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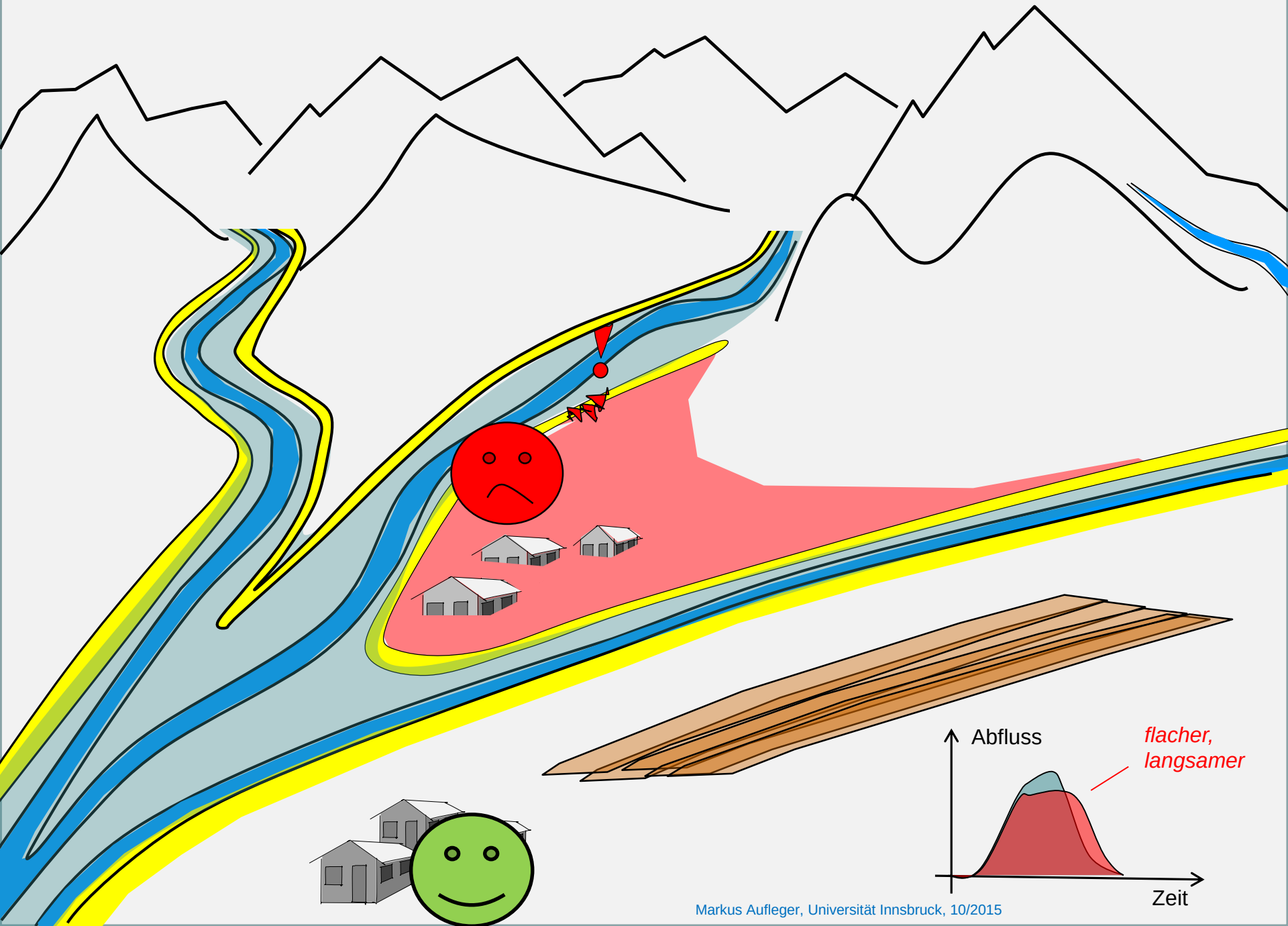
6020 Innsbruck
www.uibk.ac.at/wasserbau

Gesteuerter Rückhalt über Flutpolder

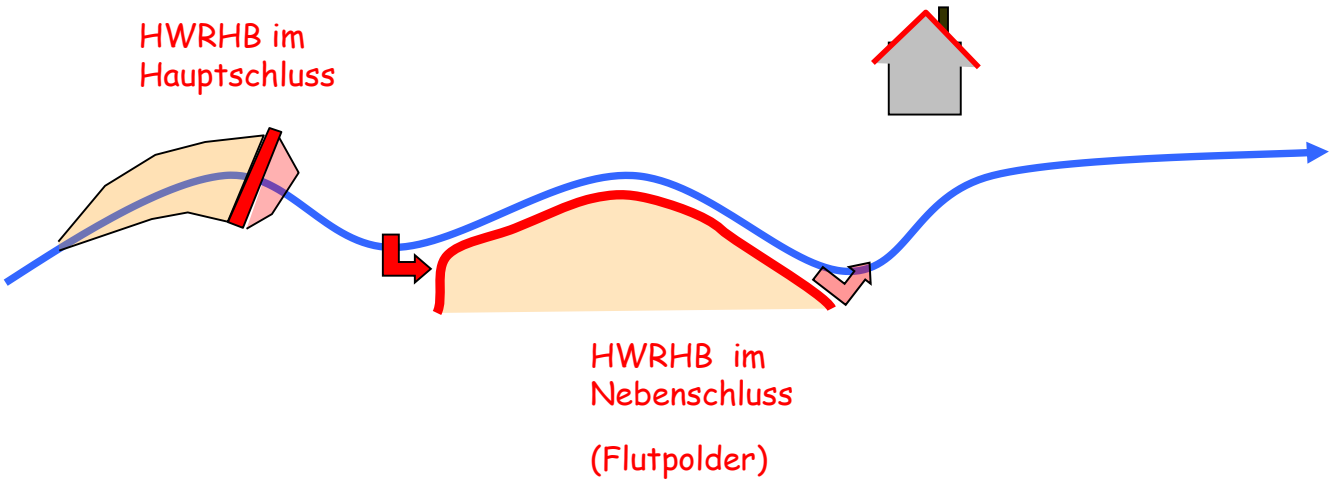
Markus Aufleger
Regensburg, 8.10.2015

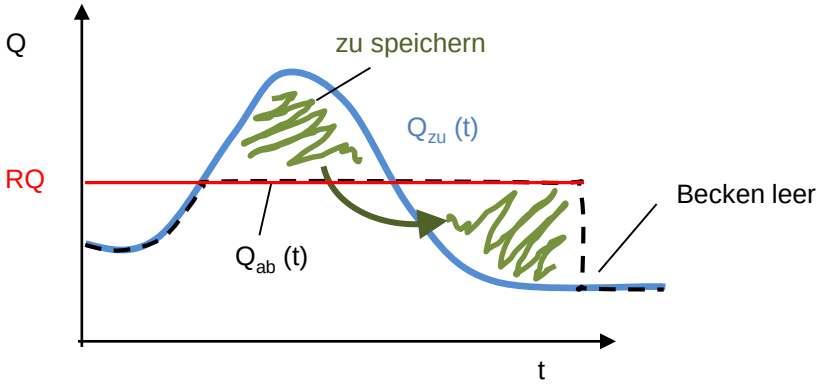
Rückblick


Abfluss
flacher,
langsamer
Zeit

Überblick

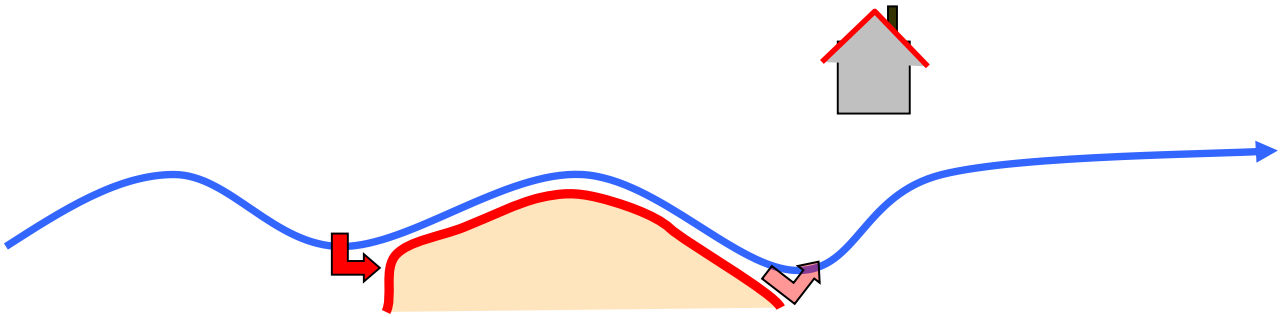
Rückhalt im Hauptschluss





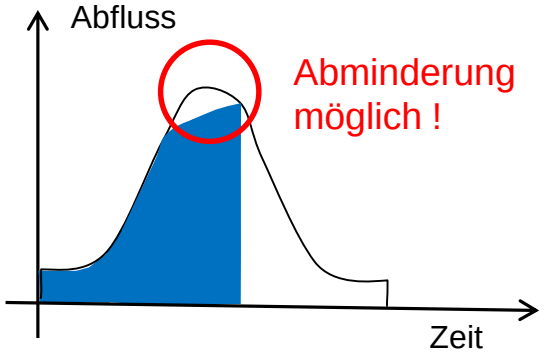
Rückhalt im Nebenschluss

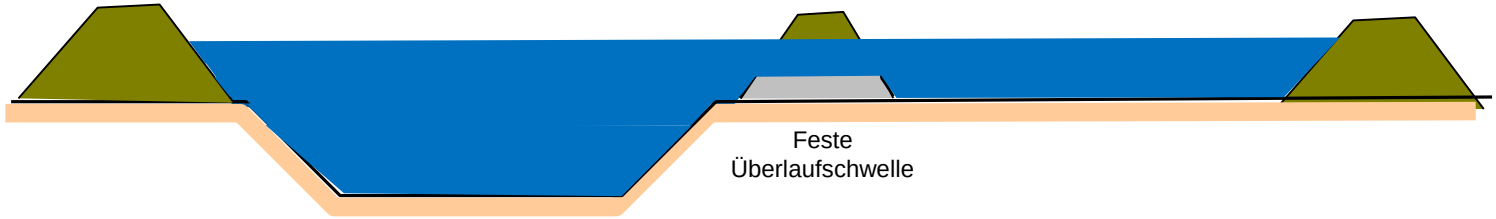
a) ungesteuert



HWRHB im Nebenschluss

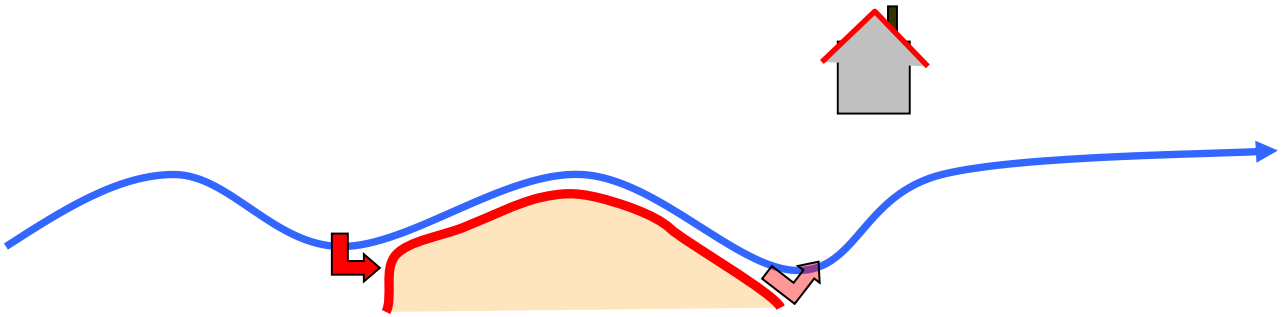
(Flutpolder)





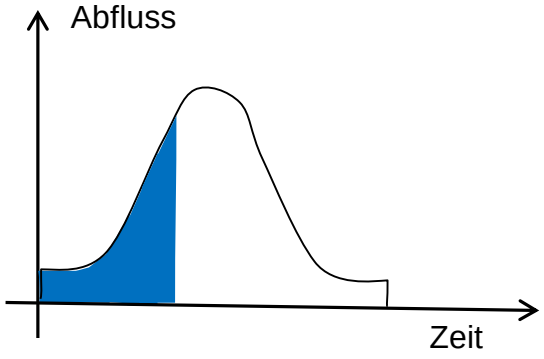
Rückhalt im Nebenschluss

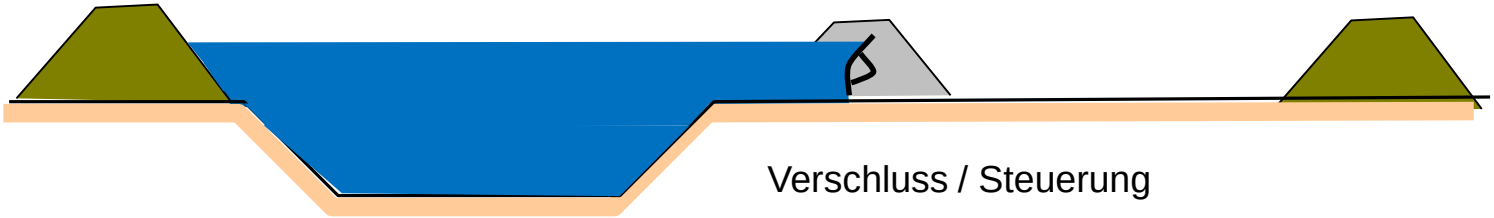
b) gesteuert



HWRHB im Nebenschluss

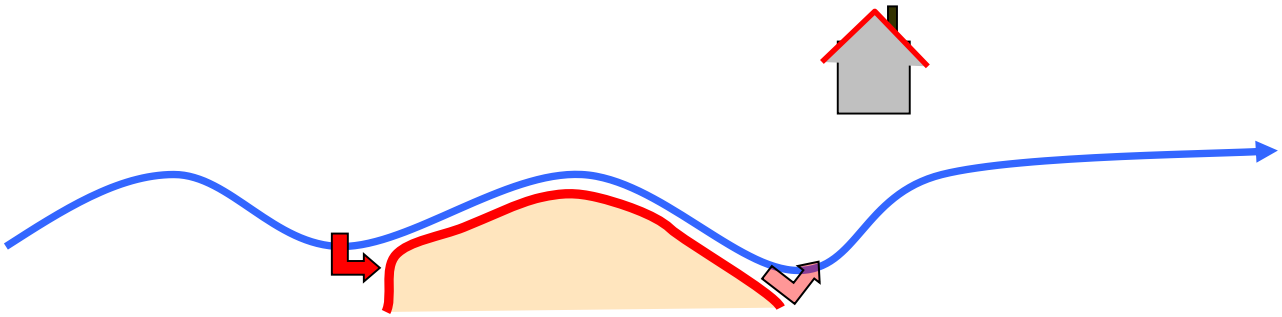
(Flutpolder)





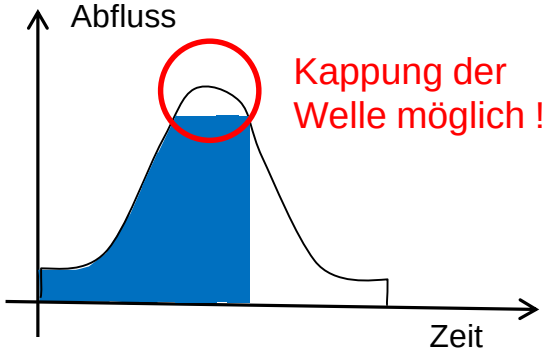
Rückhalt im Nebenschluss

b) gesteuert

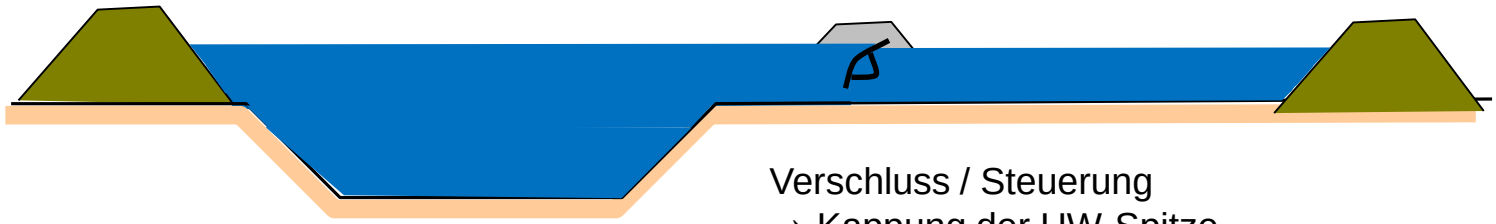


HWRHB im Nebenschluss

(Flutpolder)

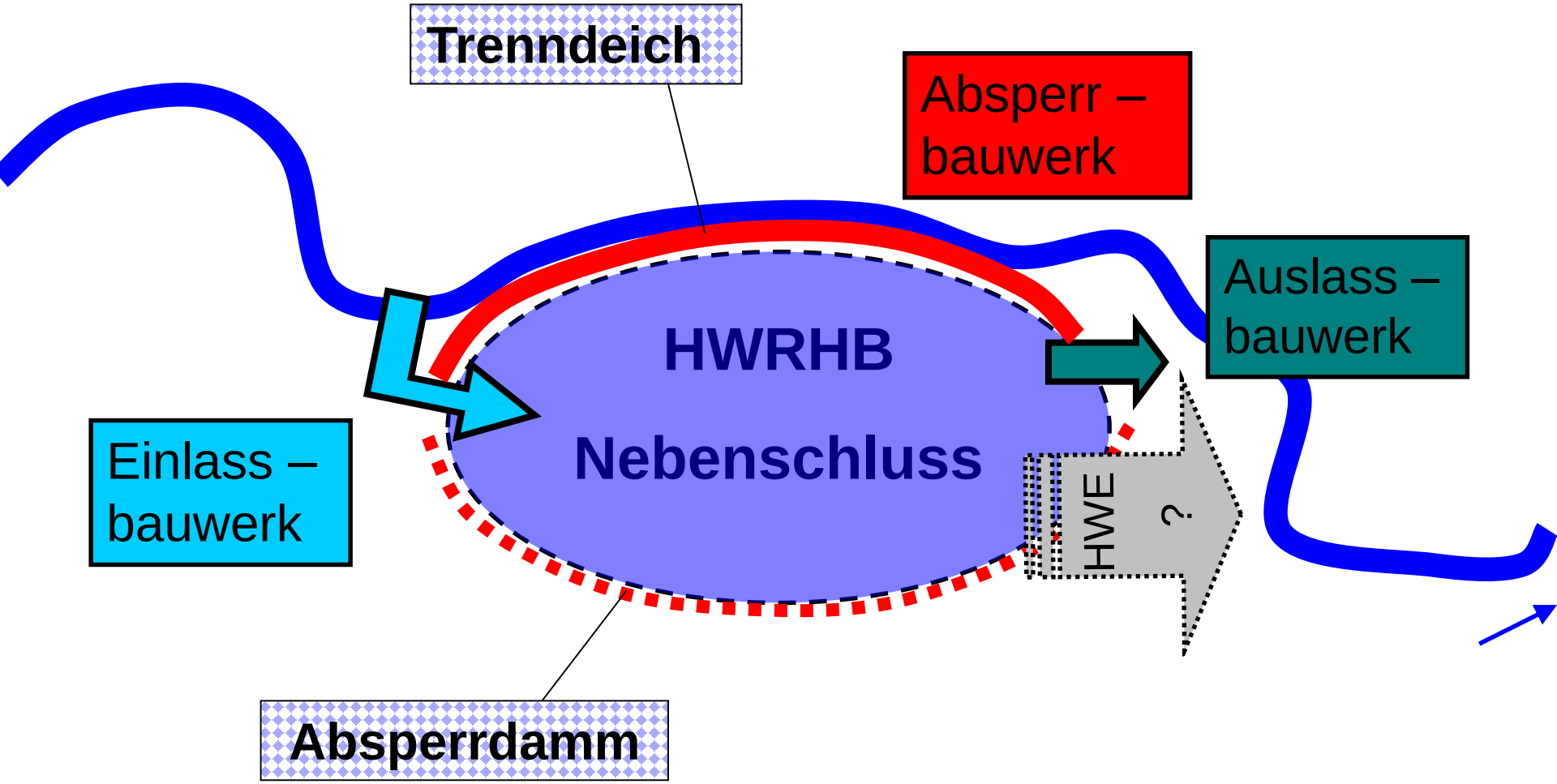


Kappung der Welle möglich !



Verschluss / Steuerung
→ Kappung der HW-Spitze

Konstruktions-elemente
(und Beispiele)


Trenndeich
Absperr – bauwerk
Auslass – bauwerk
HWRHB
Nebenschluss
Einlass – bauwerk
HWE ?
Absperrdamm

Flutpolder Weidachwiesen, Nr. 1 in Bayern !


Google earth


h
t


Google earth

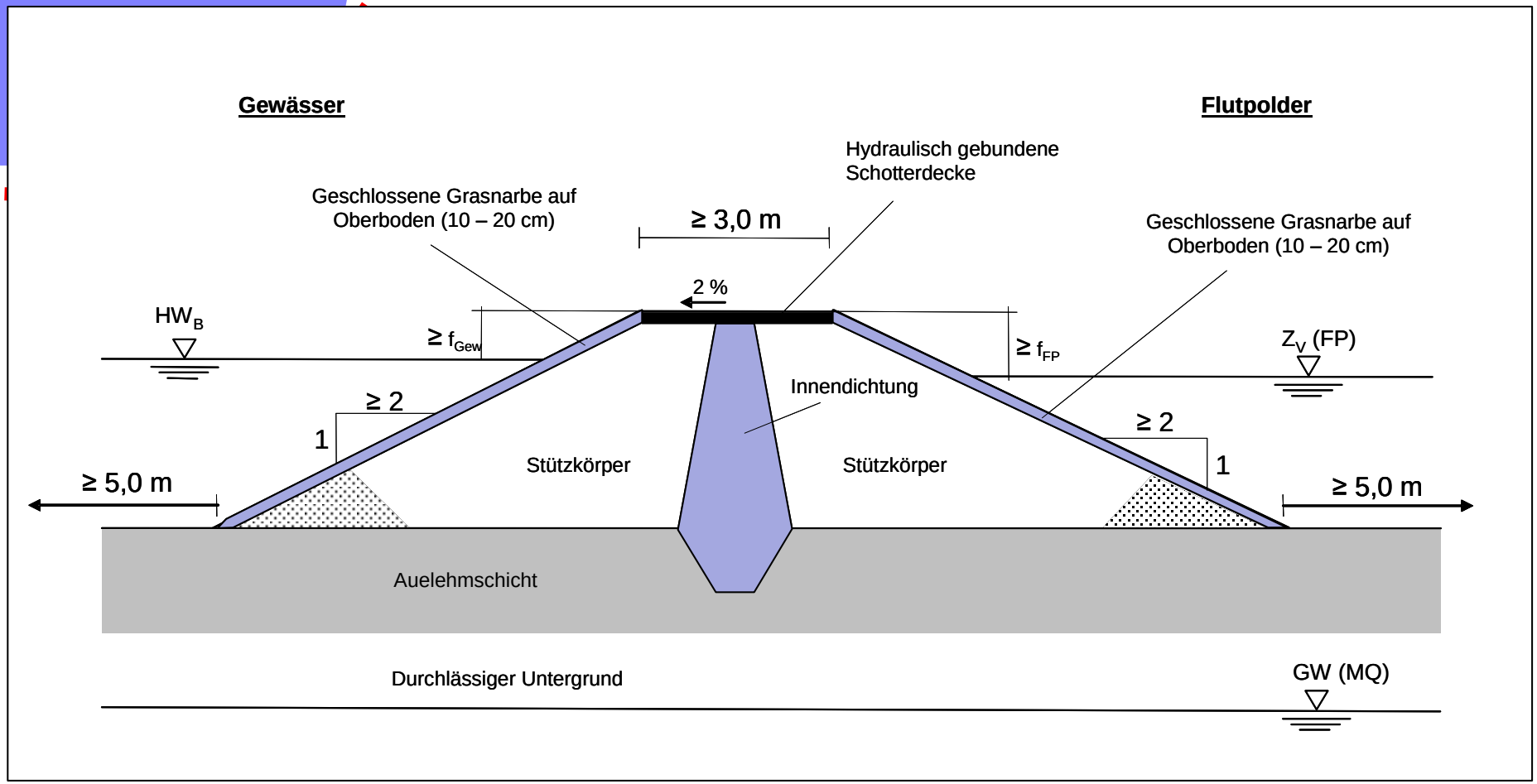
Einlass – bauwerk

Hydraulische Bemessung

- Leistungsfähigkeit ~ Steuerung **(!)**
- Alle Wehrfelder (n) stehen zur Verfügung.
- OK Wehrschwelle möglichst über MQ
- „Freies Fließen“ oder Stauregelung / Wehr ?
- Schadloses Einströmen in leeres Becken (Sohlbefestigung, Formgebung)

Konstruktion

Trenndeich



- „Absperrbauwerk“ eines Hochwasserrückhaltebecken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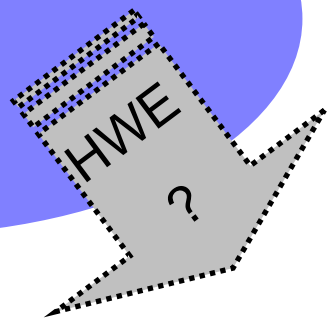
Google earth



⇒ **HWE i.a. nur notwendig,**

- falls das Einlaufbauwerk das Becken im Nebenschluss nicht zuverlässig hydraulisch vom Gewässer trennen kann.
- bei eigenem Einzugsgebiet (= Becken im Hauptschluss).

Auslass – bauwerk

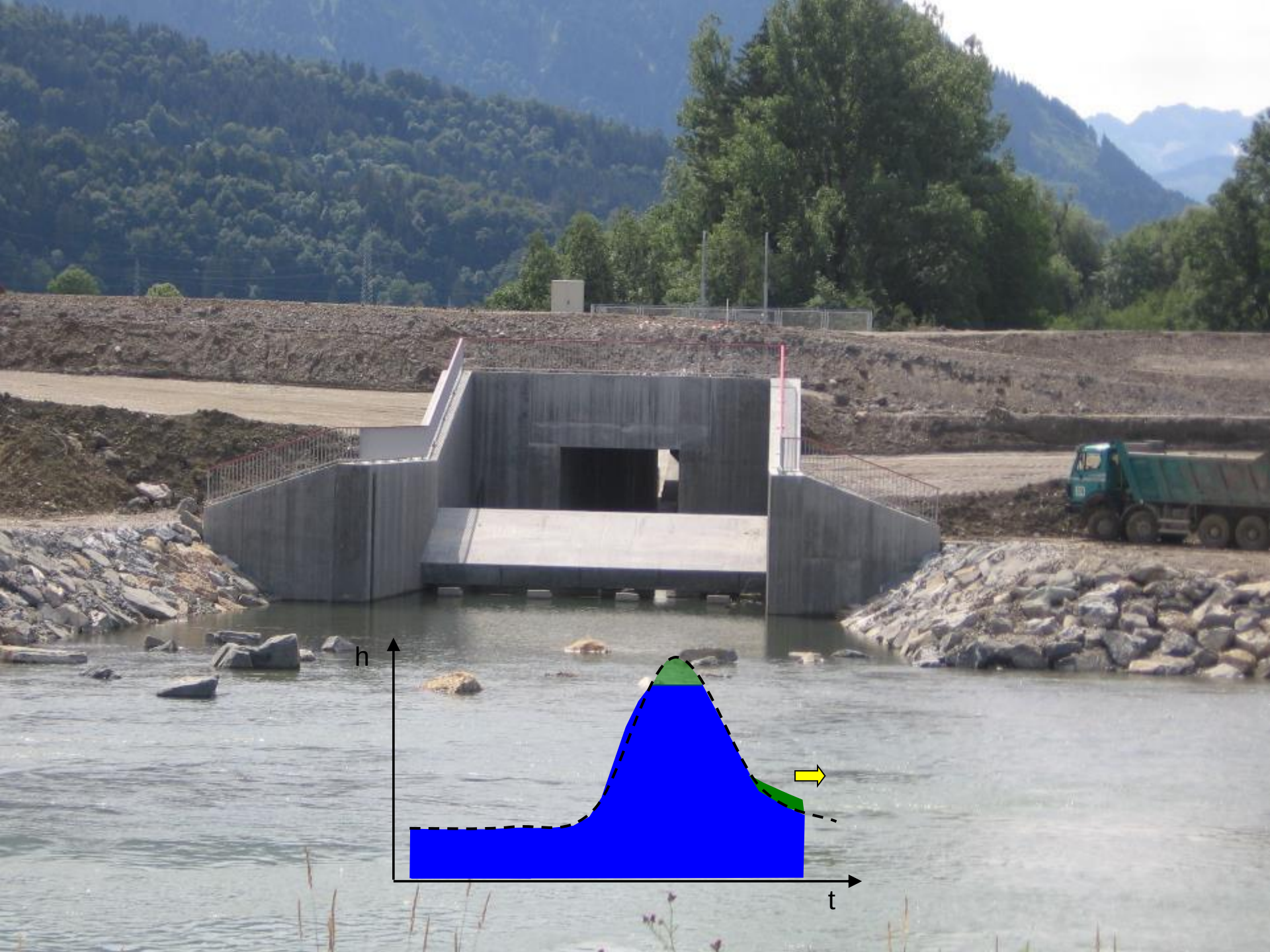
Grundsätze

- i.A.: Betriebsauslass = Grundablass
- **Zwei** Betriebsauslässe
- Jeweils **ein** Verschluss
- **Bedingung 1:** $Q_A = f$ (Entleerungszeit)
- **Bedingung 2:** $Q_A > Q_{Einlaufbauwerk}$
- Durchgängigkeit ?

DIN 19700

Hydr. Bemessung

Ausführung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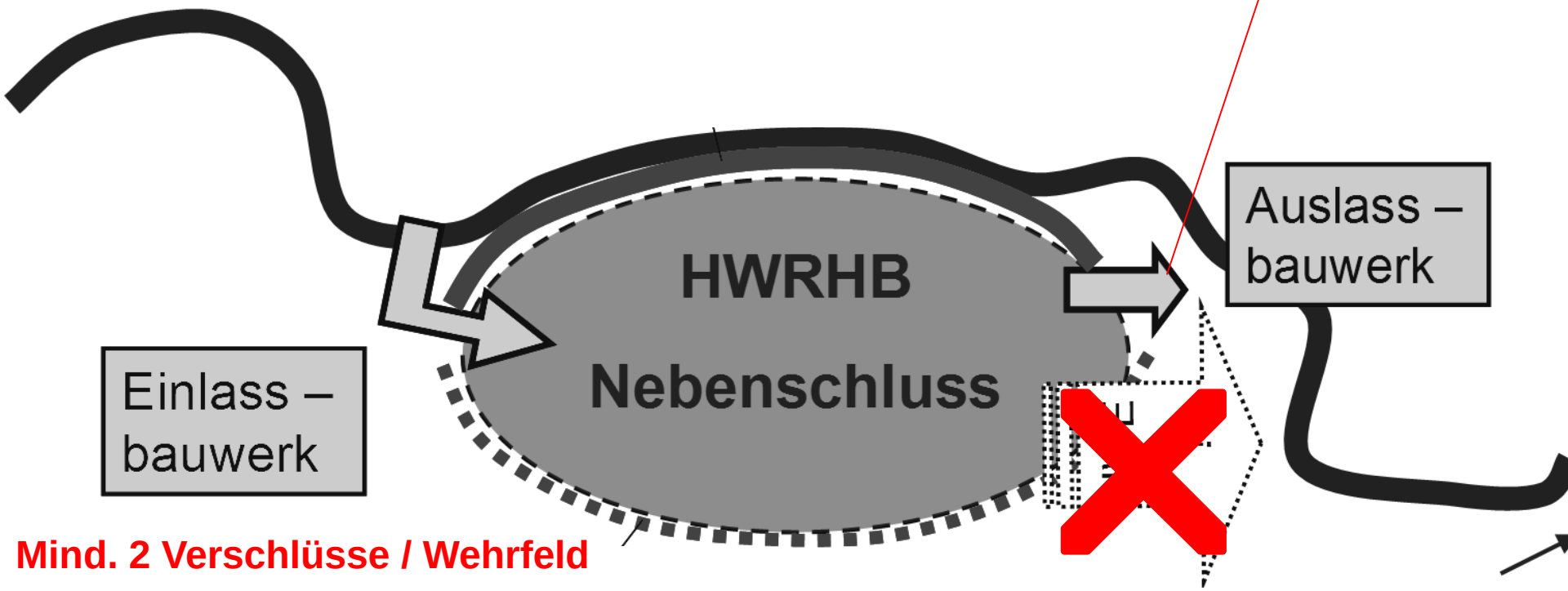
Baden-Württemberg

Dimensionierung $Q > Q_{Wehrfeld\ im\ Einlauf}$



Mind. 2 Verschlüsse / Wehrfeld

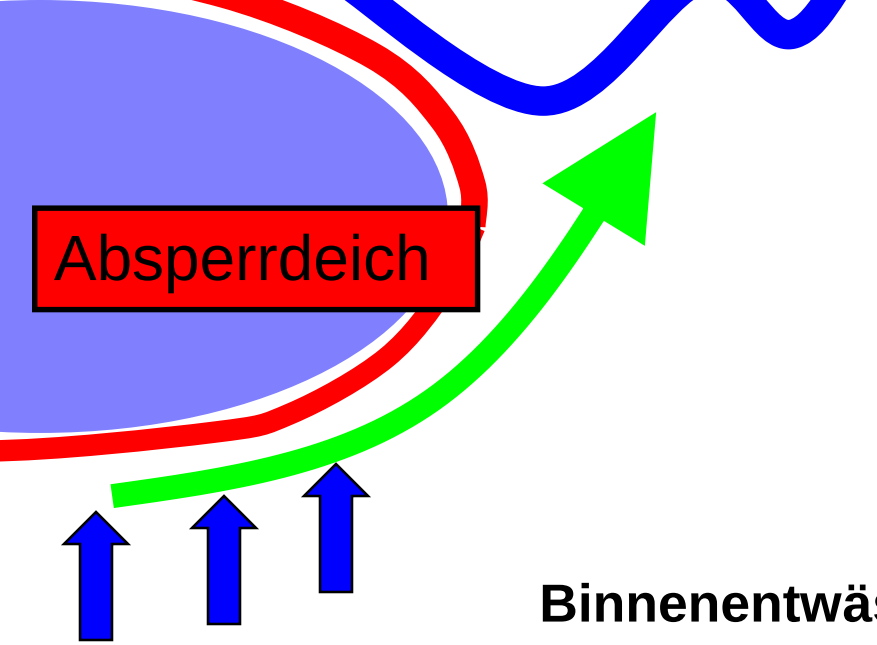
KEINE HWE !

