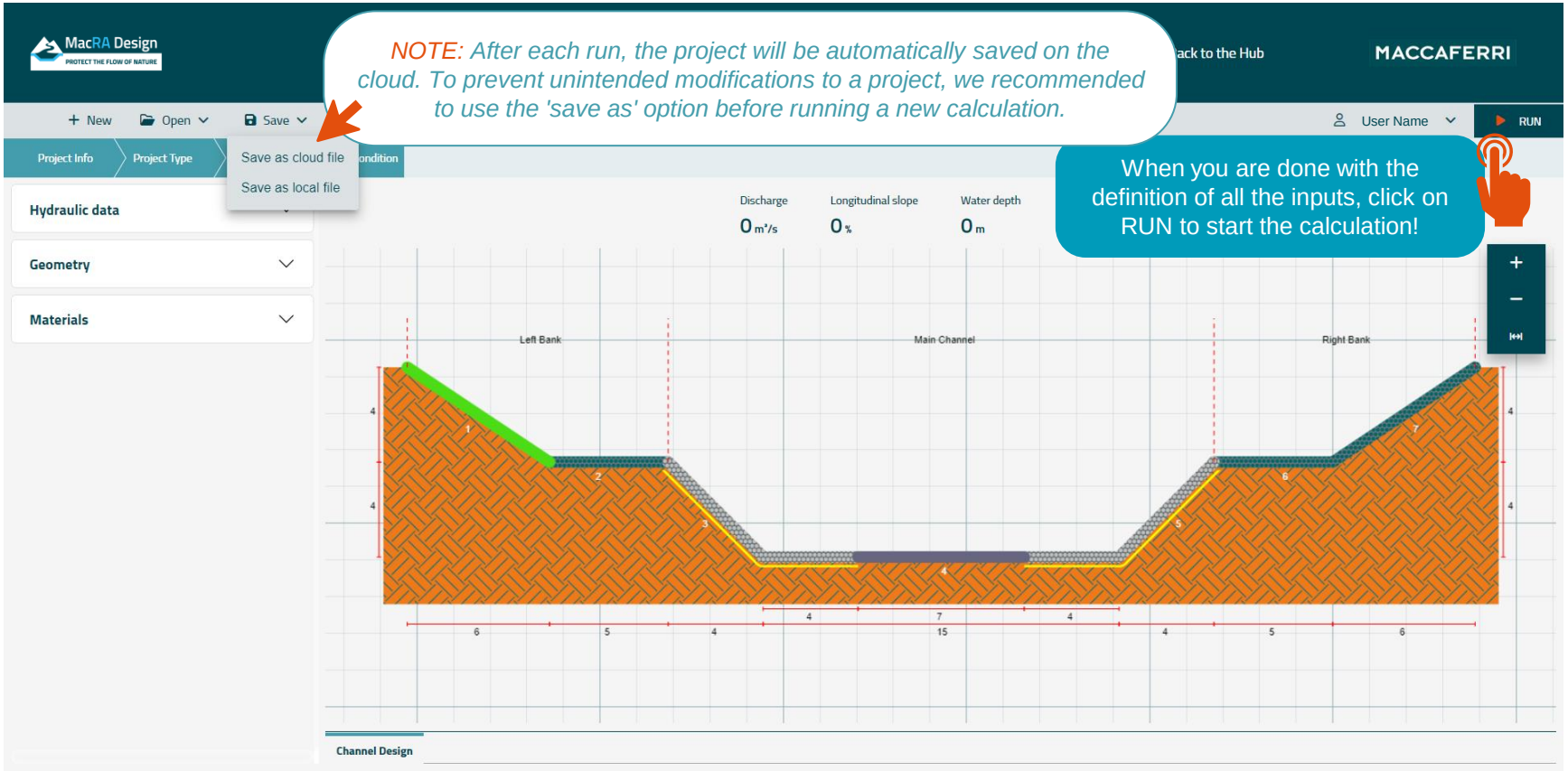


1. Choose the sector that you would like to edit
2. Select the number of subsectors that you would like to create
3. Define the length of each subsector
4. Click on the button to choose for each subsector the material to be used and its characteristics

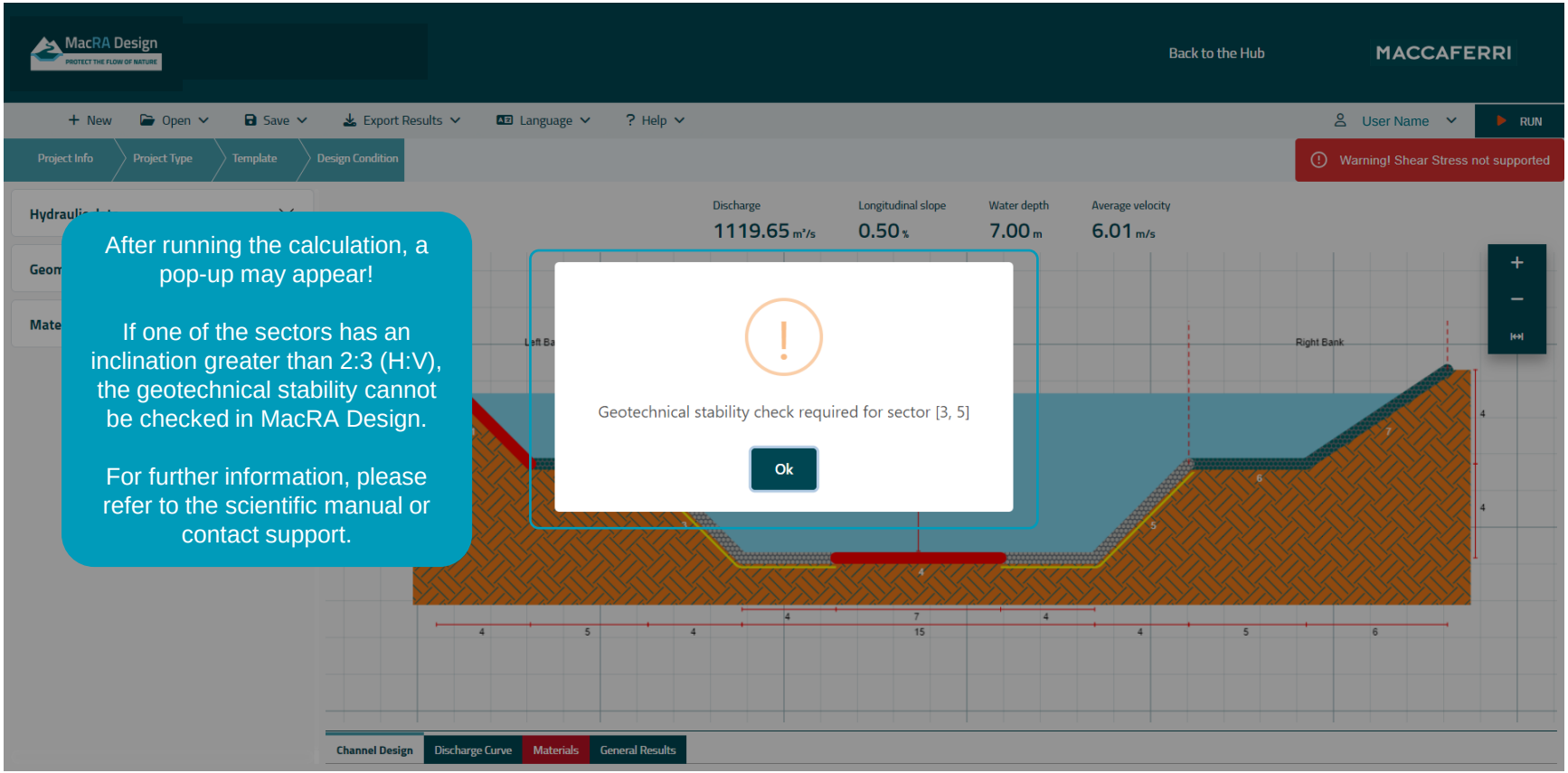
One tip: if you define the length of the right subsector and then the left one, the length of the central subsector will update automatically!

Click on “Confirm” and the selected materials for each subsector will be automatically shown in the cross-section

2.3 CHANNEL AND BANK PROTECTION – CALCULATION



2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS

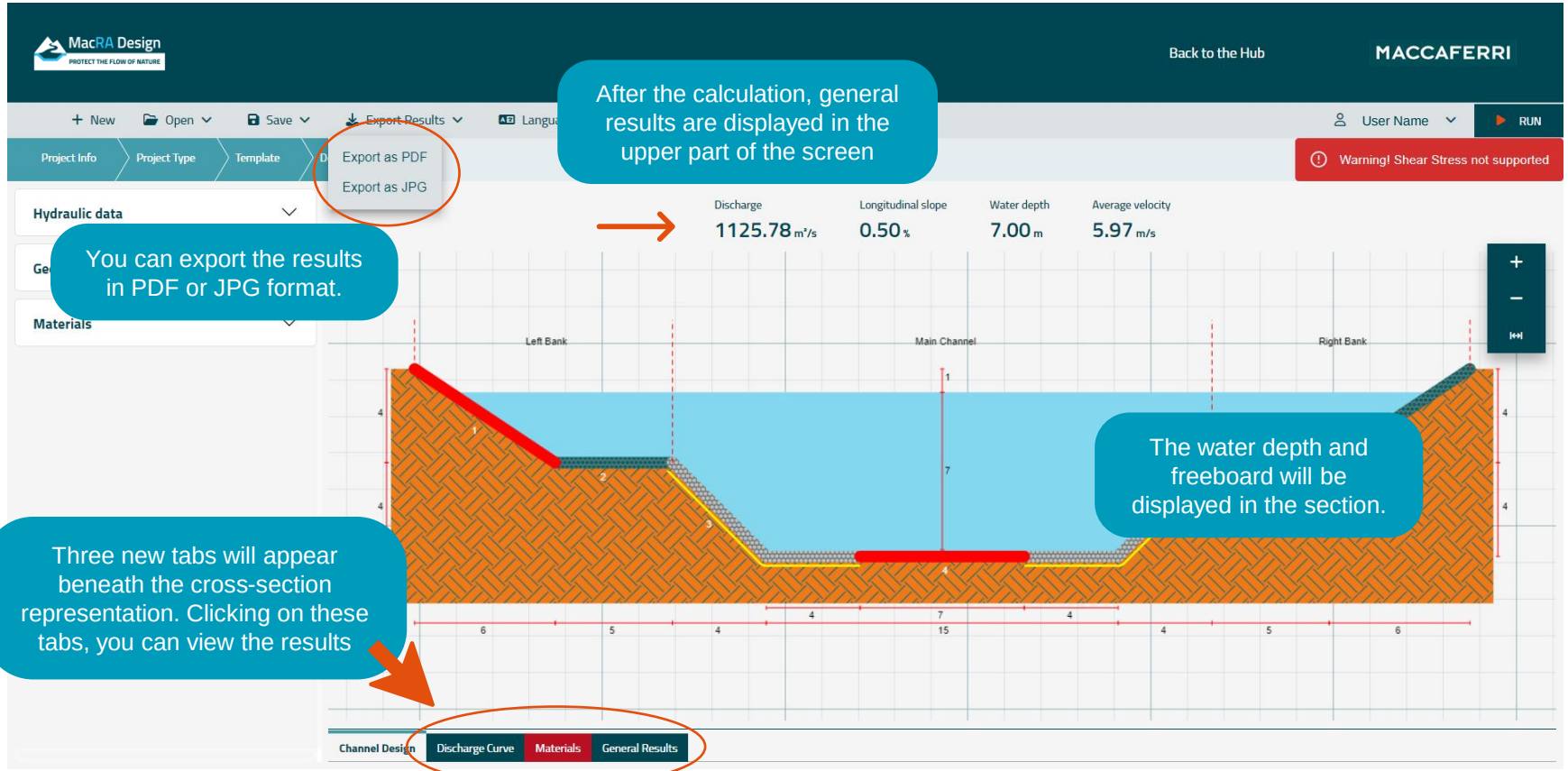


After running the calculation, a pop-up may appear!

If one of the sectors has an inclination greater than 2:3 (H:V), the geotechnical stability cannot be checked in MacRA Design.

For further information, please refer to the scientific manual or contact support.

2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS

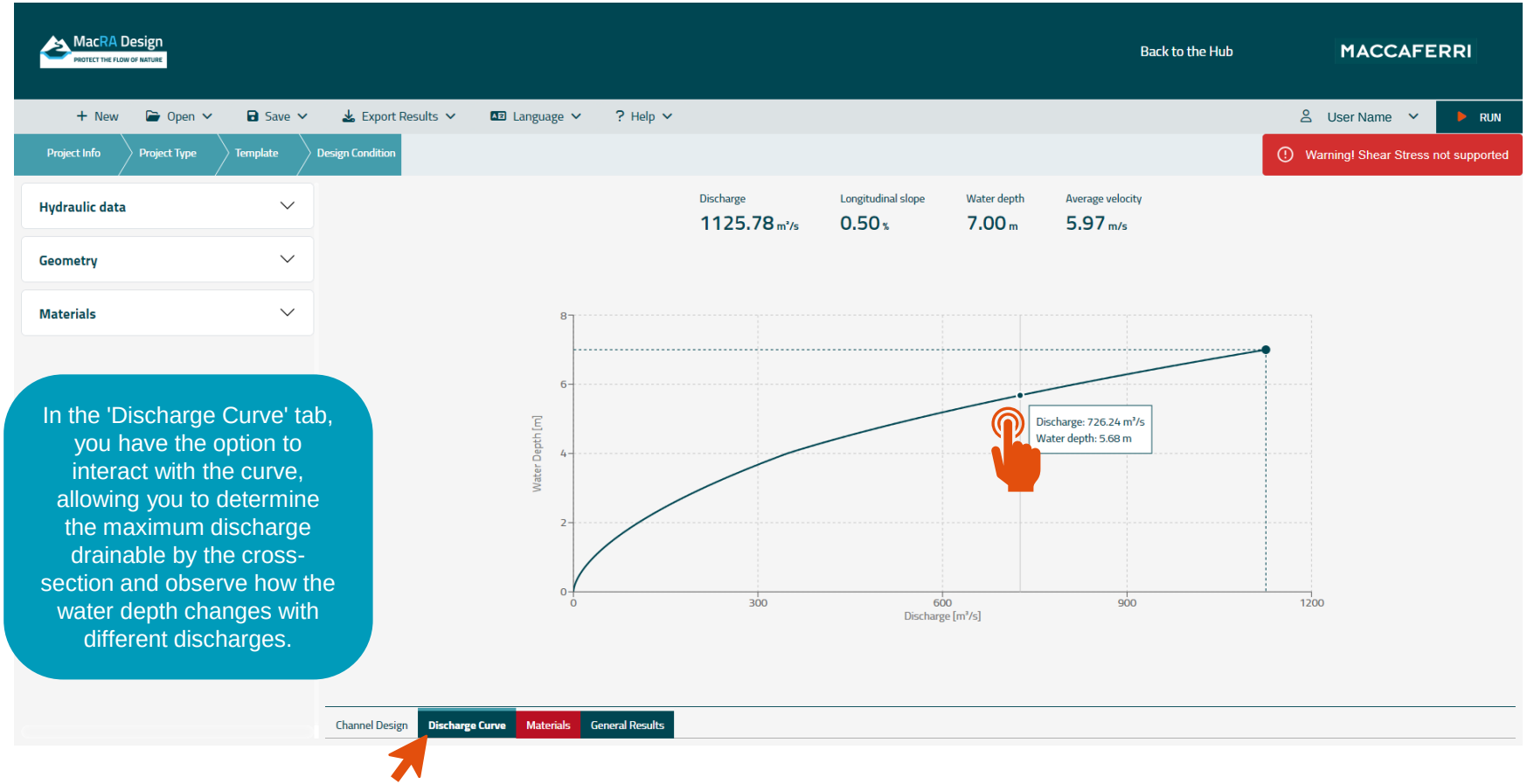


2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS

If any of the selected materials cannot withstand the calculated shear stress:

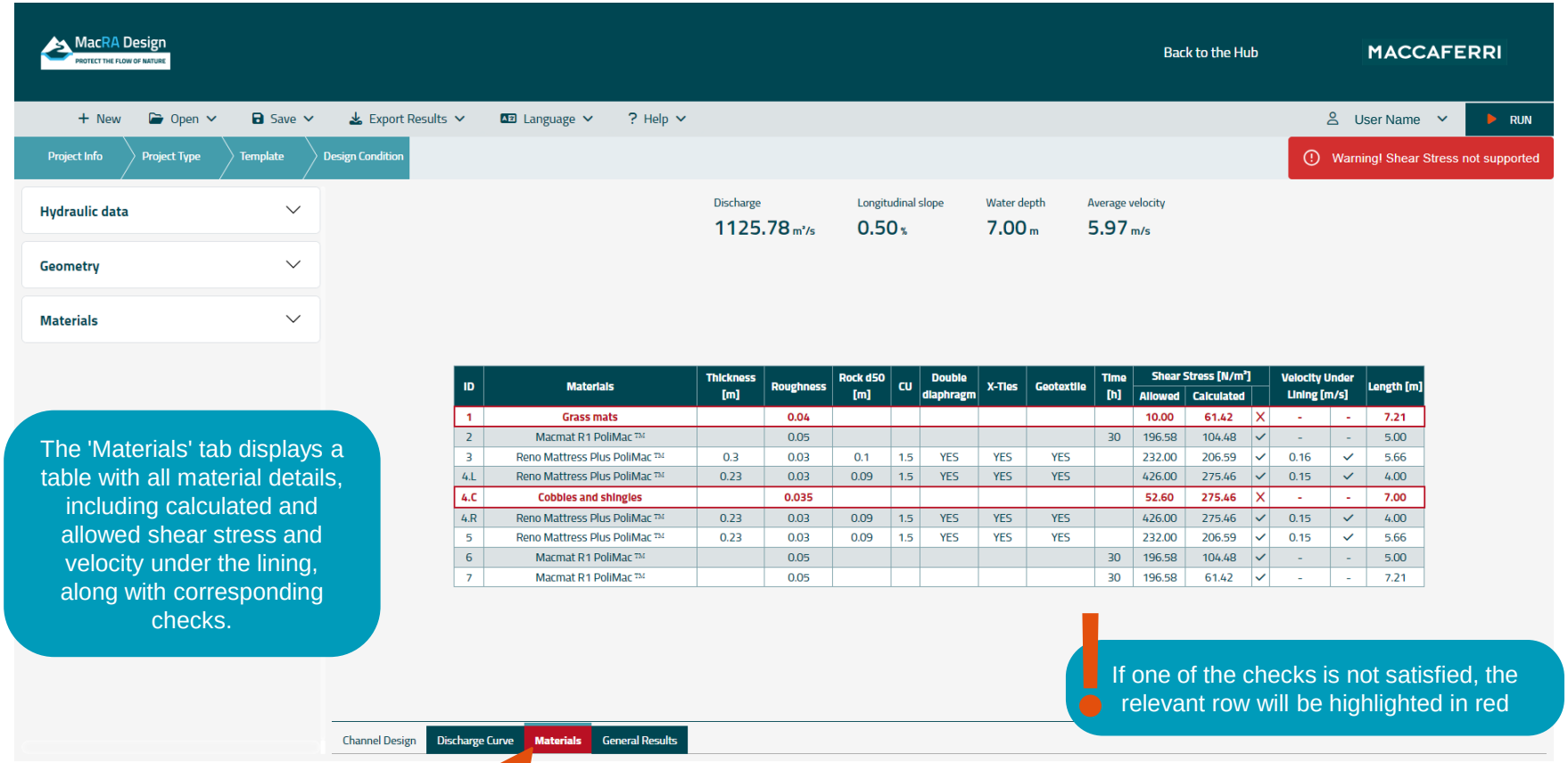
- A warning will appear in the top right corner.
- The corresponding sector or subsector will turn red
- The relevant tab will be colored in red

2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS



In the 'Discharge Curve' tab, you have the option to interact with the curve, allowing you to determine the maximum discharge drainable by the cross-section and observe how the water depth changes with different discharges.