Beispiel

Polder Altenheim, Baden-Württemberg

Beispiel

Polder Altenheim, Baden-Württemberg

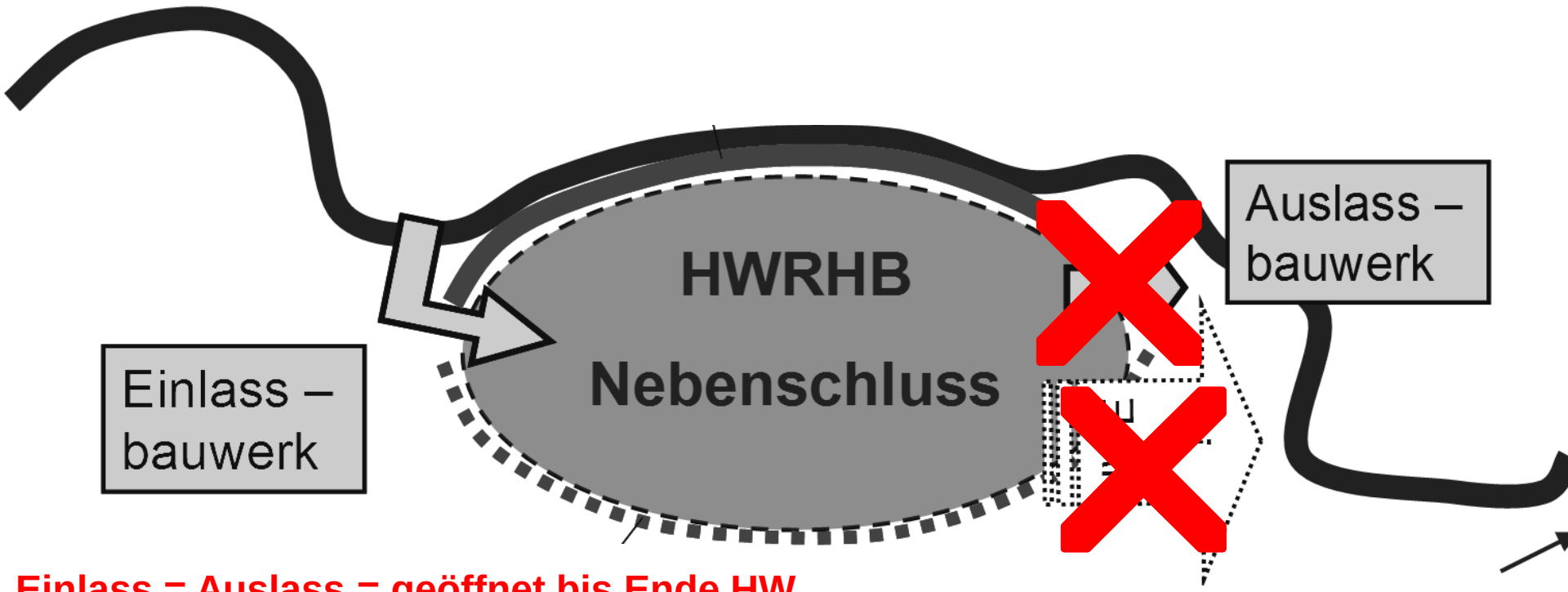


Binnenentwässerung !

Beispiel

Polder Sollingen-Gräfern, Baden-Württemberg

Rheinland-Pfalz

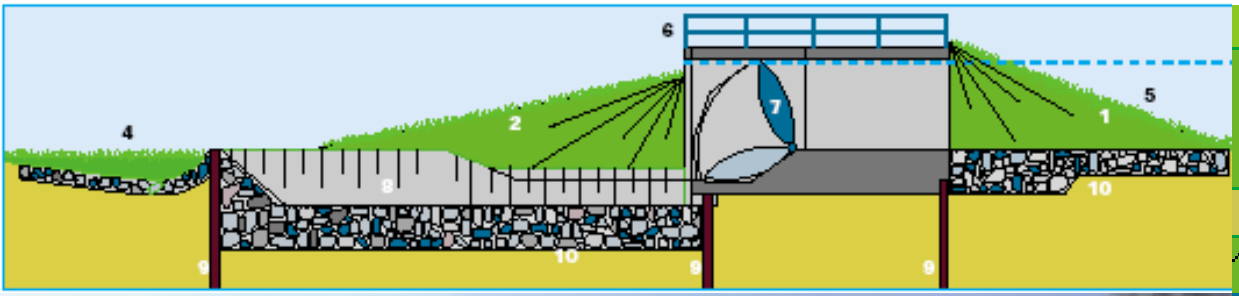


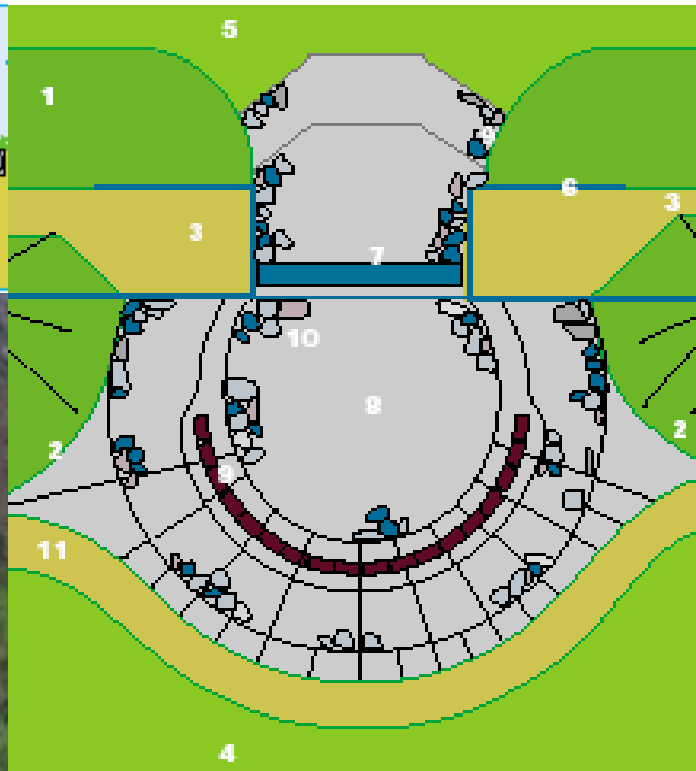
Einlass = Auslass = geöffnet bis Ende HW

Einlass – bauwerk

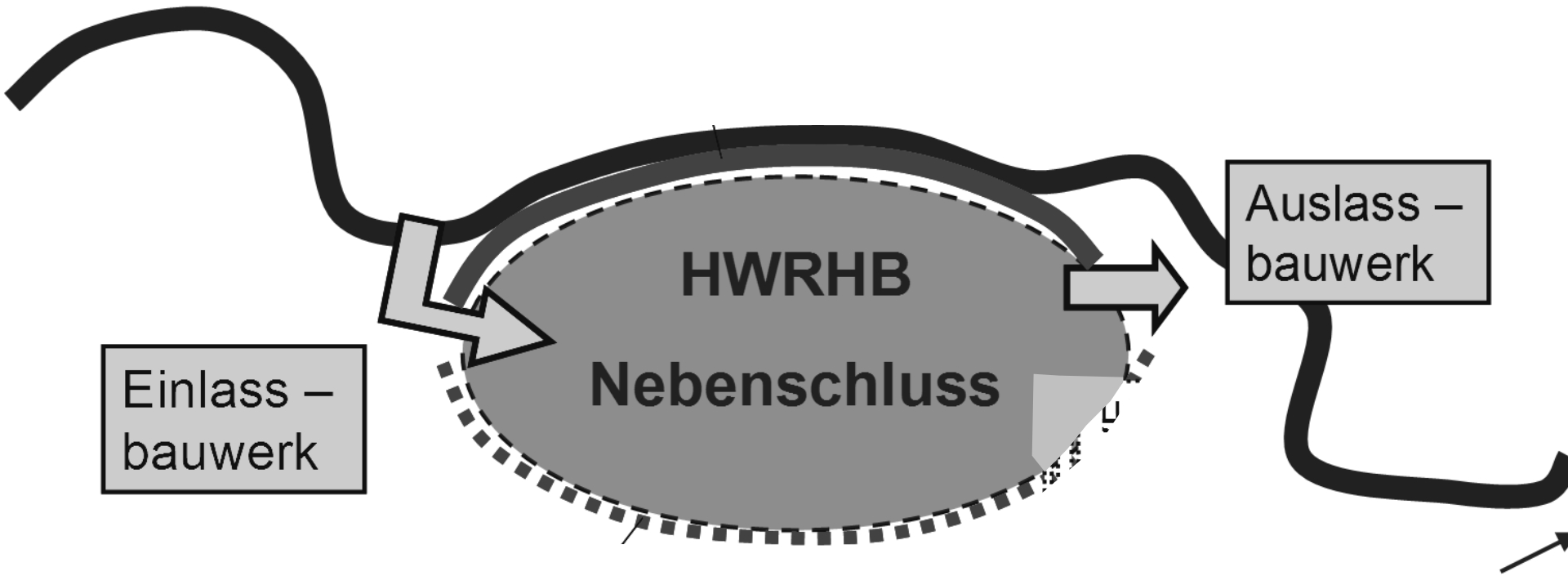
Beispiel

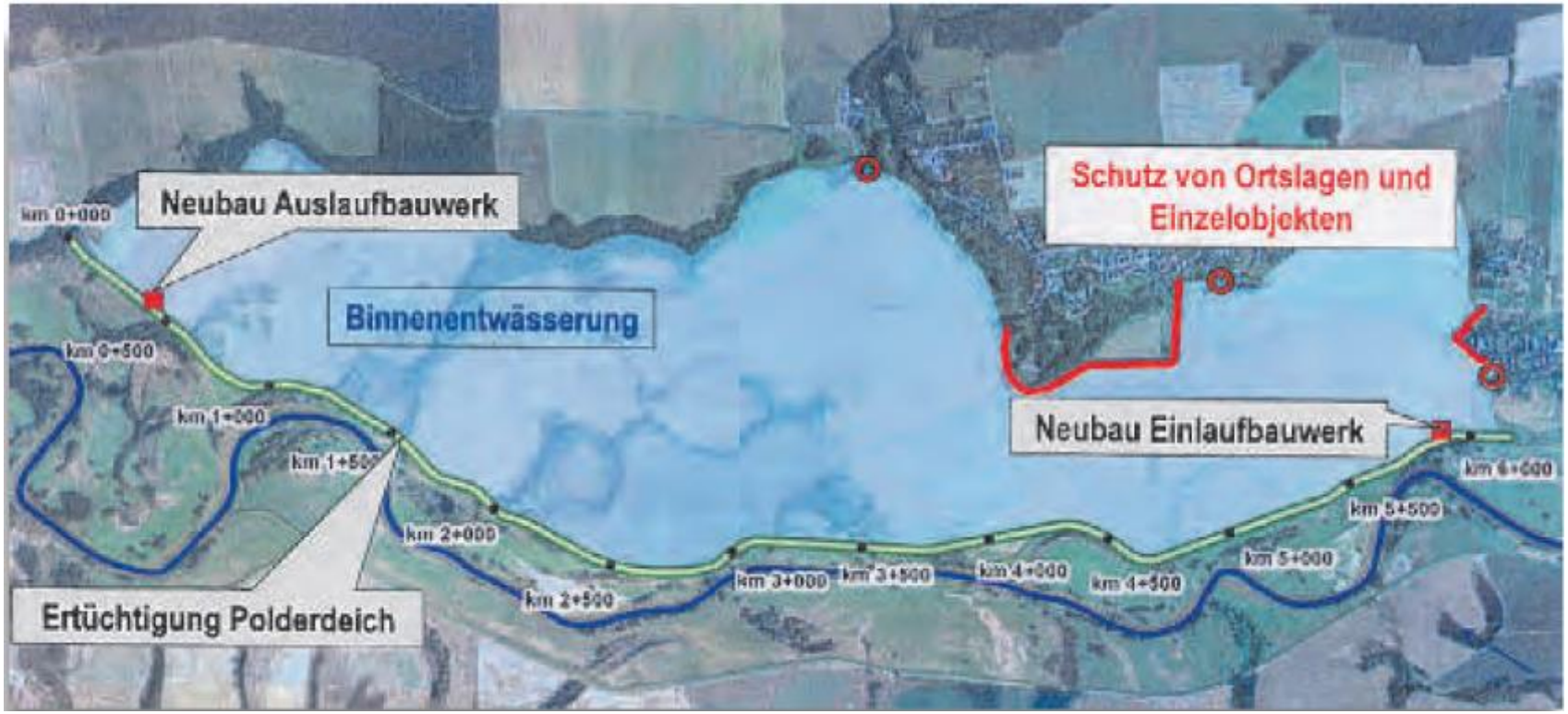
Polder Flotzgrün, Rheinland-Pfalz





Sachsen / Sachsen-Anhalt





Korrespondenz Wasserwirtschaft 5/2015

Steuerbare Flutpolder – Entwurf und Einsatzgrenzen am Beispiel der Polder Rösa und Löbnitz

17 Mio. m^3

Abb. 4: Polder Löbnitz mit Ein- und Auslaufbauwerk (gelb) und örtlichen Hochwasserschutzanlagen (rot), HQ(100)

20 Mio. m^3

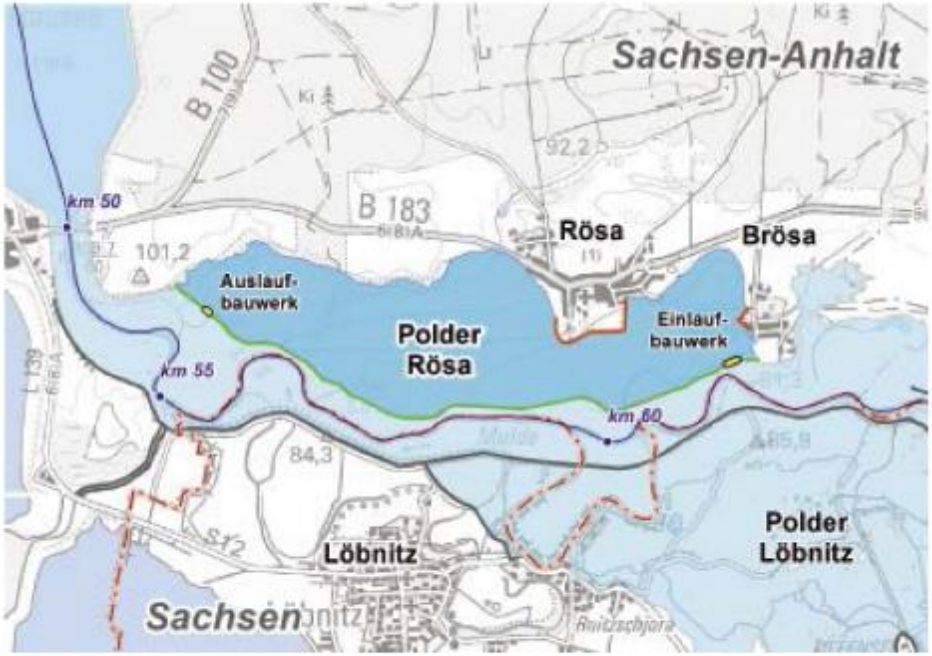


Abb. 5: Polder Rösa mit Ein- und Auslaufbauwerk (gelb) und örtlichen Hochwasserschutzanlagen (rot), HQ(200)

Korrespondenz Wasserwirtschaft 5/2015

Steuerbare Flutpolder – Entwurf und Einsatzgrenzen am Beispiel der Polder Rösa und Löbnitz

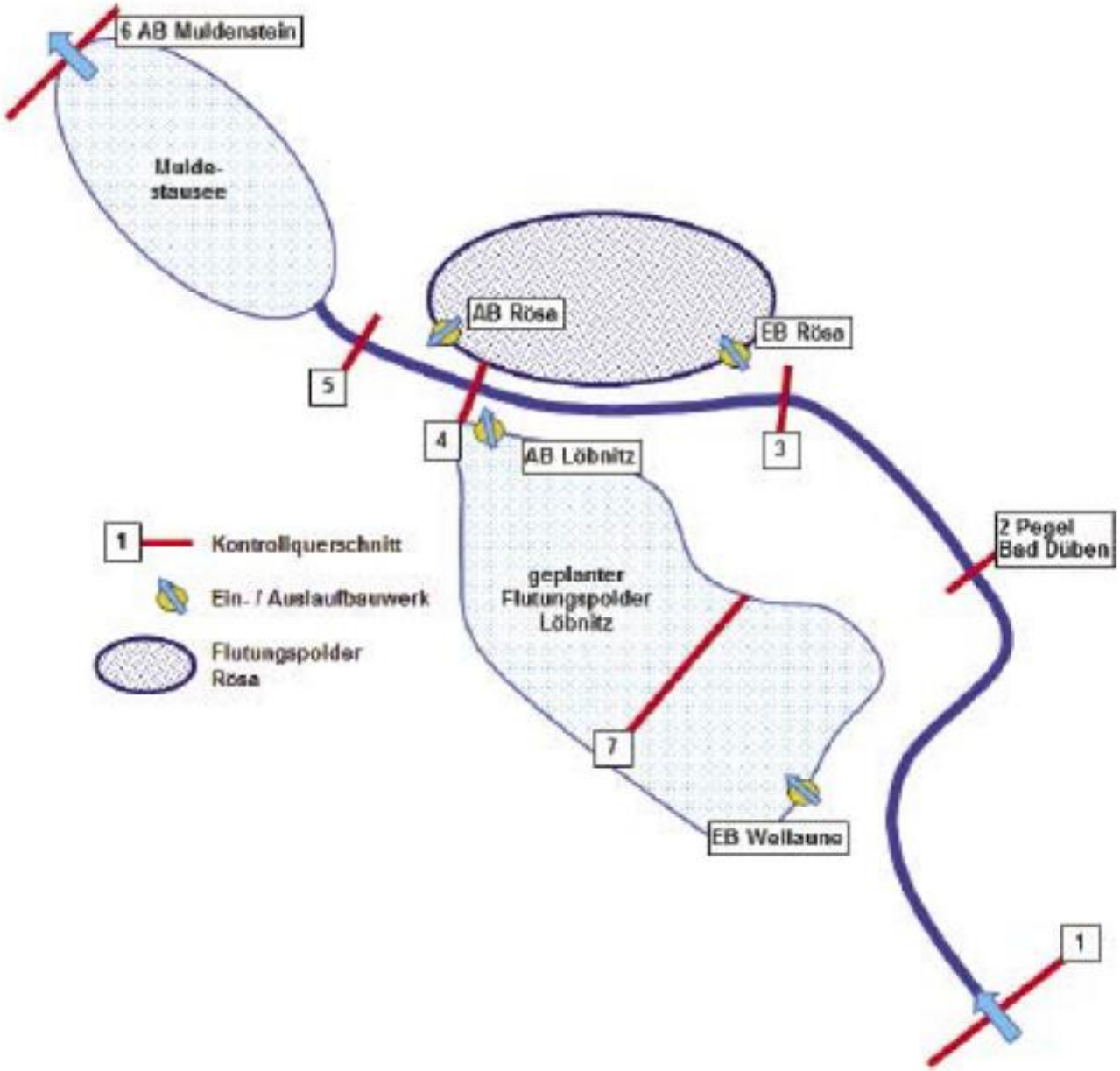


Abb. 7: Fließschema des Modellgebietes im Planzustand

Korrespondenz Wasserwirtschaft 5/2015

Steuerbare Flutpolder – Entwurf und Einsatzgrenzen am Beispiel der Polder Rösa und Löbnitz

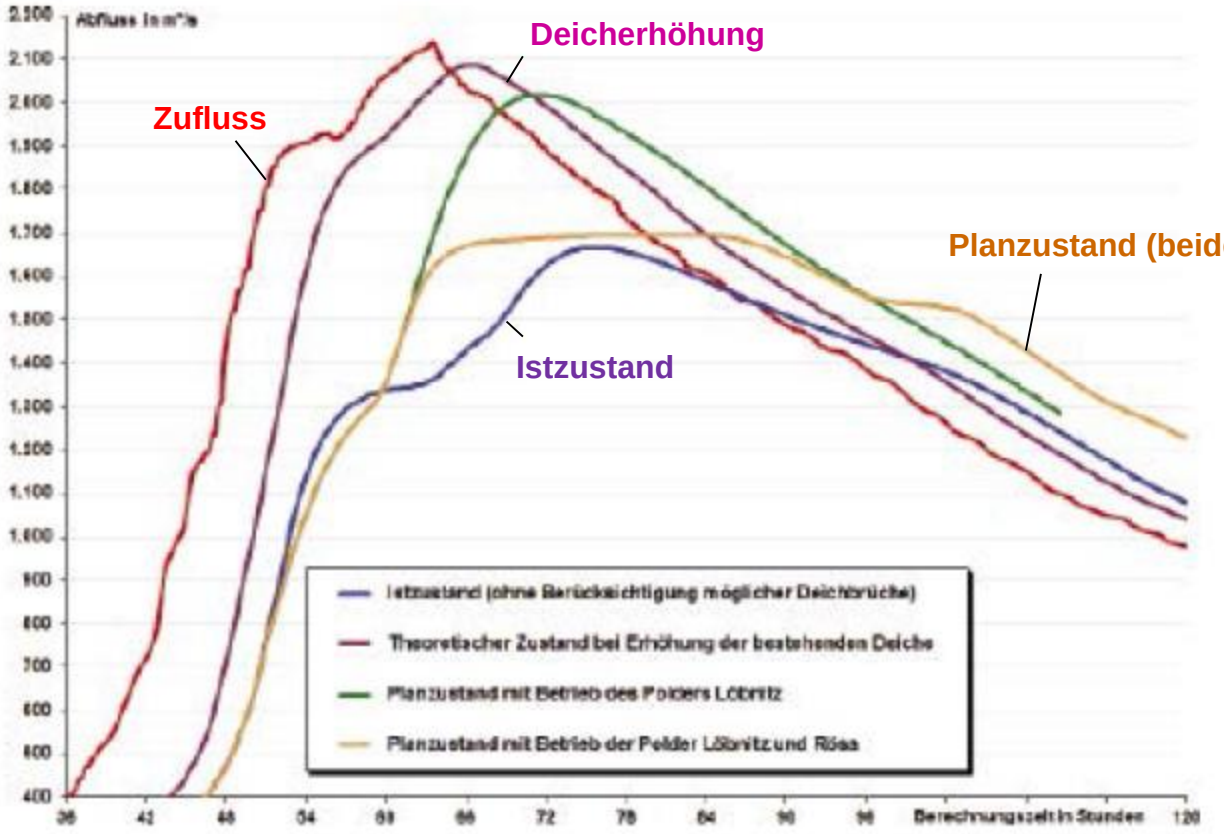
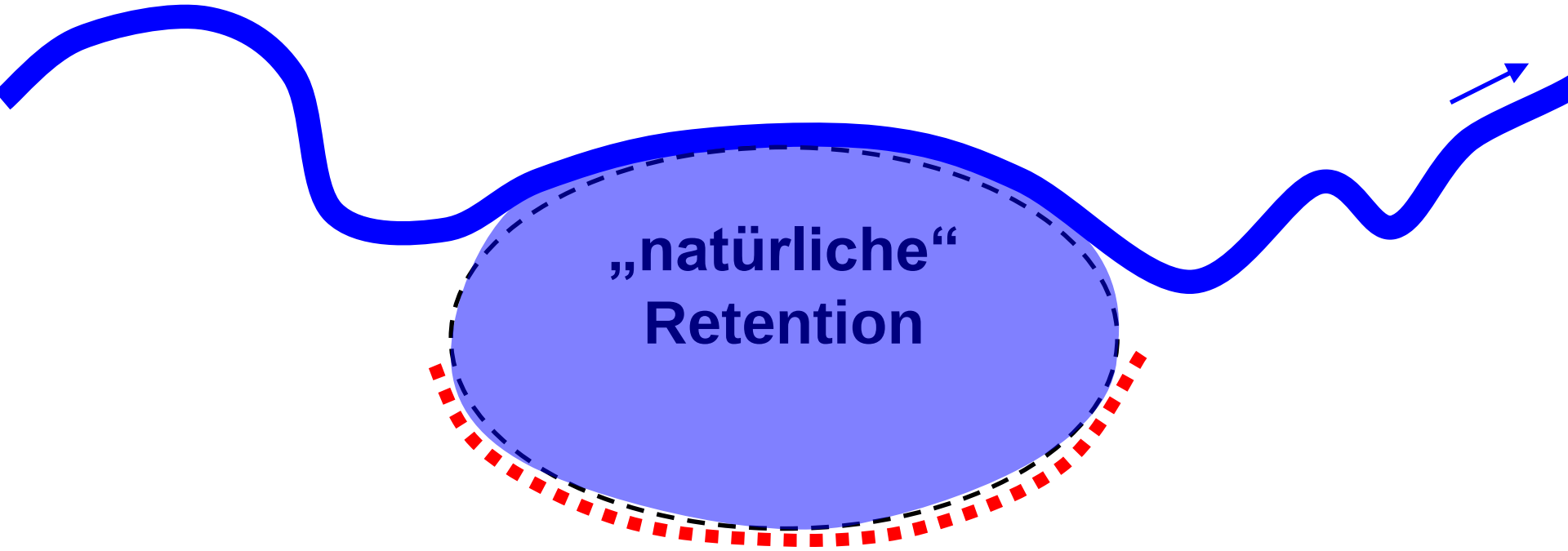


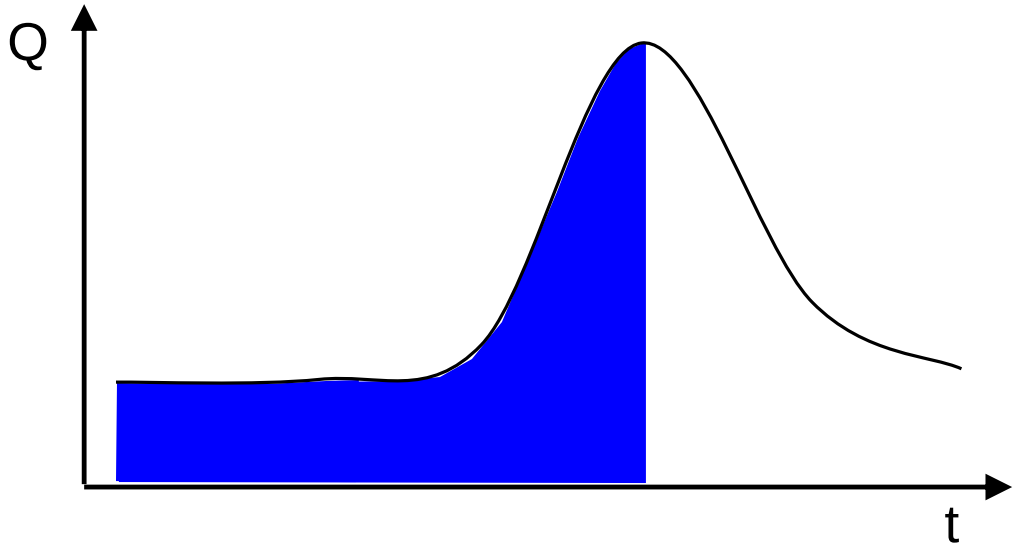
Abb. 10: Zuflussganglinie (rot) am oberen Modellrand und Abflussganglinien am Auslauf des Muldestausees bei HQ(200)

Korrespondenz Wasserwirtschaft 5/2015

Steuerbare Flutpolder – Entwurf und Einsatzgrenzen am Beispiel der Polder Rösa und Löbnitz

Steuerung und Wirksamkeit


„natürliche“
Retention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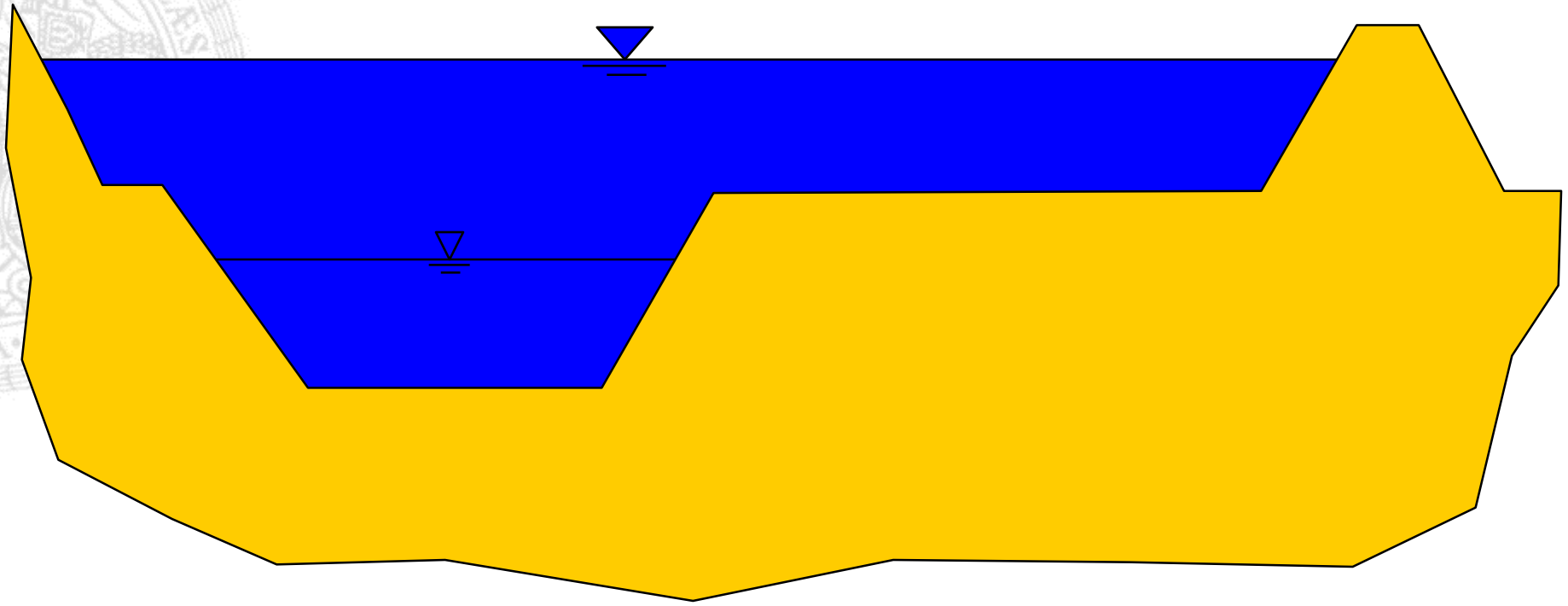
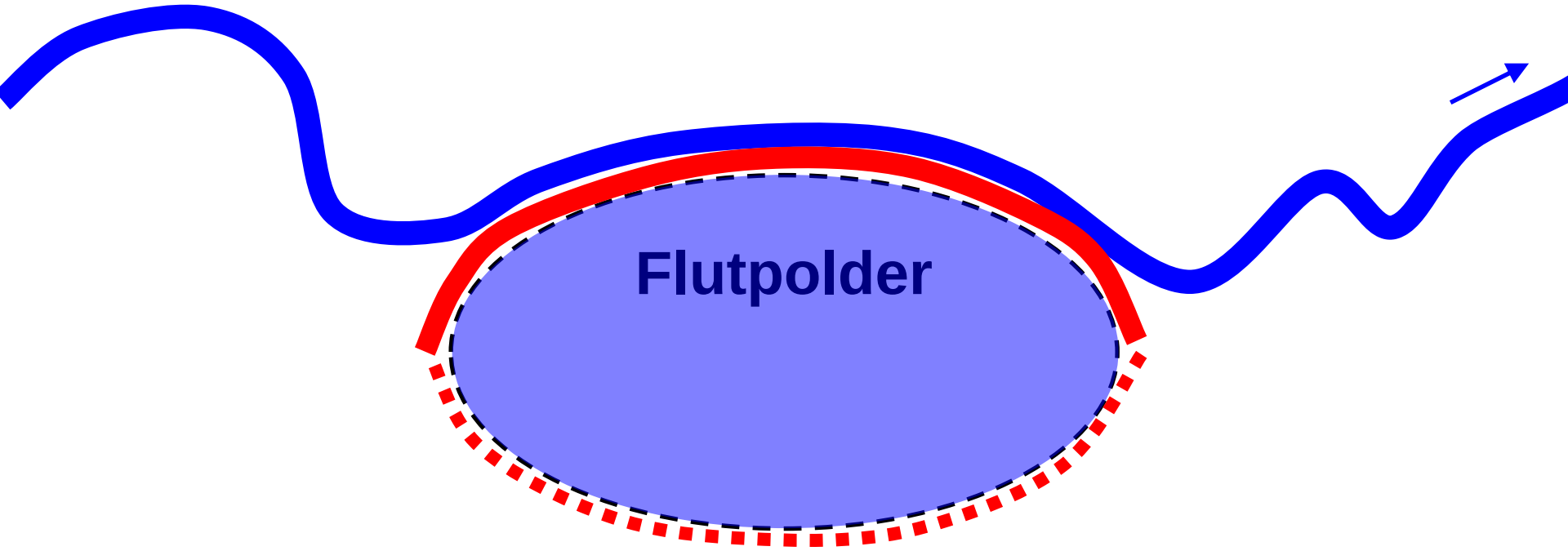
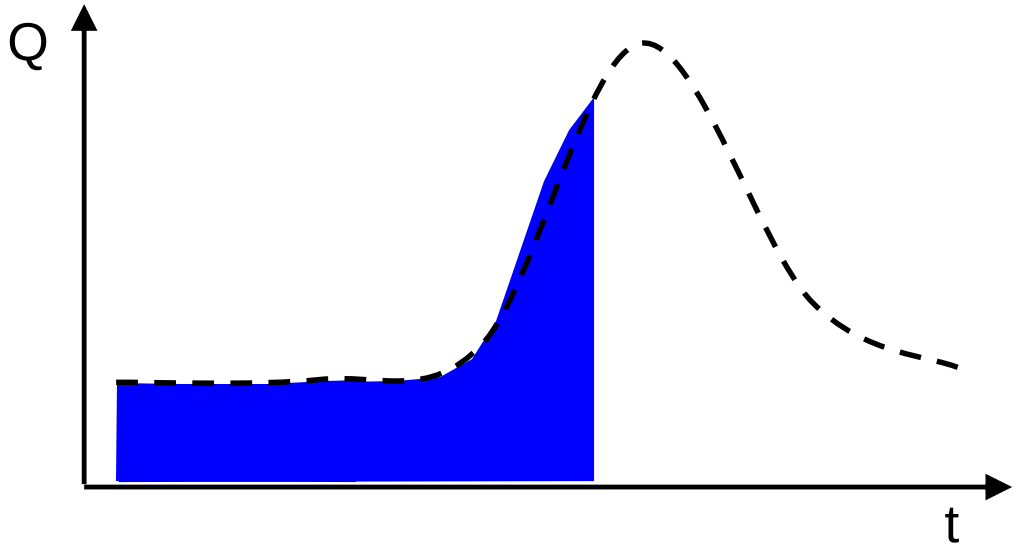



Flutpolder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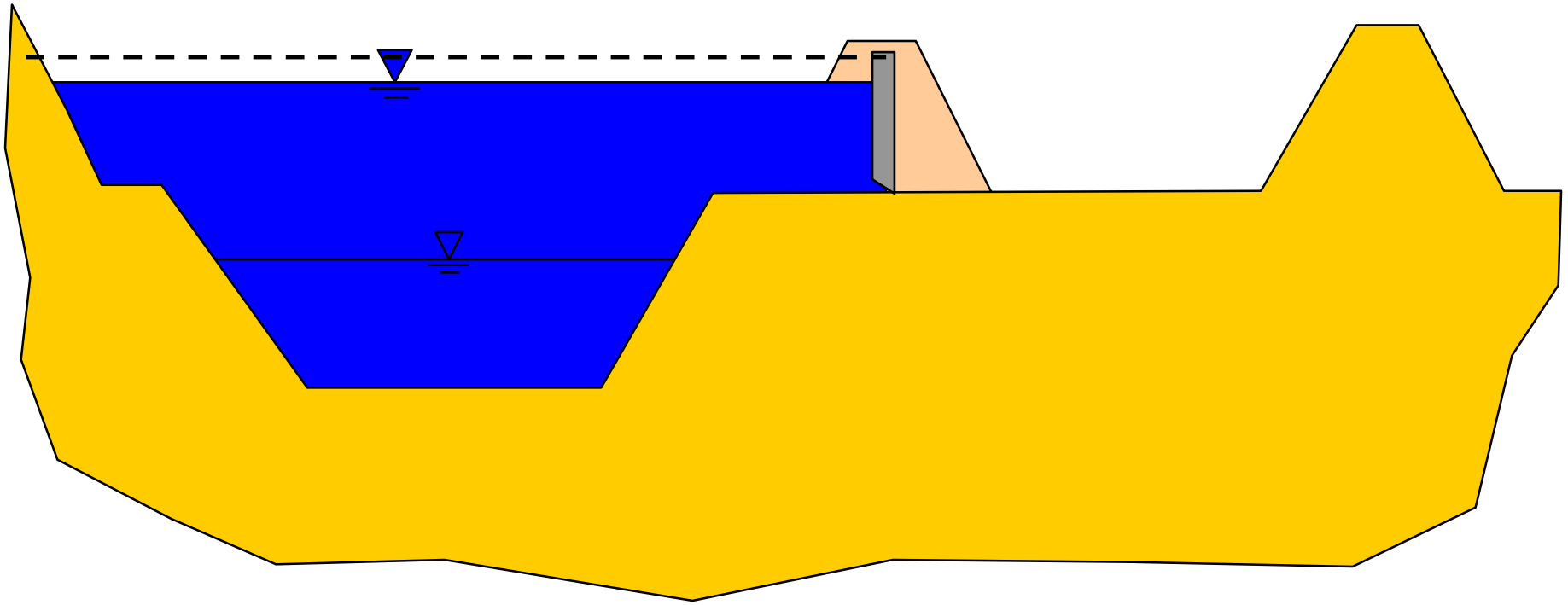

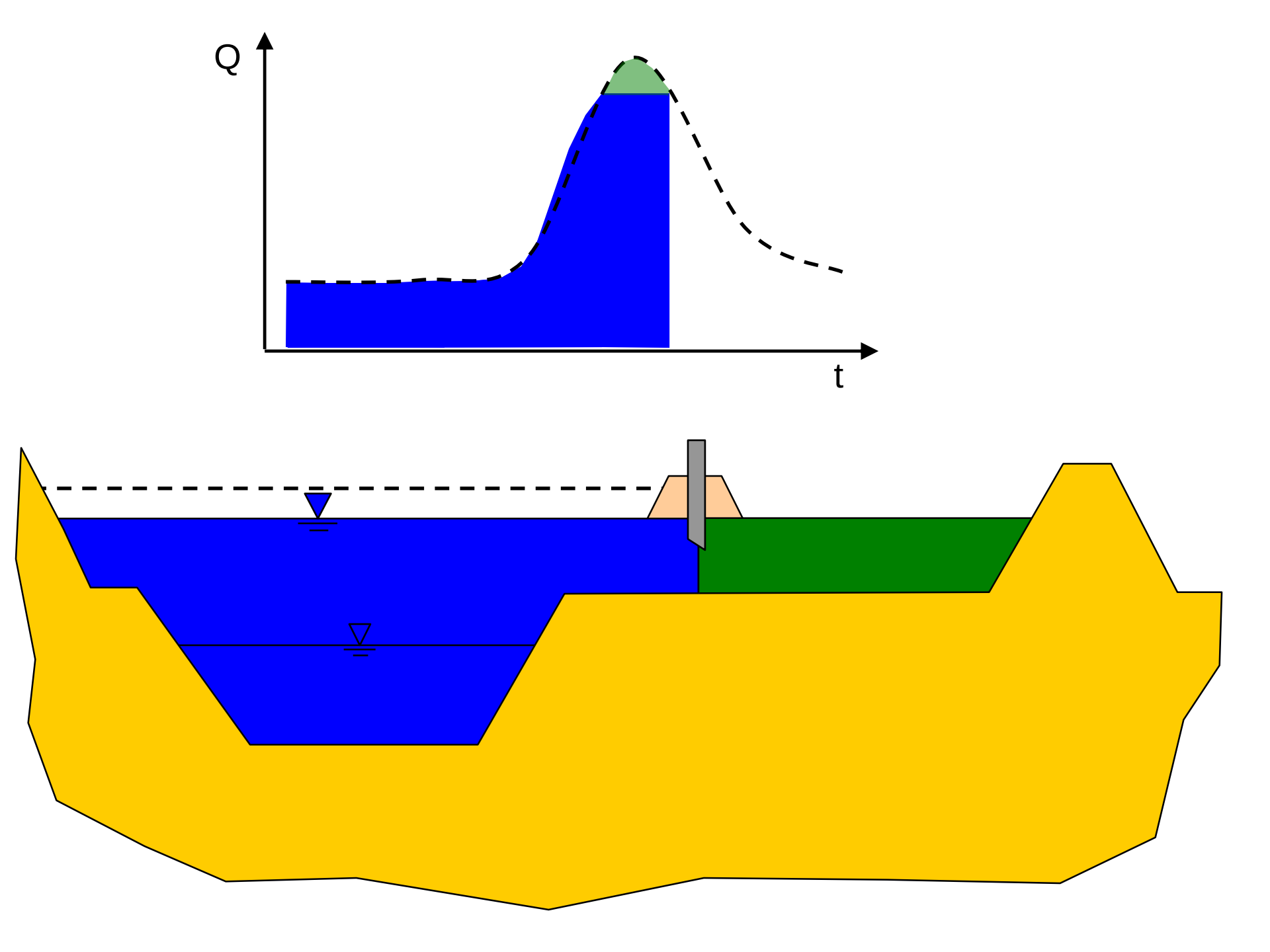
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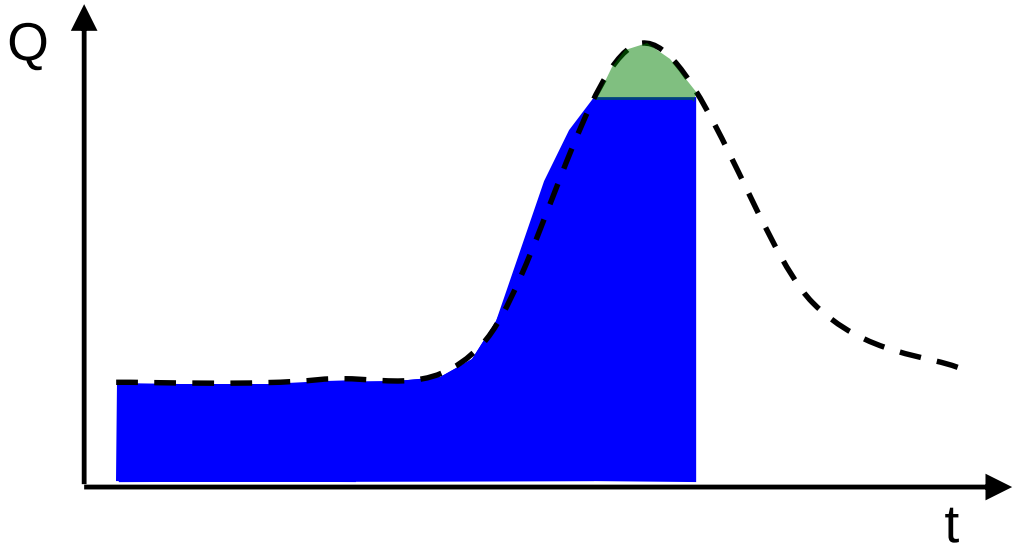
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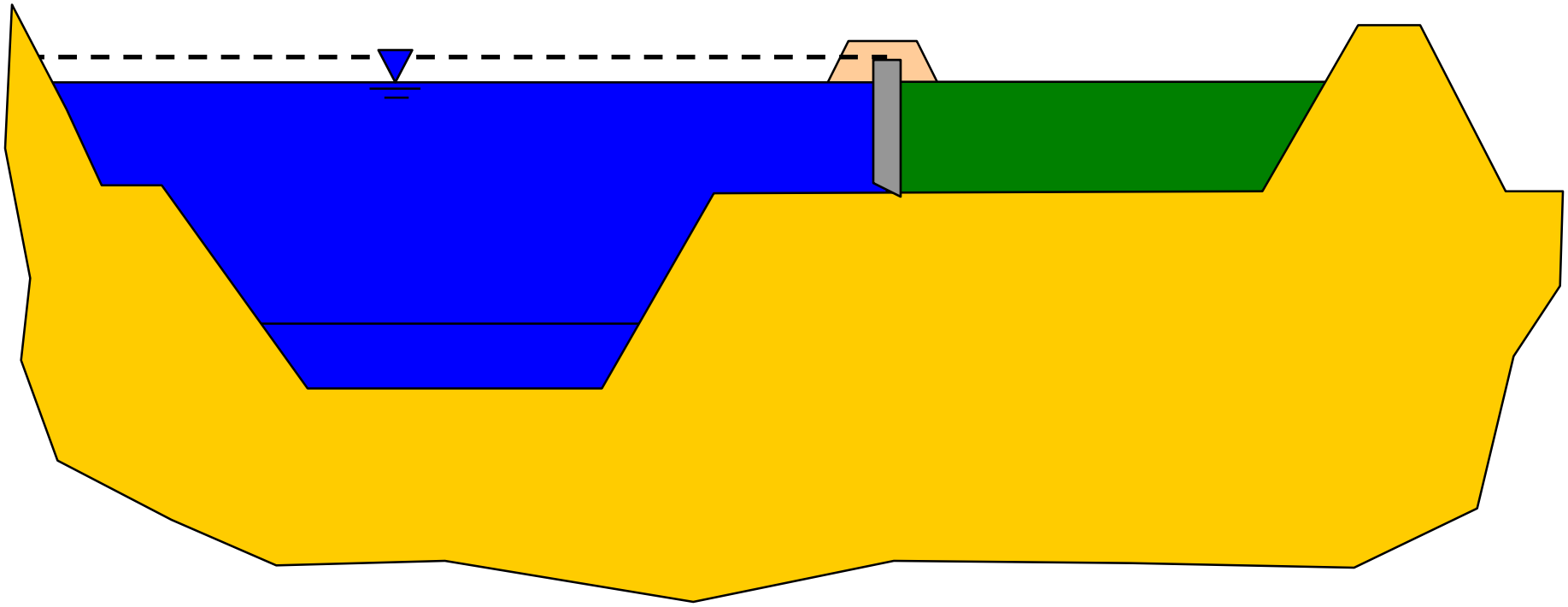

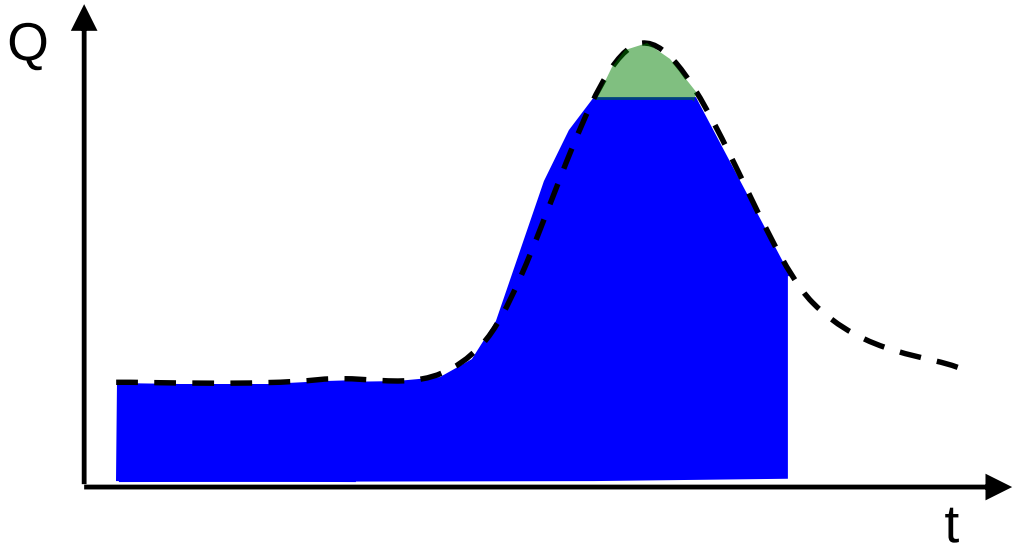
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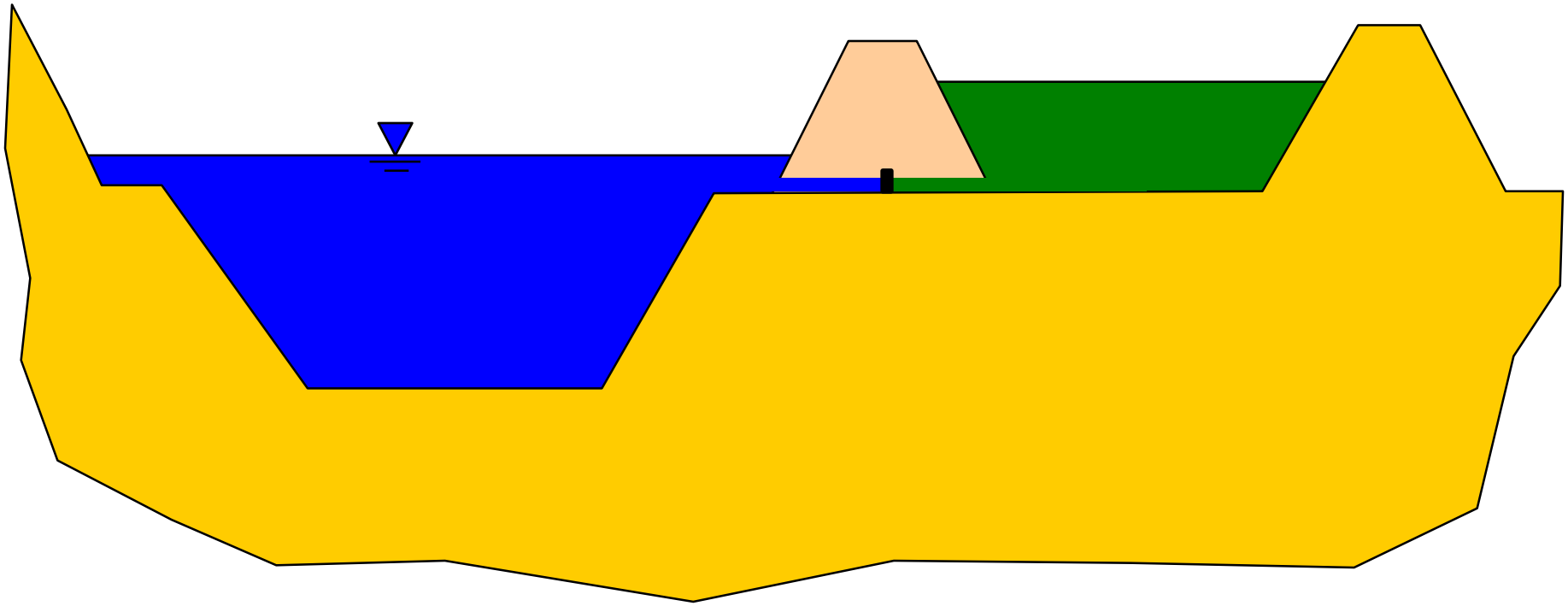

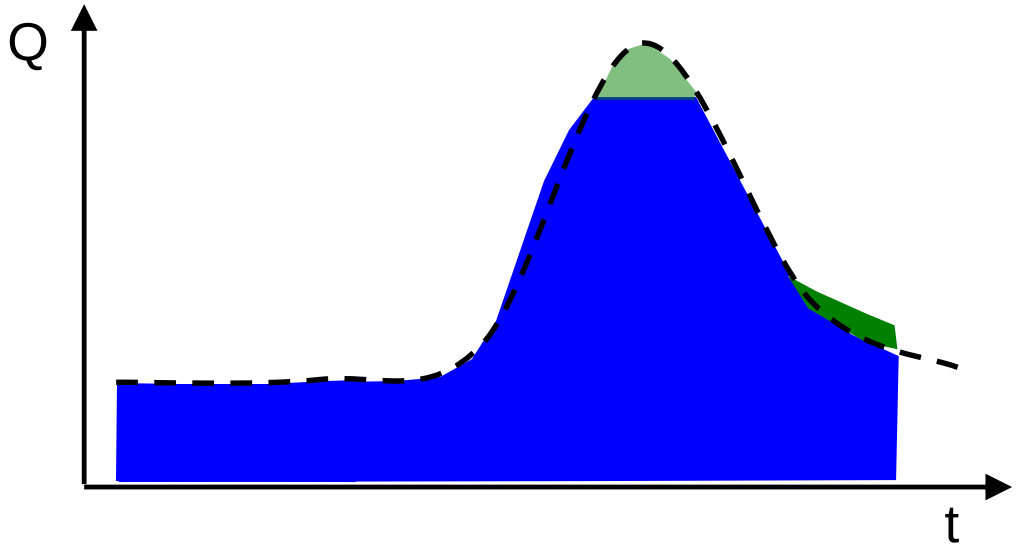
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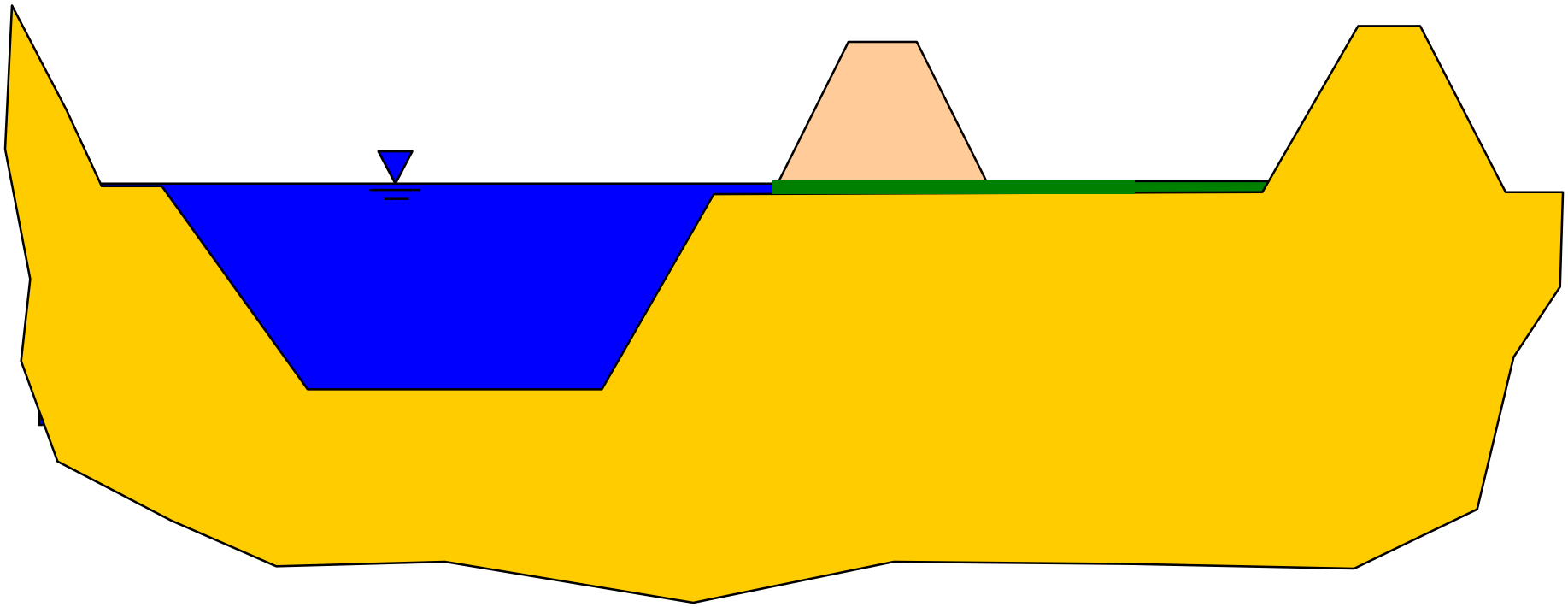
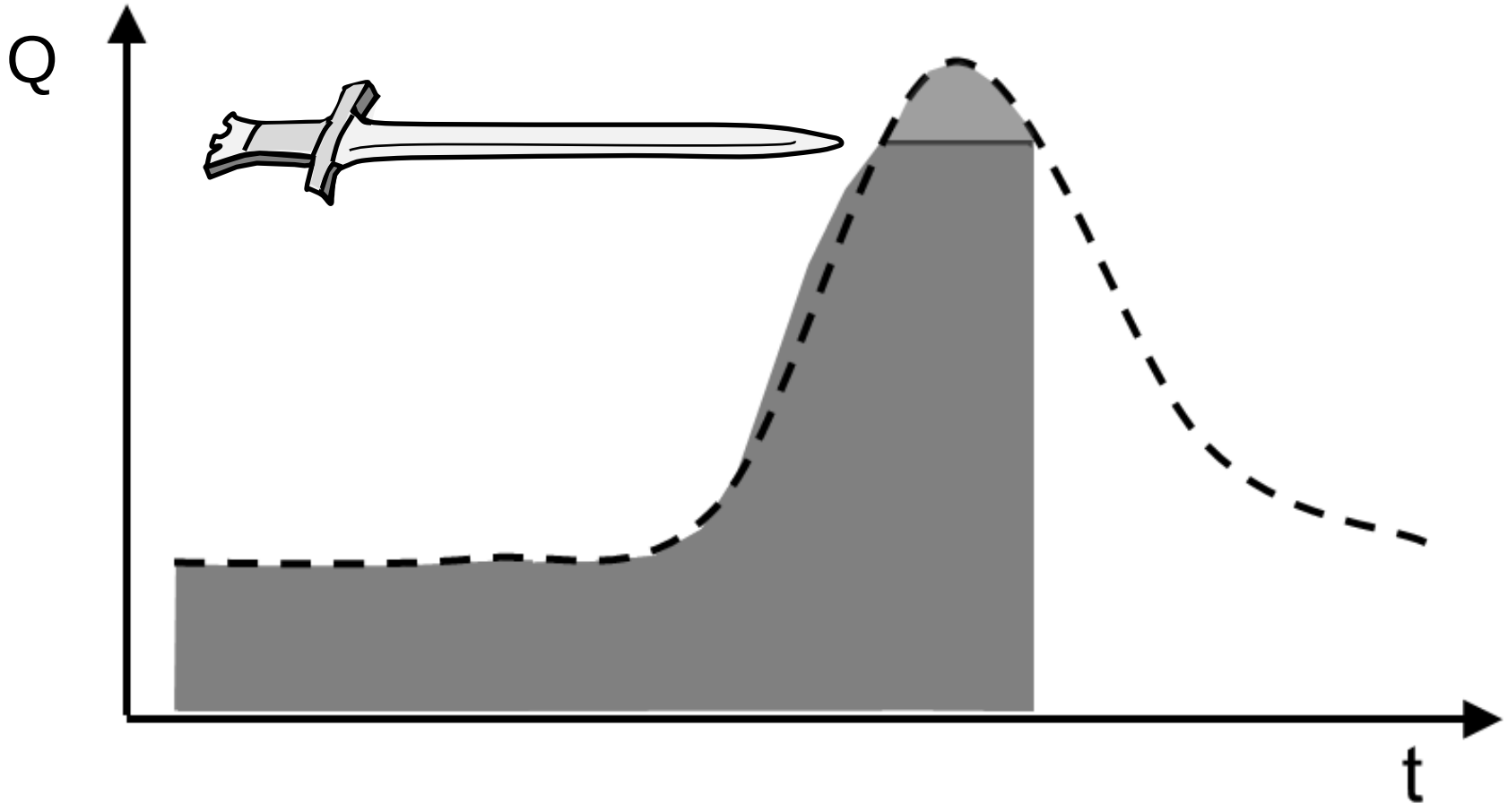
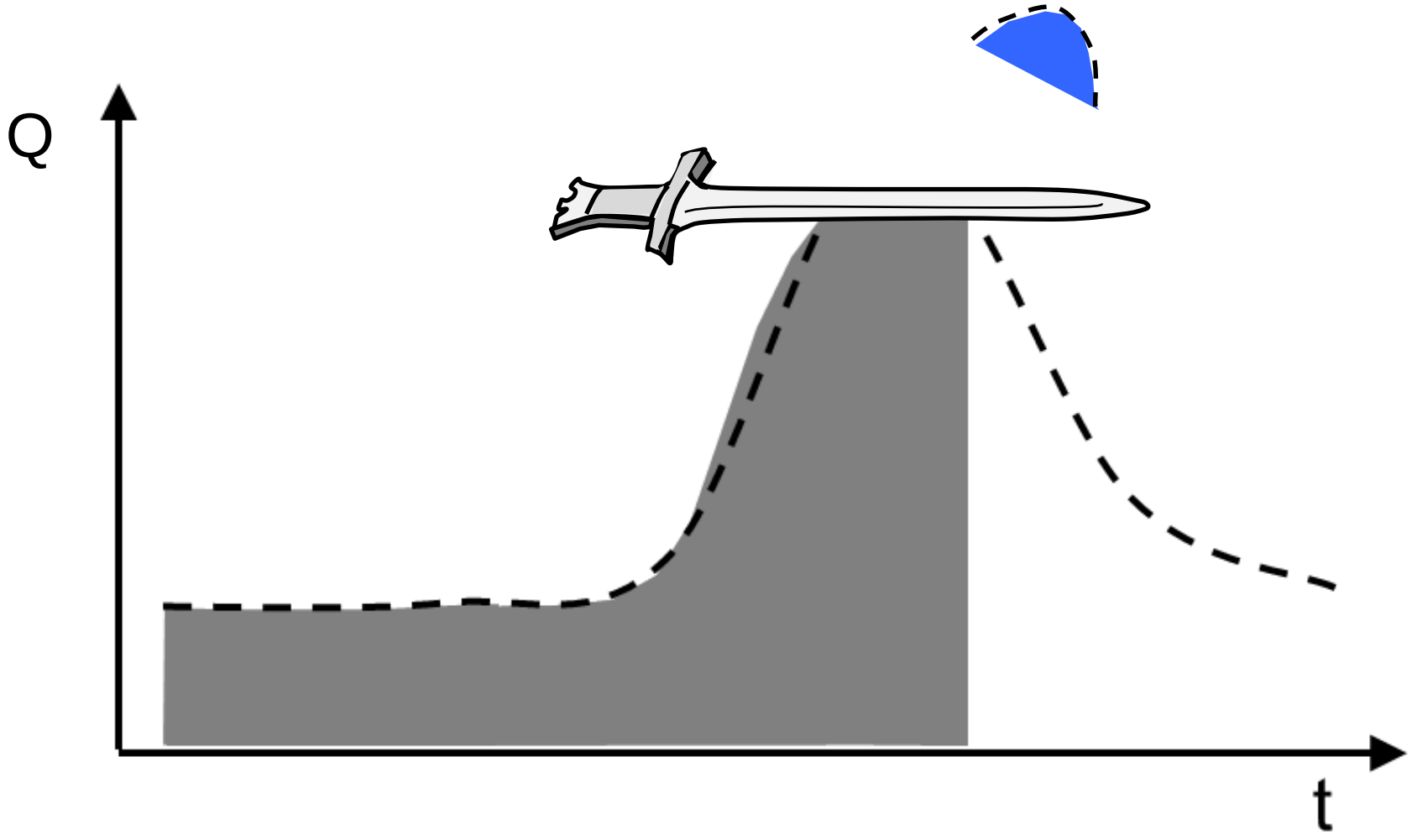


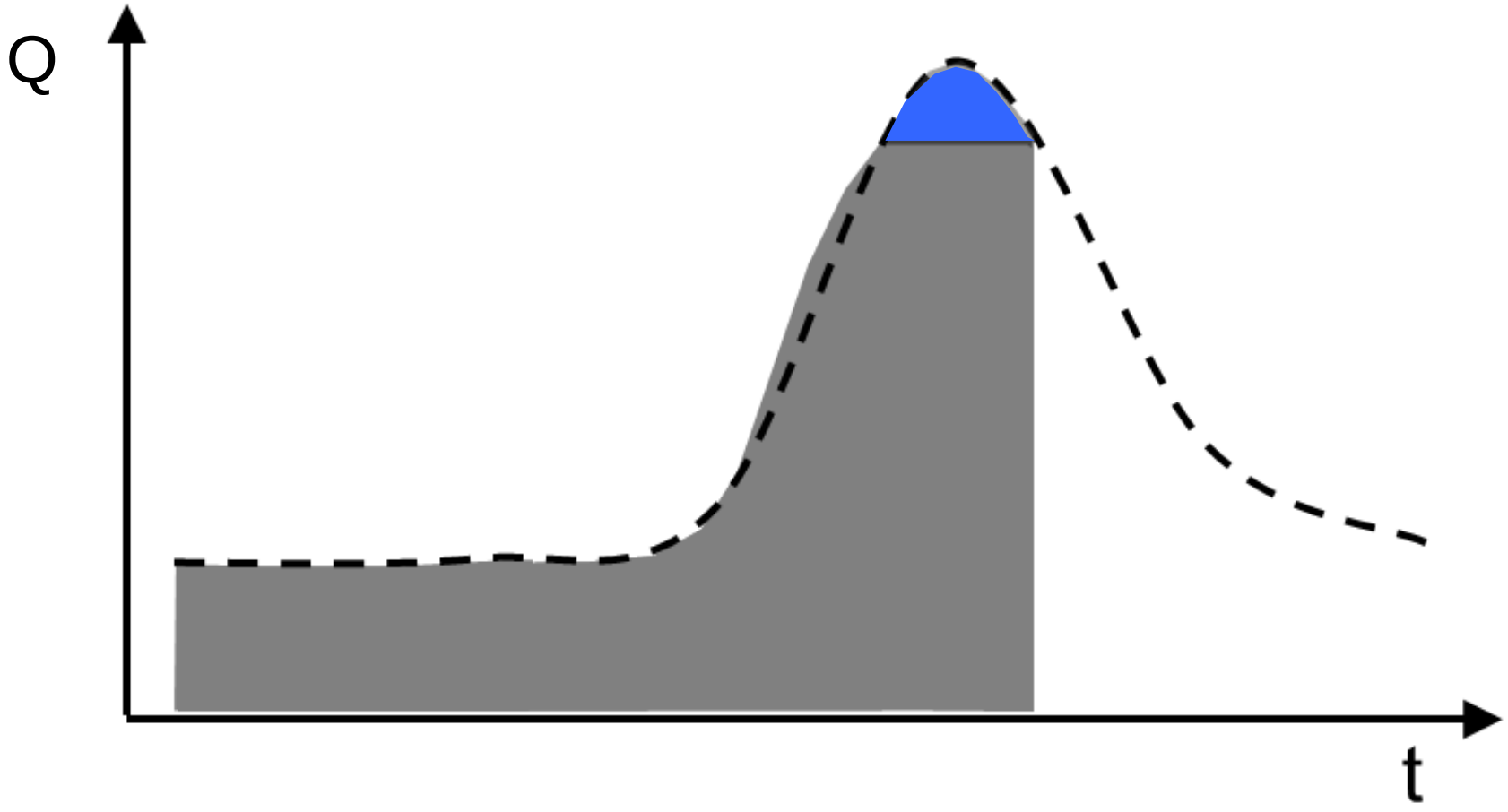
ziemlich gut ……!