2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS

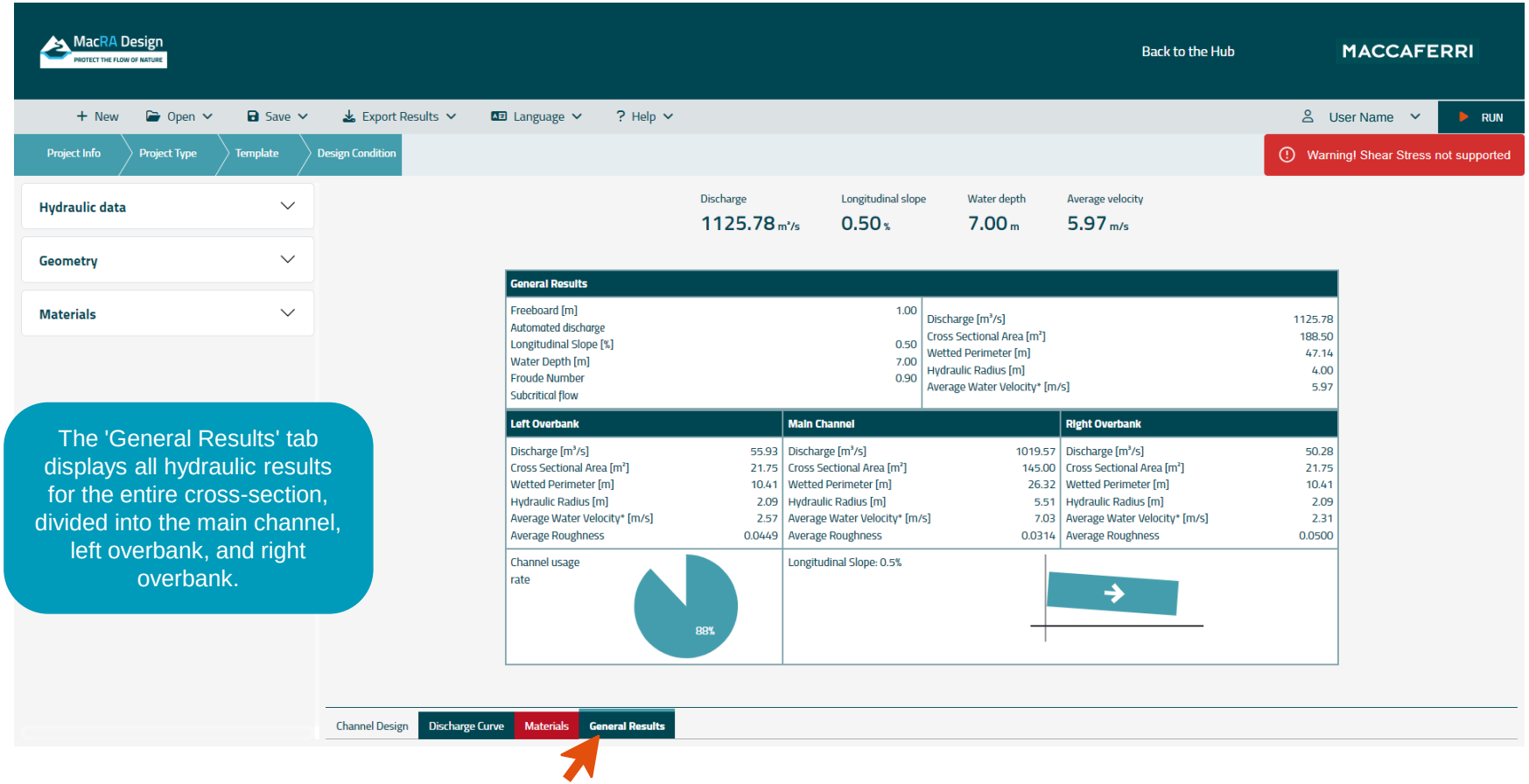


ID	Materials	Thickness [m]	Roughness	Rock d50 [m]	CU	Double diaphragm	X-Ties	Geotextile	Time [h]	Shear Stress [N/m²] Allowed	Shear Stress [N/m²] Calculated		Velocity Under Lining [m/s]		Length [m]
1	Grass mats		0.04							10.00	61.42	✗	-	-	7.21
2	Macmat R1 PoliMac ™		0.05						30	196.58	104.48	✓	-	-	5.00
3	Reno Mattress Plus PoliMac ™	0.3	0.03	0.1	1.5	YES	YES	YES		232.00	206.59	✓	0.16	✓	5.66
4.L	Reno Mattress Plus PoliMac ™	0.23	0.03	0.09	1.5	YES	YES	YES		426.00	275.46	✓	0.15	✓	4.00
4.C	Cobbles and shingles		0.035							52.60	275.46	✗	-	-	7.00
4.R	Reno Mattress Plus PoliMac ™	0.23	0.03	0.09	1.5	YES	YES	YES		426.00	275.46	✓	0.15	✓	4.00
5	Reno Mattress Plus PoliMac ™	0.23	0.03	0.09	1.5	YES	YES	YES		232.00	206.59	✓	0.15	✓	5.66
6	Macmat R1 PoliMac ™		0.05						30	196.58	104.48	✓	-	-	5.00
7	Macmat R1 PoliMac ™		0.05						30	196.58	61.42	✓	-	-	7.21

The 'Materials' tab displays a table with all material details, including calculated and allowed shear stress and velocity under the lining, along with corresponding checks.

If one of the checks is not satisfied, the relevant row will be highlighted in red

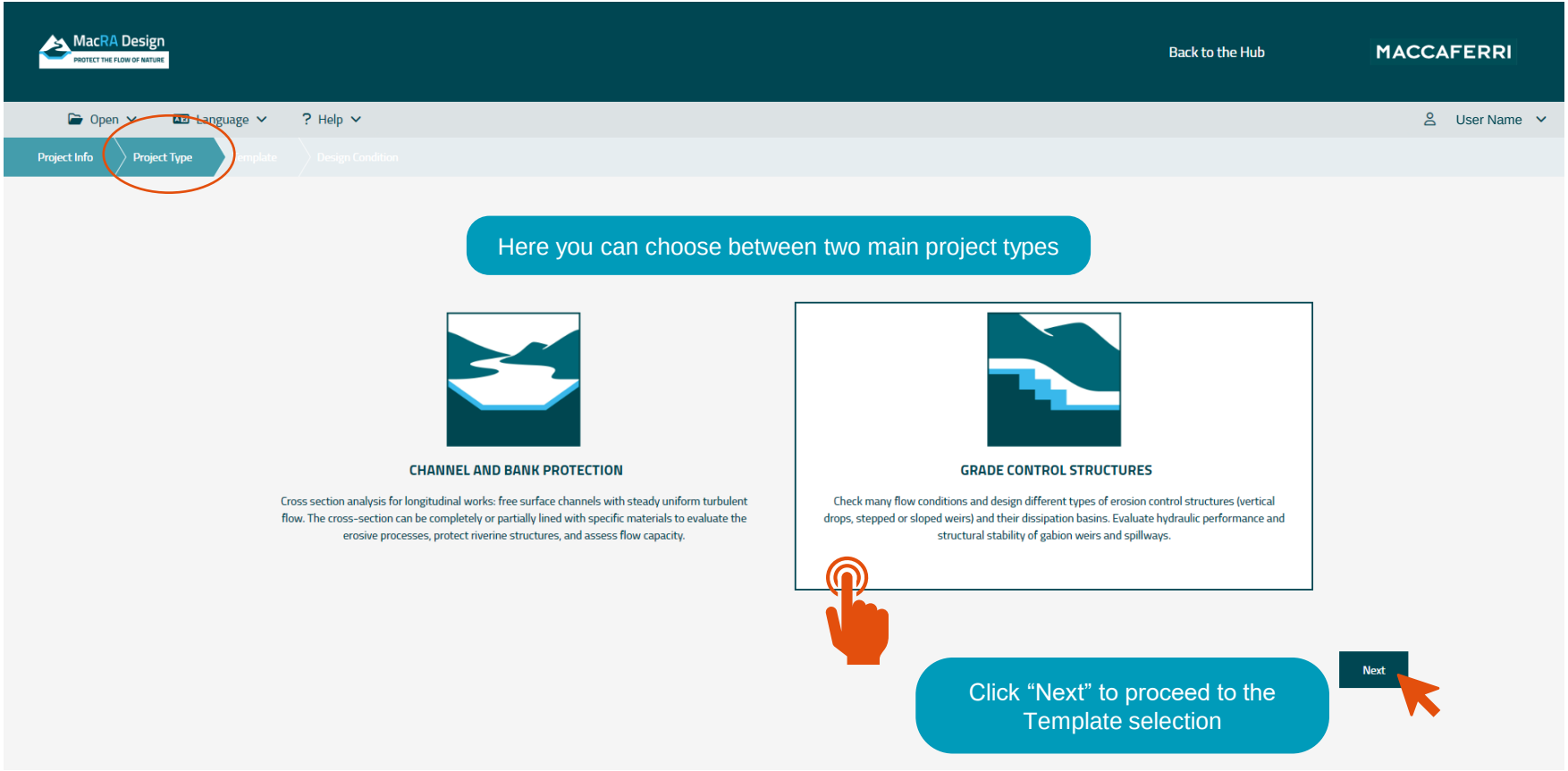
2.4 CHANNEL AND BANK PROTECTION – OUTPUT RESULTS



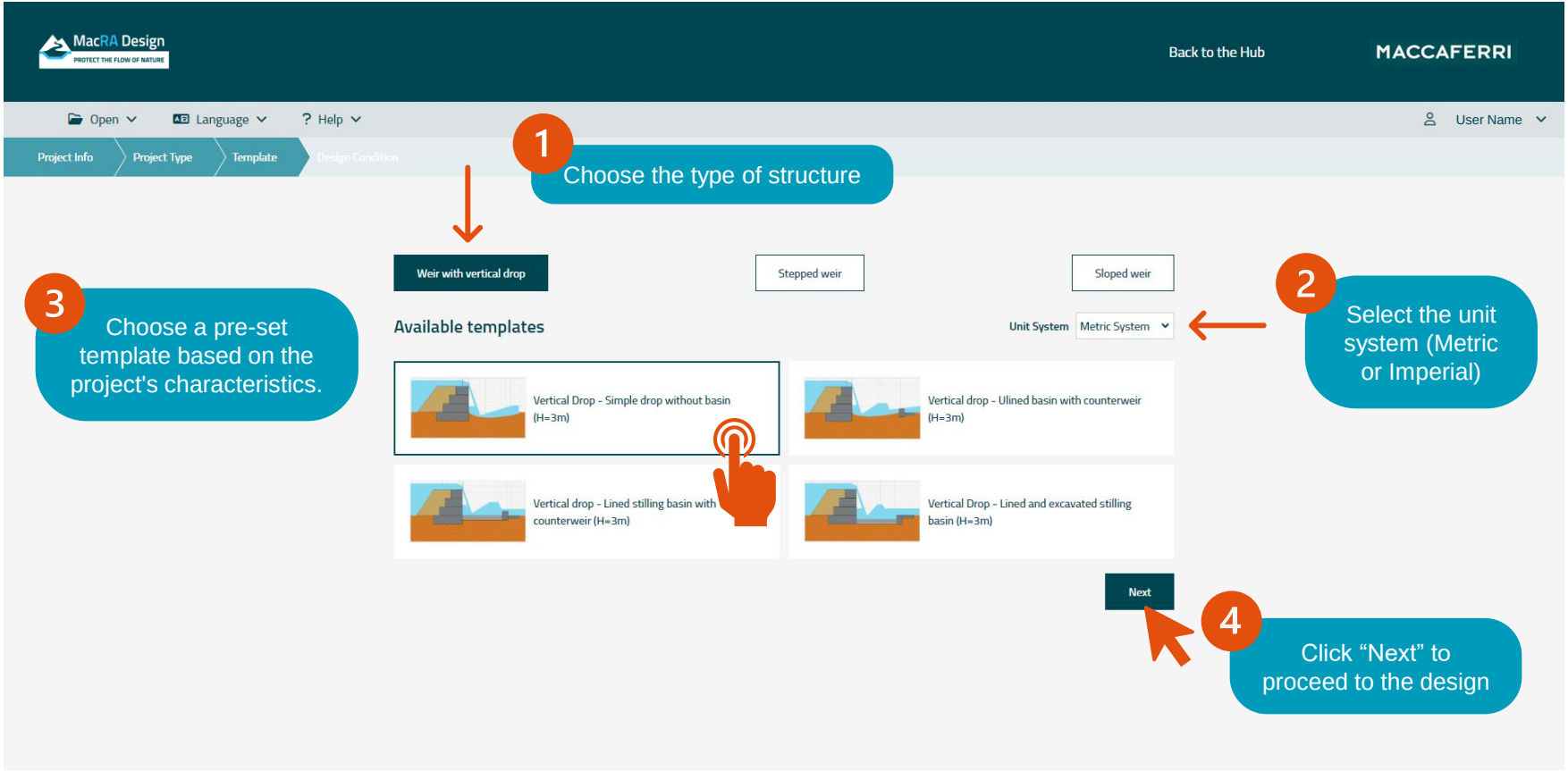
The 'General Results' tab displays all hydraulic results for the entire cross-section, divided into the main channel, left overbank, and right overbank.

GRADE CONTROL STRUCTURES

3 GRADE CONTROL STRUCTURES



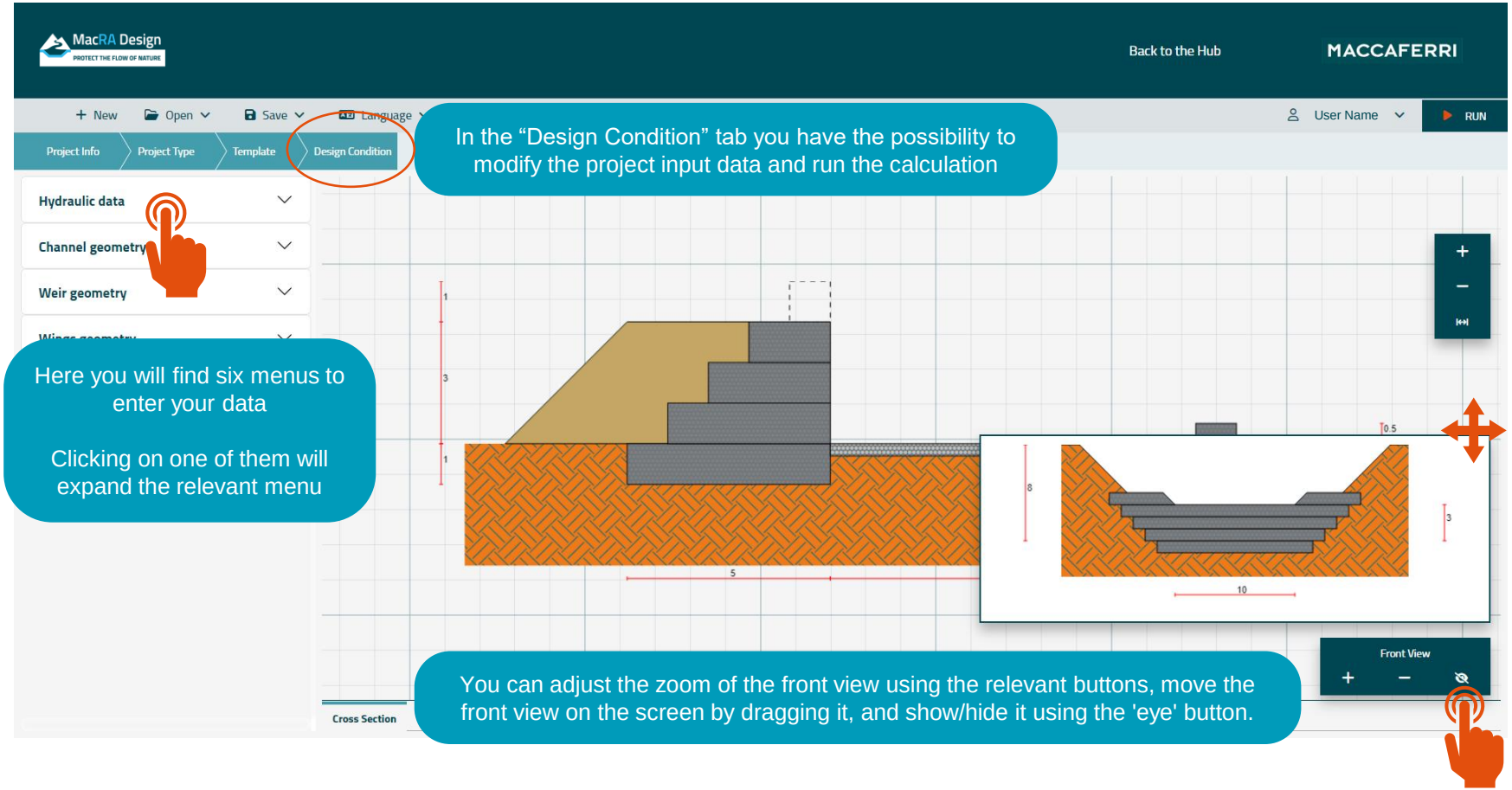
3.1 GRADE CONTROL STRUCTURES - TEMPLATE



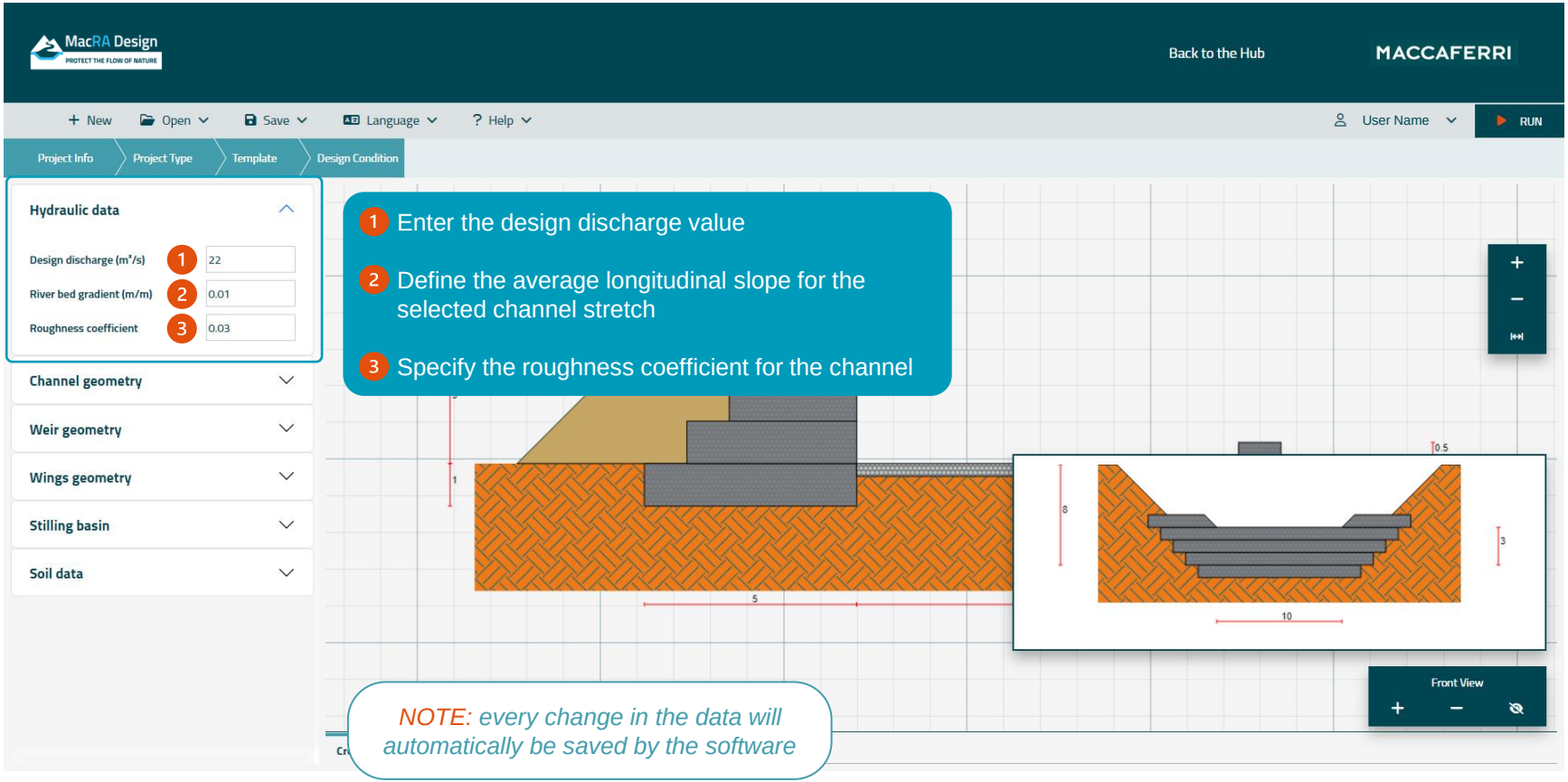
GRADE CONTROL STRUCTURES

WEIRS WITH VERTICAL DROP

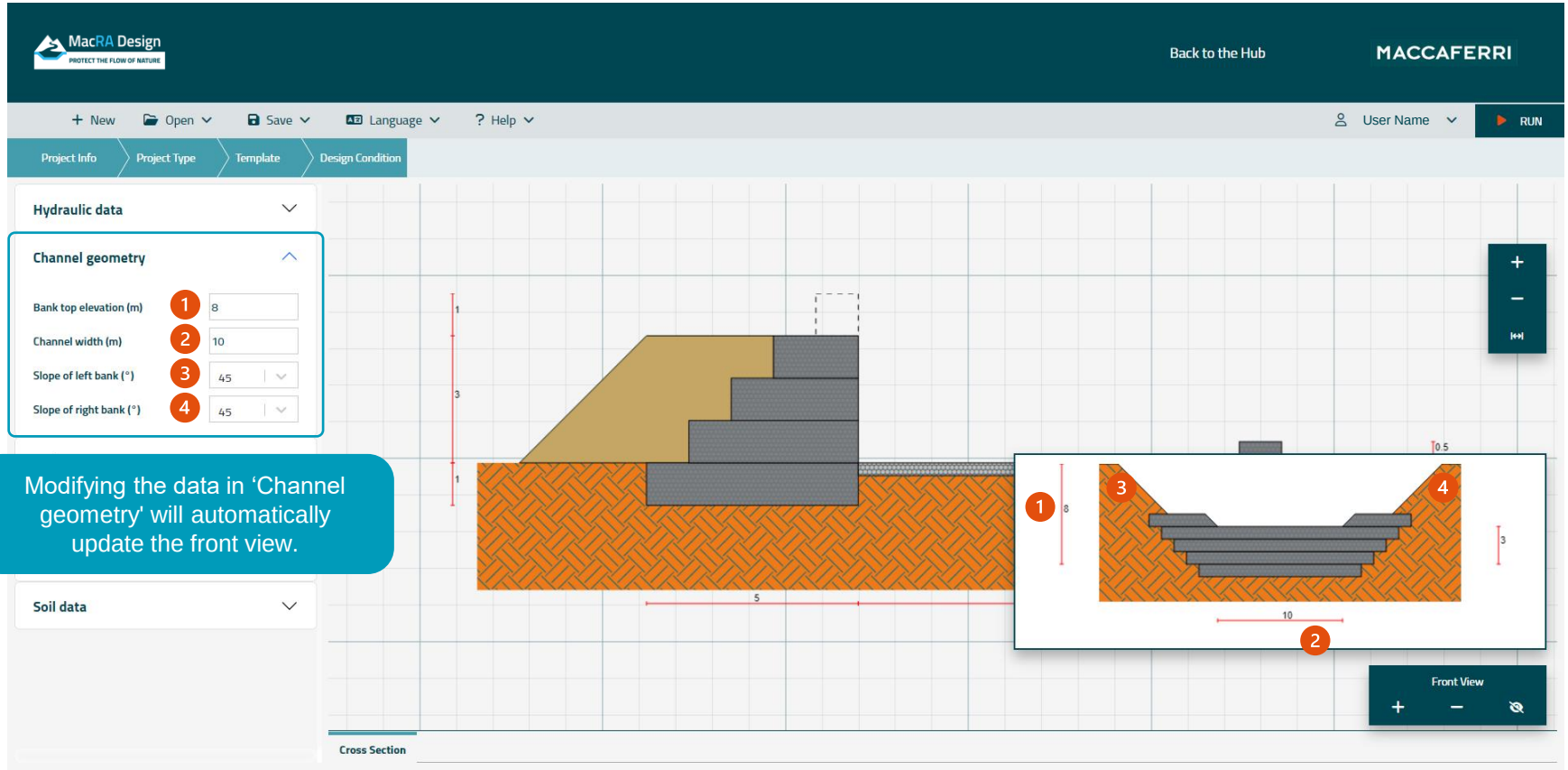
3.2.1 WEIRS WITH VERTICAL DROP – DESIGN CONDITION



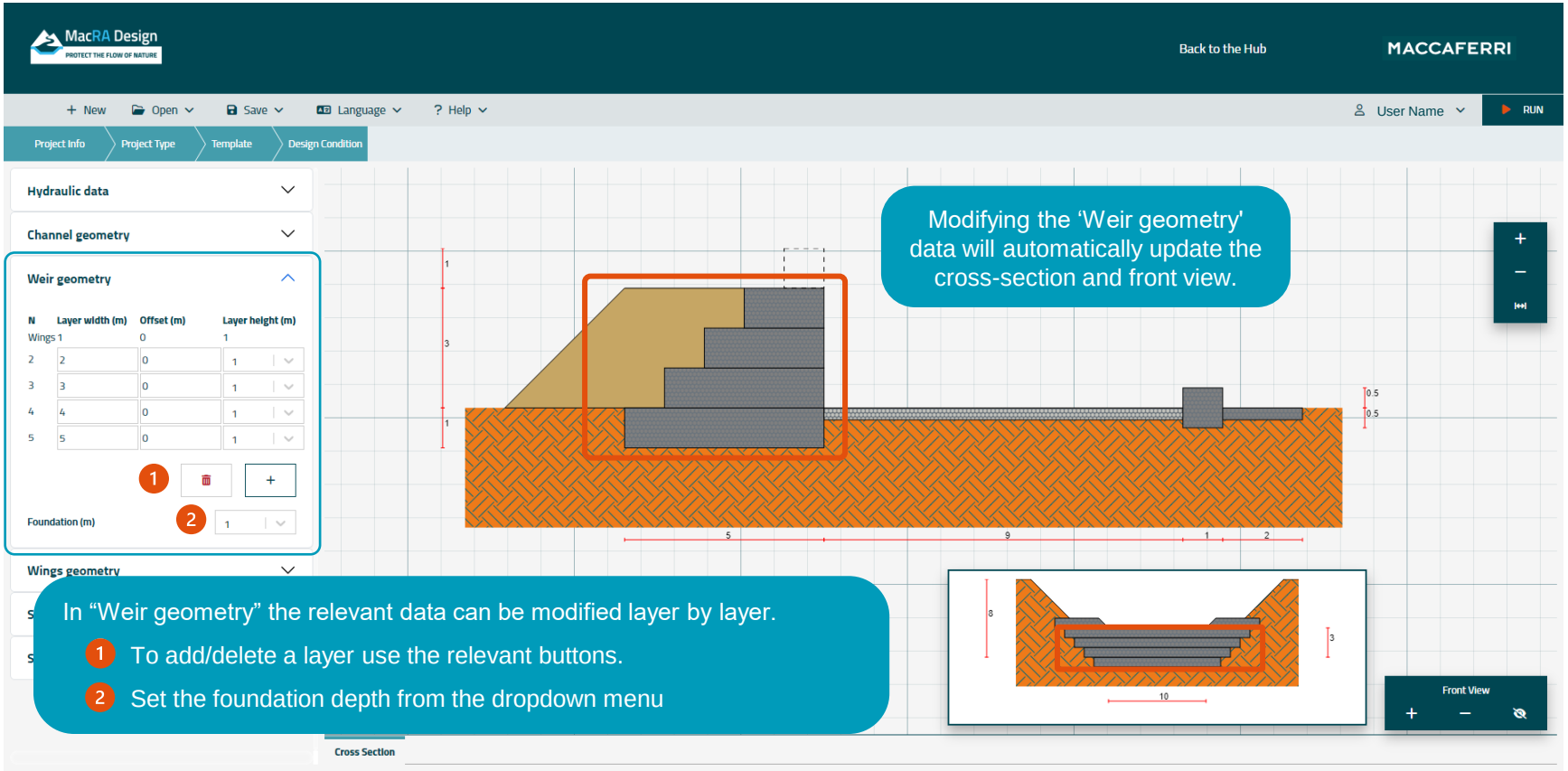
3.2.1.1 WEIRS WITH VERTICAL DROP – HYDRAULIC DATA



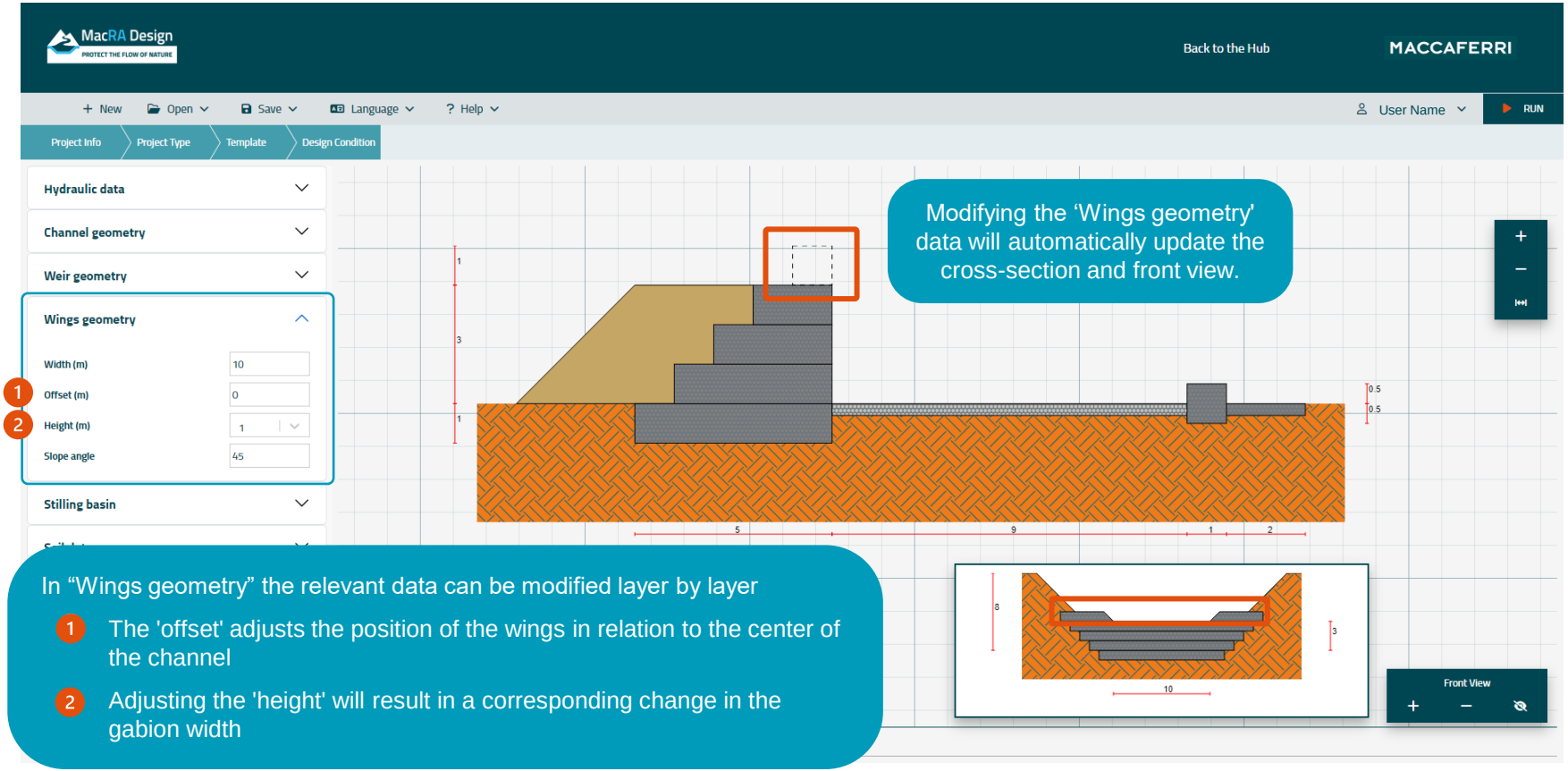
3.2.1.2 WEIRS WITH VERTICAL DROP – CHANNEL GEOMETRY



3.2.1.3 WEIRS WITH VERTICAL DROP – WEIR GEOMETRY



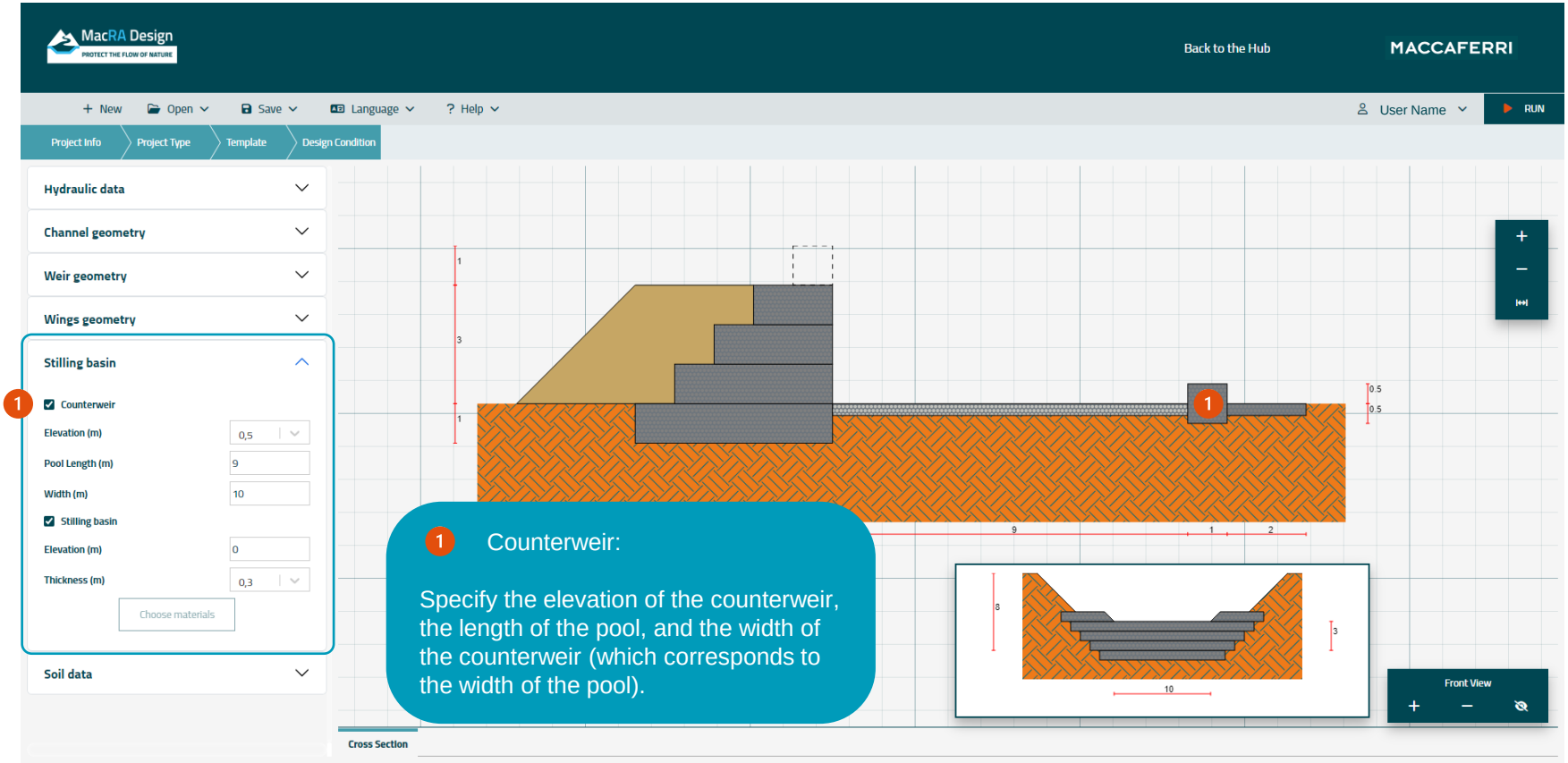
3.2.1.4 WEIRS WITH VERTICAL DROP – WINGS GEOMETRY



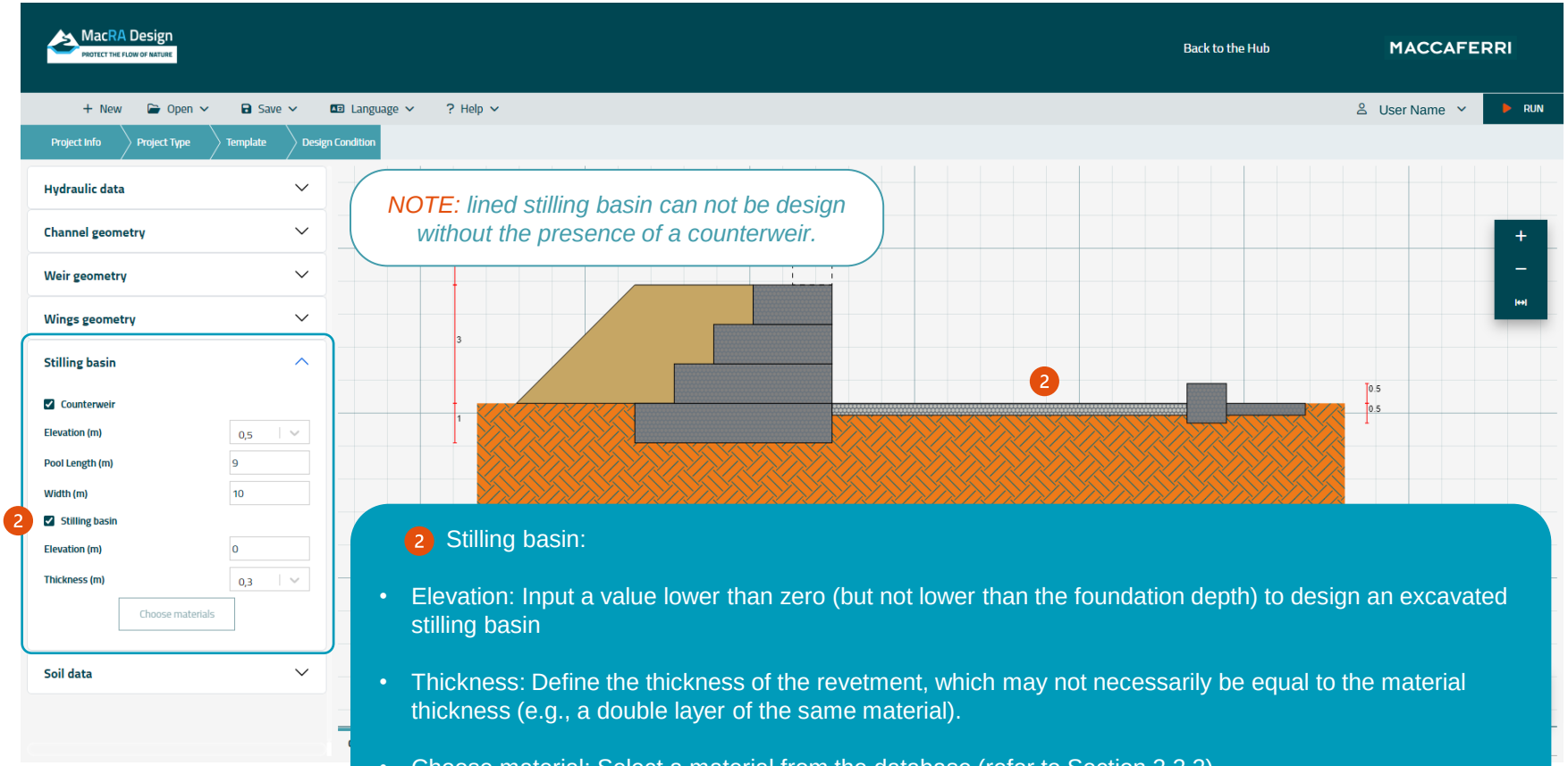
In “Wings geometry” the relevant data can be modified layer by layer

1. The 'offset' adjusts the position of the wings in relation to the center of the channel
2. Adjusting the 'height' will result in a corresponding change in the gabion width