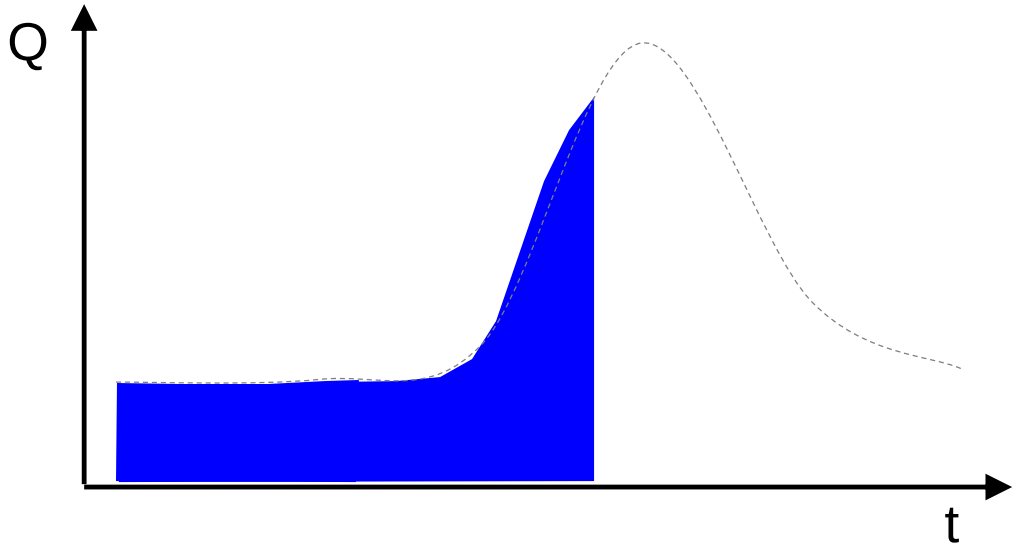


ziemlich gut ……!



ziemlich gut ……!

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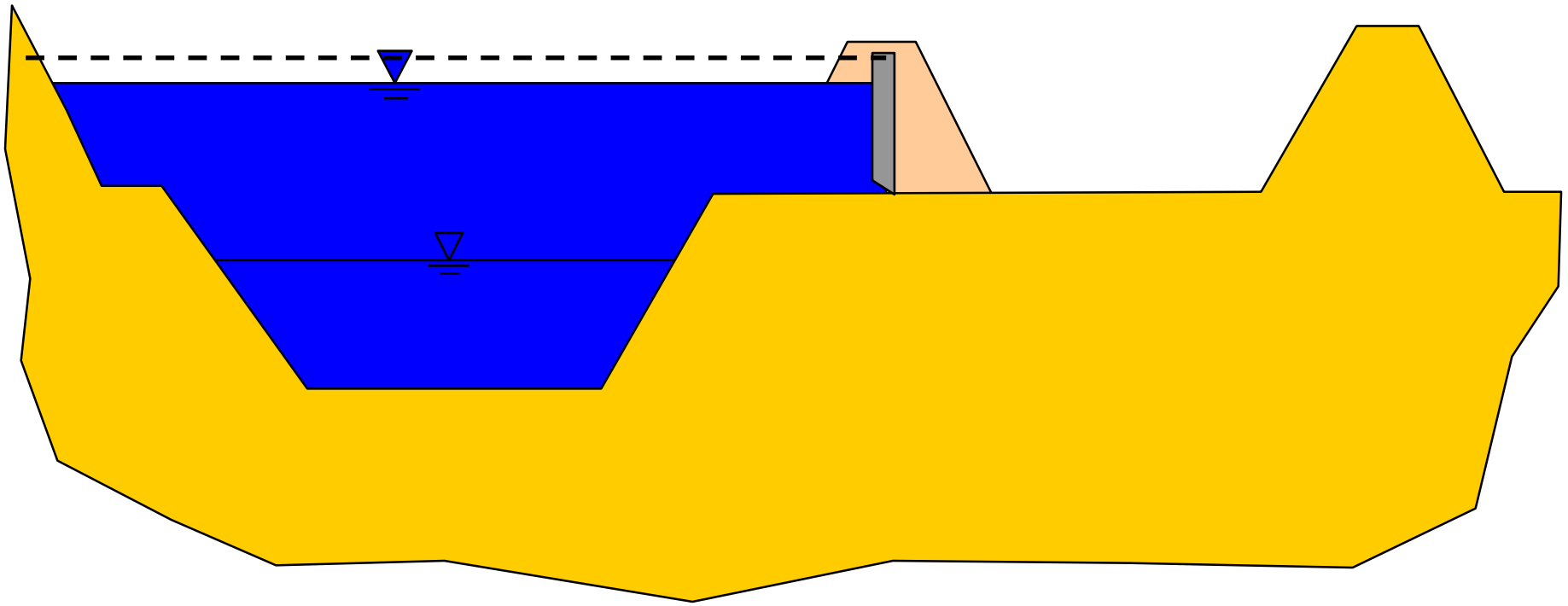

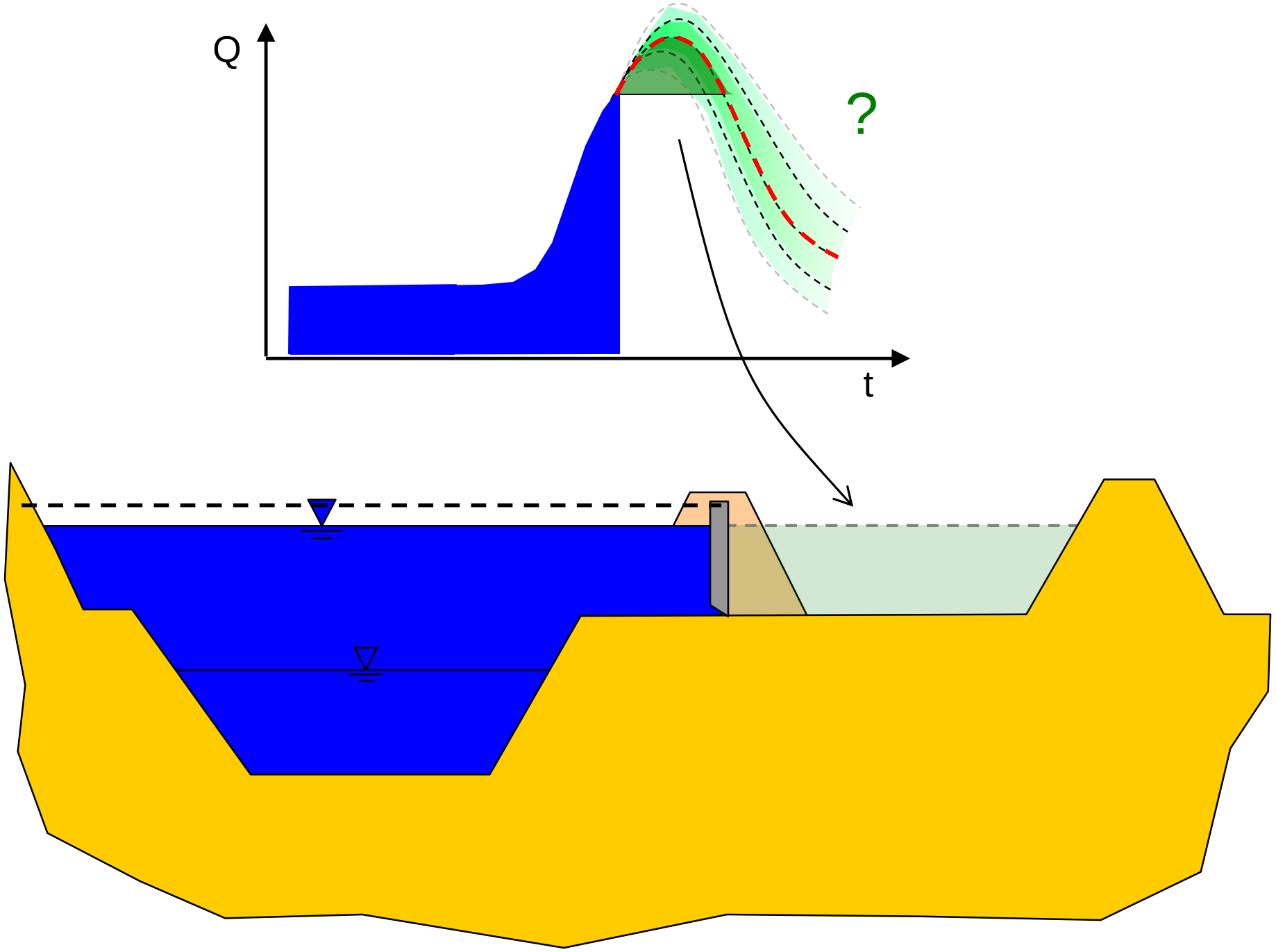
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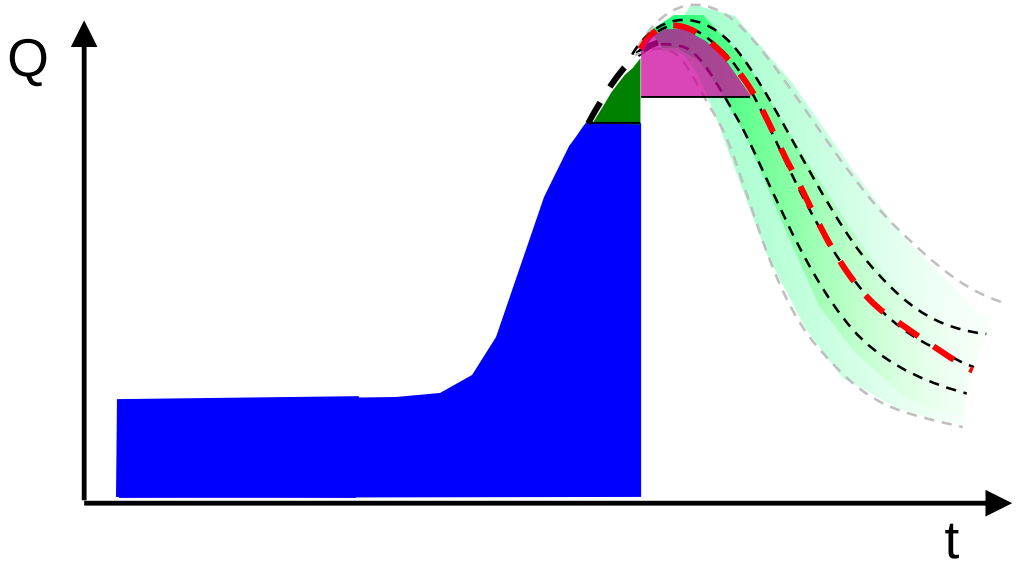
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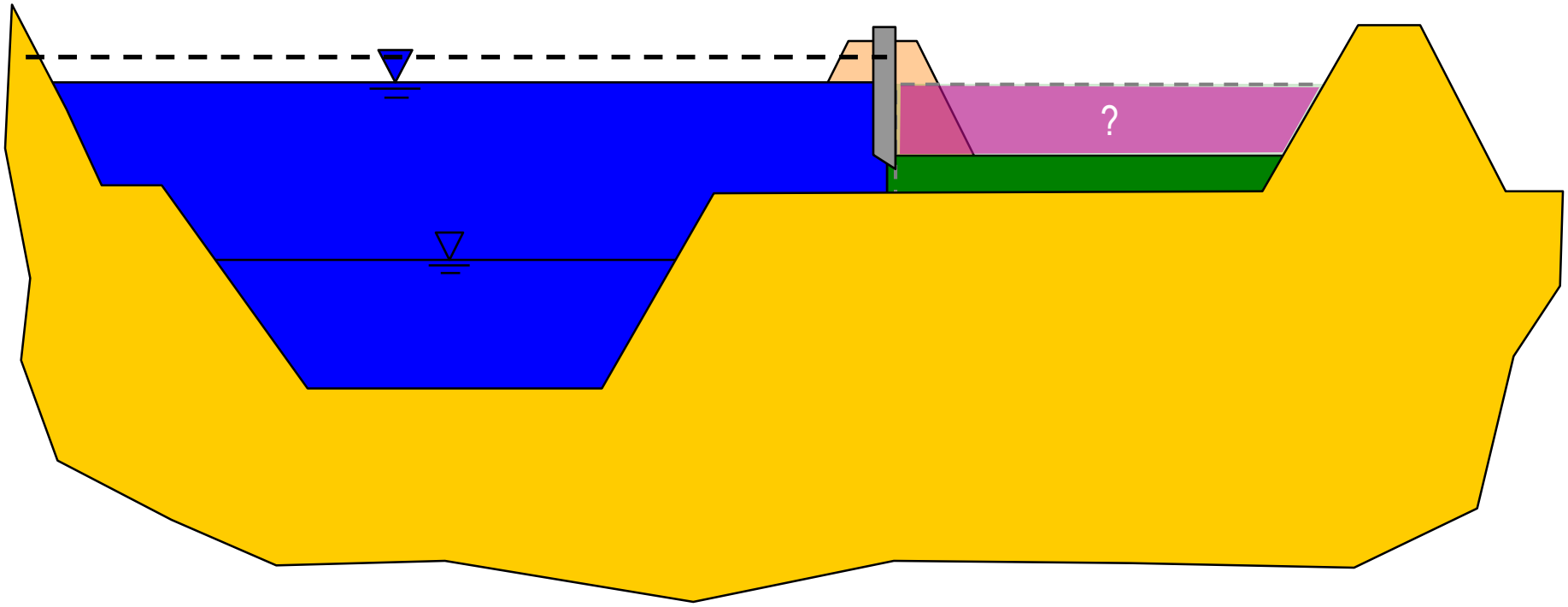
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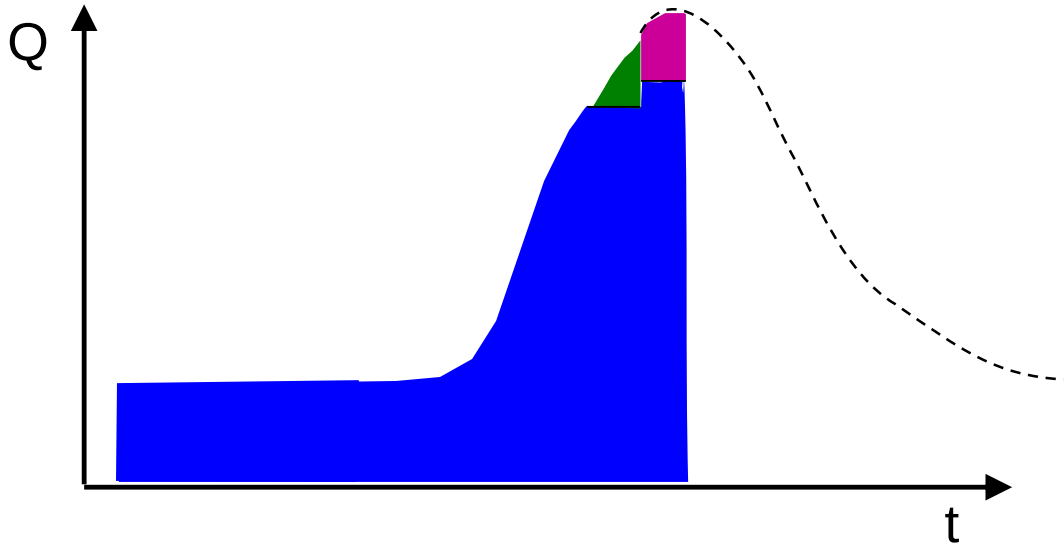
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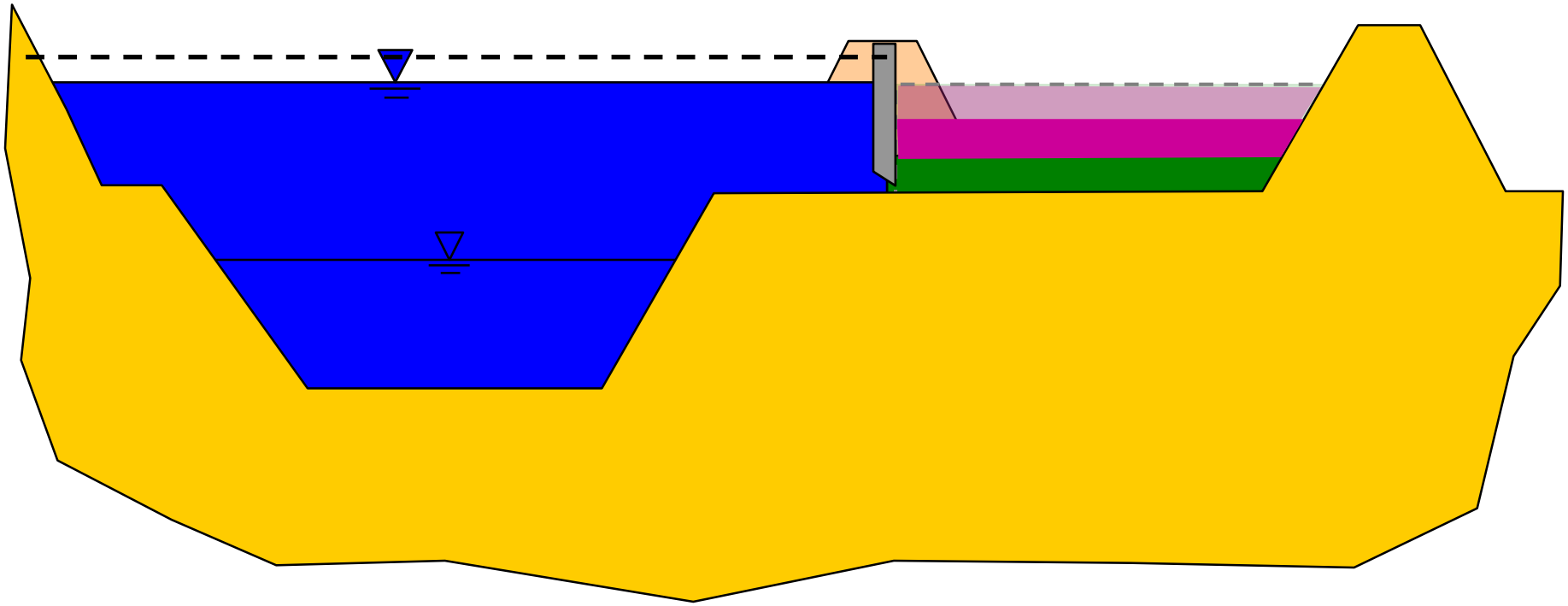
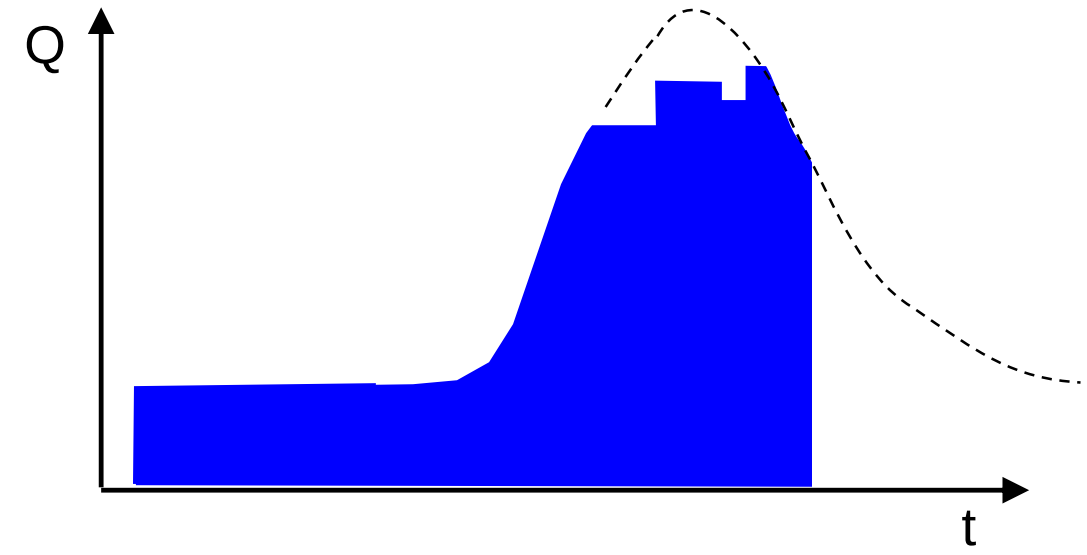
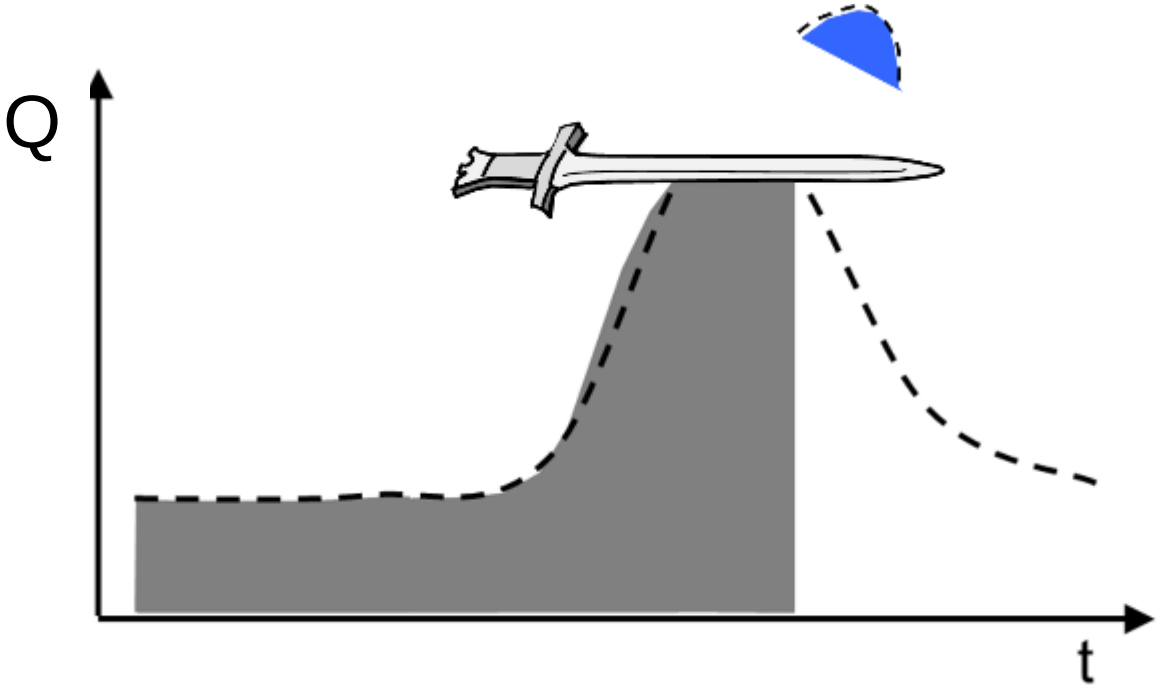
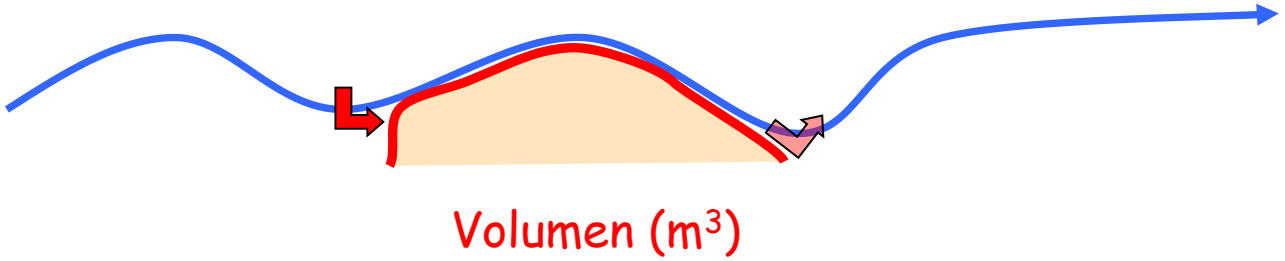




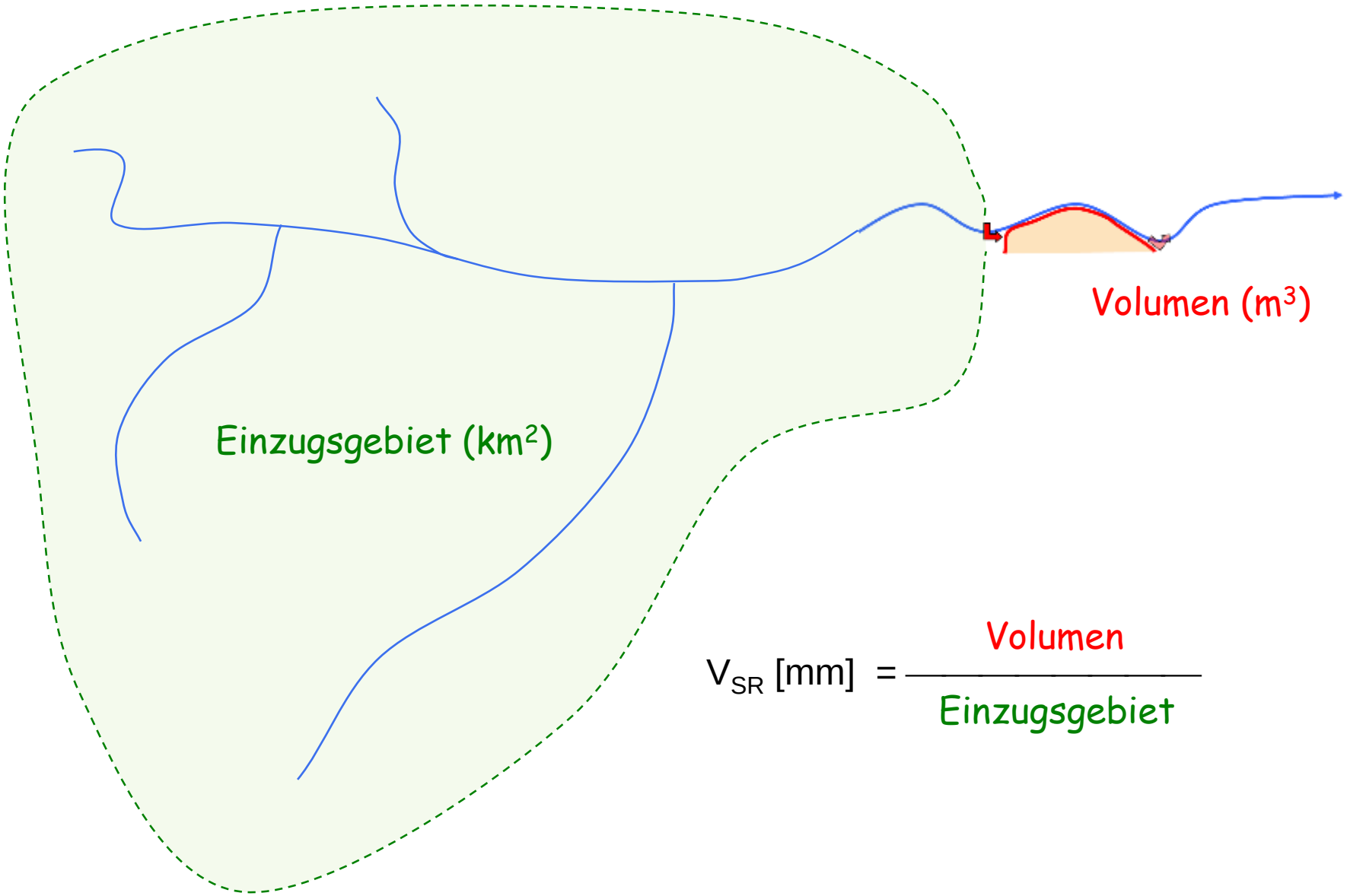


→ POTENTIAL !

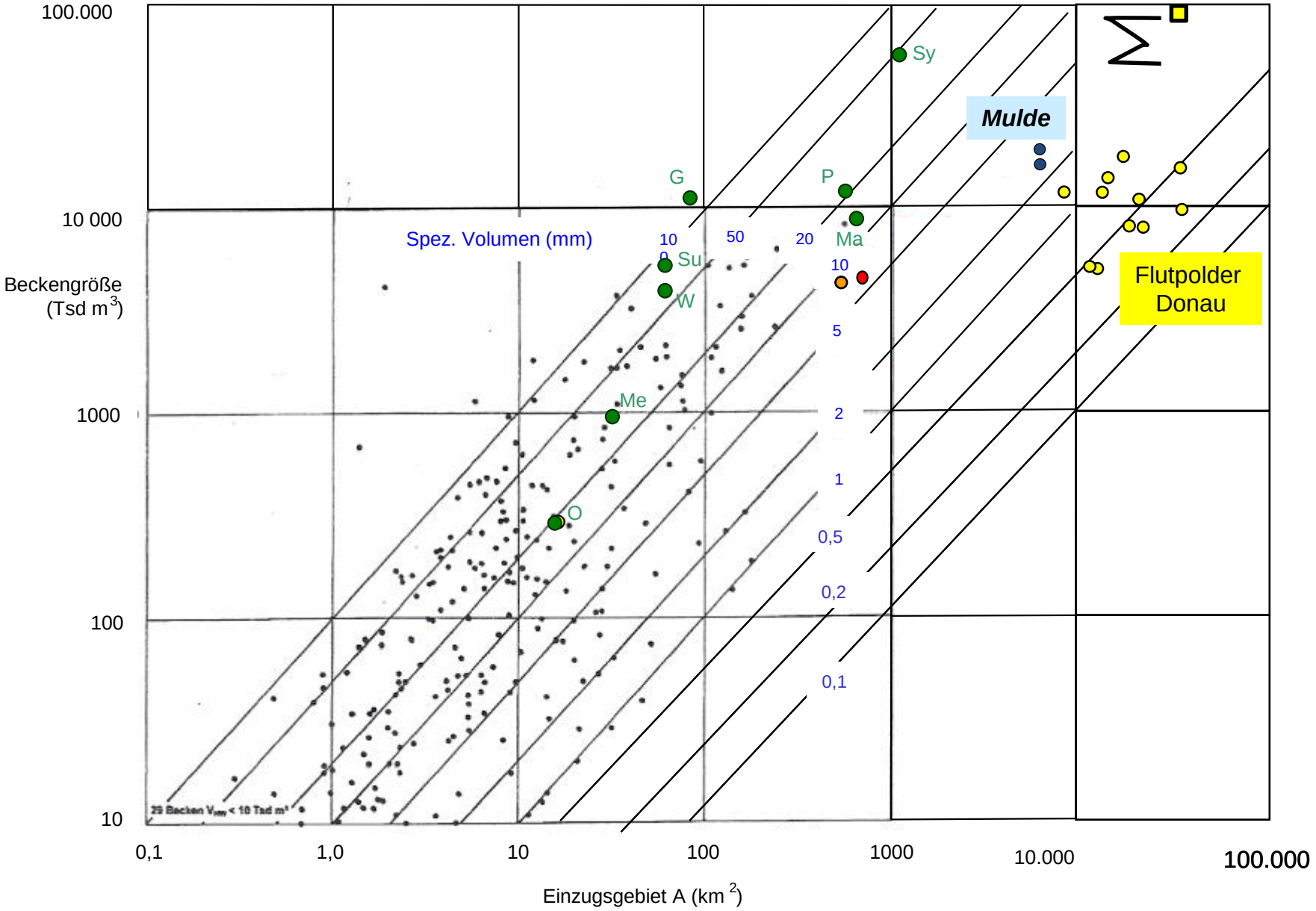
Spezifisches Rückhaltevolumen V_{SR} [mm]



Spezifisches Rückhaltevolumen V_{SR} [mm]



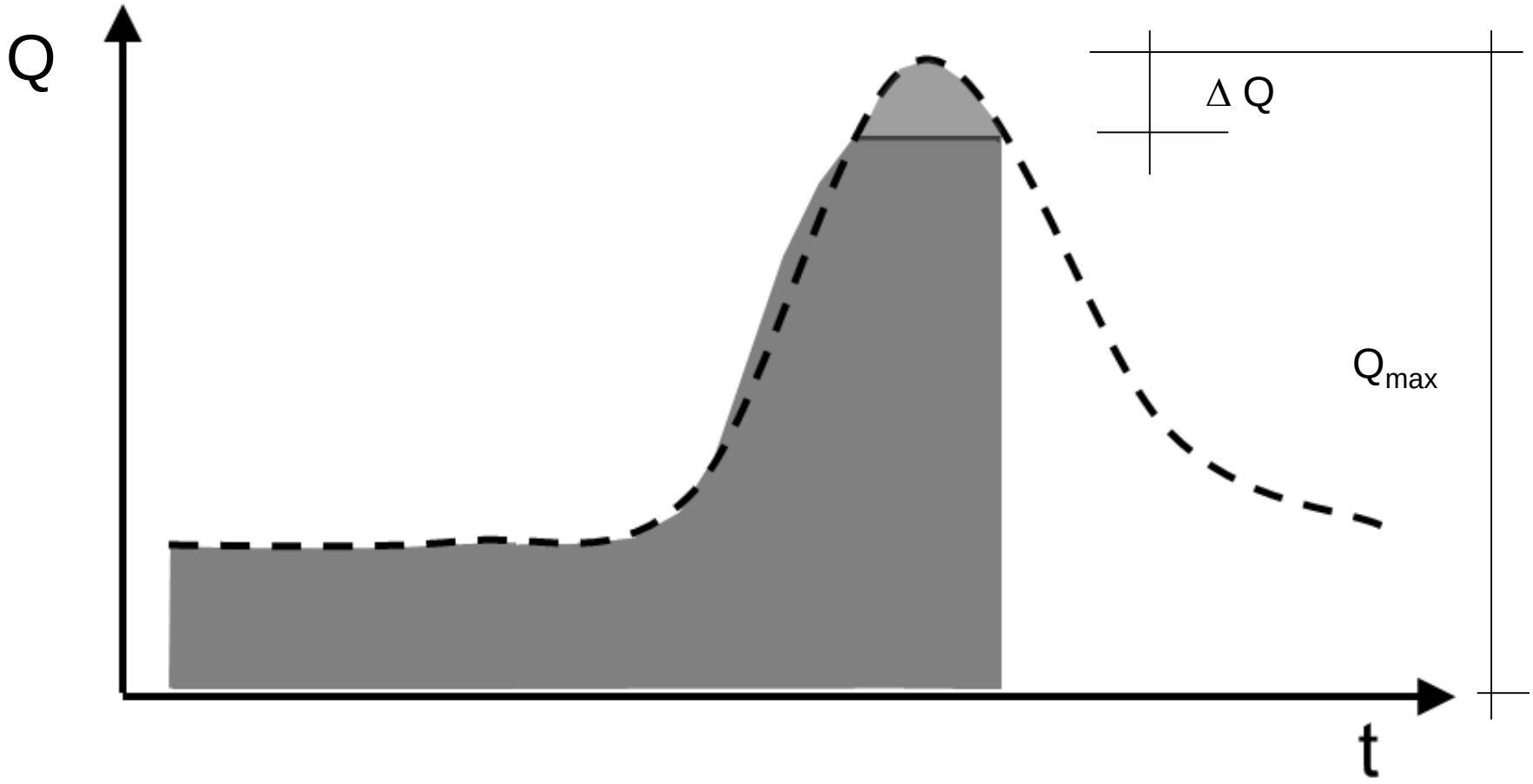
$$V_{SR}\,[mm] = \frac{\text{Volumen}}{\text{Einzugsgebiet}}$$

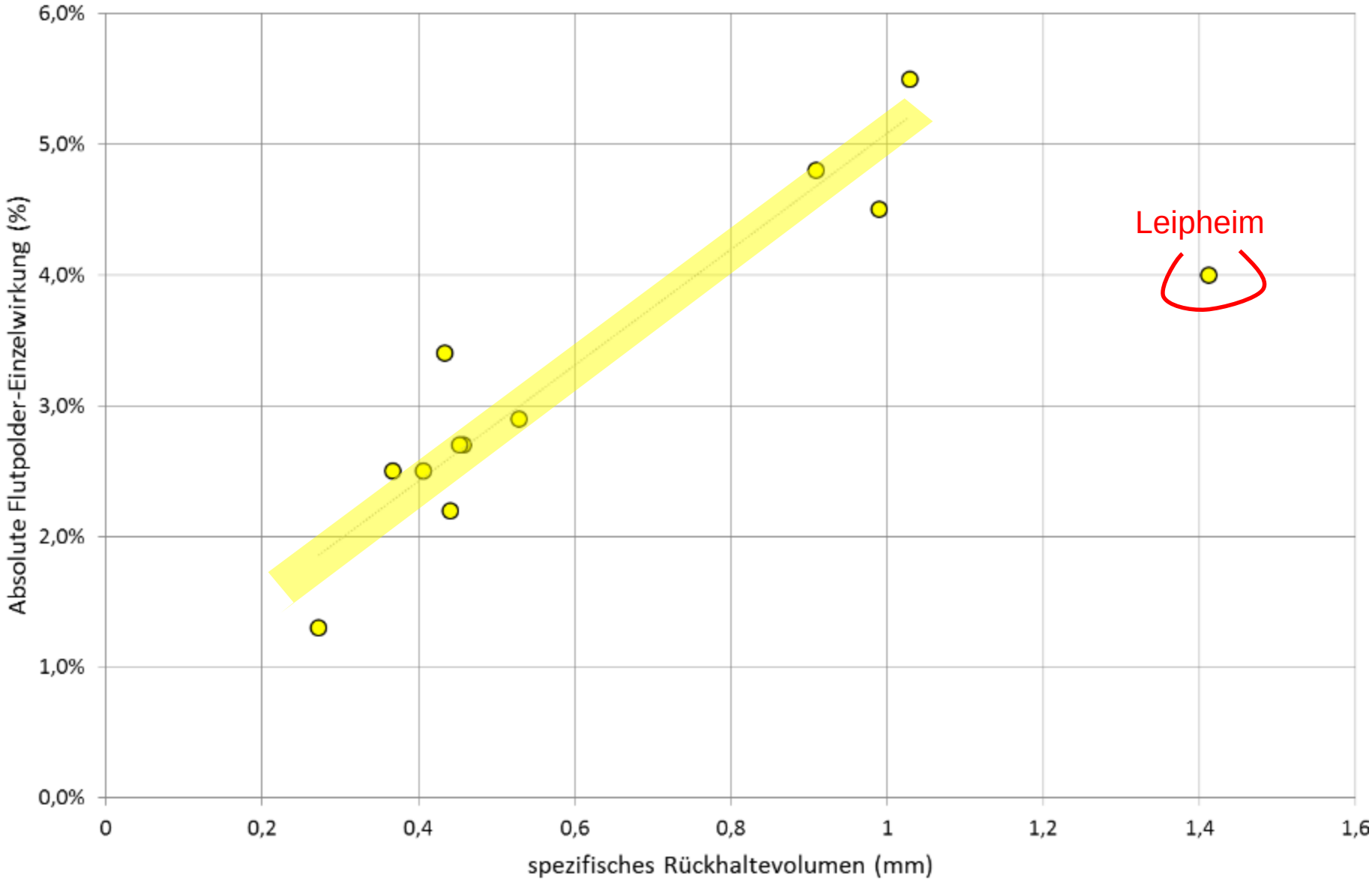


Beckenvolumina in Abhängigkeit der Einzugsgebietsgröße für 280 Anlagen in Baden-Württemberg und Hessen (•), 9 Hochwasserrückhaltebecken im Hauptschluss in Bayern (●), das Seifener Becken (●) sowie den Polder Feldolling (●) (an der Mangfall, in Planung)

Absolute Flutpolder-Einzelwirkung (%)

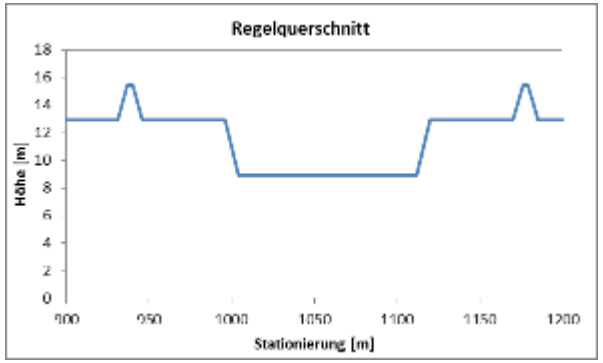
$$\frac{\Delta Q}{Q_{max}}$$



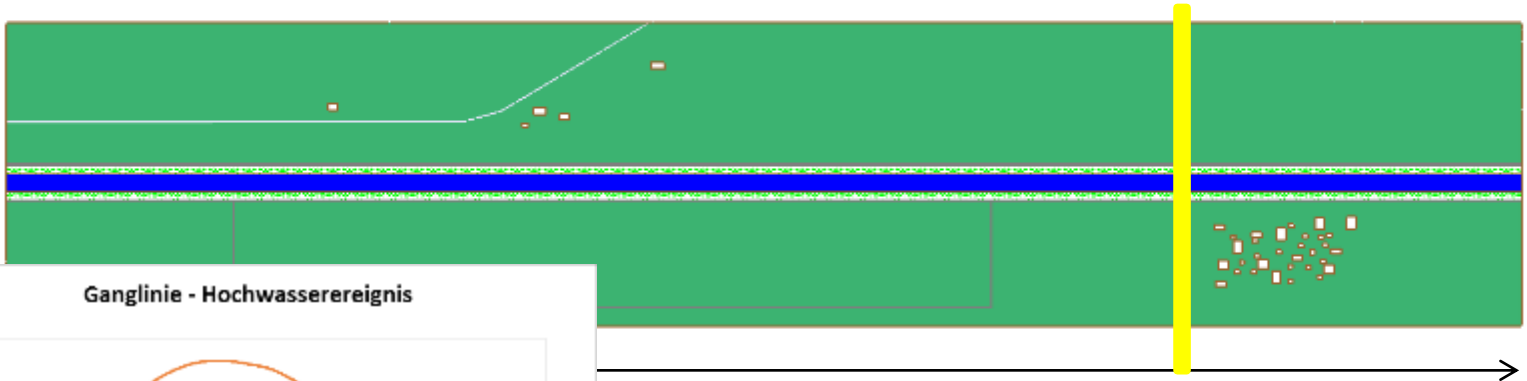

6,0%
5,0%
4,0%
3,0%
2,0%
1,0%
0,0%
Absolute Flutpolder-Einzelwirkung (%)
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
spezifisches Rückhaltevolumen (mm)
Leipheim

2D Numerik zur Visualisierung

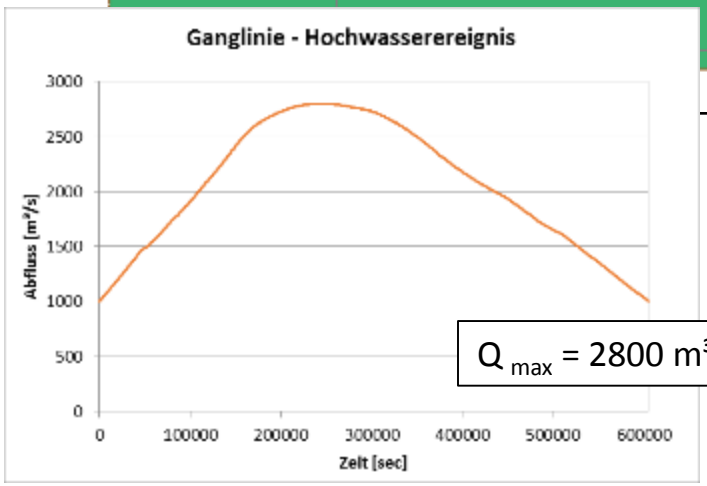
„typisch regulierter“ Fluss



Zufluss



Auslauf



Länge: 10 km

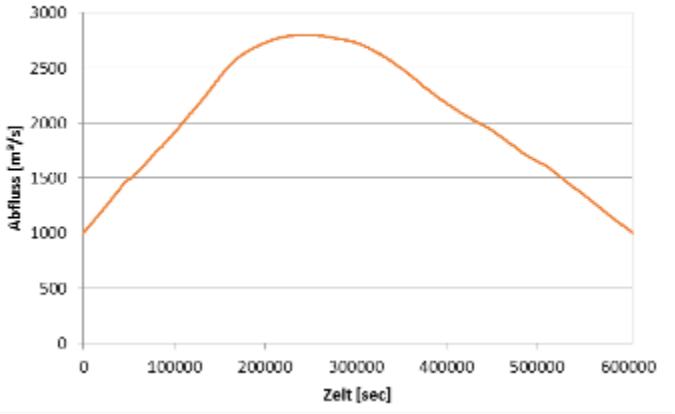
Querprofil 4

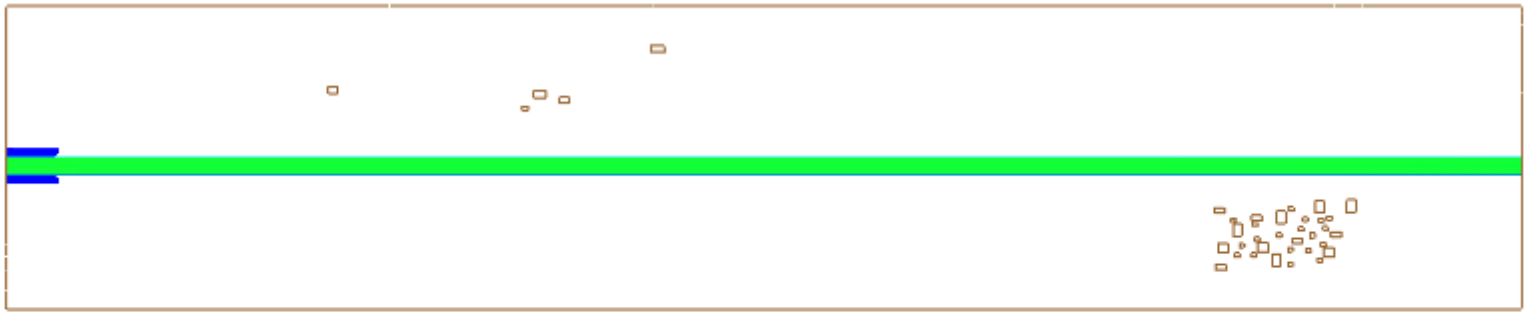
Q_{max} = 2800 m³/s → 2 T 20 h

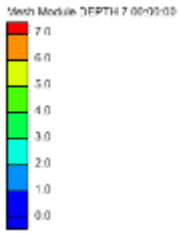
Gefälle: 1 ‰
Breite: ~ 100 m
Deichhöhe: 2.5 m