3.2.1.5 WEIRS WITH VERTICAL DROP – STILLING BASIN



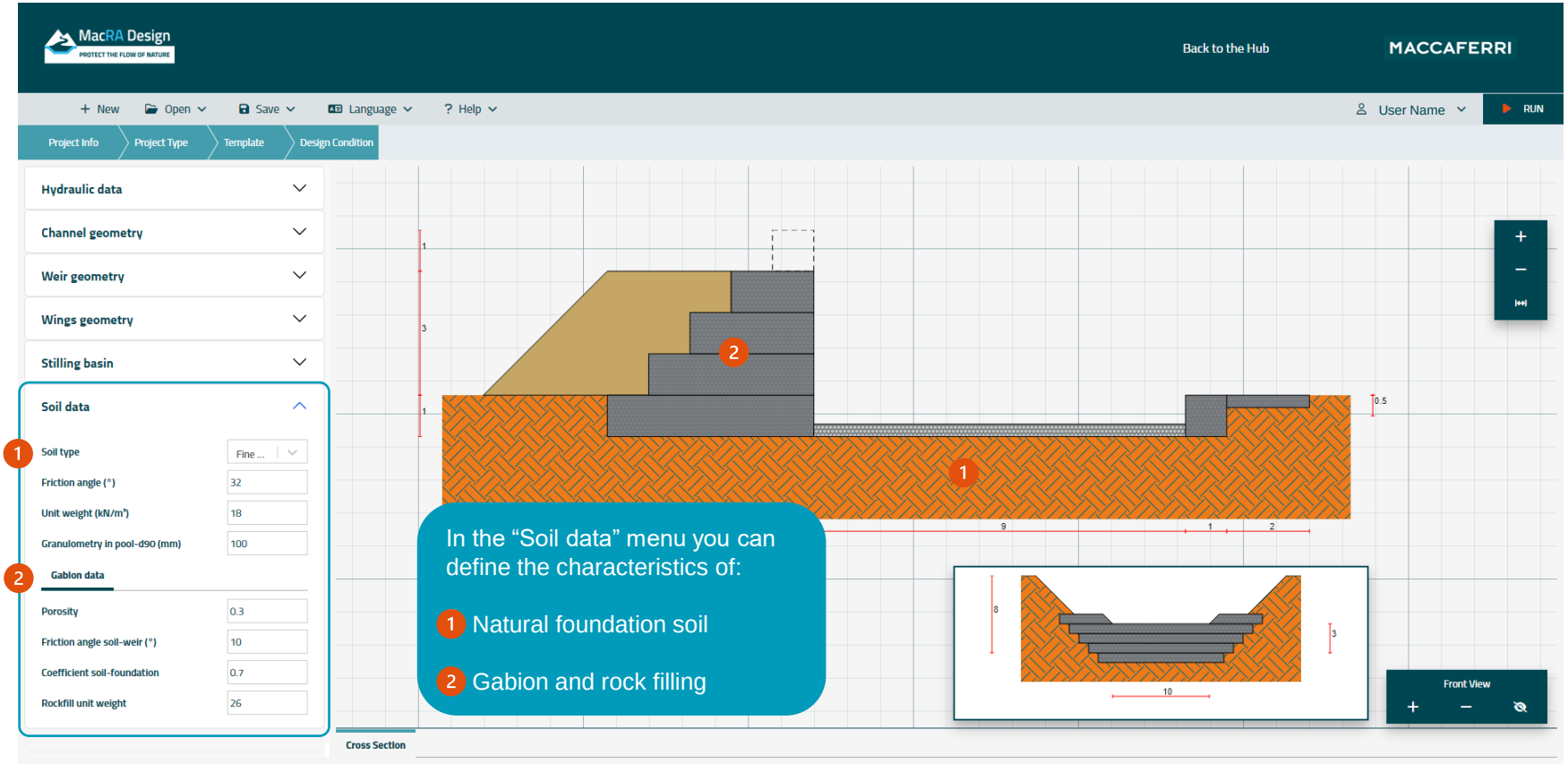
3.2.1.5 WEIRS WITH VERTICAL DROP – STILLING BASIN



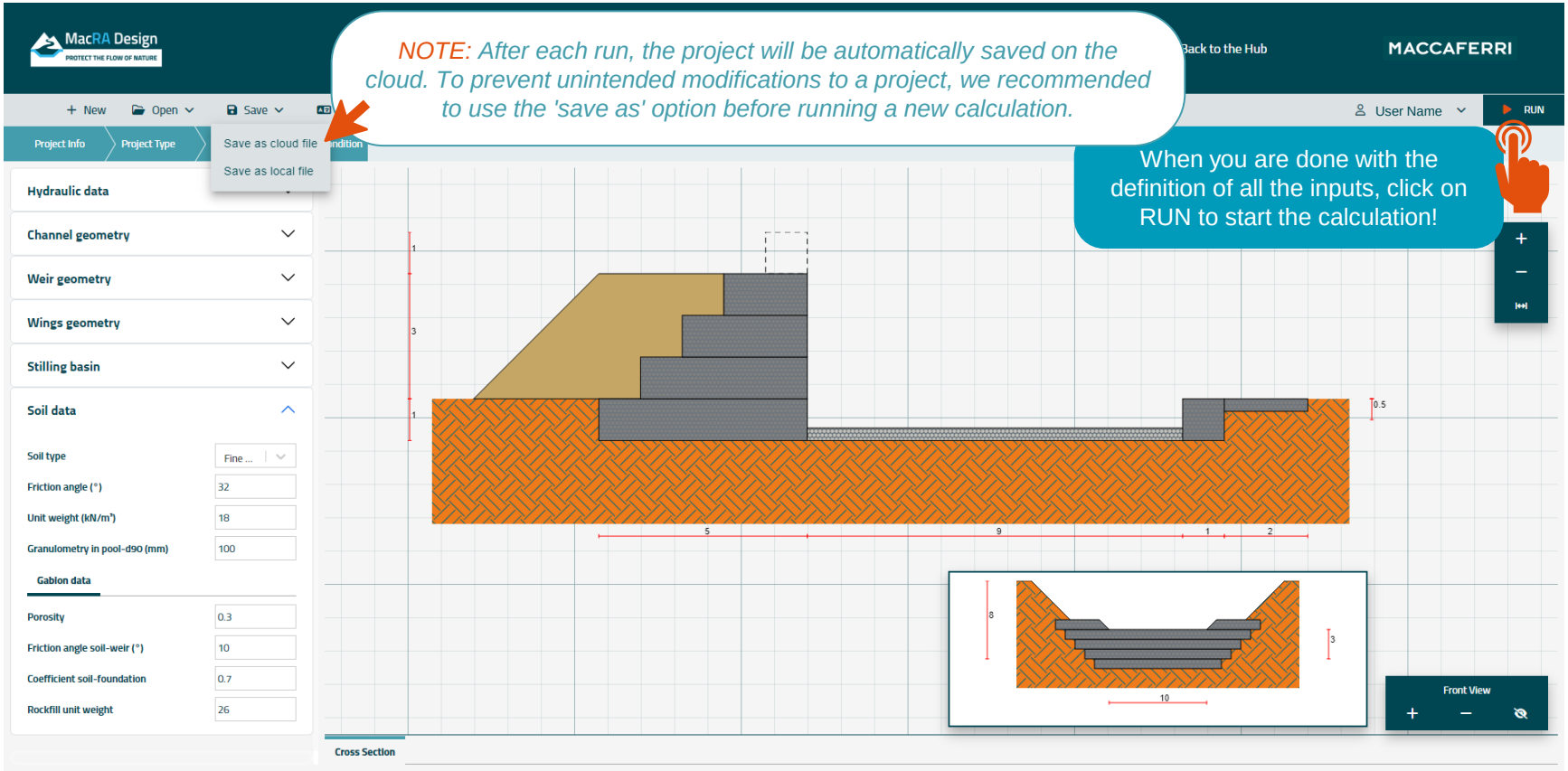
2 Stilling basin:

- Elevation: Input a value lower than zero (but not lower than the foundation depth) to design an excavated stilling basin
- Thickness: Define the thickness of the revetment, which may not necessarily be equal to the material thickness (e.g., a double layer of the same material).
- Choose material: Select a material from the database (refer to Section 2.2.2).

3.2.1.6 WEIRS WITH VERTICAL DROP – SOIL DATA



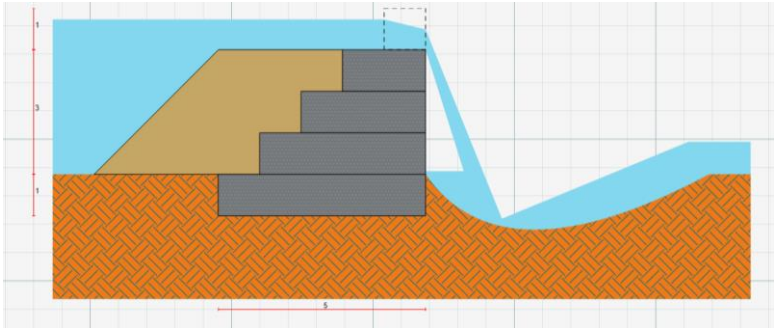
3.2.2 WEIRS WITH VERTICAL DROP – CALCULATION



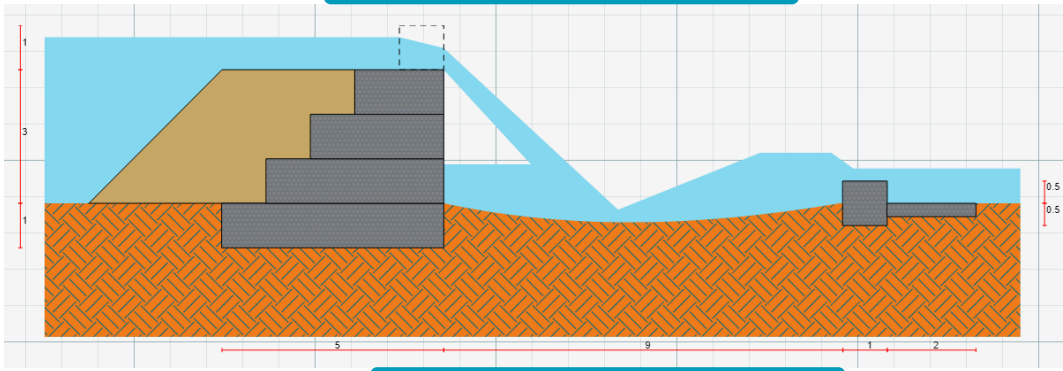
3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS

Depending on the design (presence or not of counterweir and lined stilling basin) the software returns different results: maximum expected scour depth or shear stress acting on the lining material and relative checks

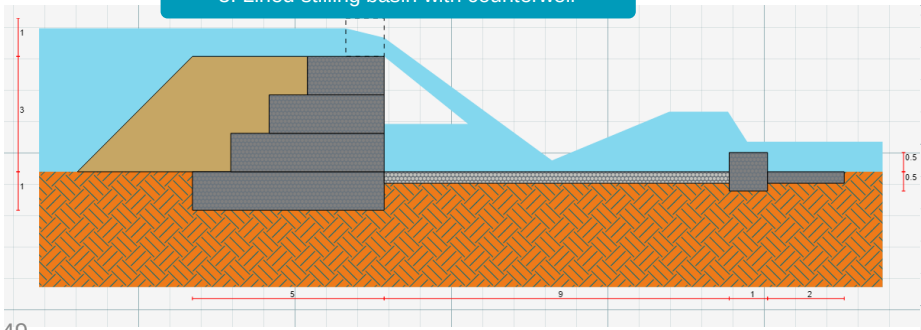
1. Simple drop without stilling basin



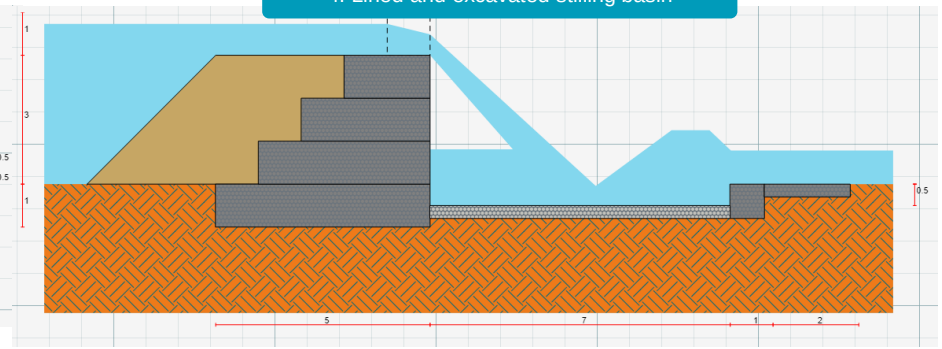
2. Unlined basin with counterweir



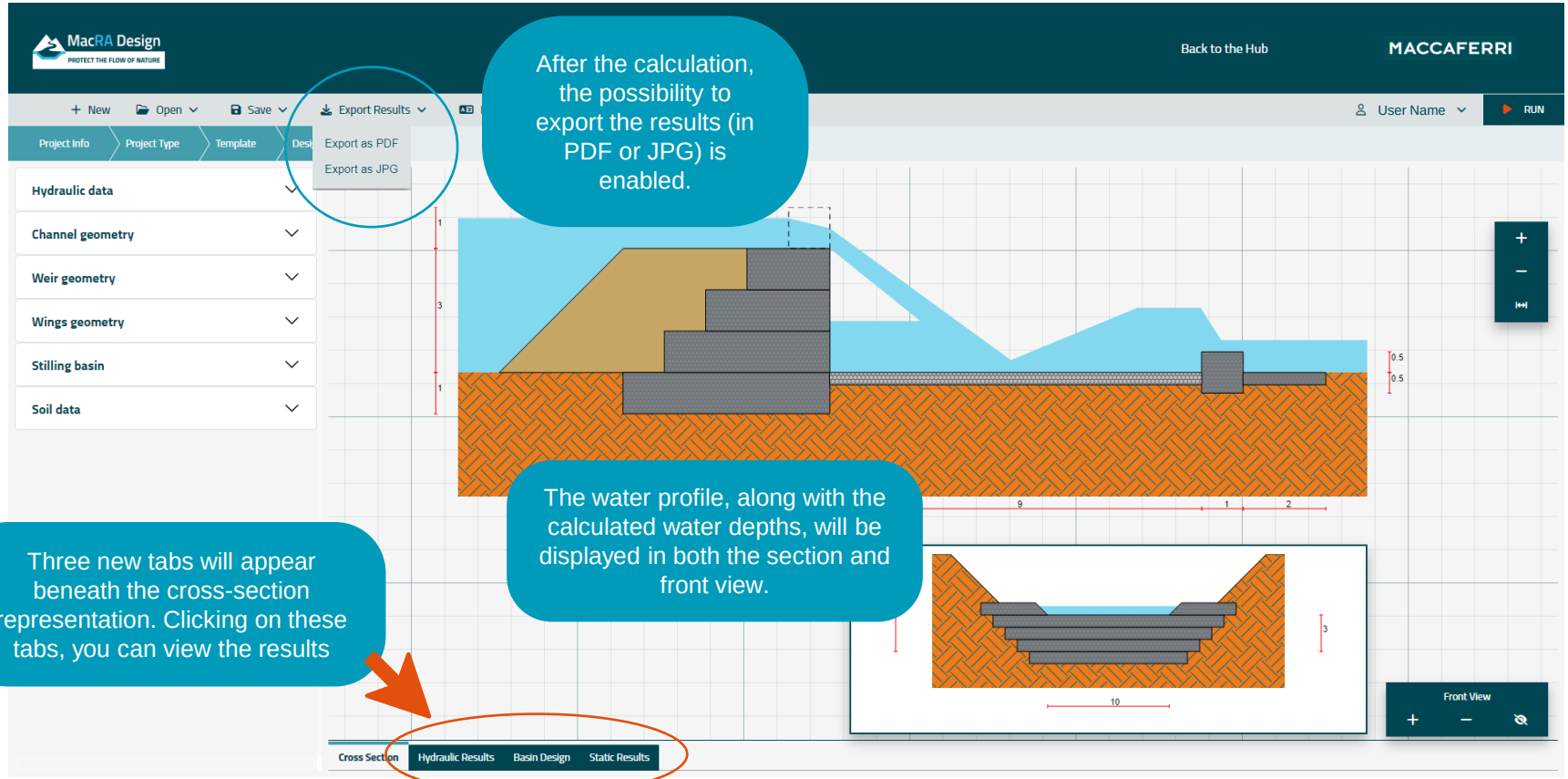
3. Lined stilling basin with counterweir



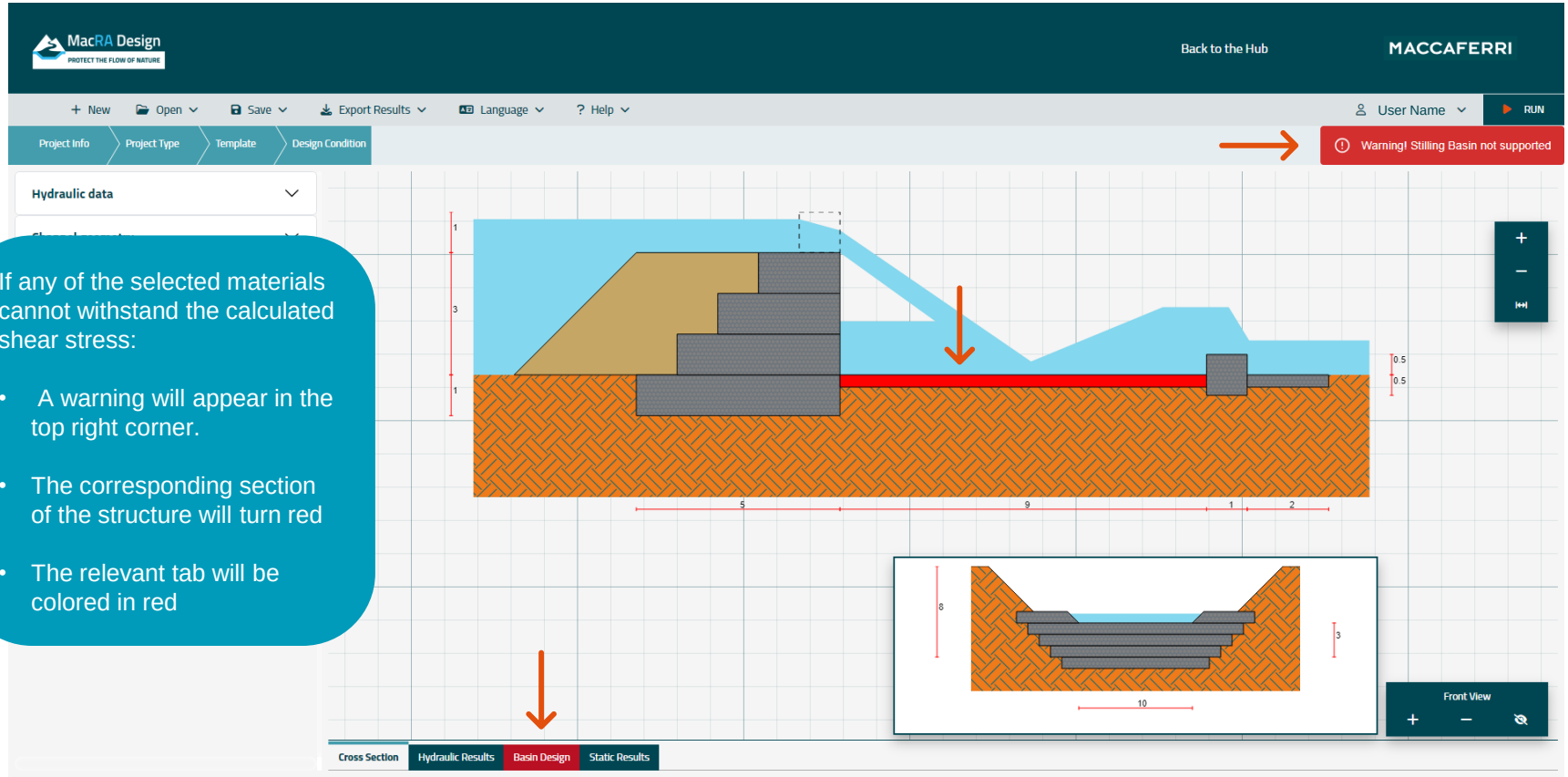
4. Lined and excavated stilling basin



3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS



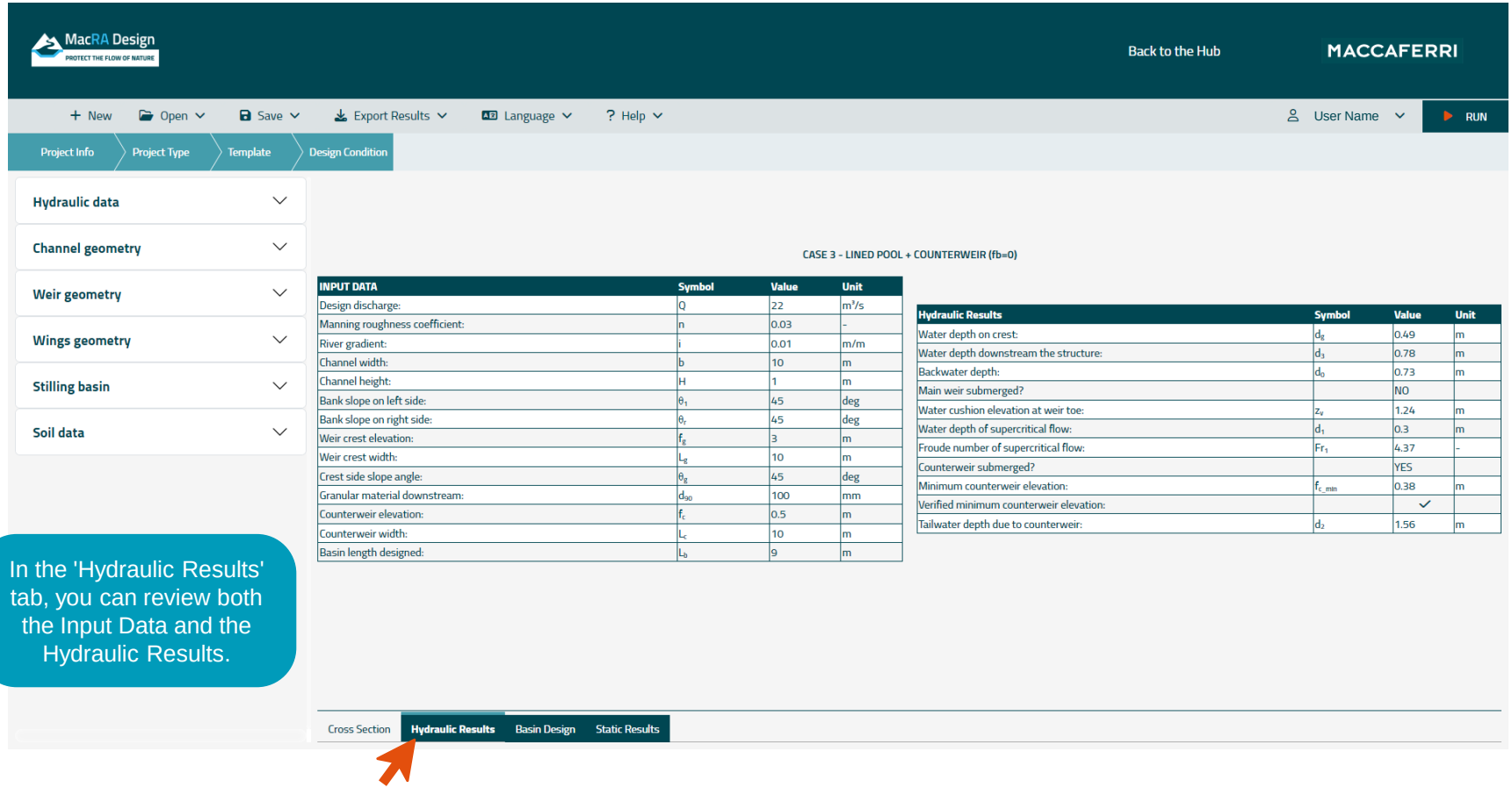
3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS



If any of the selected materials cannot withstand the calculated shear stress:

- A warning will appear in the top right corner.
- The corresponding section of the structure will turn red
- The relevant tab will be colored in red

3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS



INPUT DATA	Symbol	Value	Unit
Design discharge:	Q	22	m^3/s
Manning roughness coefficient:	n	0.03	-
River gradient:	i	0.01	m/m
Channel width:	b	10	m
Channel height:	H	1	m
Bank slope on left side:	θ_l	45	deg
Bank slope on right side:	θ_r	45	deg
Weir crest elevation:	f_g	3	m
Weir crest width:	L_g	10	m
Crest side slope angle:	θ_g	45	deg
Granular material downstream:	d_{90}	100	mm
Counterweir elevation:	f_c	0.5	m
Counterweir width:	L_c	10	m
Basin length designed:	L_b	9	m

Hydraulic Results	Symbol	Value	Unit
Water depth on crest:	d_g	0.49	m
Water depth downstream the structure:	d_3	0.78	m
Backwater depth:	d_0	0.73	m
Main weir submerged?		NO	
Water cushion elevation at weir toe:	z_v	1.24	m
Water depth of supercritical flow:	d_1	0.3	m
Froude number of supercritical flow:	Fr_1	4.37	-
Counterweir submerged?		YES	
Minimum counterweir elevation:	f_{c_min}	0.38	m
Verified minimum counterweir elevation:		✓	
Tailwater depth due to counterweir:	d_2	1.56	m

In the 'Hydraulic Results' tab, you can review both the Input Data and the Hydraulic Results.

3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS

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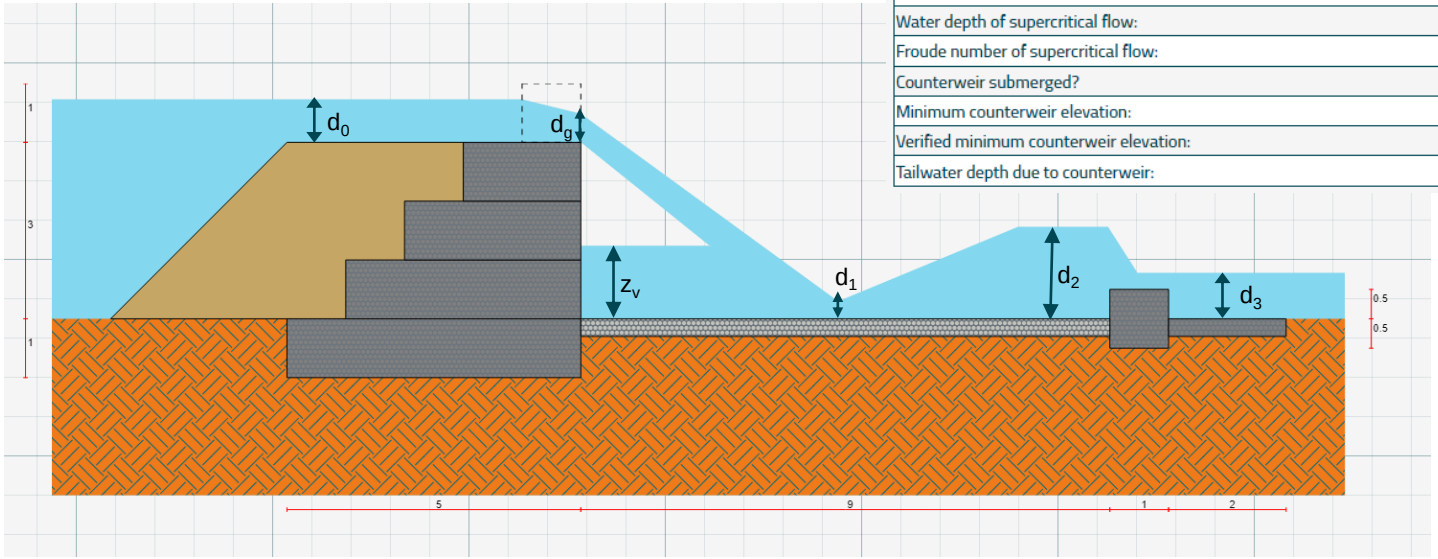
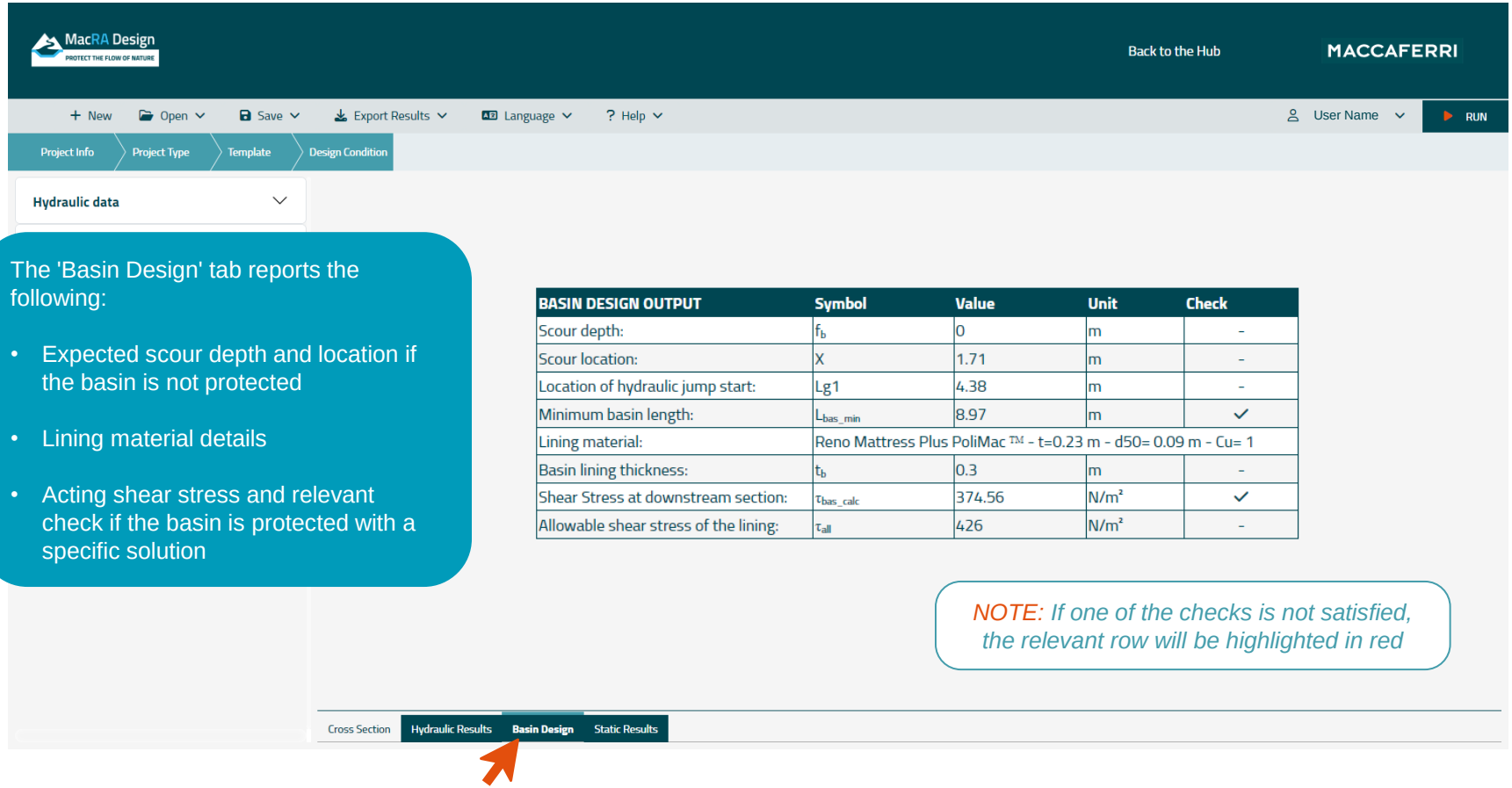
NOTE: d1 and d2 also represent the conjugated depths of the hypothetical hydraulic jump to be confined in the basin. The graphical representation is theoretical and is provided for easy visualization of the relative depths. In practice, due to the turbulent nature of the hydraulic jump, distinguishing the depth d1 could be challenging.

Hydraulic Results	Symbol	Value	Unit
Water depth on crest:	d_g	0.49	m
Water depth downstream the structure:	d_3	0.78	m
Backwater depth:	d_0	0.73	m
Main weir submerged?		NO	
Water cushion elevation at weir toe:	z_v	1.24	m
Water depth of supercritical flow:	d_1	0.3	m
Froude number of supercritical flow:	Fr_1	4.37	-
Counterweir submerged?		YES	
Minimum counterweir elevation:	f_{c_min}	0.38	m
Verified minimum counterweir elevation:		✓	
Tailwater depth due to counterweir:	d_2	1.56	m



3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS



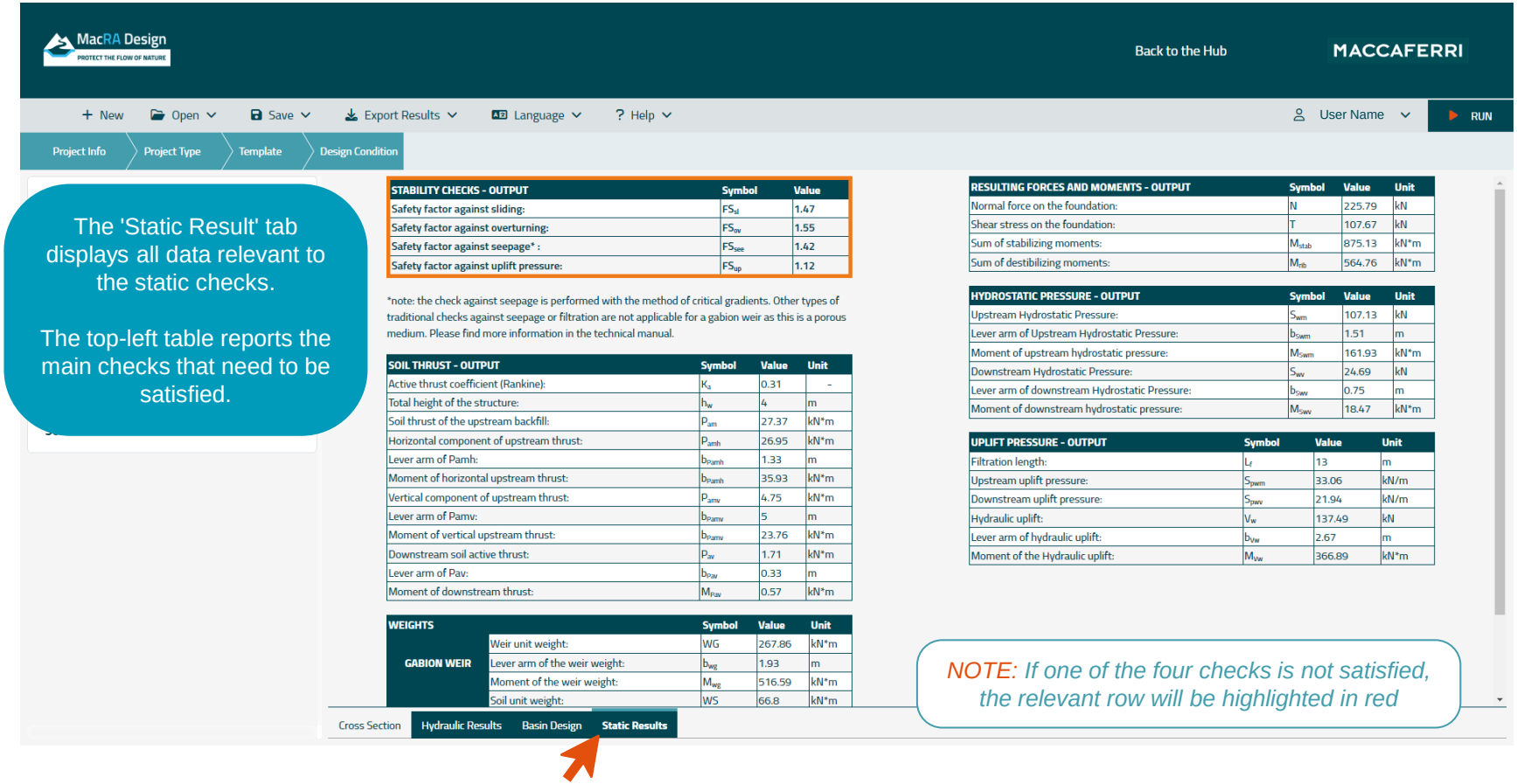
The 'Basin Design' tab reports the following:

- Expected scour depth and location if the basin is not protected
- Lining material details
- Acting shear stress and relevant check if the basin is protected with a specific solution

BASIN DESIGN OUTPUT	Symbol	Value	Unit	Check
Scour depth:	f_b	0	m	-
Scour location:	X	1.71	m	-
Location of hydraulic jump start:	Lg1	4.38	m	-
Minimum basin length:	L_{bas_min}	8.97	m	✓
Lining material:	Reno Mattress Plus PoliMac ™ - t=0.23 m - d50= 0.09 m - Cu= 1			
Basin lining thickness:	t_b	0.3	m	-
Shear Stress at downstream section:	τ_{bas_calc}	374.56	N/m²	✓
Allowable shear stress of the lining:	τ_{all}	426	N/m²	-

NOTE: If one of the checks is not satisfied, the relevant row will be highlighted in red

3.2.3 WEIRS WITH VERTICAL DROP – OUTPUT RESULTS



The 'Static Result' tab displays all data relevant to the static checks.

The top-left table reports the main checks that need to be satisfied.

STABILITY CHECKS - OUTPUT	Symbol	Value
Safety factor against sliding:	FS_{sl}	1.47
Safety factor against overturning:	FS_{ov}	1.55
Safety factor against seepage* :	FS_{see}	1.42
Safety factor against uplift pressure:	FS_{up}	1.12

*note: the check against seepage is performed with the method of critical gradients. Other types of traditional checks against seepage or filtration are not applicable for a gabion weir as this is a porous medium. Please find more information in the technical manual.

SOIL THRUST - OUTPUT	Symbol	Value	Unit
Active thrust coefficient (Rankine):	K_a	0.31	-
Total height of the structure:	h_w	4	m
Soil thrust of the upstream backfill:	P_{am}	27.37	kN*m
Horizontal component of upstream thrust:	P_{amh}	26.95	kN*m
Lever arm of Pamh:	b_{Pamh}	1.33	m
Moment of horizontal upstream thrust:	b_{Pamh}	35.93	kN*m
Vertical component of upstream thrust:	P_{amv}	4.75	kN*m
Lever arm of Pamv:	b_{Pamv}	5	m
Moment of vertical upstream thrust:	b_{Pamv}	23.76	kN*m
Downstream soil active thrust:	P_{av}	1.71	kN*m
Lever arm of Pav:	b_{Pav}	0.33	m
Moment of downstream thrust:	M_{Pav}	0.57	kN*m

WEIGHTS		Symbol	Value	Unit
GABION WEIR	Weir unit weight:	WG	267.86	kN*m
	Lever arm of the weir weight:	b_{wg}	1.93	m
	Moment of the weir weight:	M_{wg}	516.59	kN*m
	Soil unit weight:	WS	66.8	kN*m

RESULTING FORCES AND MOMENTS - OUTPUT	Symbol	Value	Unit
Normal force on the foundation:	N	225.79	kN
Shear stress on the foundation:	T	107.67	kN
Sum of stabilizing moments:	M_{stab}	875.13	kN*m
Sum of destibilizing moments:	M_{rib}	564.76	kN*m

HYDROSTATIC PRESSURE - OUTPUT	Symbol	Value	Unit
Upstream Hydrostatic Pressure:	S_{wm}	107.13	kN
Lever arm of Upstream Hydrostatic Pressure:	b_{Swm}	1.51	m
Moment of upstream hydrostatic pressure:	M_{Swm}	161.93	kN*m
Downstream Hydrostatic Pressure:	S_{wv}	24.69	kN
Lever arm of downstream Hydrostatic Pressure:	b_{Swv}	0.75	m
Moment of downstream hydrostatic pressure:	M_{Swv}	18.47	kN*m

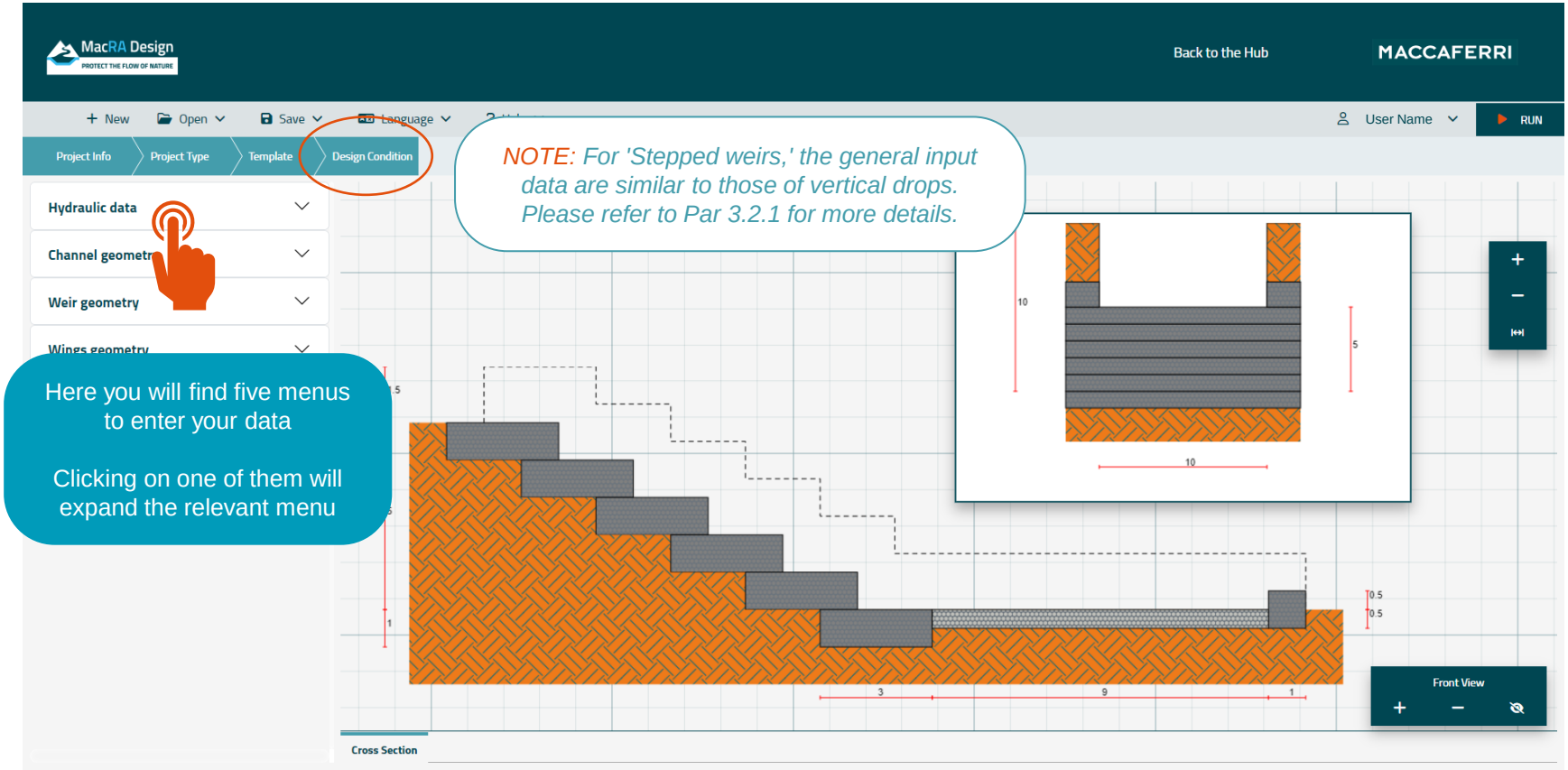
UPLIFT PRESSURE - OUTPUT	Symbol	Value	Unit
Filtration length:	L_f	13	m
Upstream uplift pressure:	S_{pwm}	33.06	kN/m
Downstream uplift pressure:	S_{pwv}	21.94	kN/m
Hydraulic uplift:	V_w	137.49	kN
Lever arm of hydraulic uplift:	b_{vw}	2.67	m
Moment of the Hydraulic uplift:	M_{vw}	366.89	kN*m