„typisch regulierter“ Fluss – Wassertiefe

0 00:00:01

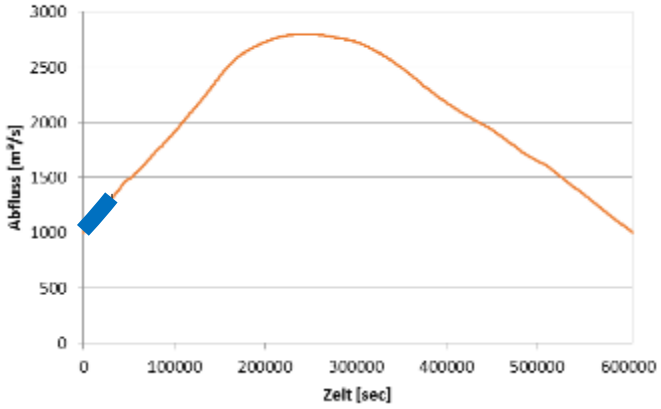


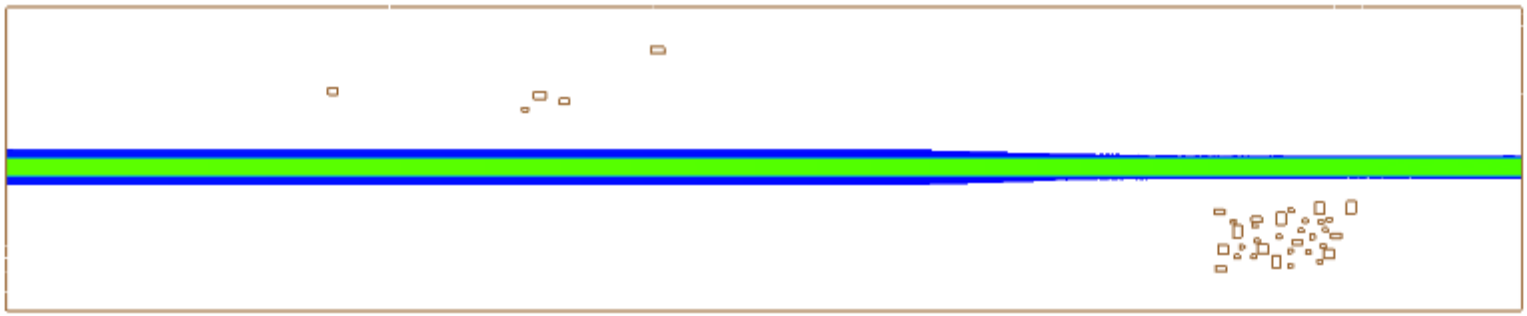


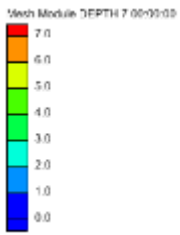


„typisch regulierter“ Fluss – Wassertiefe

0 09:00:00

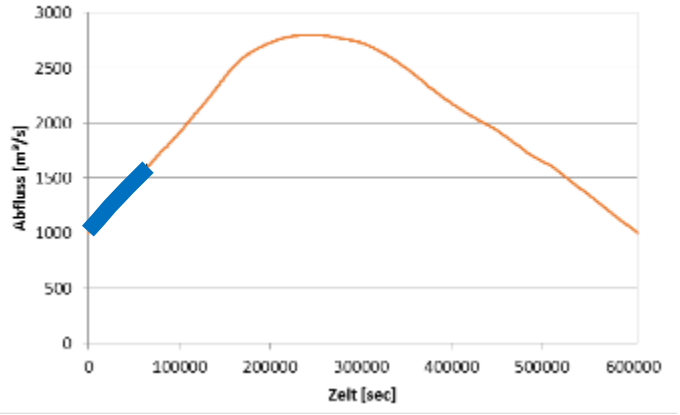


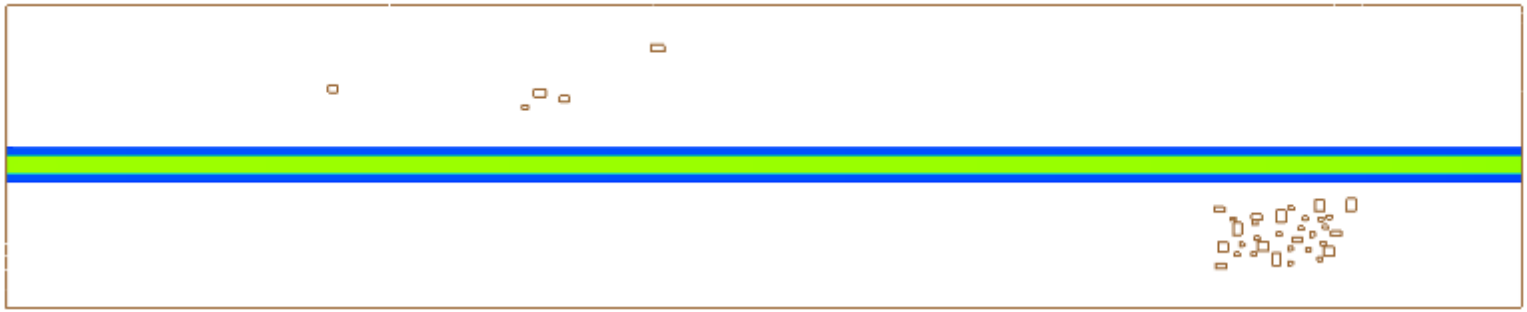


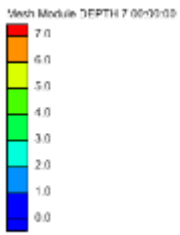


„typisch regulierter“ Fluss – Wassertiefe

0 18:00:00

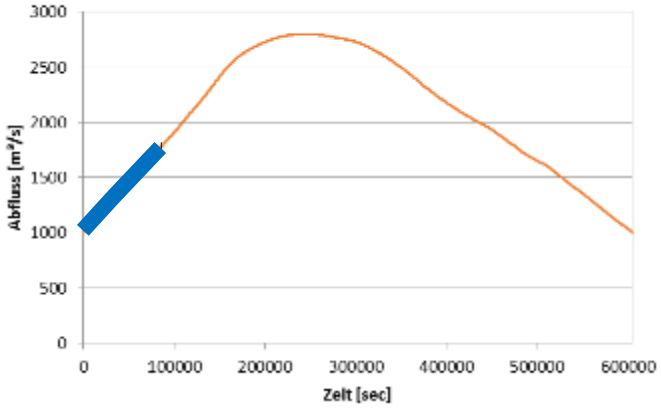


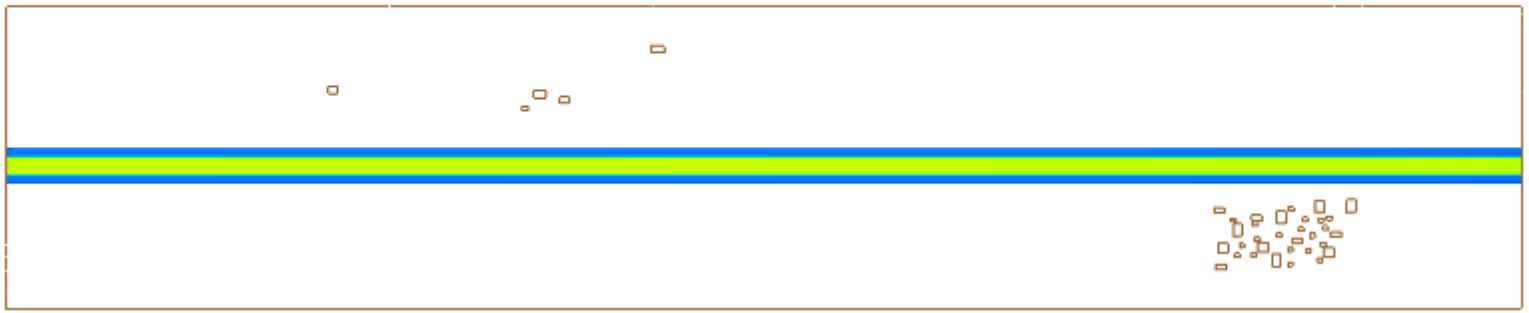


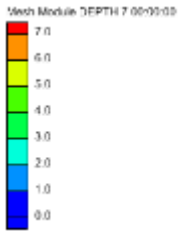


„typisch regulierter“ Fluss – Wassertiefe

1 00:00:00

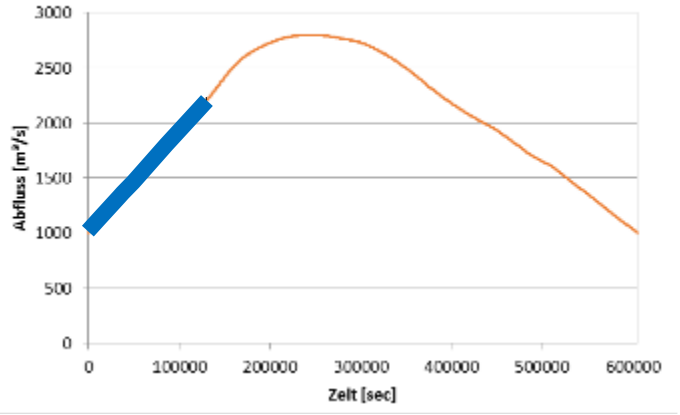


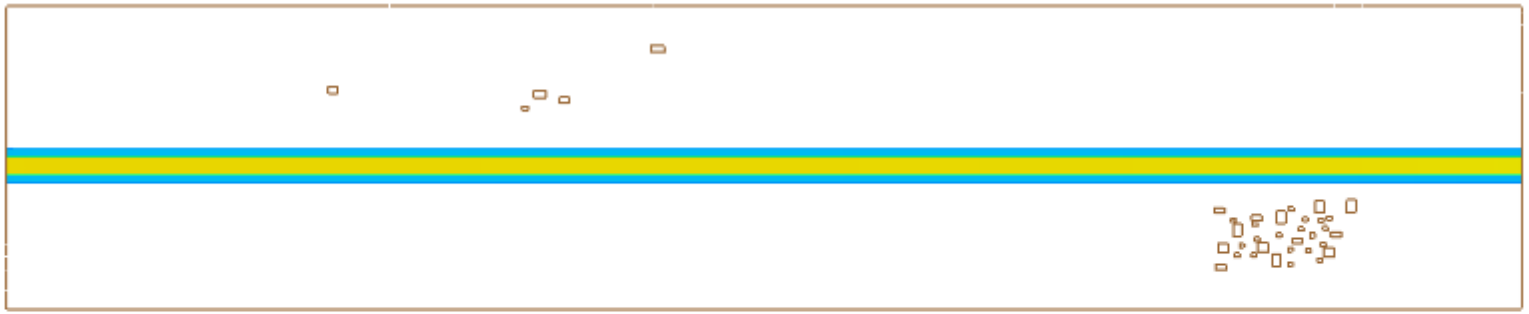




„typisch regulierter“ Fluss – Wassertiefe

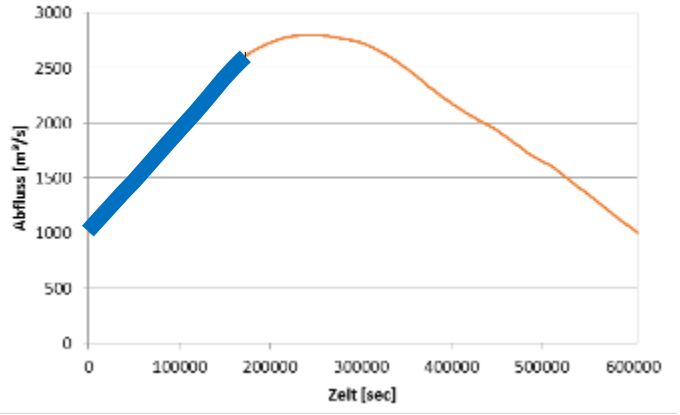
1 12:00:00

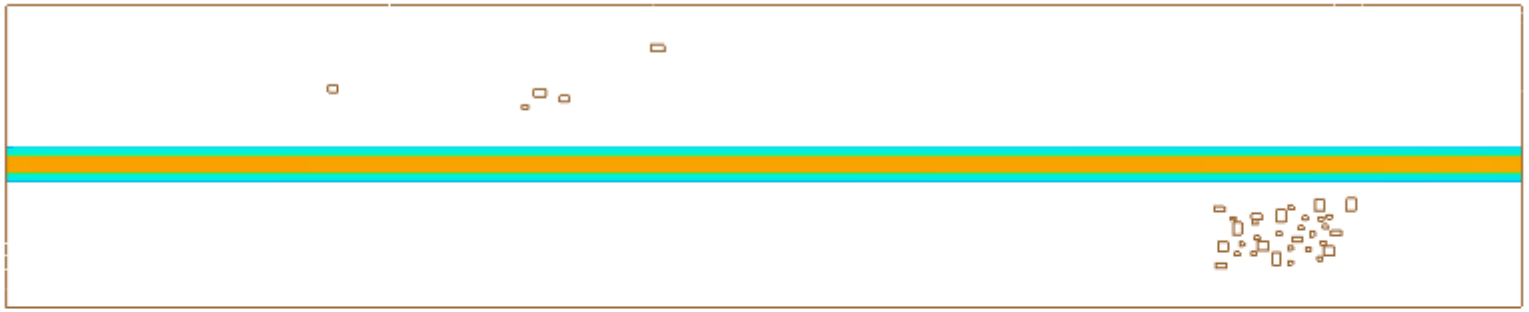


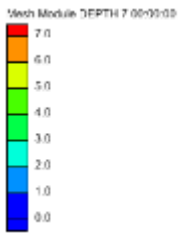


„typisch regulierter“ Fluss – Wassertiefe

2 00:00:00

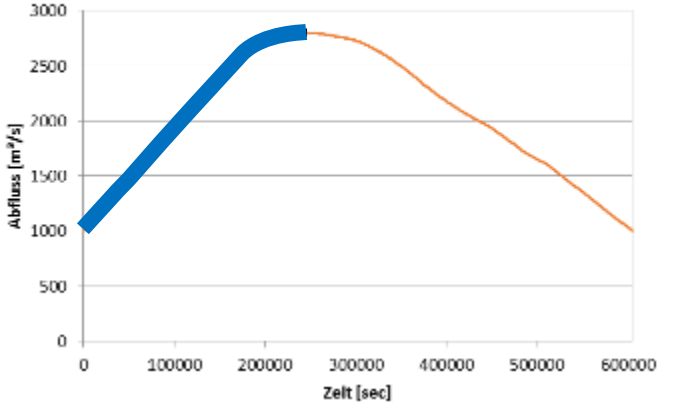


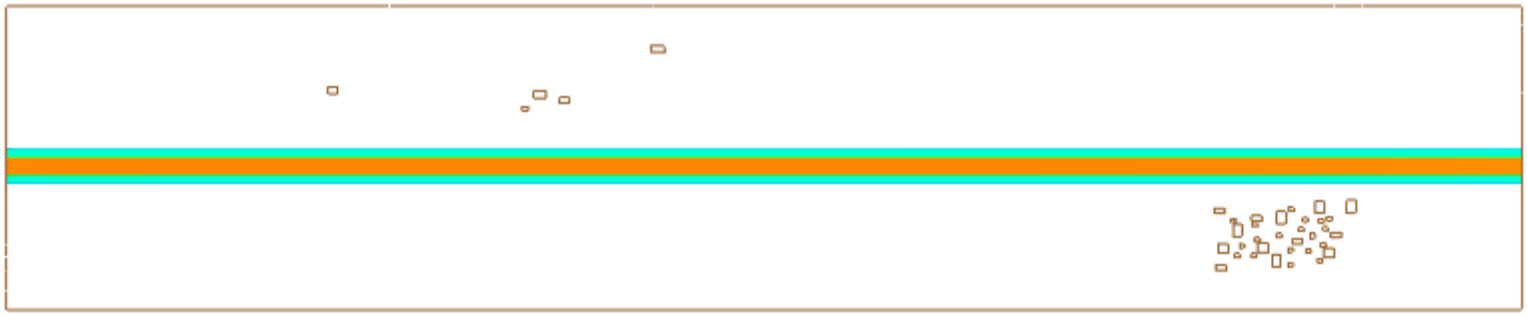


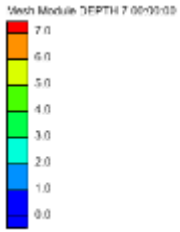


„typisch regulierter“ Fluss – Wassertiefe

2 20:00:00

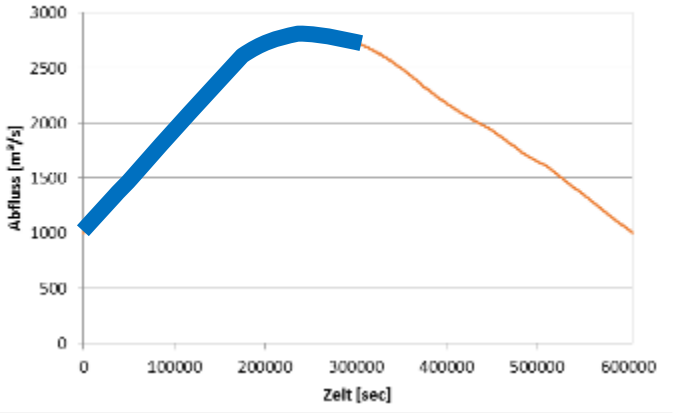


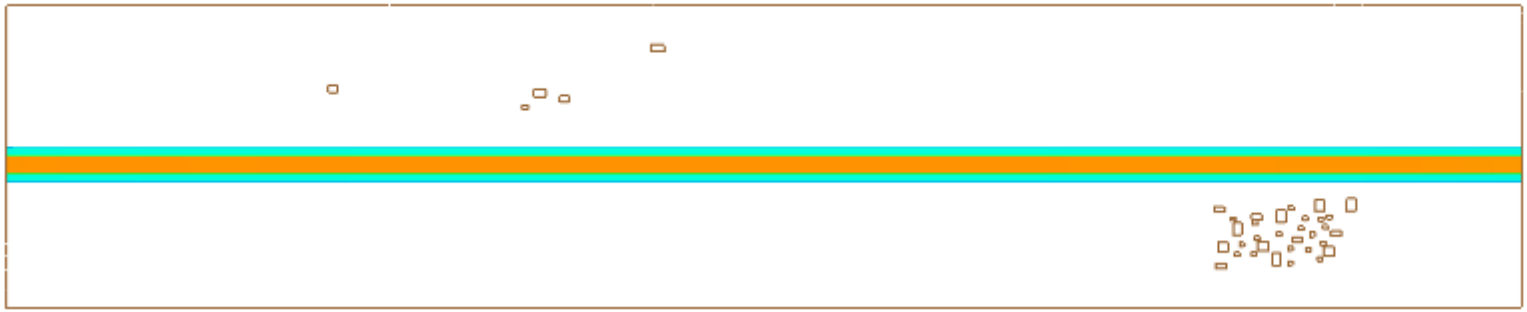


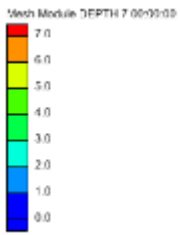


„typisch regulierter“ Fluss – Wassertiefe

3 12:00:00

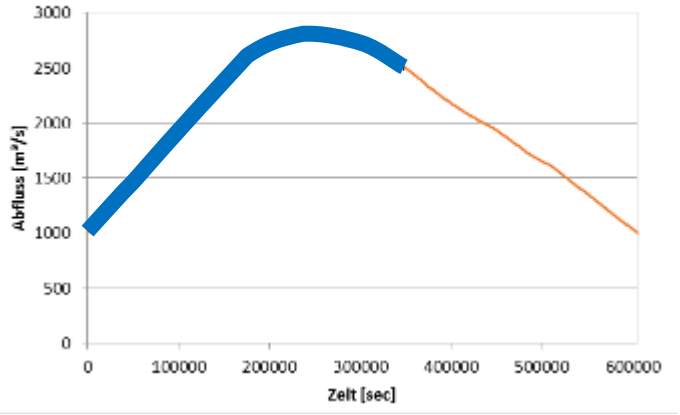


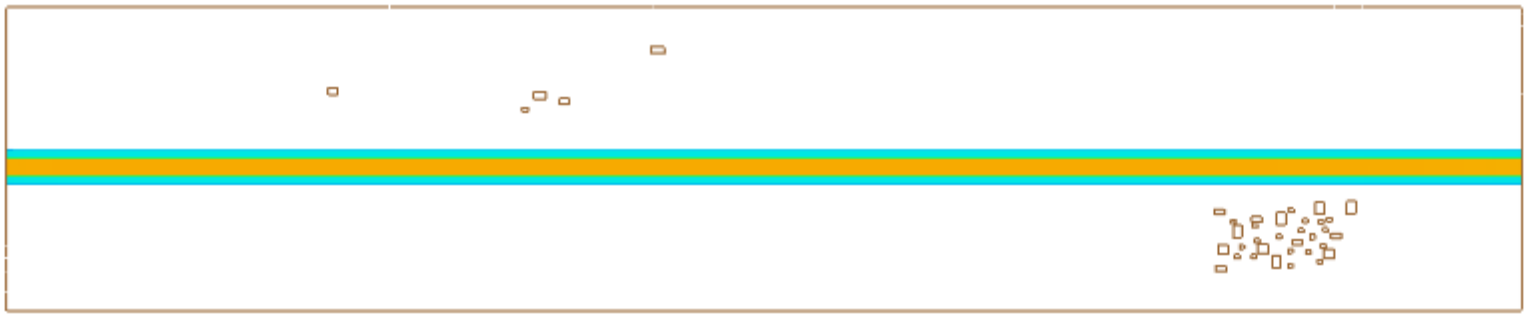


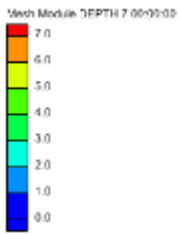


„typisch regulierter“ Fluss – Wassertiefe

4 00:00:00

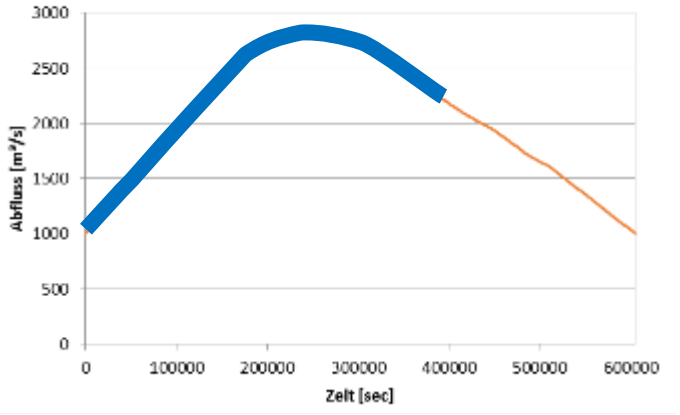


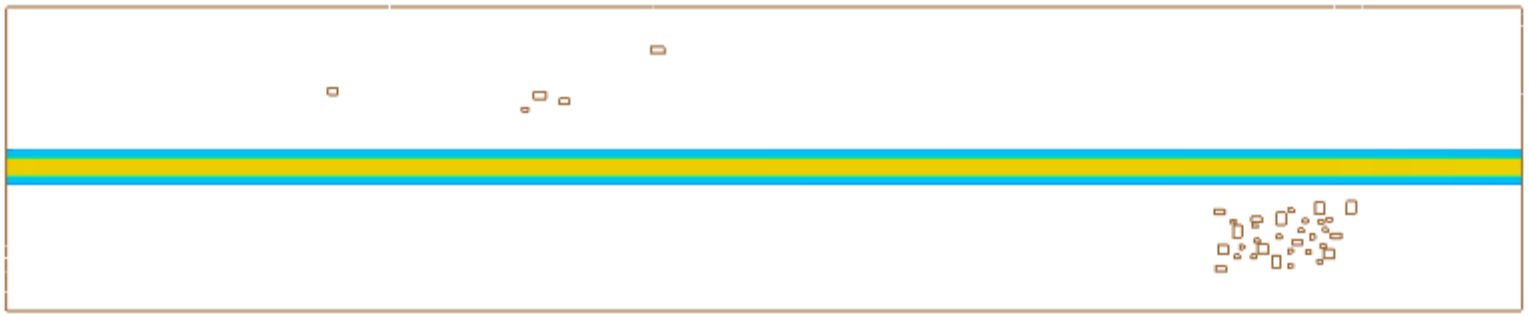


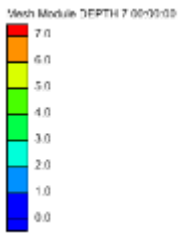


„typisch regulierter“ Fluss – Wassertiefe

4 12:00:00

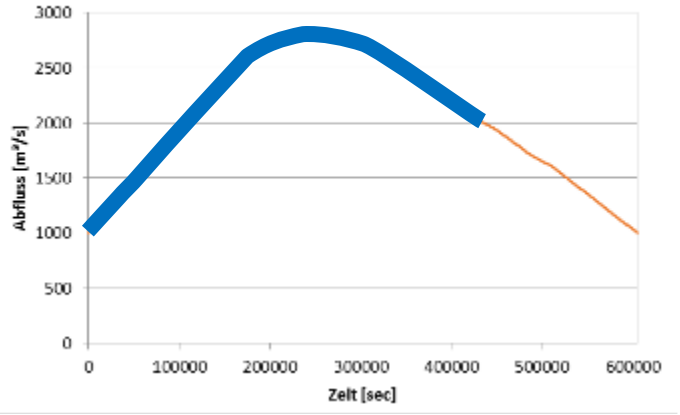


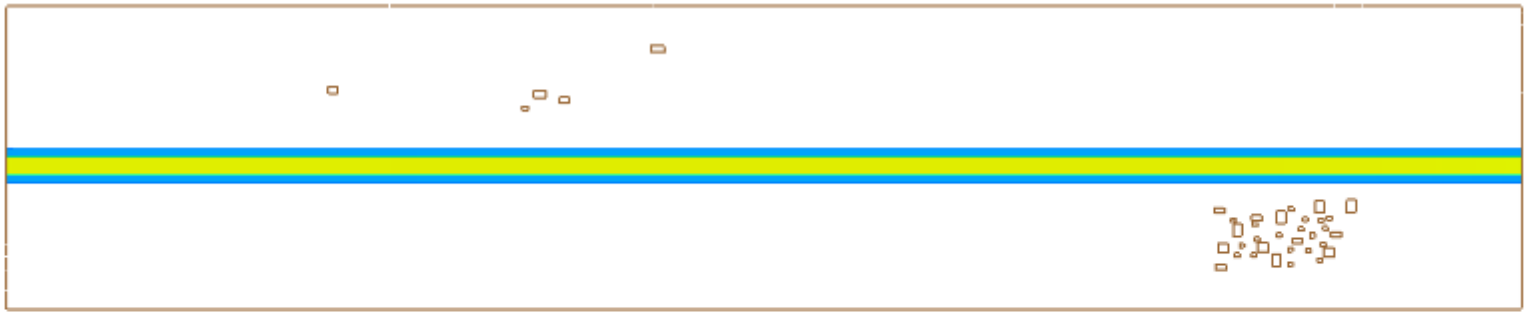


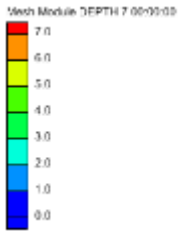


„typisch regulierter“ Fluss – Wassertiefe

5 00:00:00

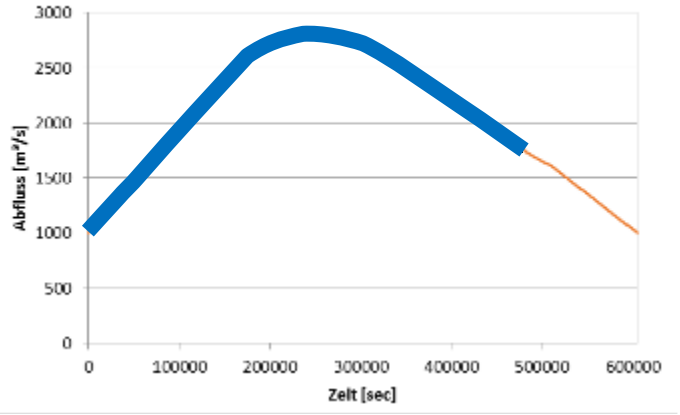


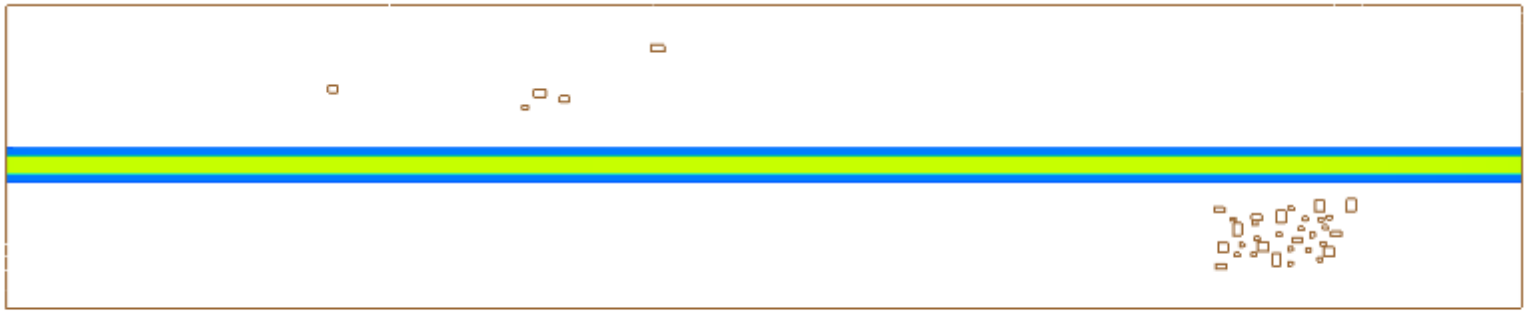


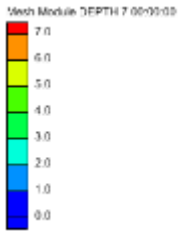


„typisch regulierter“ Fluss – Wassertiefe

5 12:00:00

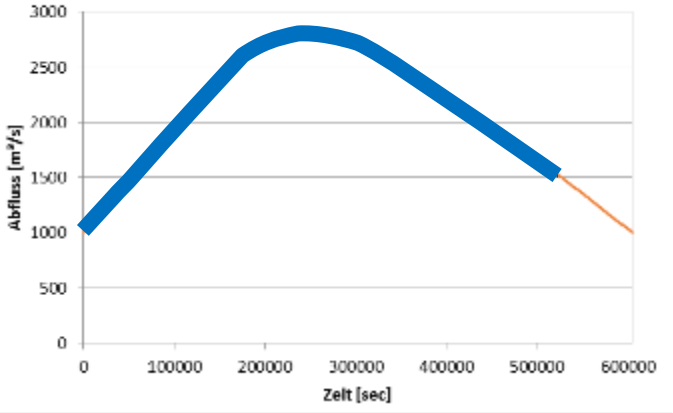


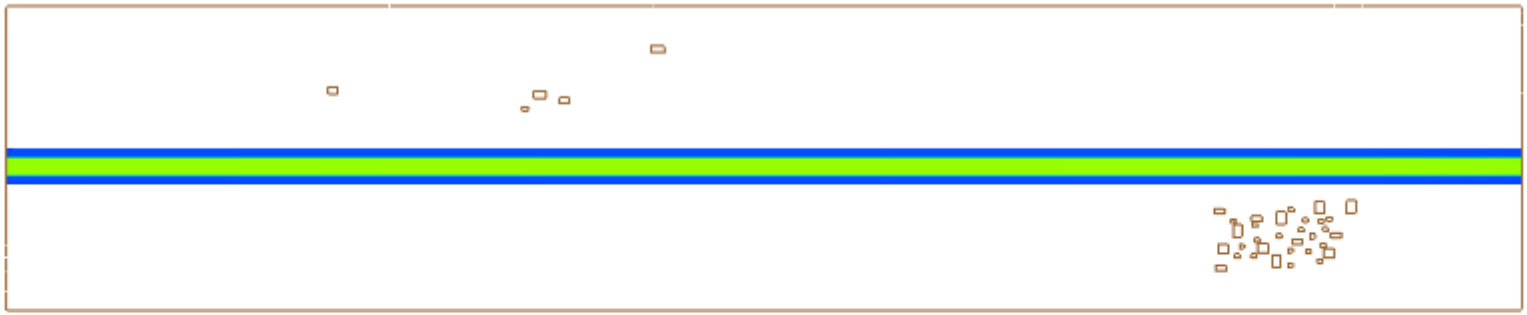


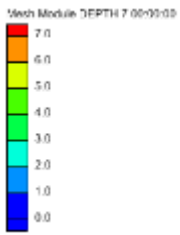


„typisch regulierter“ Fluss – Wassertiefe

6 00:00:00

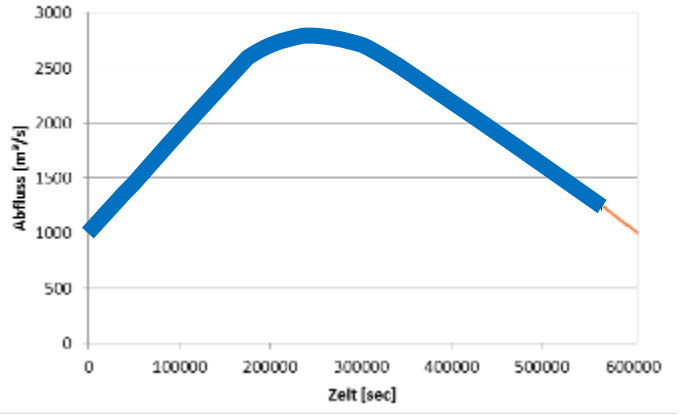


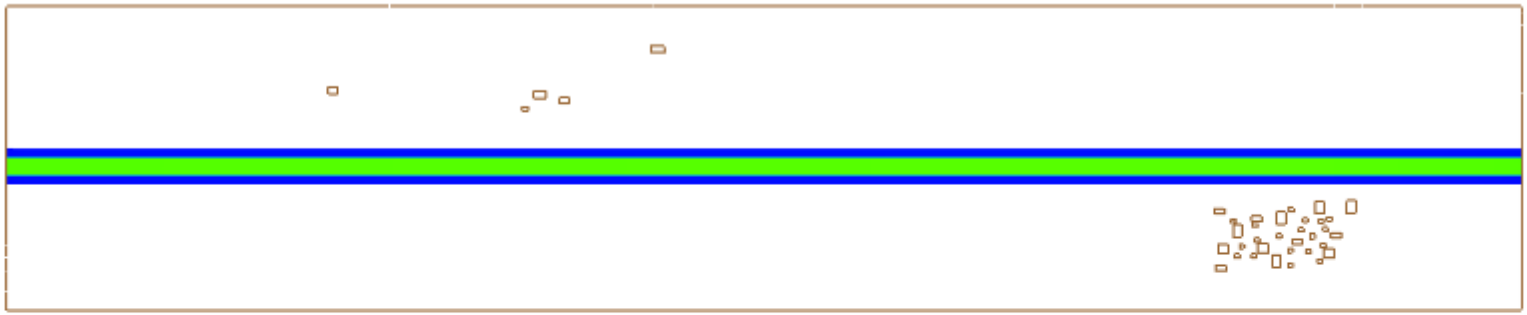


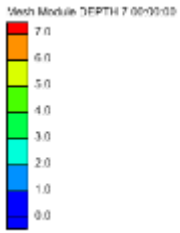


„typisch regulierter“ Fluss – Wassertiefe

6 12:00:00

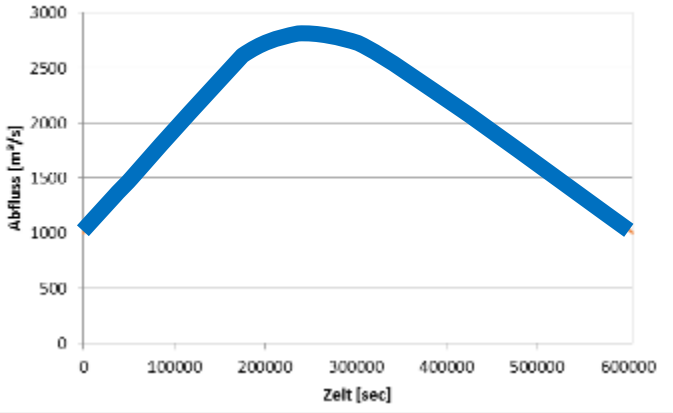


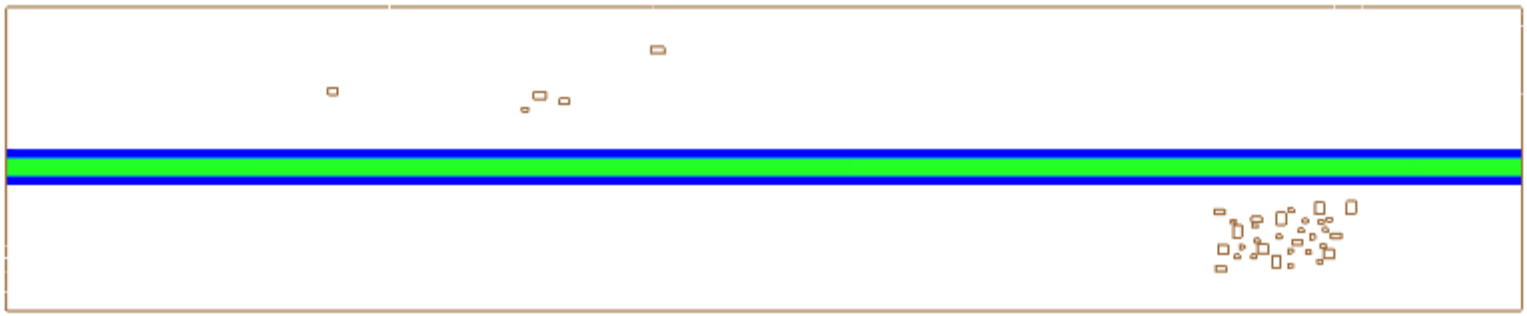


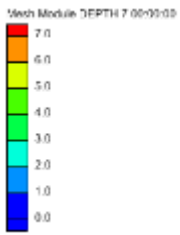


„typisch regulierter“ Fluss – Wassertiefe

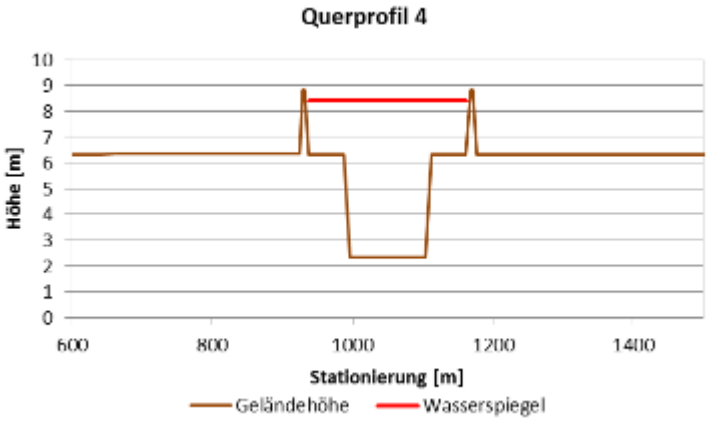
7 00:00:00



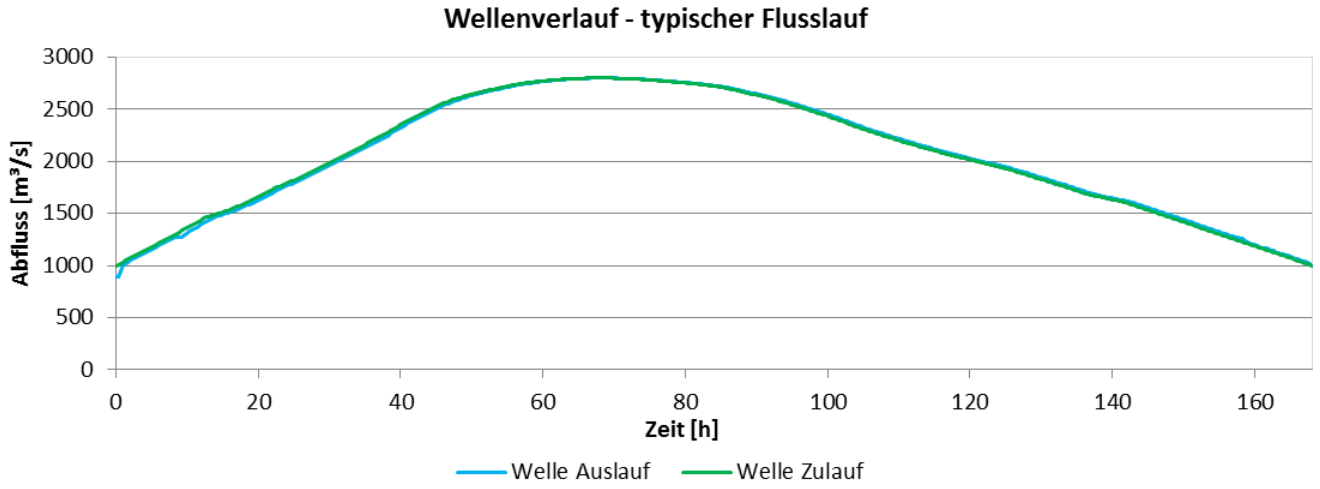




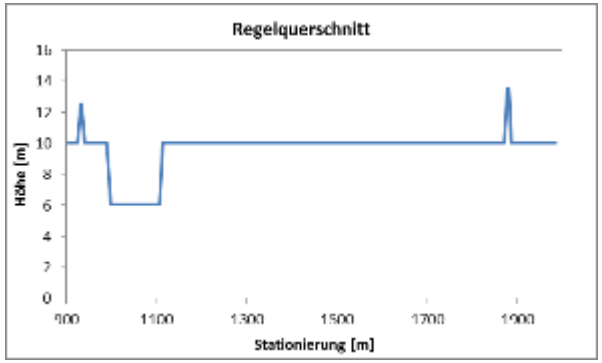
„typisch regulierter“ Fluss



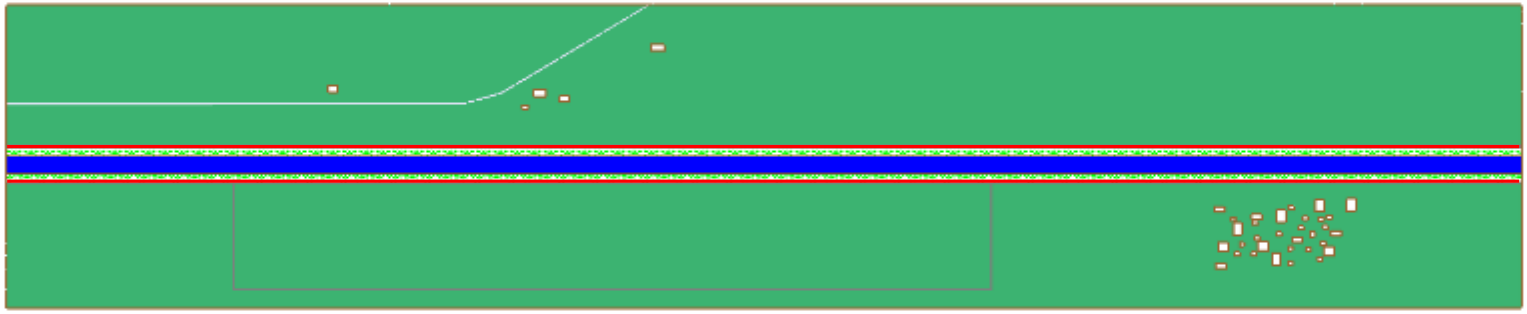
- Freibord: 0.44 m bei maximalen Abfluss
- Zeitliche Verschiebung: ca. 1 Stunde



Deichrückverlegung

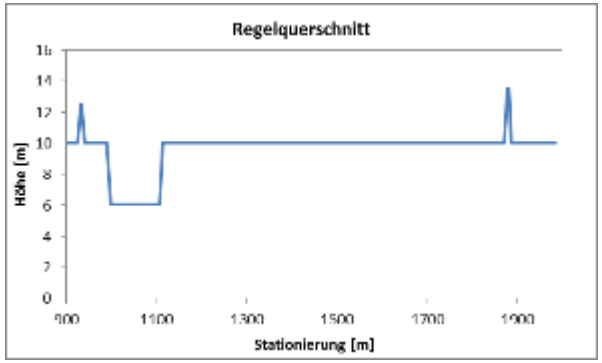


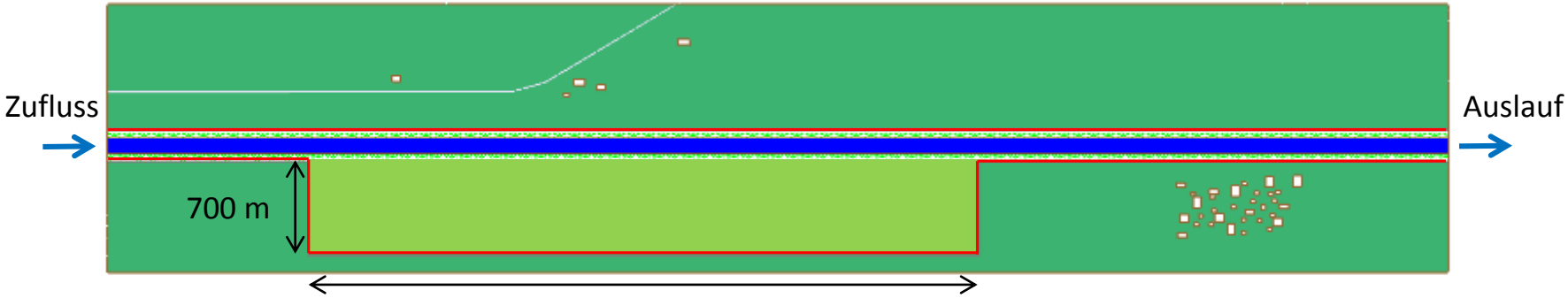
Zufluss



Auslauf

Deichrückverlegung





Länge: 5 km

Deichrückverlegung – Wassertiefe

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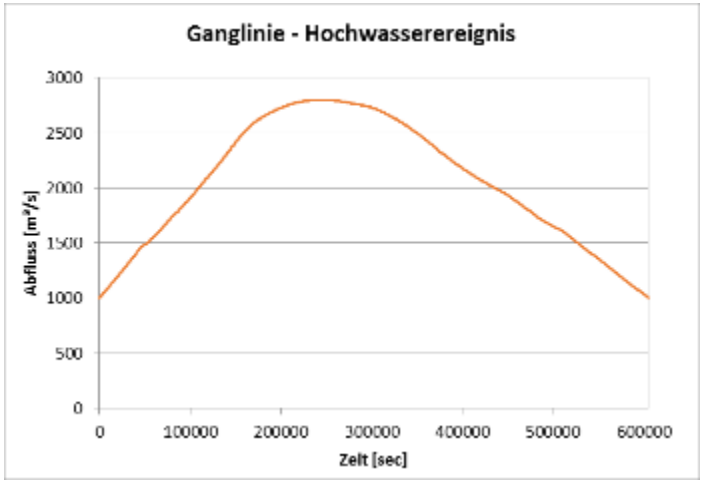

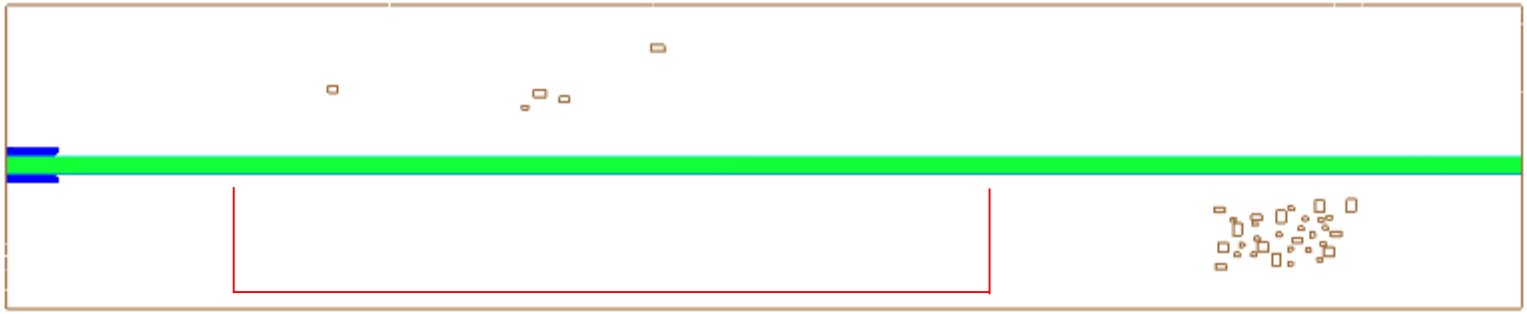

Deichrückverlegung – Wassertiefe

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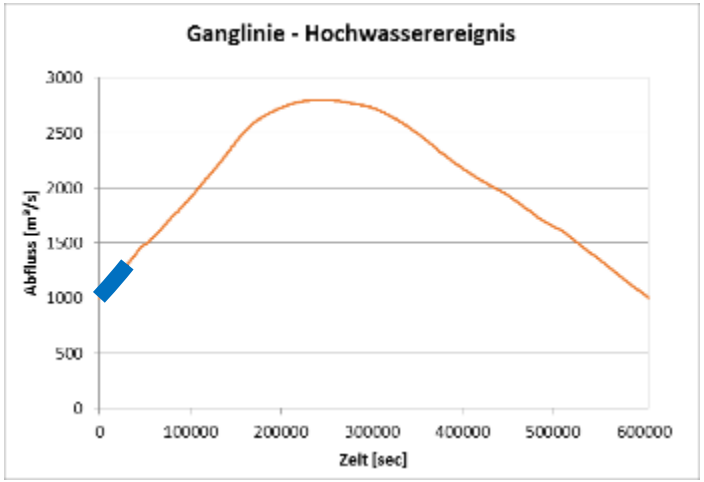