NOTE: If one of the four checks is not satisfied, the relevant row will be highlighted in red

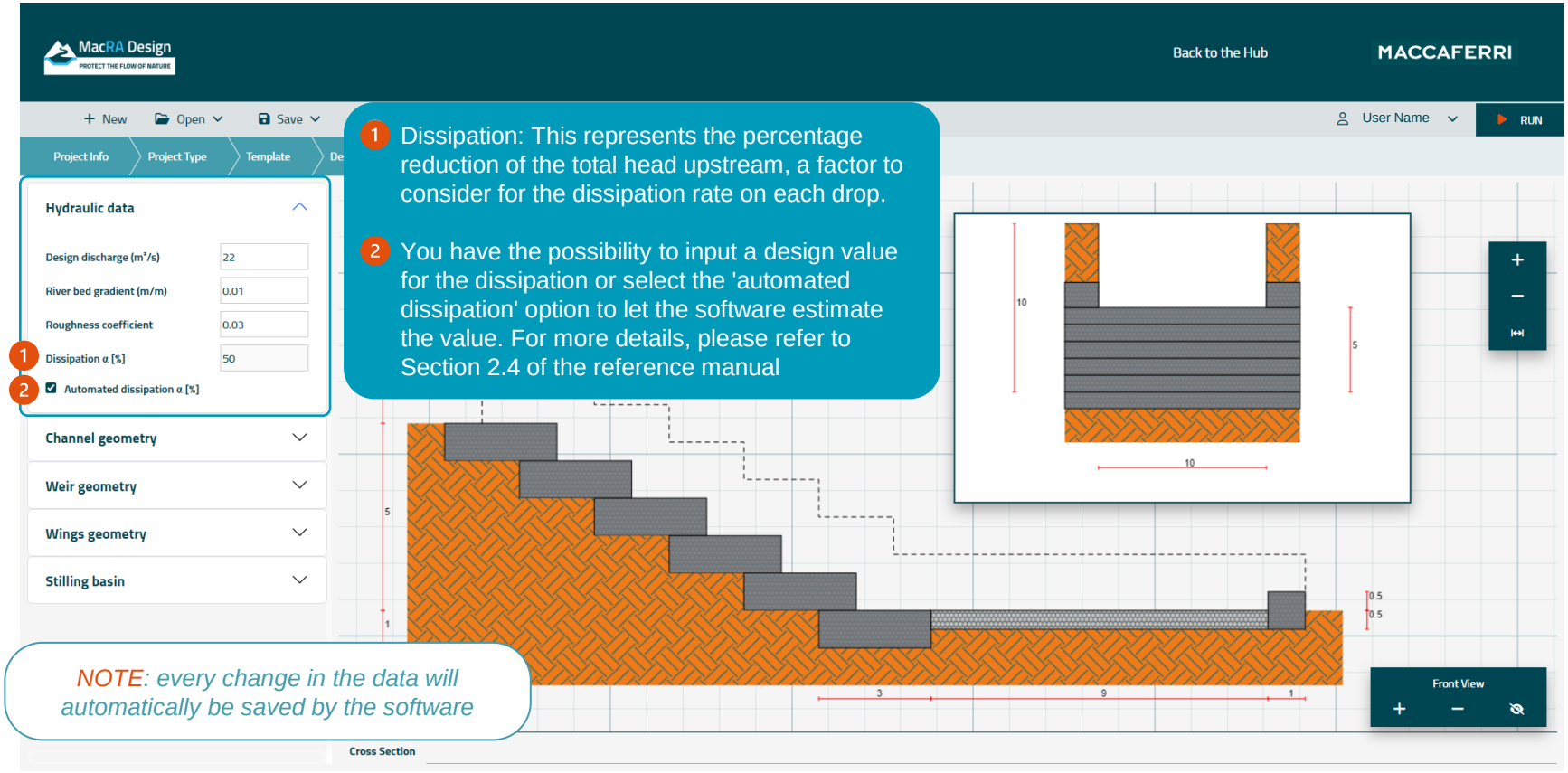
GRADE CONTROL STRUCTURES

STEPPED WEIRS (DROP STRUCTURES)

3.3.1 STEPPED WEIRS – DESIGN CONDITION

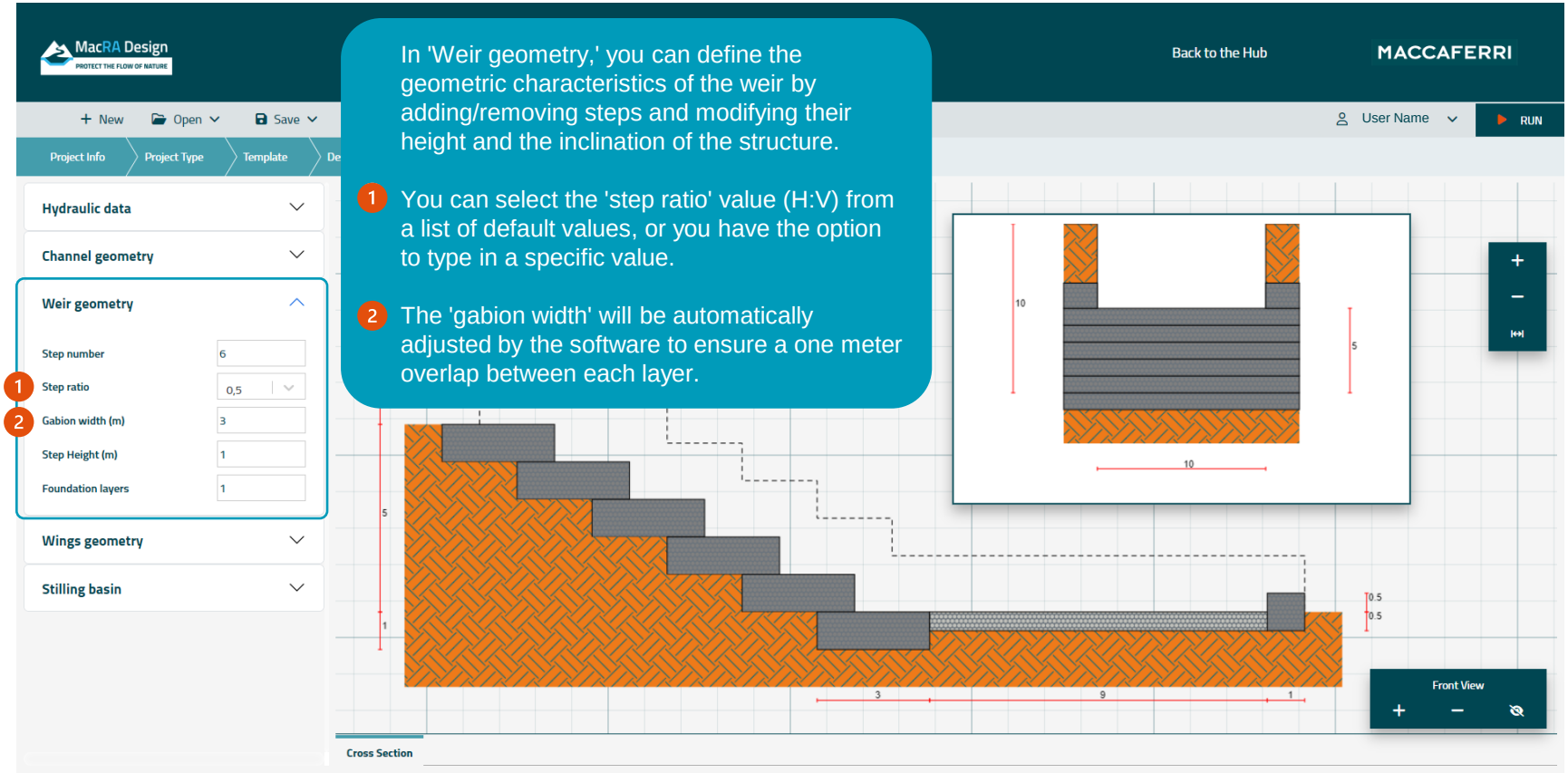


3.3.1.1 STEPPED WEIRS – HYDRAULIC DATA

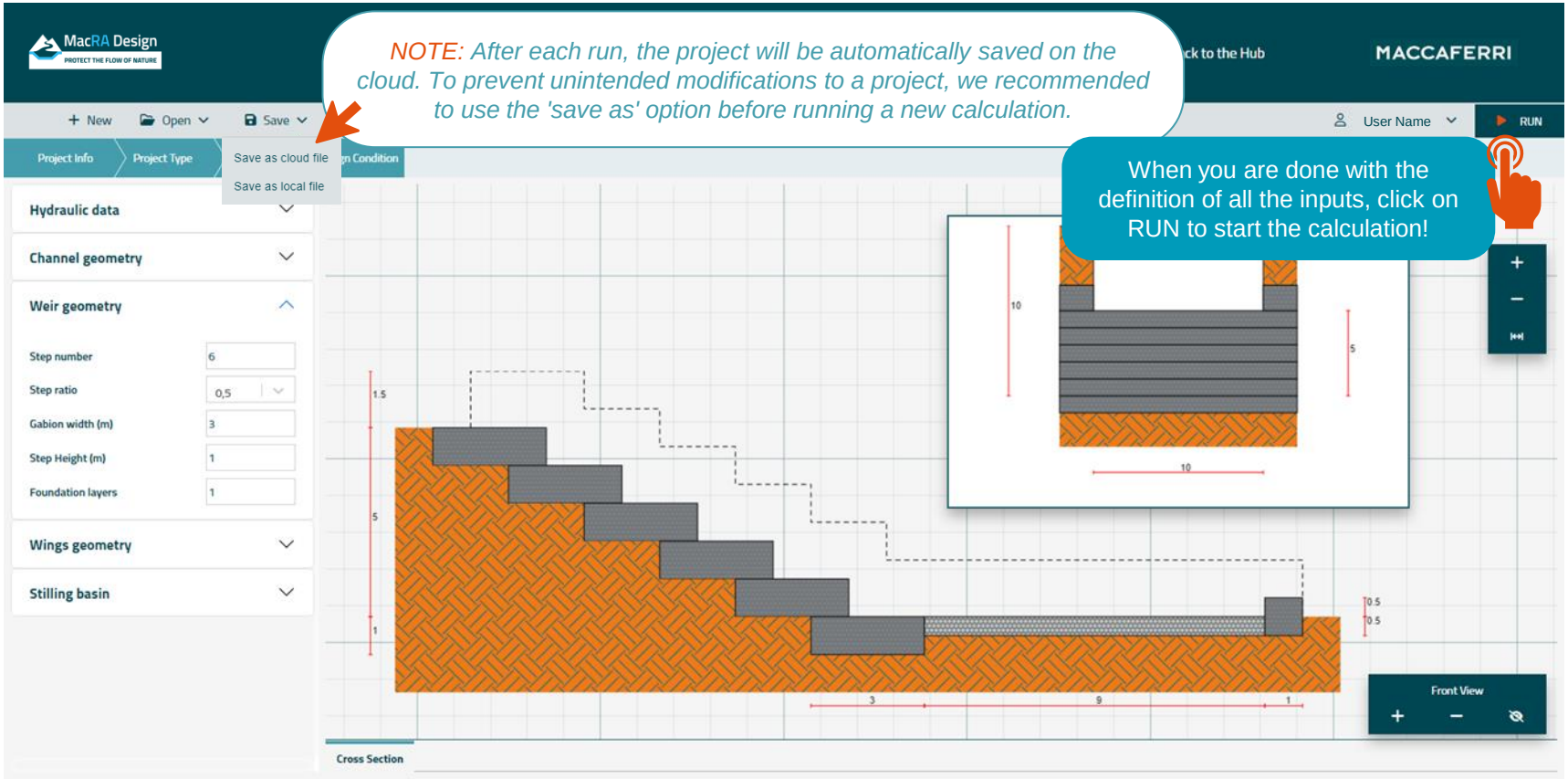


NOTE: every change in the data will automatically be saved by the software

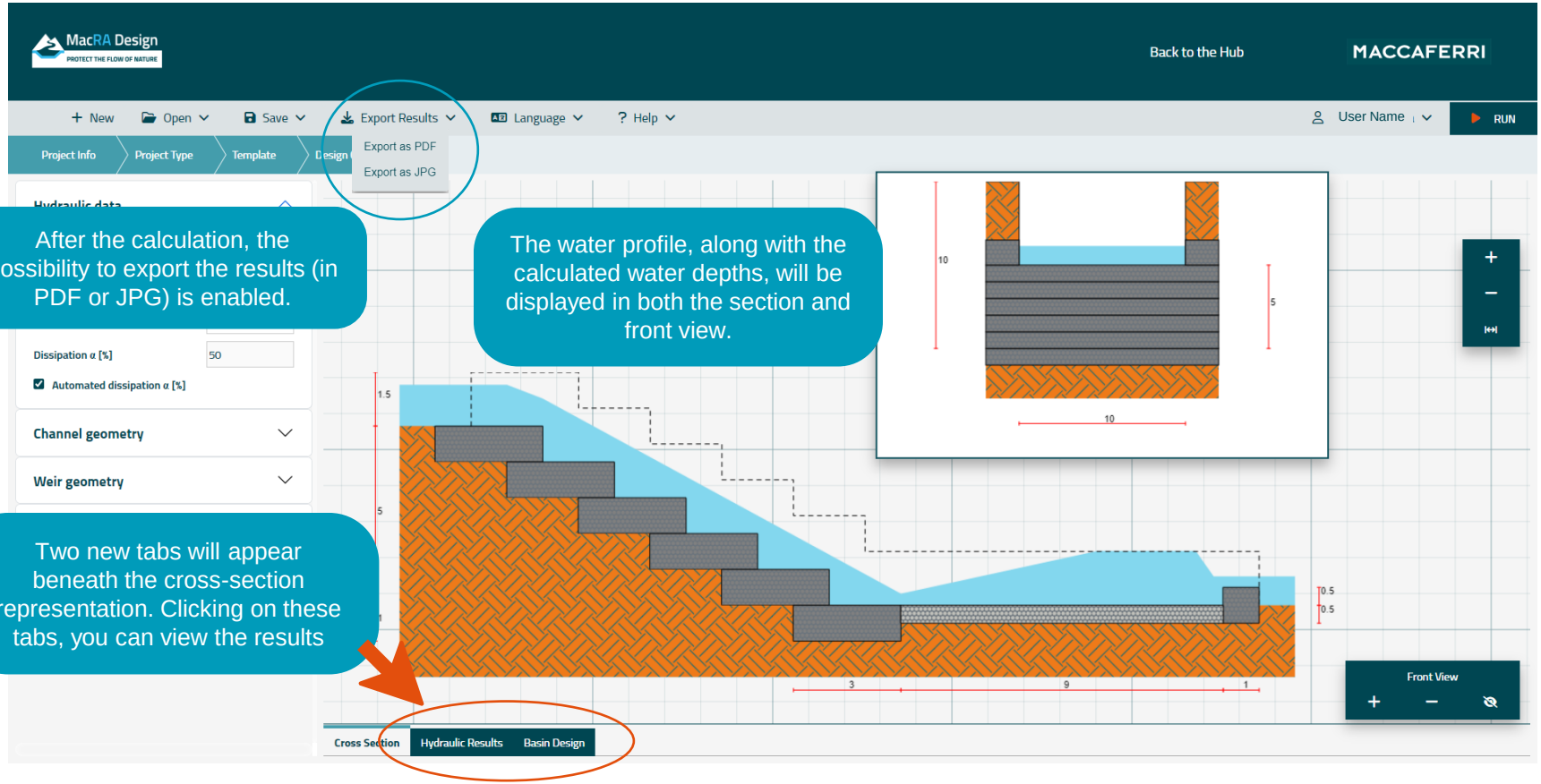
3.3.1.2 STEPPED WEIRS – WEIR GEOMETRY



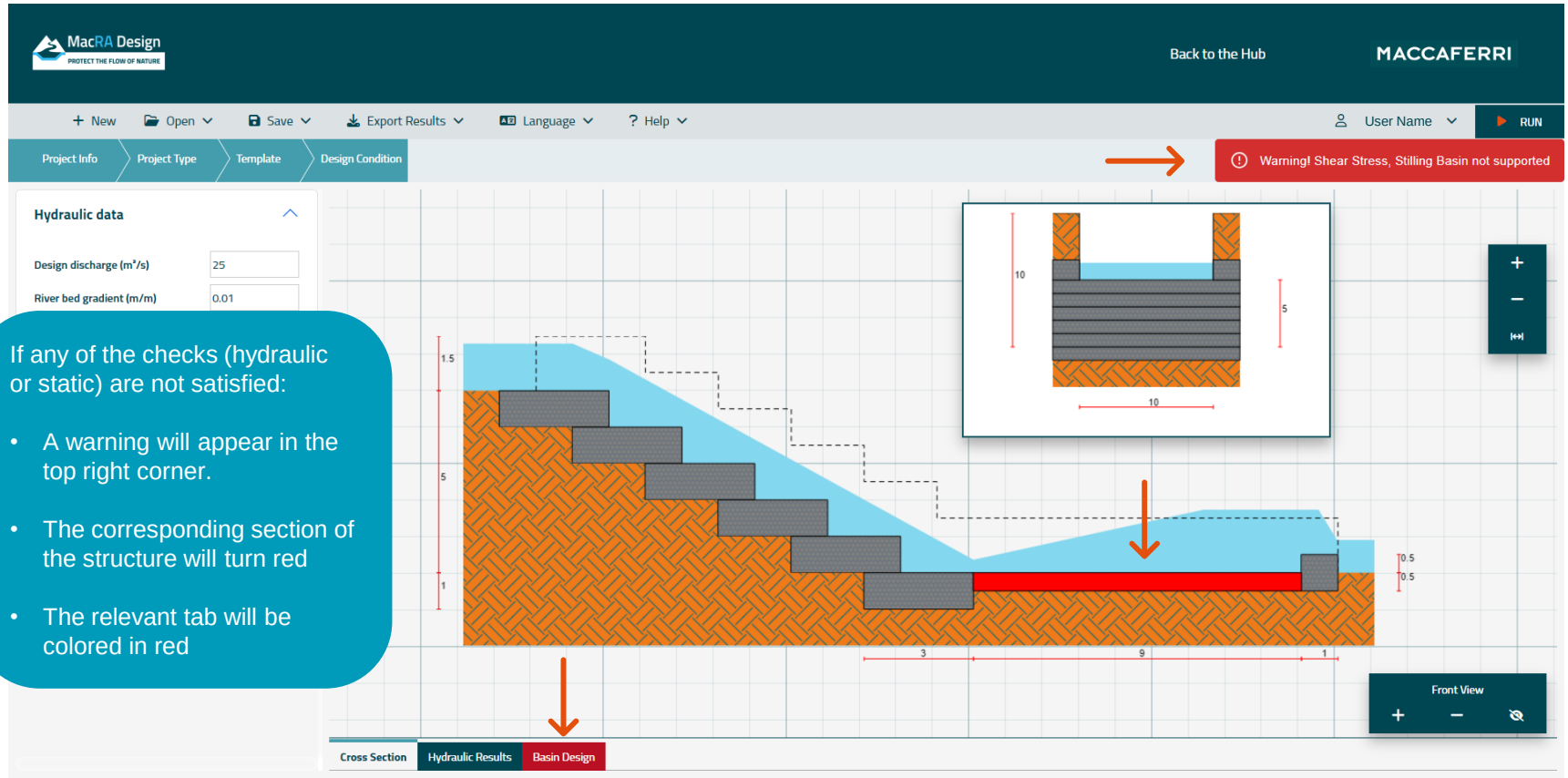
3.3.2 STEPPED WEIRS – CALCULATION



3.3.3 STEPPED WEIRS – OUTPUT RESULTS



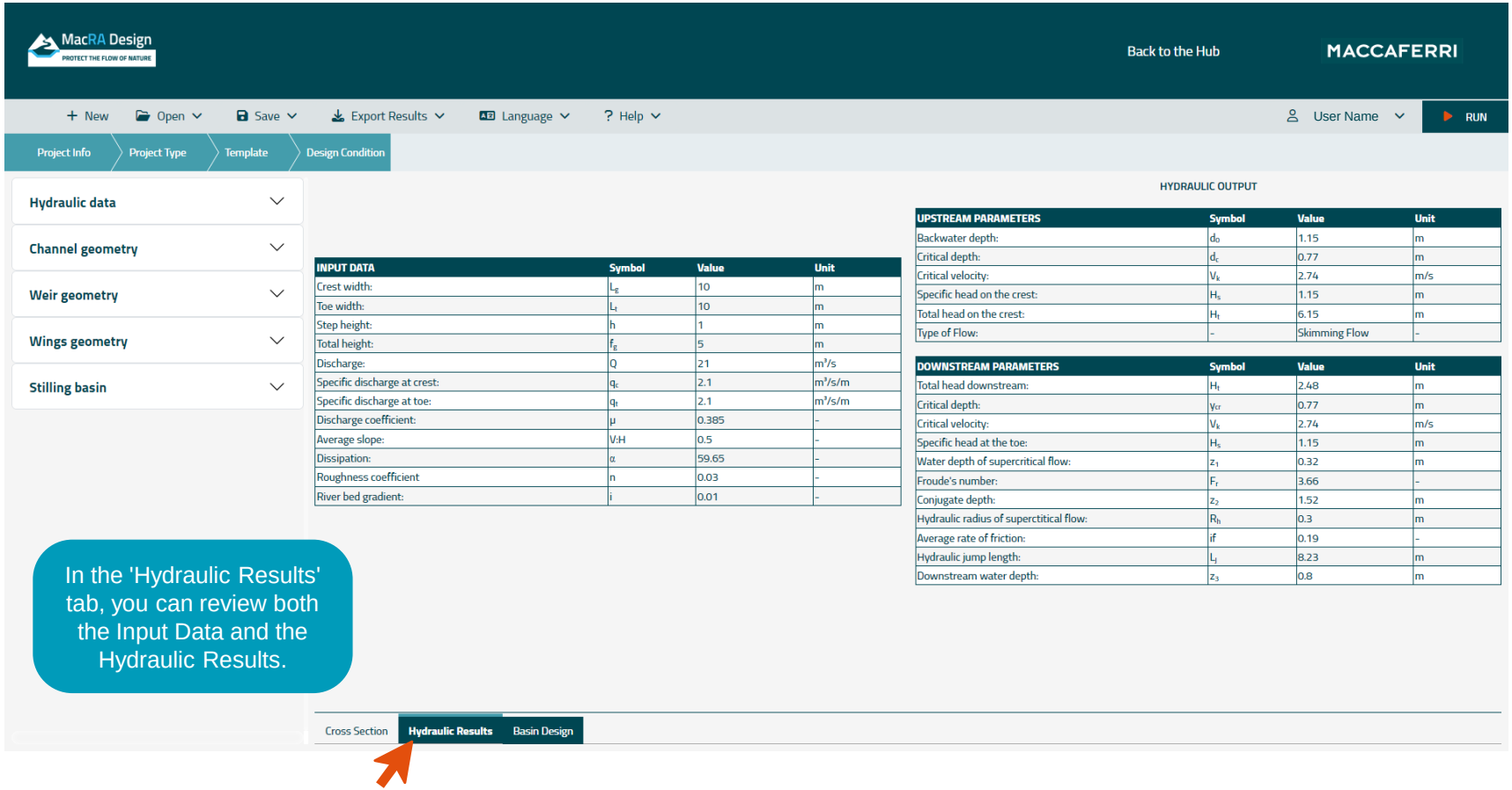
3.3.3 STEPPED WEIRS – OUTPUT RESULTS



If any of the checks (hydraulic or static) are not satisfied:

- A warning will appear in the top right corner.
- The corresponding section of the structure will turn red
- The relevant tab will be colored in red

3.3.3 STEPPED WEIRS – OUTPUT RESULTS



In the 'Hydraulic Results' tab, you can review both the Input Data and the Hydraulic Results.

3.3.3 STEPPED WEIRS – OUTPUT RESULTS

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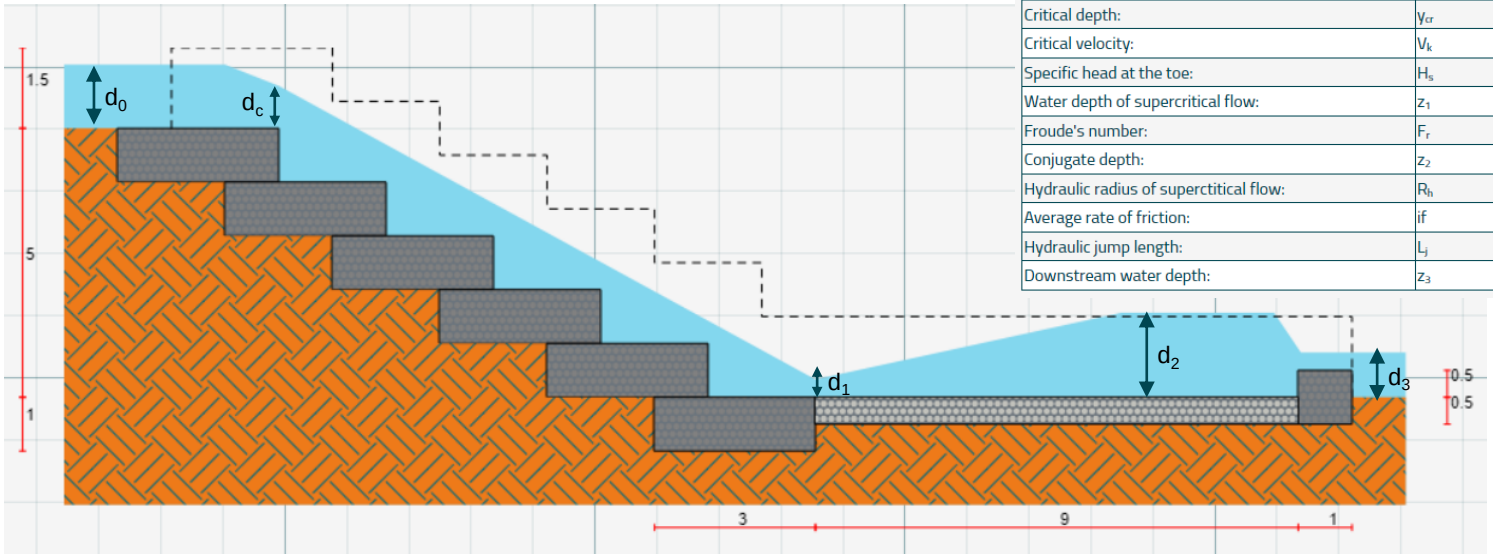
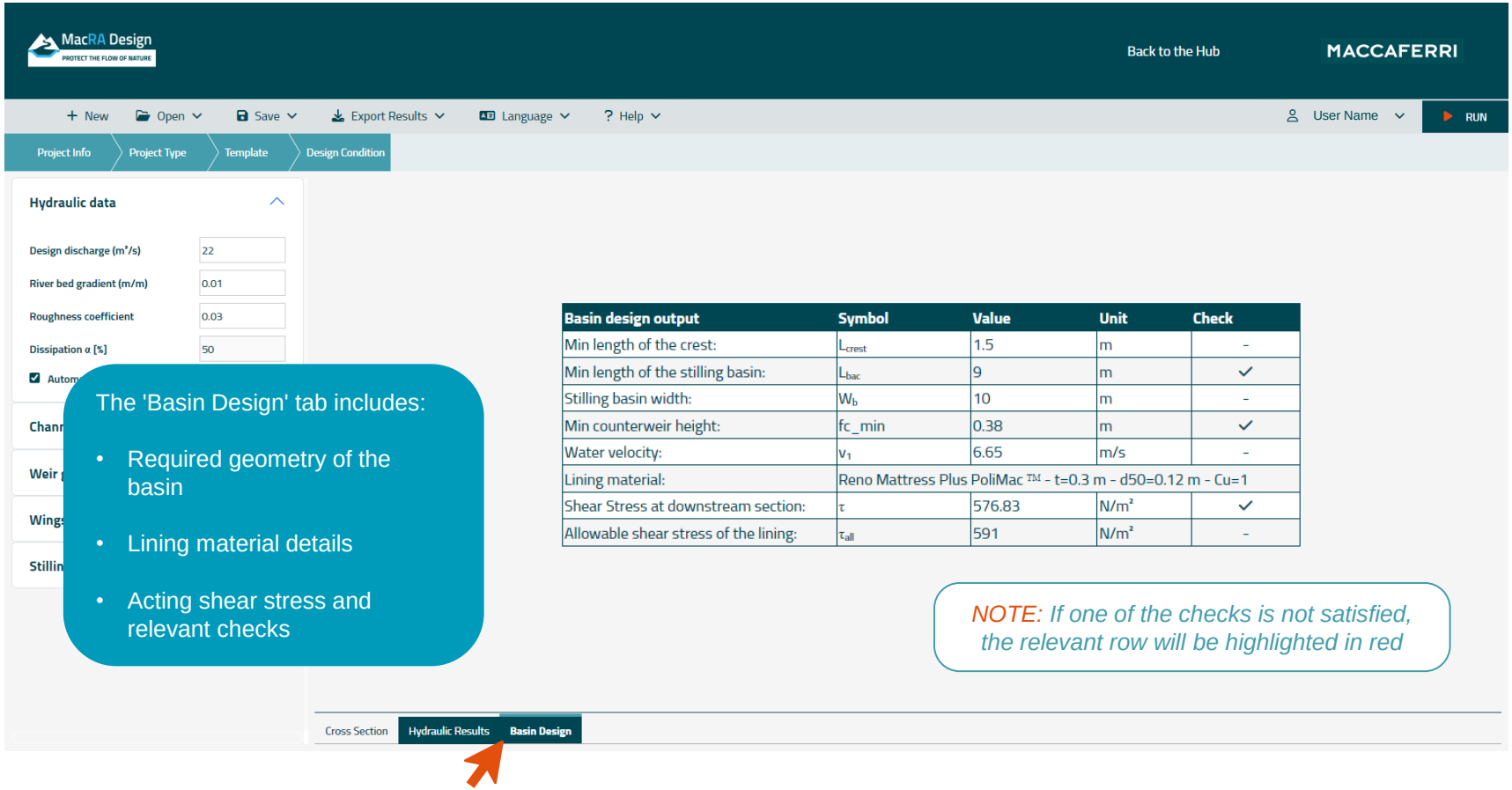
NOTE: d1 and d2 also represent the conjugated depths of the hypothetical hydraulic jump to be confined in the basin. The graphical representation is theoretical and is provided for easy visualization of the relative depths. In practice, due to the turbulent nature of the hydraulic jump, distinguishing the depth d1 could be challenging.

UPSTREAM PARAMETERS	Symbol	Value	Unit
Backwater depth:	d_0	1.19	m
Critical depth:	d_c	0.79	m
Critical velocity:	V_k	2.78	m/s
Specific head on the crest:	H_s	1.19	m
Total head on the crest:	H_t	6.19	m
Type of Flow:	-	Skimming Flow	-

DOWNSTREAM PARAMETERS	Symbol	Value	Unit
Total head downstream:	H_t	2.59	m
Critical depth:	y_{cr}	0.79	m
Critical velocity:	V_k	2.78	m/s
Specific head at the toe:	H_s	1.19	m
Water depth of supercritical flow:	z_1	0.33	m
Froude's number:	F_r	3.69	-
Conjugate depth:	z_2	1.57	m
Hydraulic radius of superctitical flow:	R_h	0.31	m
Average rate of friction:	if	0.19	-
Hydraulic jump length:	L_j	8.55	m
Downstream water depth:	z_3	0.83	m



3.3.3 STEPPED WEIRS – OUTPUT RESULTS



Basin design output	Symbol	Value	Unit	Check
Min length of the crest:	L_{crest}	1.5	m	-
Min length of the stilling basin:	L_{bac}	9	m	✓
Stilling basin width:	W_b	10	m	-
Min counterweir height:	fc_min	0.38	m	✓
Water velocity:	v_1	6.65	m/s	-
Lining material:	Reno Mattress Plus PoliMac ™ - t=0.3 m - d50=0.12 m - Cu=1			
Shear Stress at downstream section:	τ	576.83	N/m²	✓
Allowable shear stress of the lining:	τ_{all}	591	N/m²	-

The 'Basin Design' tab includes:

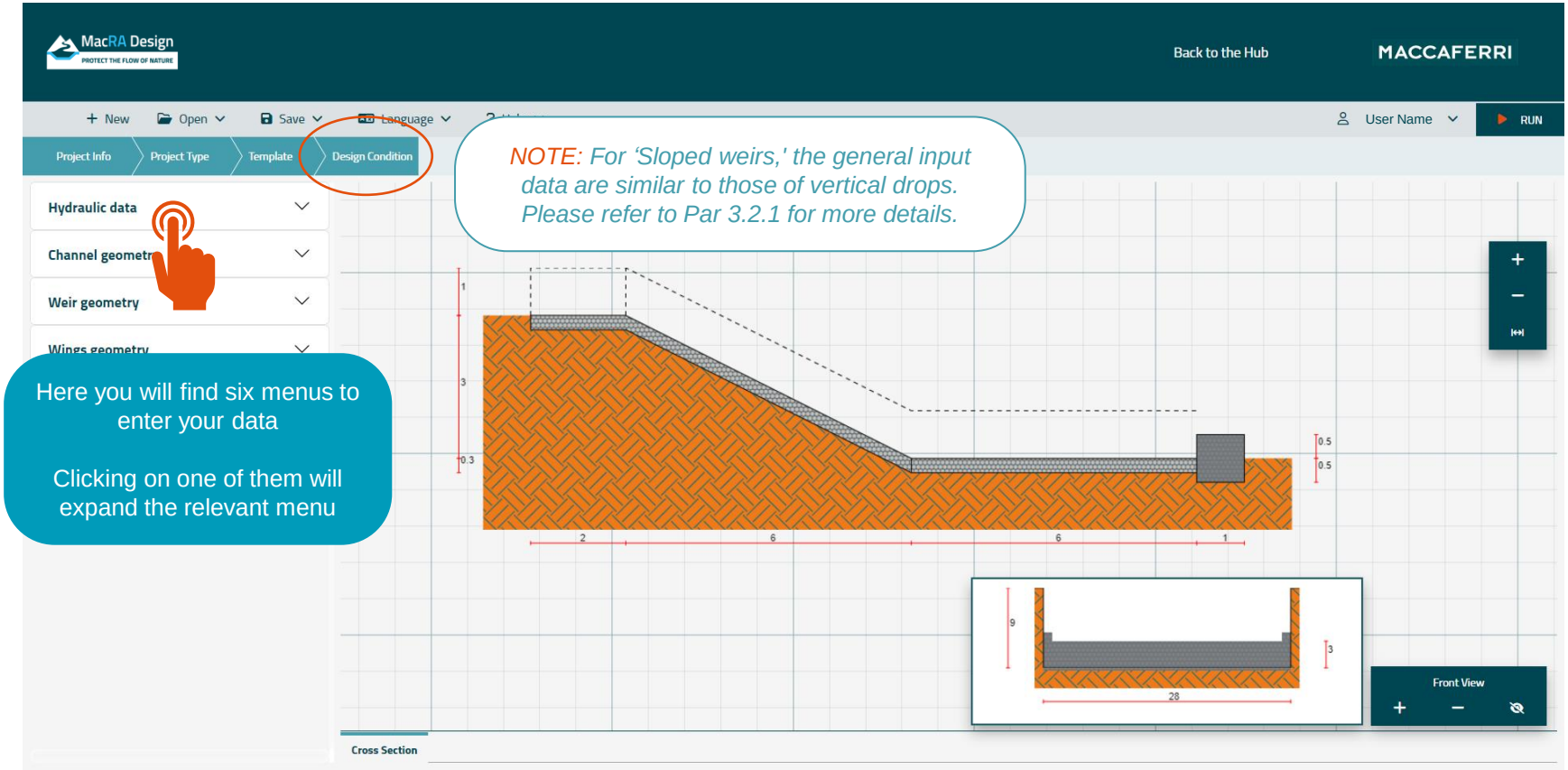
- Required geometry of the basin
- Lining material details
- Acting shear stress and relevant checks

NOTE: If one of the checks is not satisfied, the relevant row will be highlighted in red

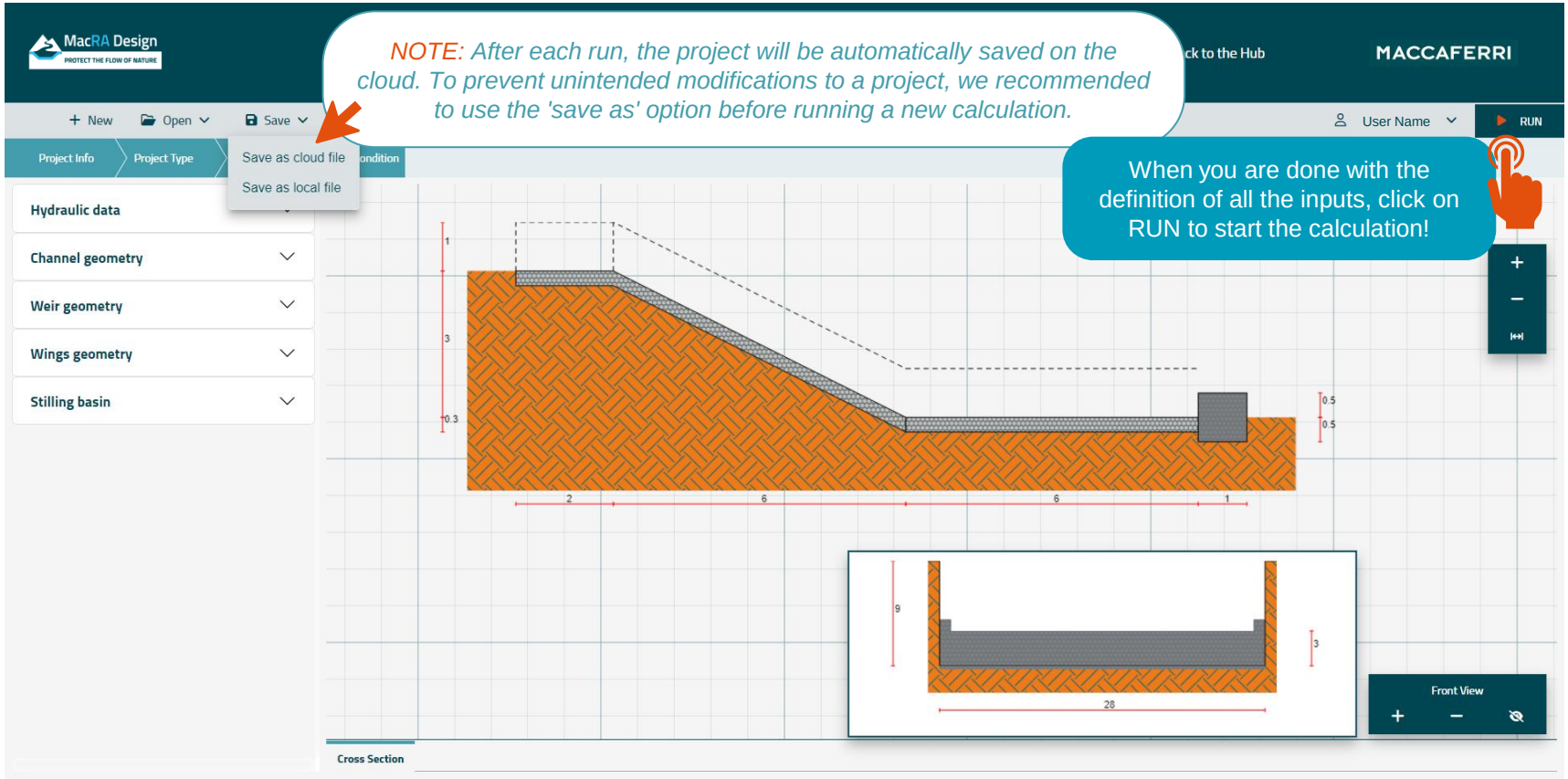
GRADE CONTROL STRUCTURES

SLOPED WEIRS (CHUTES & SPILLAWAYS)