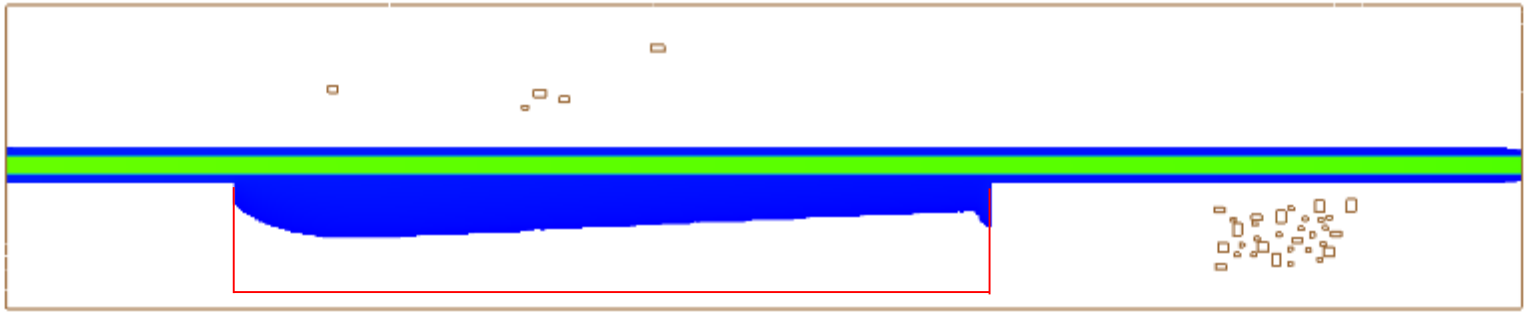

Deichrückverlegung – Wassertiefe

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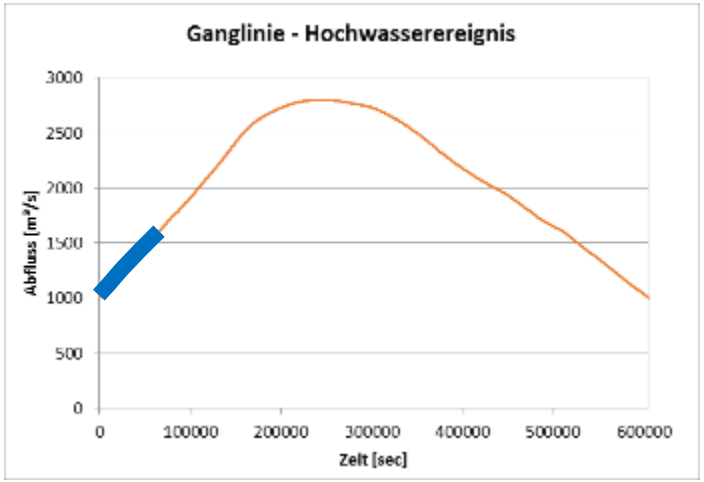

Deichrückverlegung – Wassertiefe

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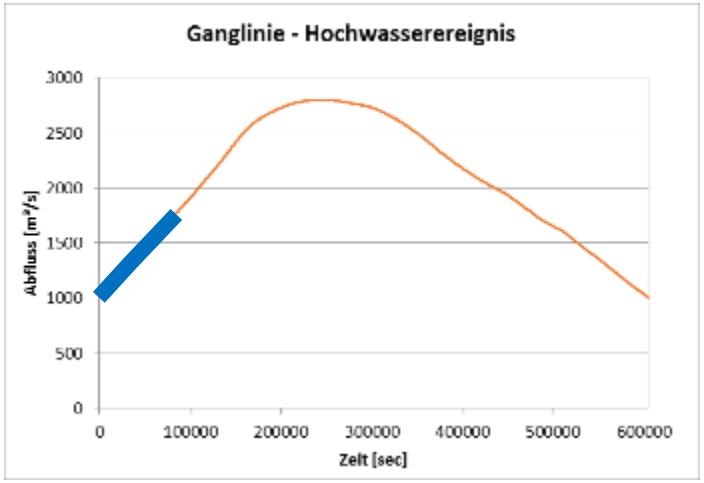
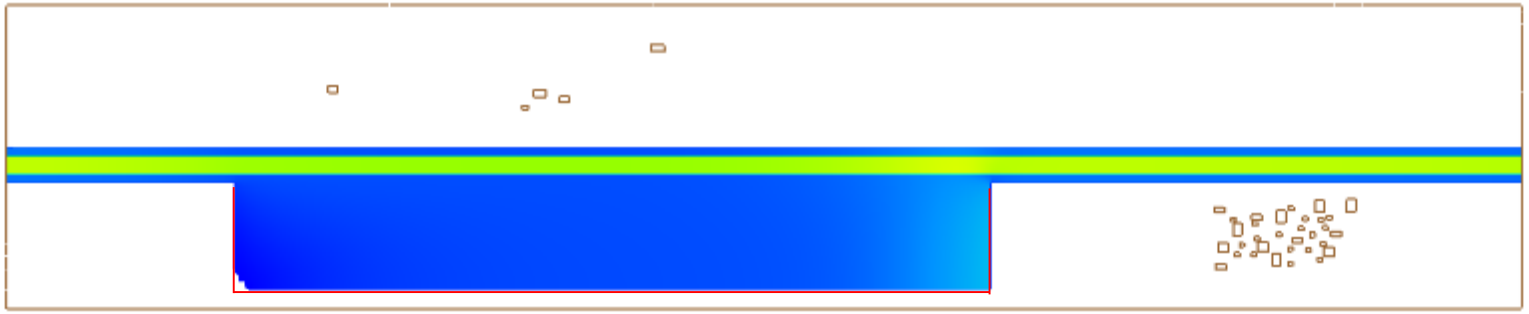
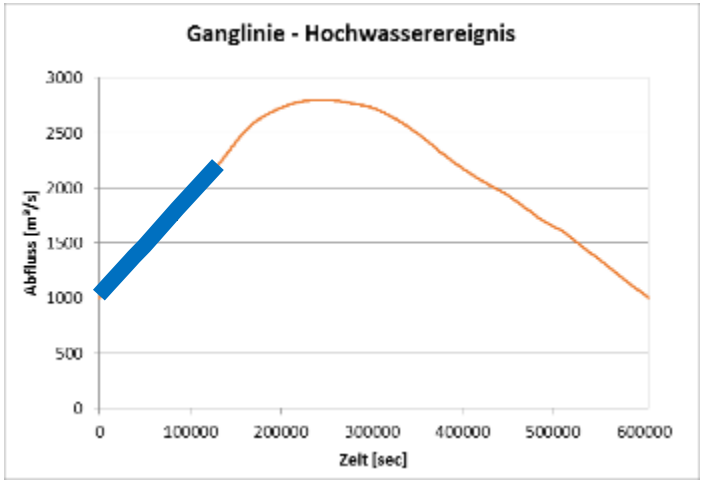
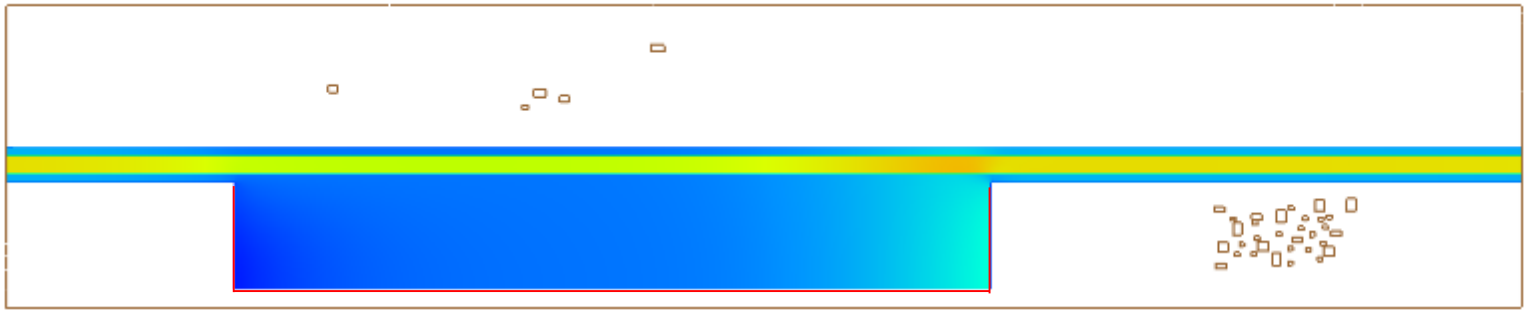




Deichrückverlegung – Wassertiefe

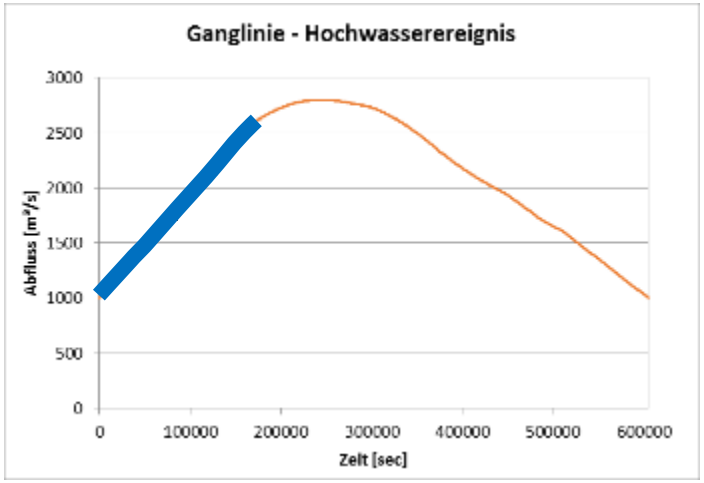
1 12:00:00

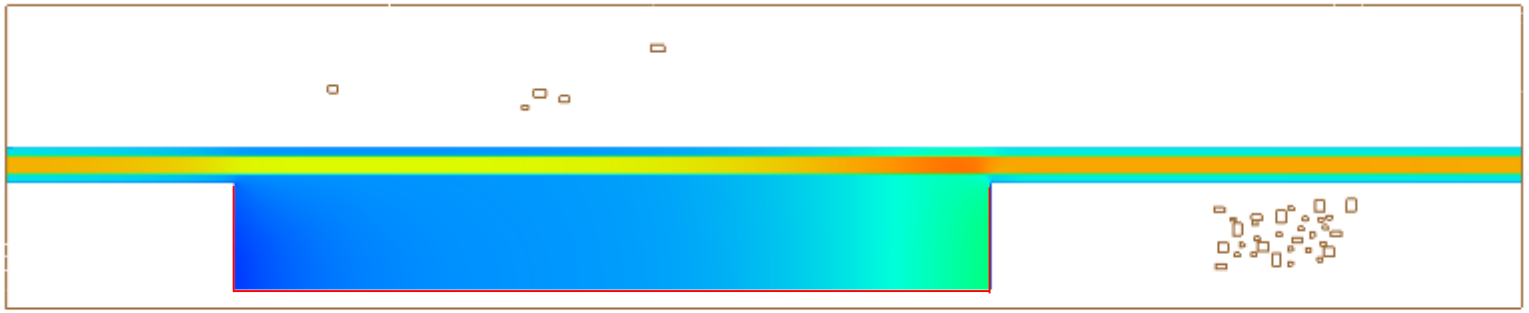




Deichrückverlegung – Wassertiefe

2 00:00:00





Deichrückverlegung – Wassertiefe

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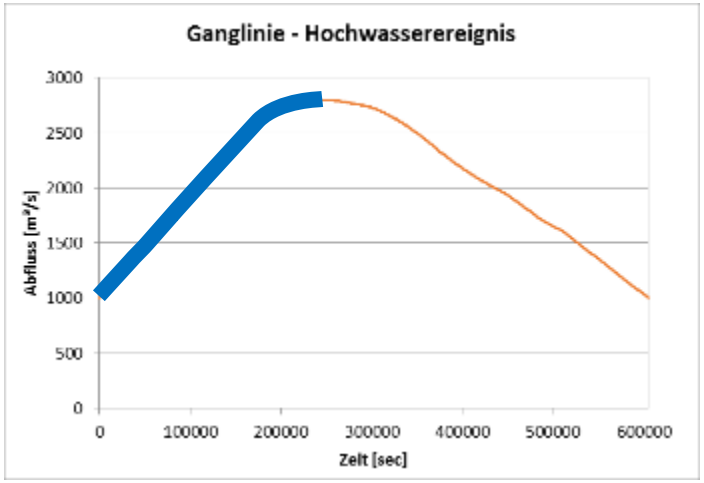

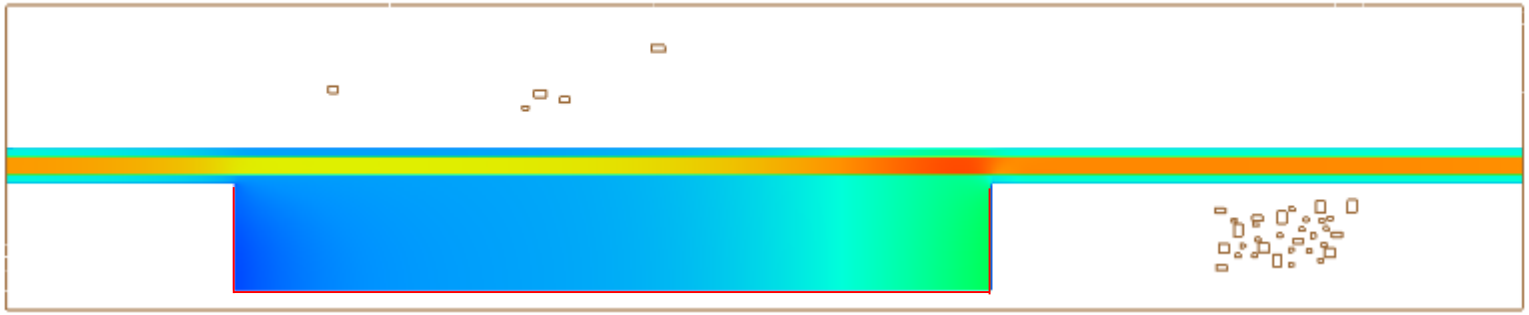

Deichrückverlegung – Wassertiefe

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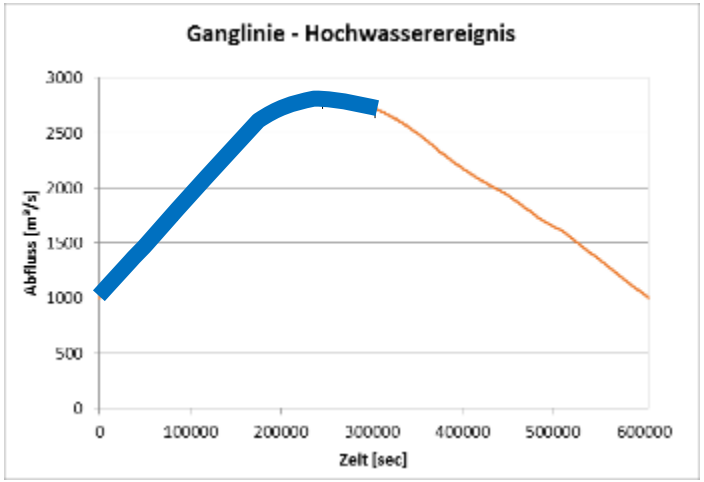
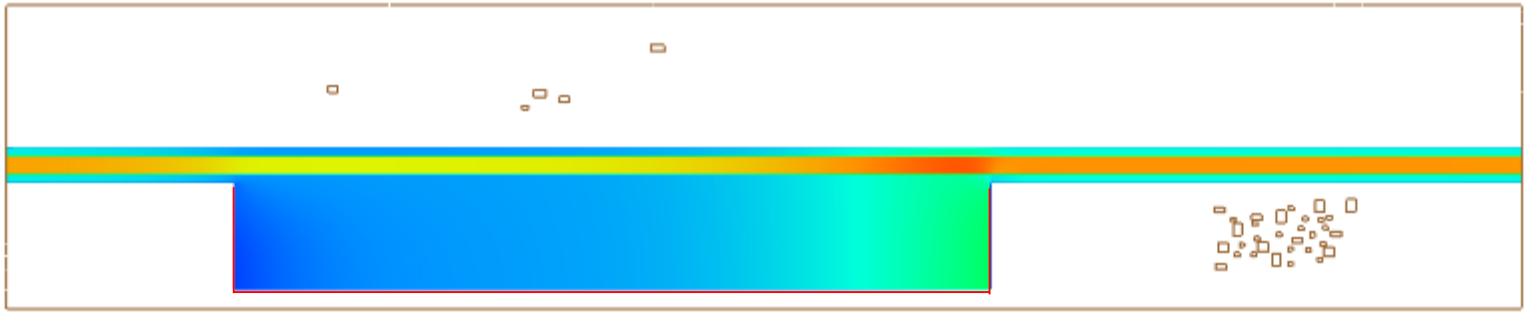
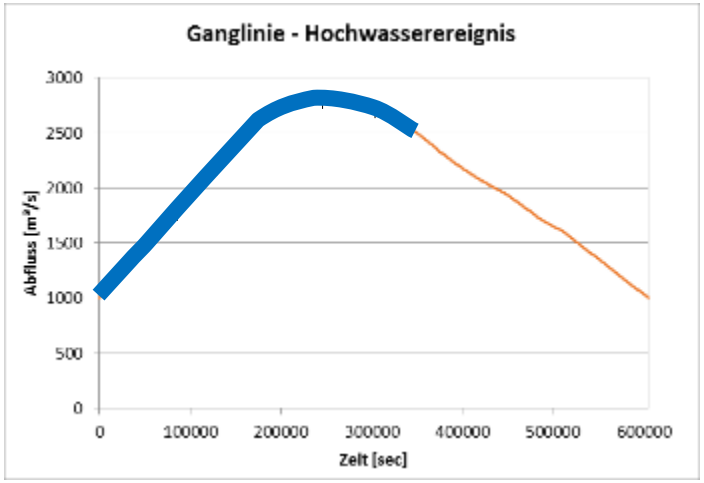
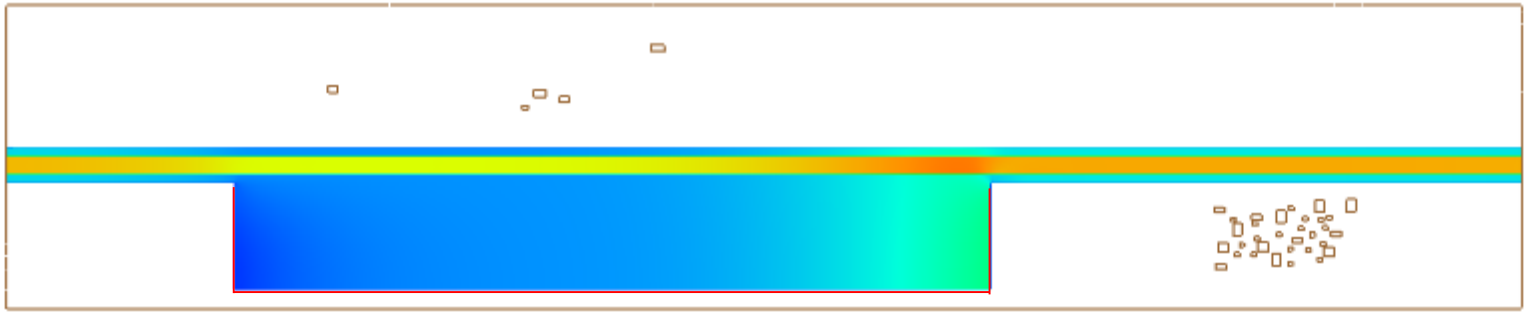




Deichrückverlegung – Wassertiefe

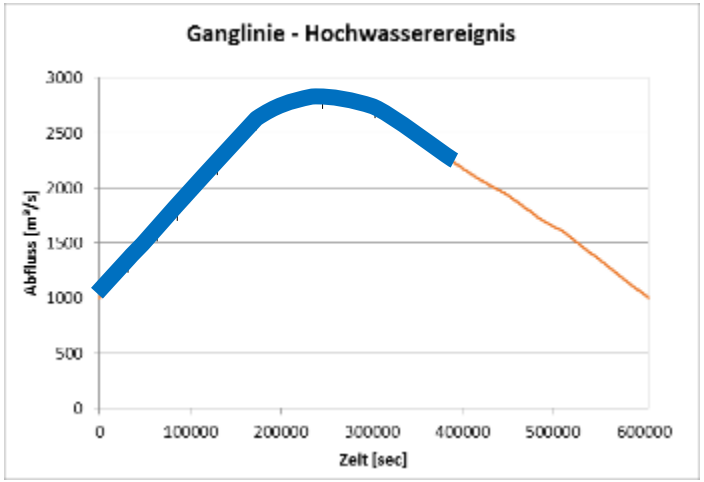
4 00:00:00

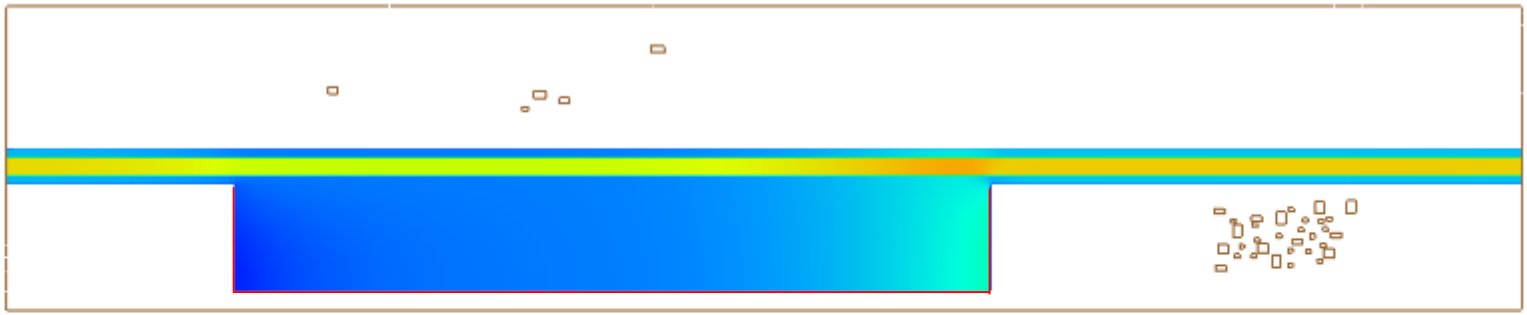




Deichrückverlegung – Wassertiefe

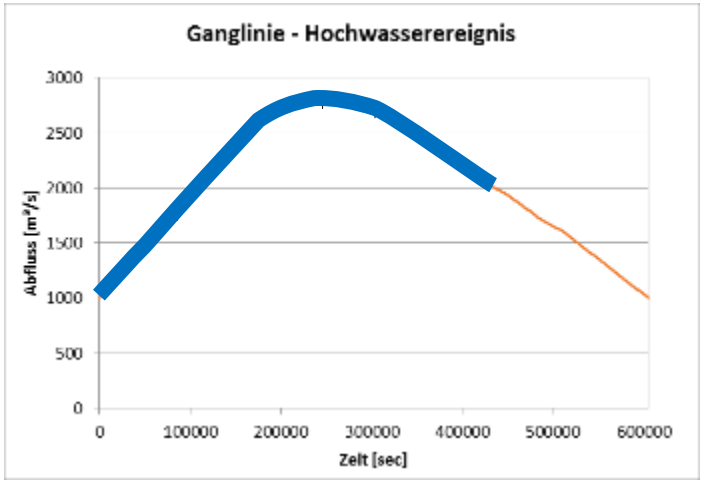
4 12:00:00

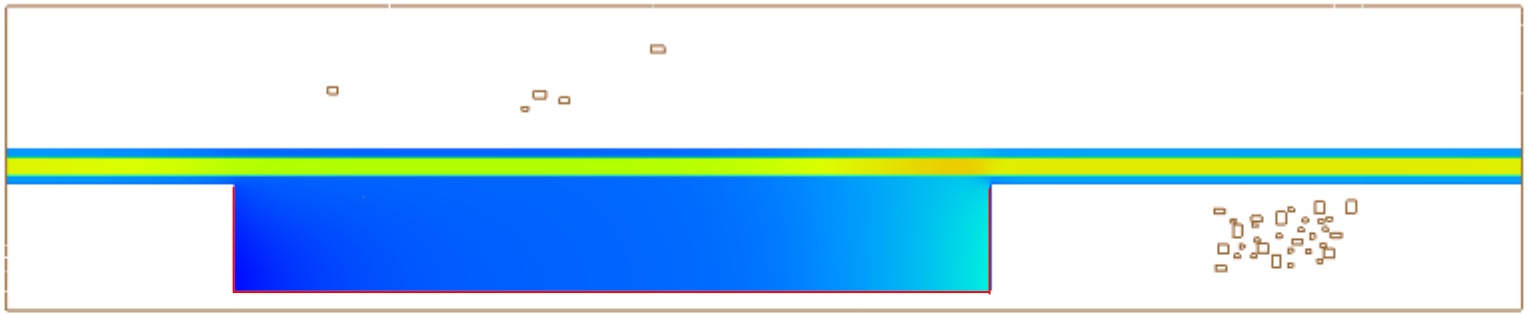




Deichrückverlegung – Wassertiefe

5 00:00:00





Deichrückverlegung – Wassertiefe

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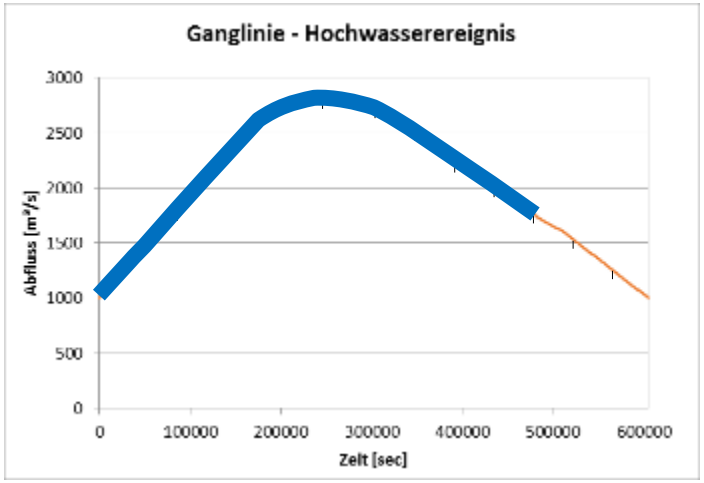
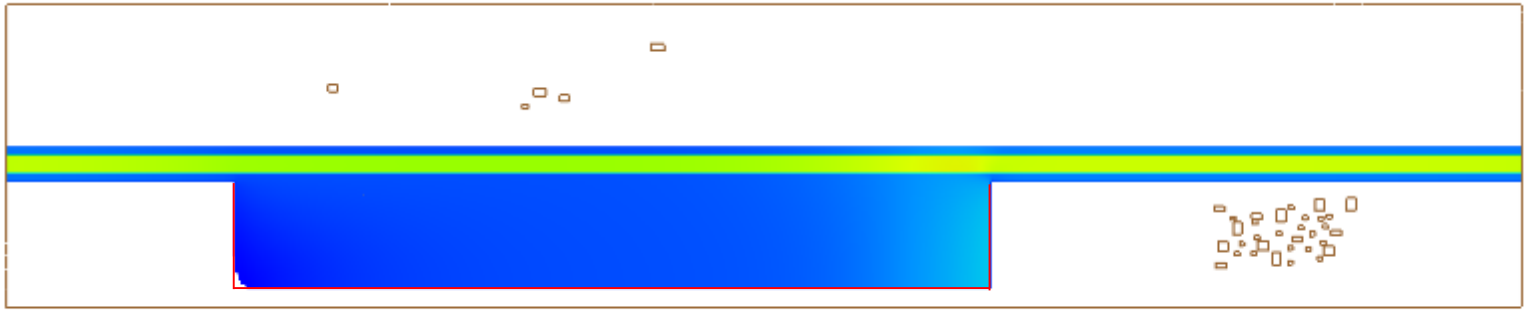
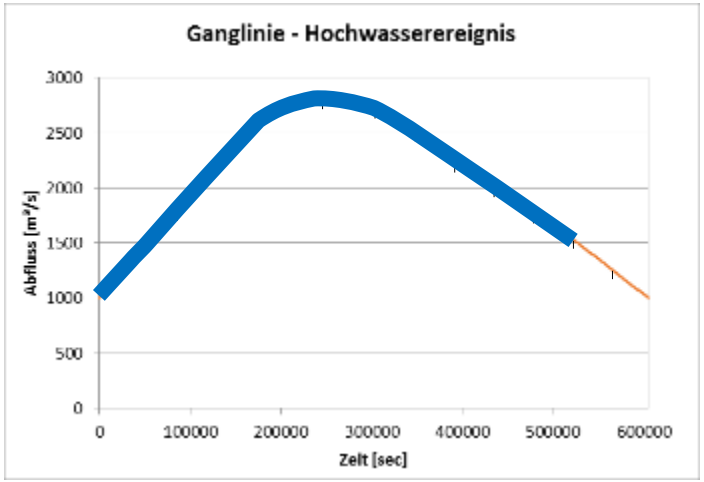
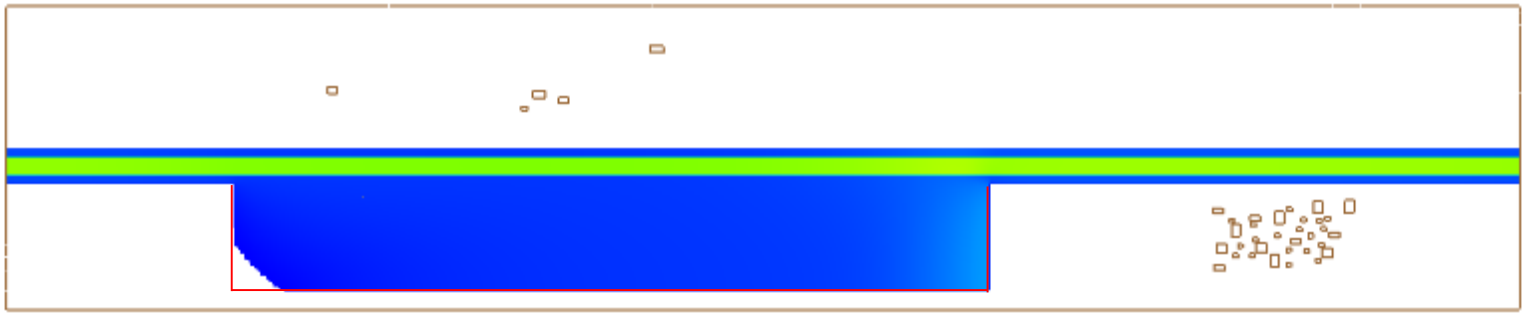