3.4.1 SLOPED WEIRS – DESIGN CONDITION



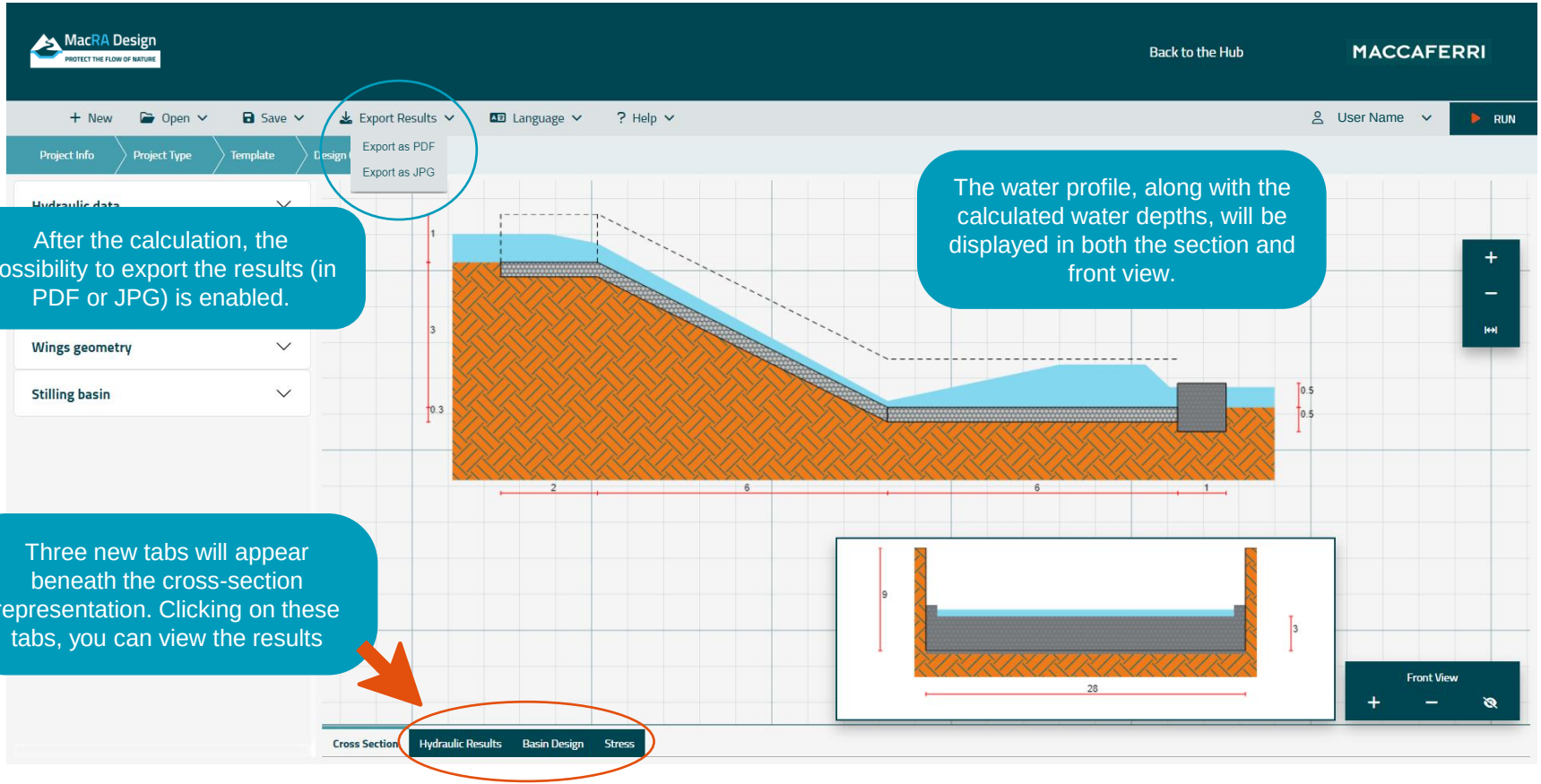
3.4.2 SLOPED WEIRS – CALCULATION



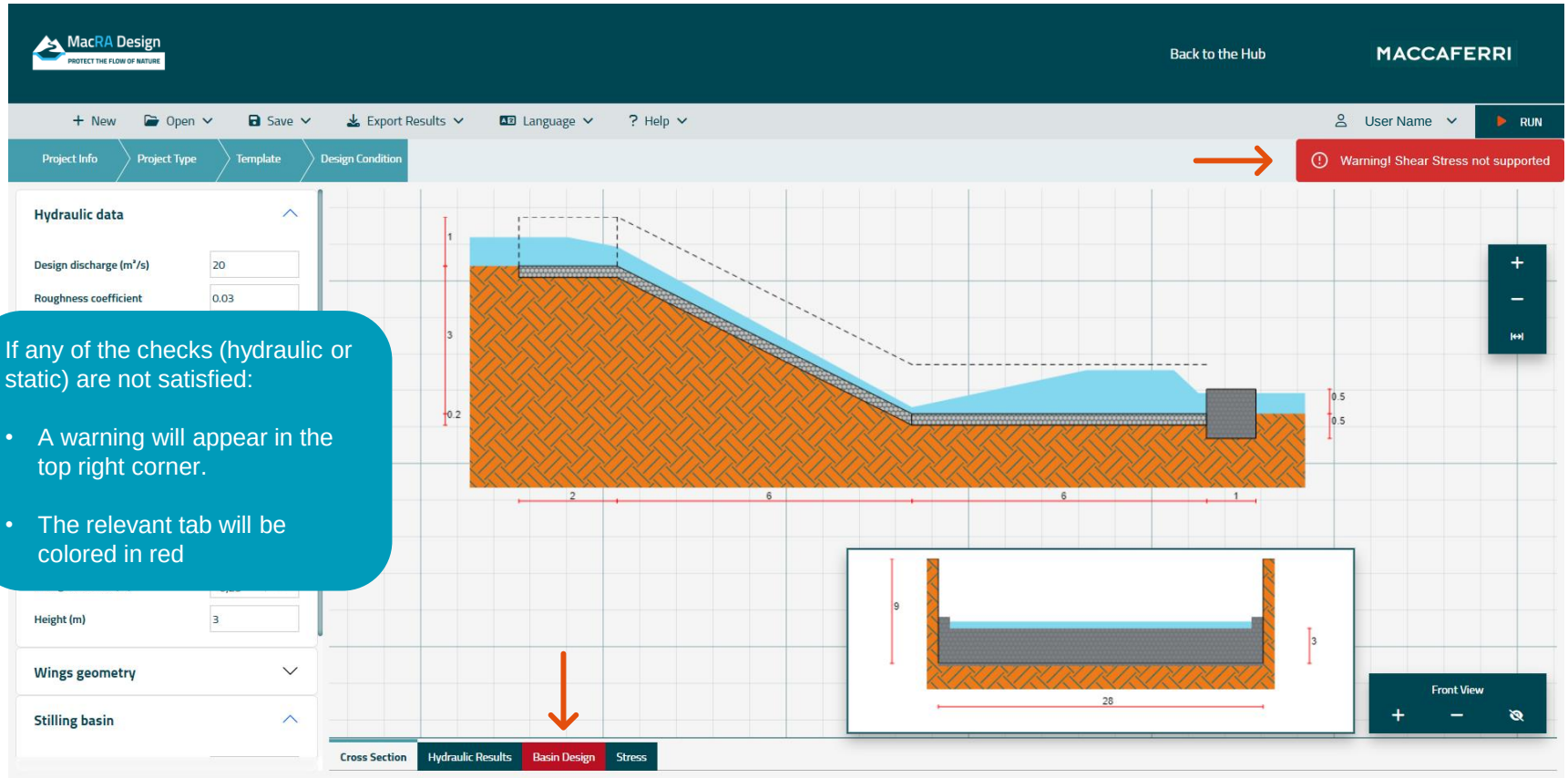
NOTE: After each run, the project will be automatically saved on the cloud. To prevent unintended modifications to a project, we recommended to use the 'save as' option before running a new calculation.

When you are done with the definition of all the inputs, click on RUN to start the calculation!

3.4.3 SLOPED WEIRS – OUTPUT RESULTS



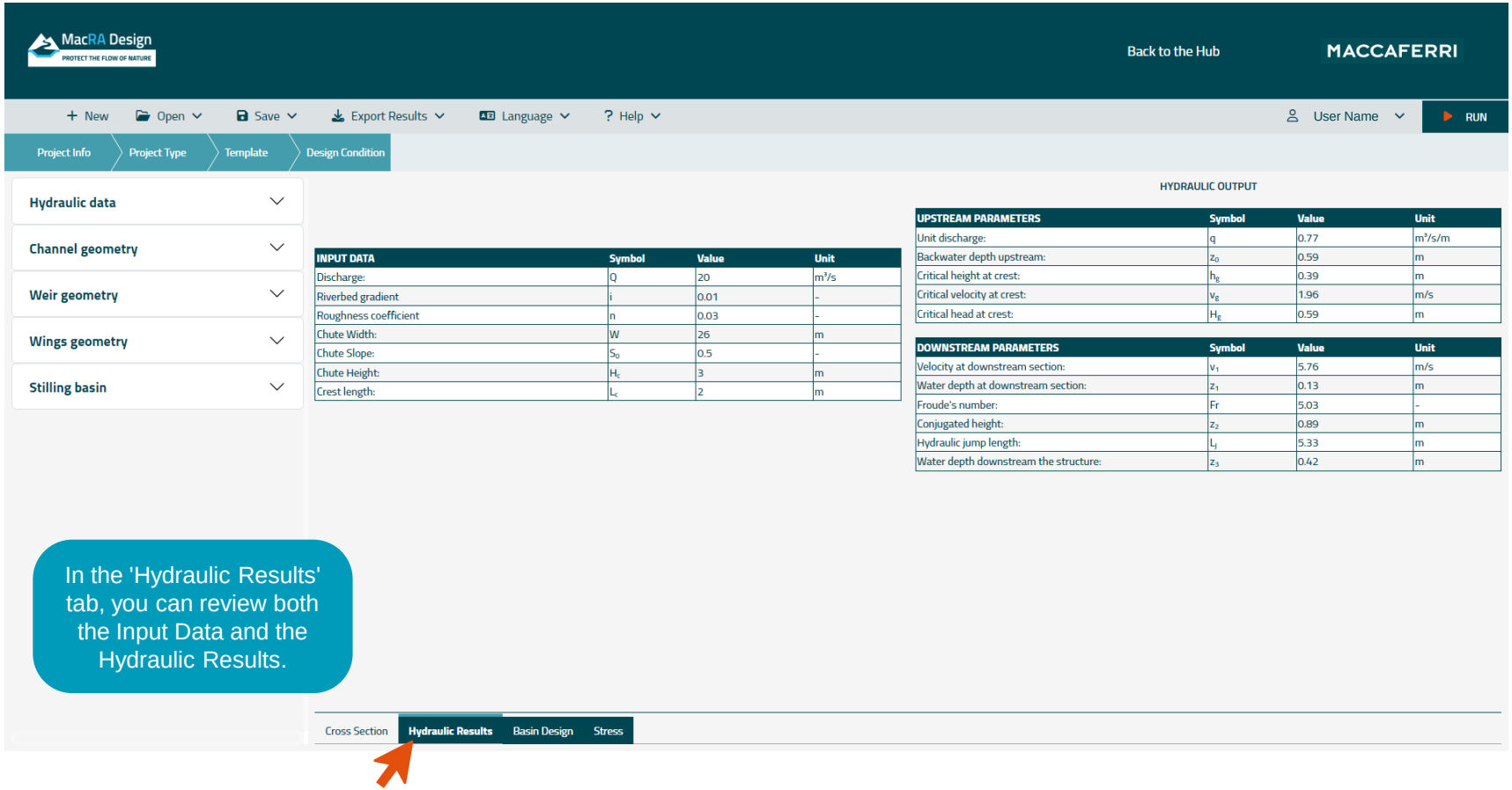
3.4.3 SLOPED WEIRS – OUTPUT RESULTS



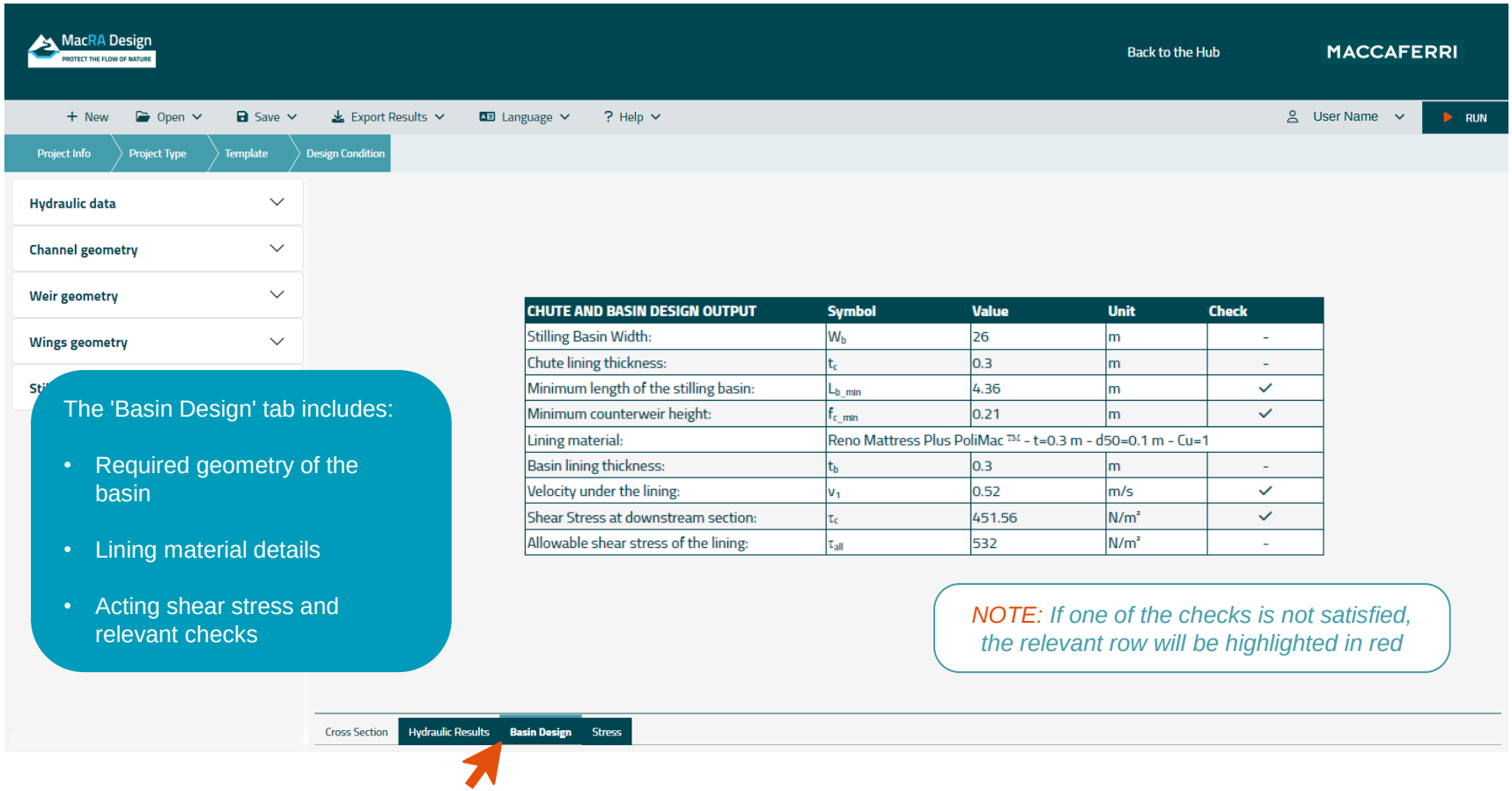
If any of the checks (hydraulic or static) are not satisfied:

- A warning will appear in the top right corner.
- The relevant tab will be colored in red

3.4.3 SLOPED WEIRS – OUTPUT RESULTS



3.4.3 SLOPED WEIRS – OUTPUT RESULTS



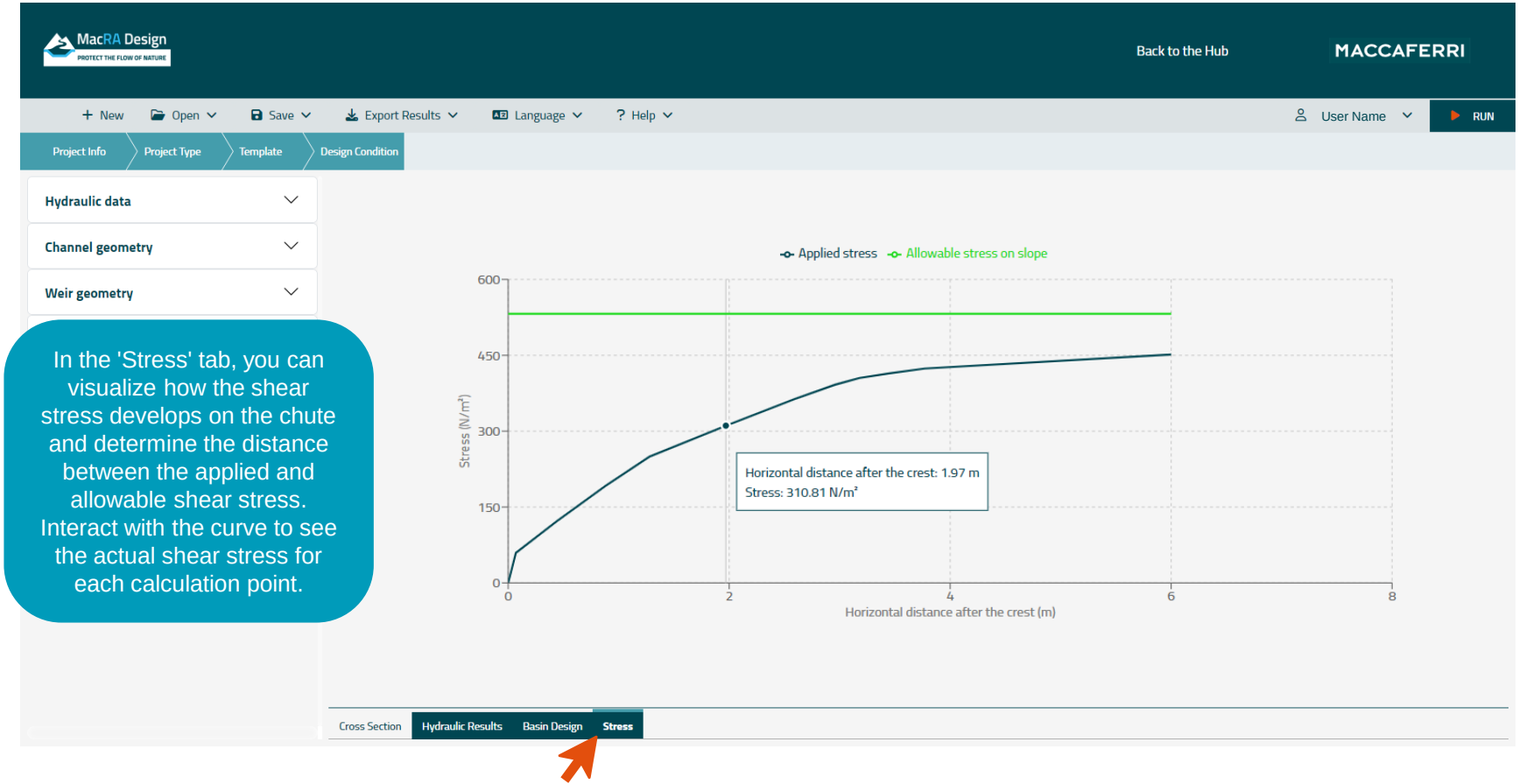
CHUTE AND BASIN DESIGN OUTPUT	Symbol	Value	Unit	Check
Stilling Basin Width:	W_b	26	m	-
Chute lining thickness:	t_c	0.3	m	-
Minimum length of the stilling basin:	L_{b_min}	4.36	m	✓
Minimum counterweir height:	f_{c_min}	0.21	m	✓
Lining material:	Reno Mattress Plus PoliMac ™ - t=0.3 m - d50=0.1 m - Cu=1			
Basin lining thickness:	t_b	0.3	m	-
Velocity under the lining:	v_1	0.52	m/s	✓
Shear Stress at downstream section:	τ_c	451.56	N/m²	✓
Allowable shear stress of the lining:	τ_{all}	532	N/m²	-

The 'Basin Design' tab includes:

- Required geometry of the basin
- Lining material details
- Acting shear stress and relevant checks

NOTE: If one of the checks is not satisfied, the relevant row will be highlighted in red

3.4.3 SLOPED WEIRS – OUTPUT RESULTS



In the 'Stress' tab, you can visualize how the shear stress develops on the chute and determine the distance between the applied and allowable shear stress. Interact with the curve to see the actual shear stress for each calculation point.