Deichrückverlegung – Wassertiefe

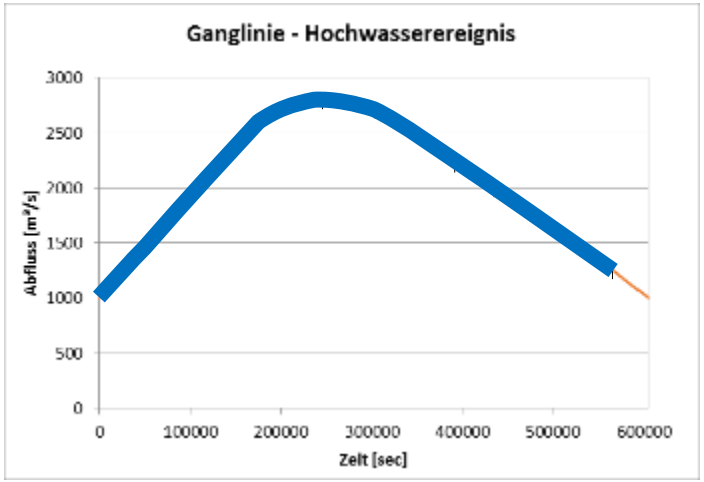
6 00:00:00





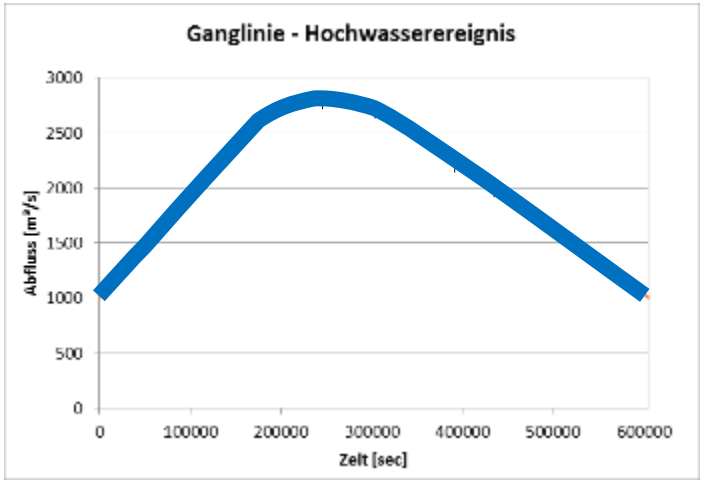
Deichrückverlegung – Wassertiefe

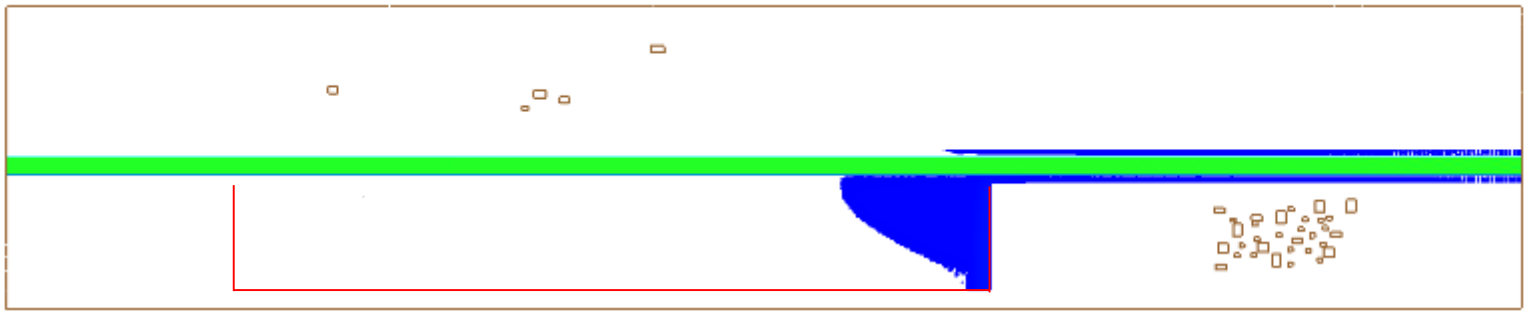
6 12:00:00



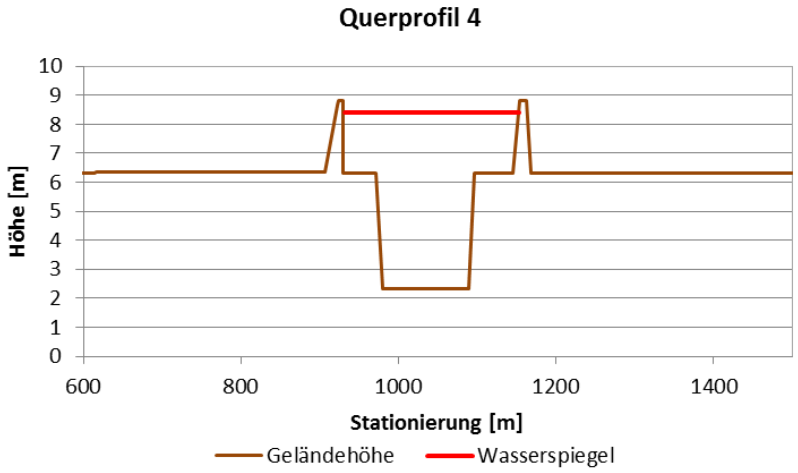
Deichrückverlegung – Wassertiefe

7 00:00:00



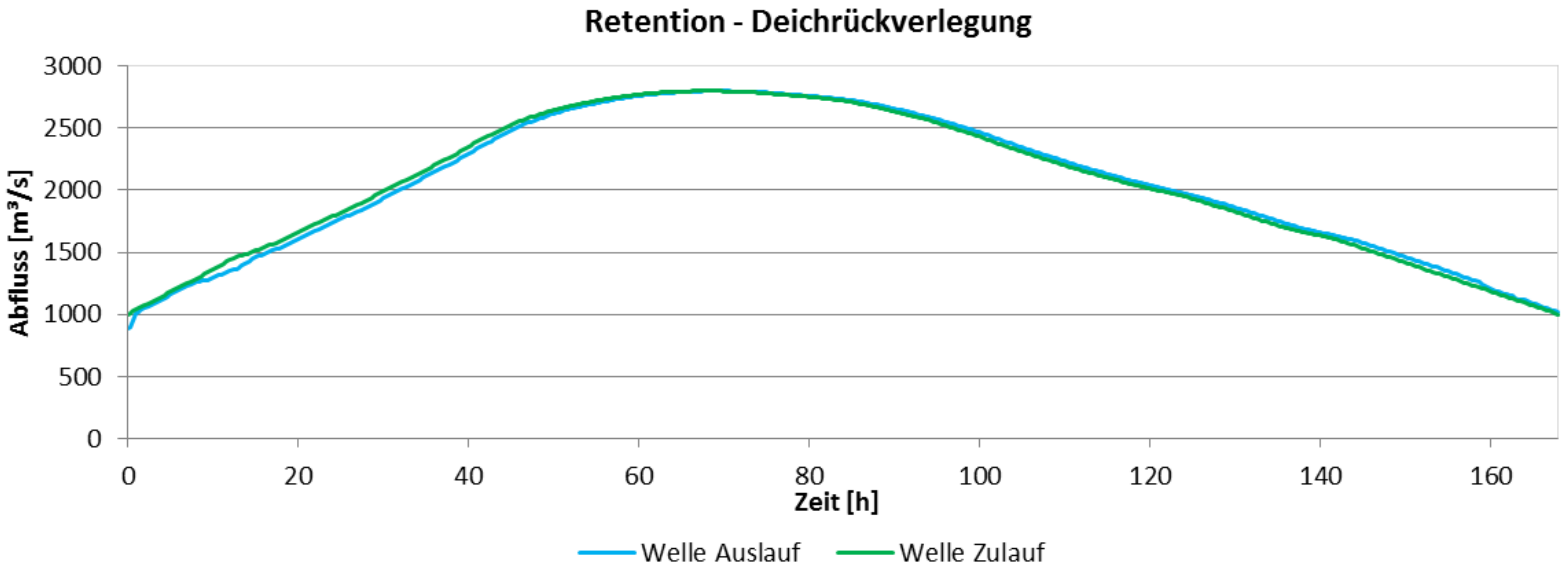


Deichrückverlegung



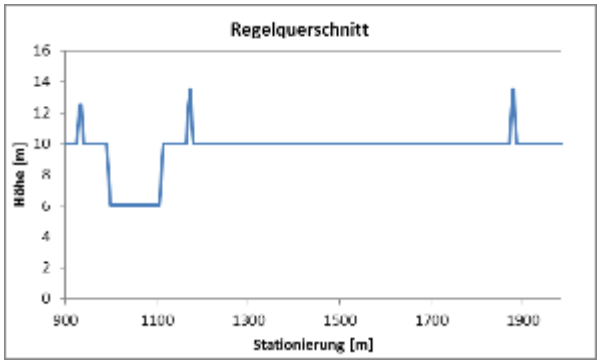
- Freibord: 0.44 m bei maximalen Abfluss

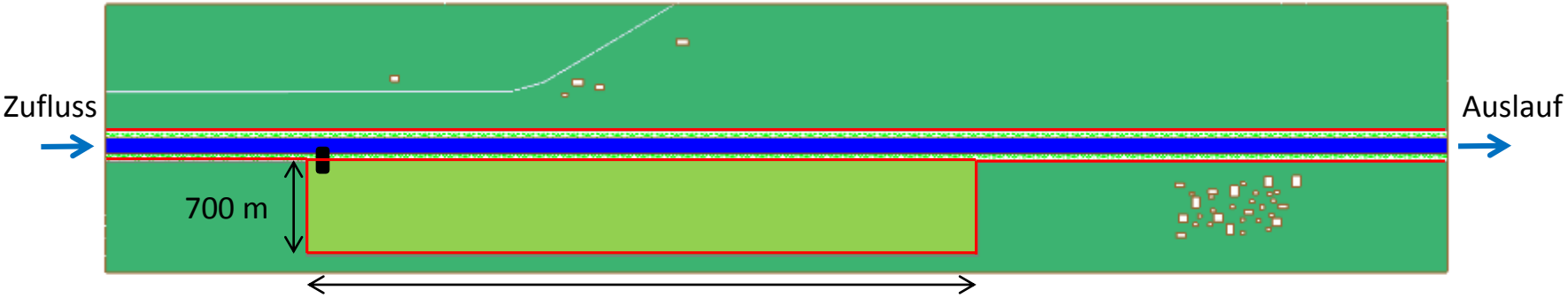
Deichrückverlegung

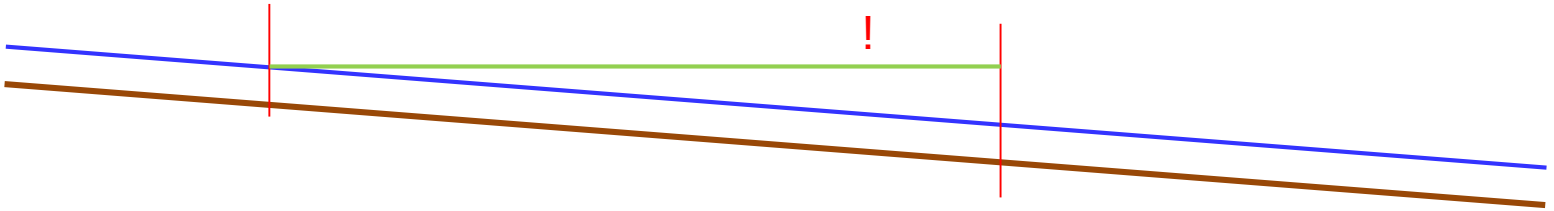


- Fließende Retention:
  - Verzögerung des Abflusses: ca. 1 Stunde
  - Annähernd keine Reduktion der Abflussspitze

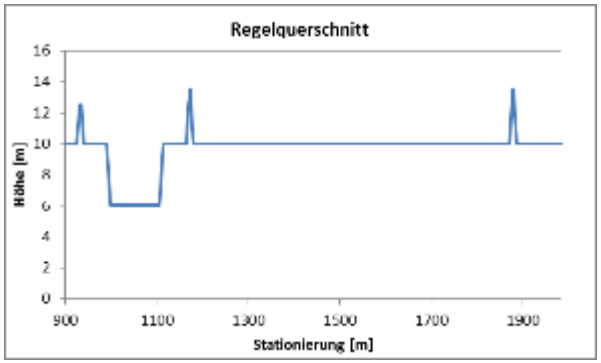
Gesteuerter Rückhalt im Nebenschluss Flutpolder

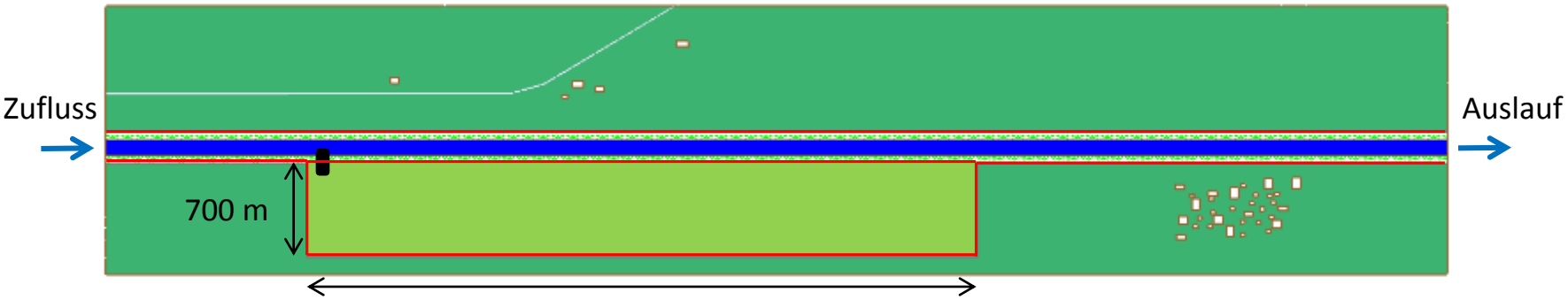




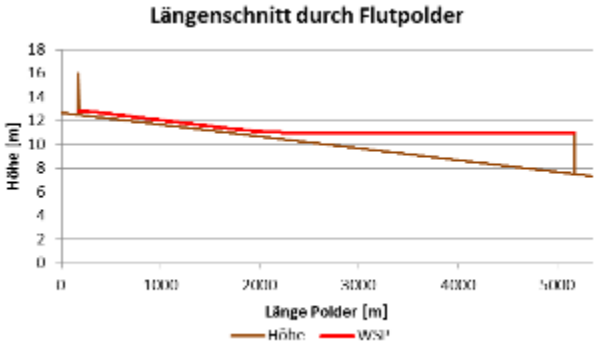


Gesteuerter Rückhalt im Nebenschluss Flutpolder





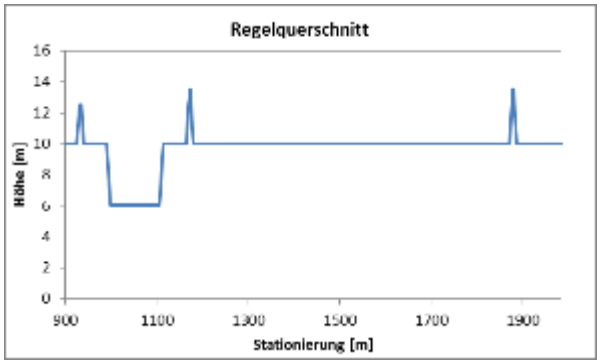
Länge: 5 km

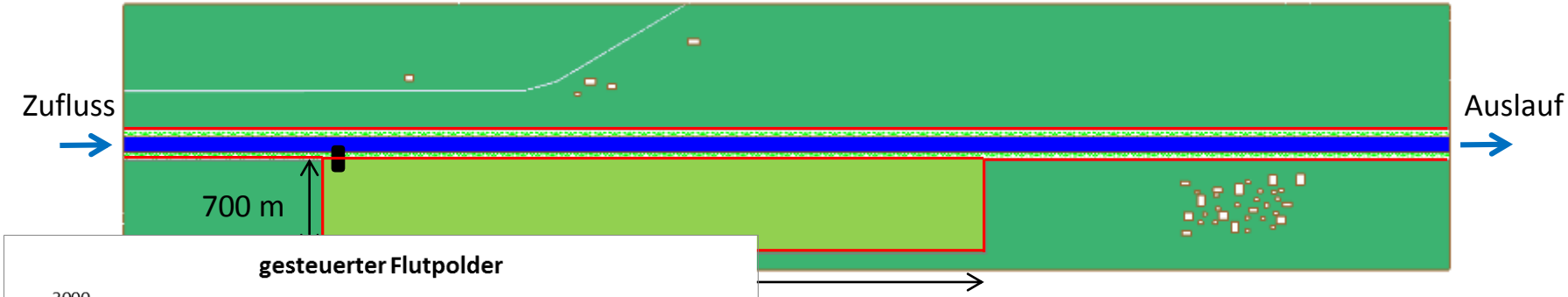


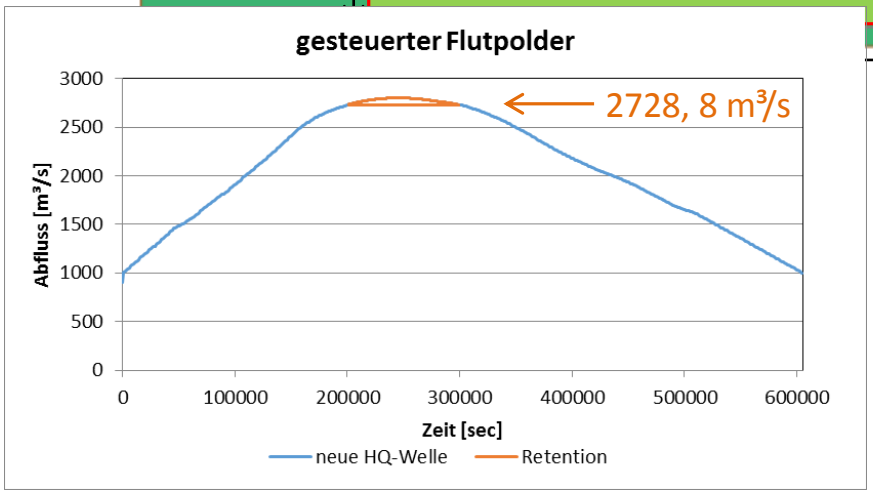
Retentionsvolumen: 4.6 Mio m³

– Bei einer Deichhöhe von 3,5 m

Gesteuerter Rückhalt im Nebenschluss Flutpolder





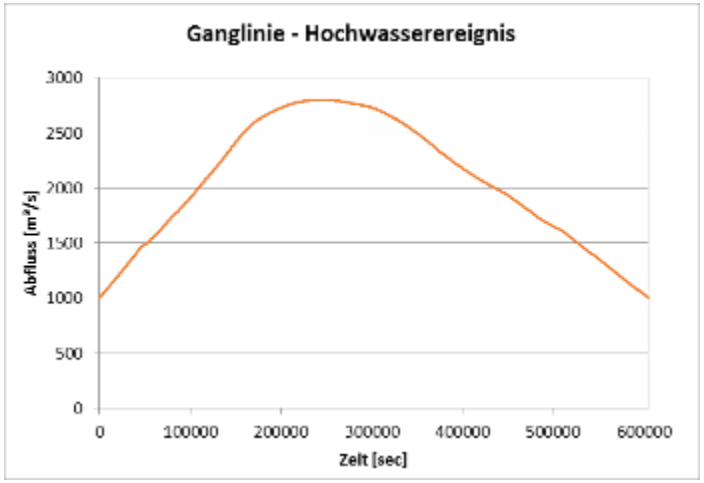


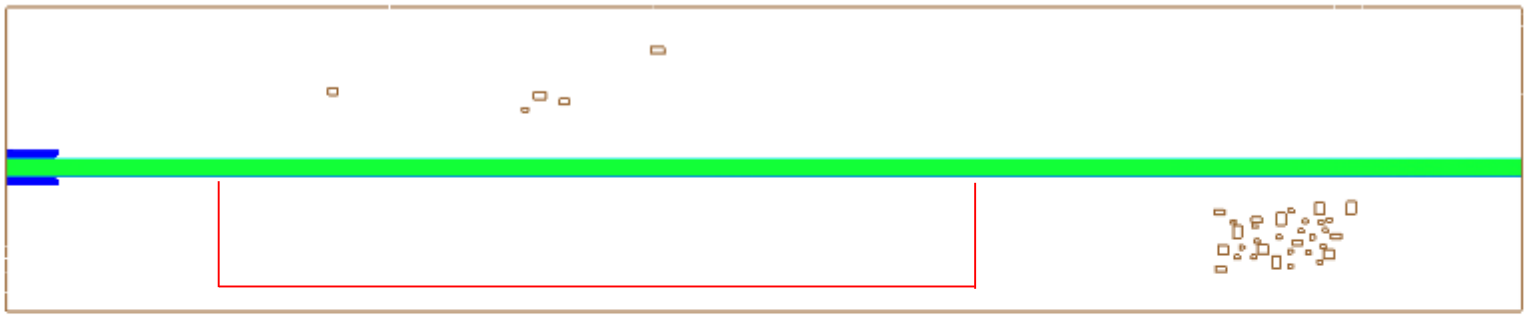
Retentionsvolumen: 4.6 Mio m³

- Bei einer Deichhöhe von 3,5 m

Flutpolder – **theoretischer Ablauf** - Wassertiefe

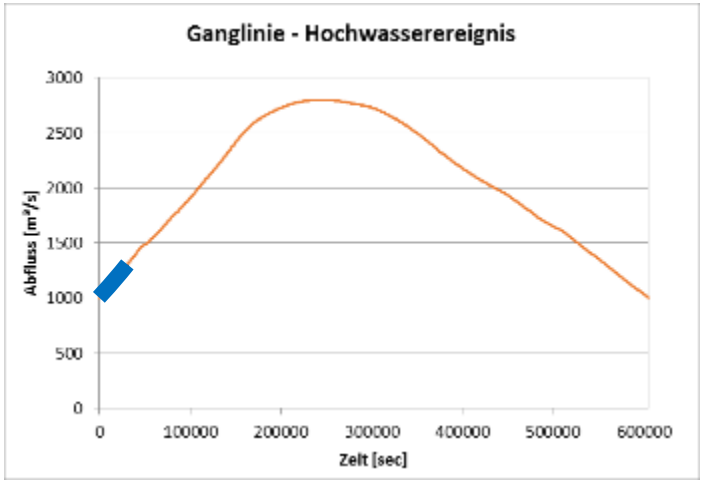
0 00:00:01





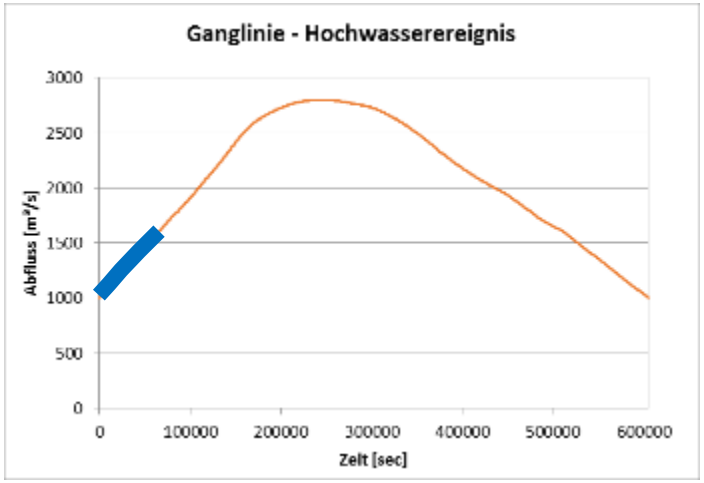
Flutpolder – **theoretischer Ablauf** - Wassertiefe

0 10:00:00



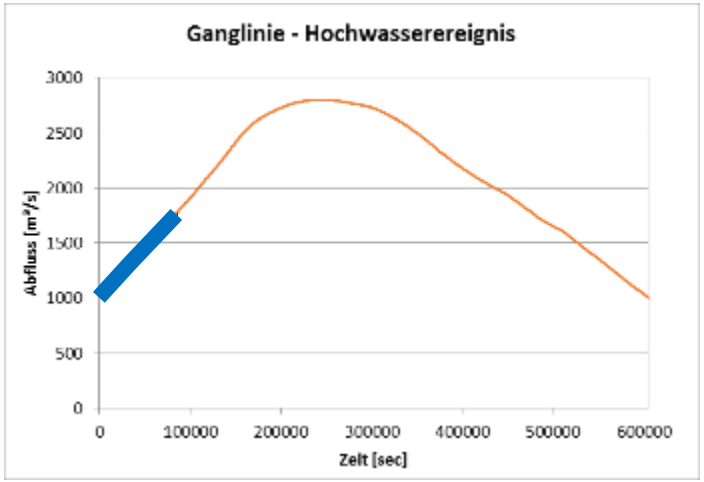
Flutpolder – **theoretischer Ablauf** - Wassertiefe

0 18:00:00



Flutpolder – **theoretischer Ablauf** - Wassertiefe

1 00:00:00



Flutpolder – **theoretischer Ablauf** - Wassertiefe

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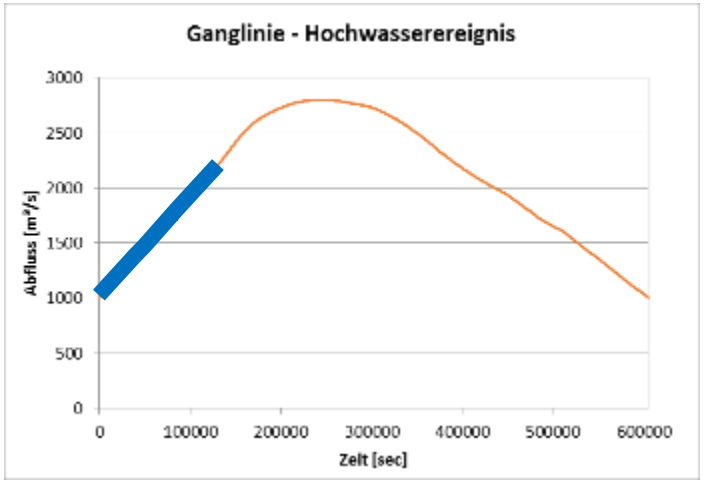
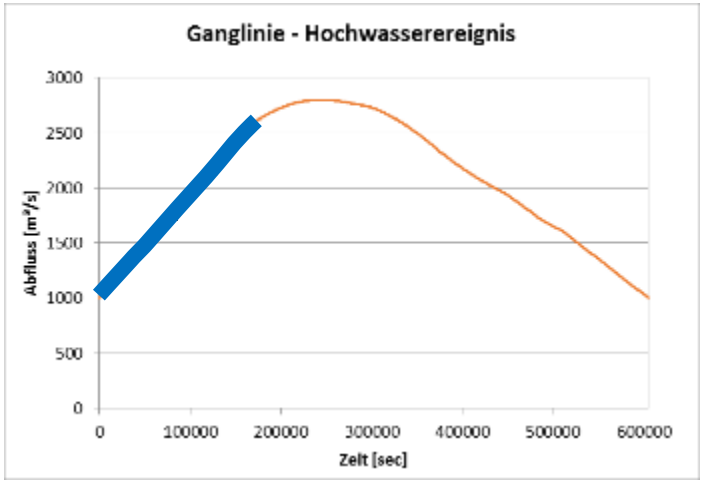
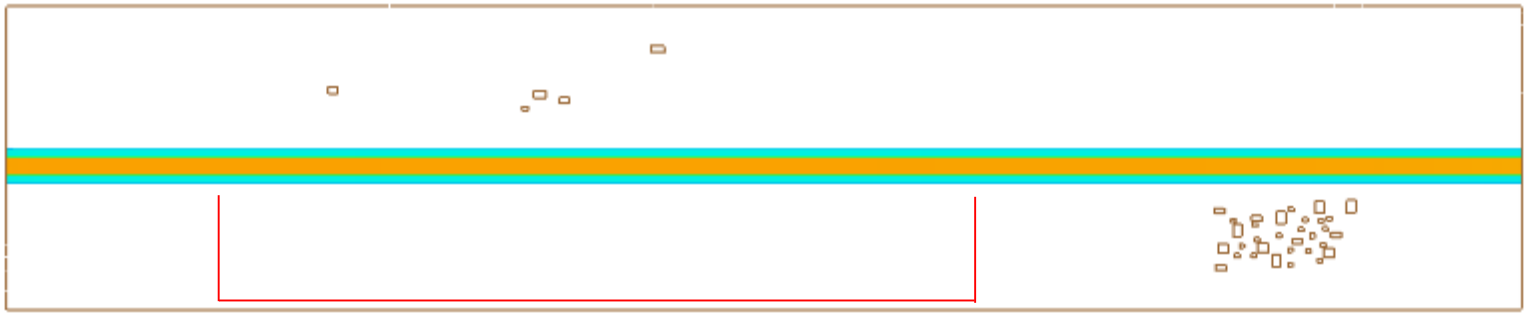


Flutpolder – **theoretischer Ablauf** - Wassertiefe

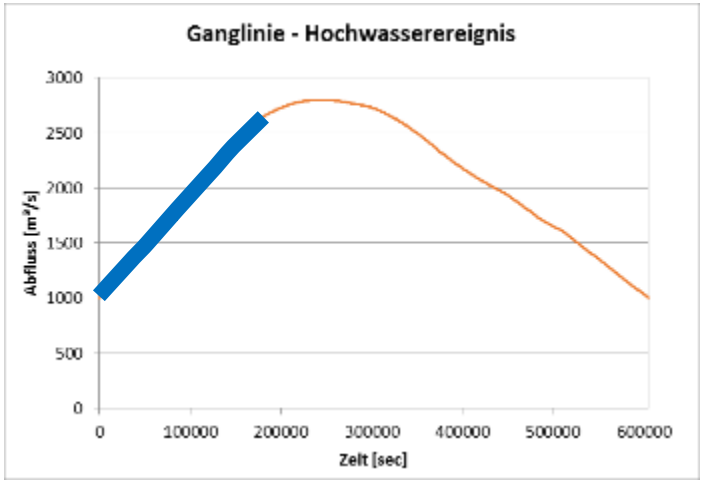
2 00:00:00

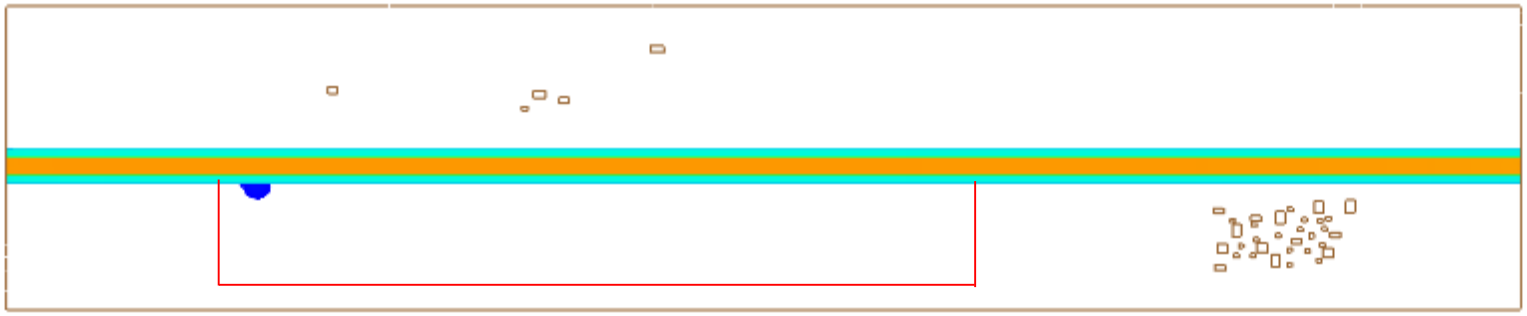




Flutpolder – **theoretischer Ablauf** - Wassertiefe

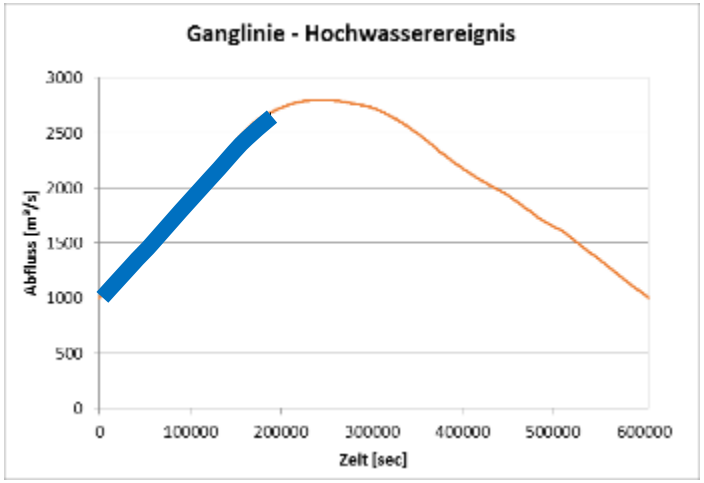
2 04:20:00

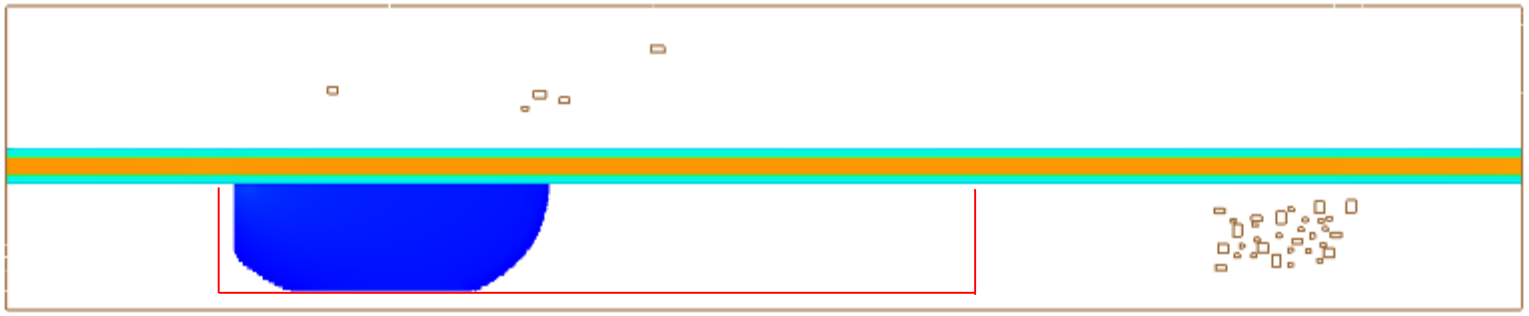




Flutpolder – **theoretischer Ablauf** - Wassertiefe

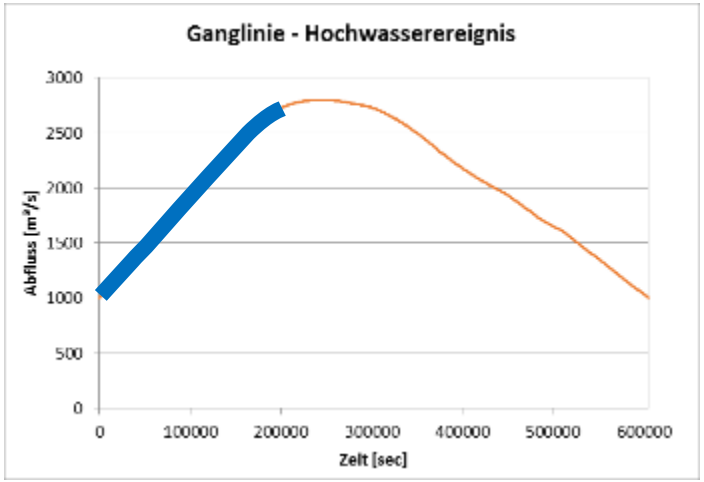
2 07:00:00

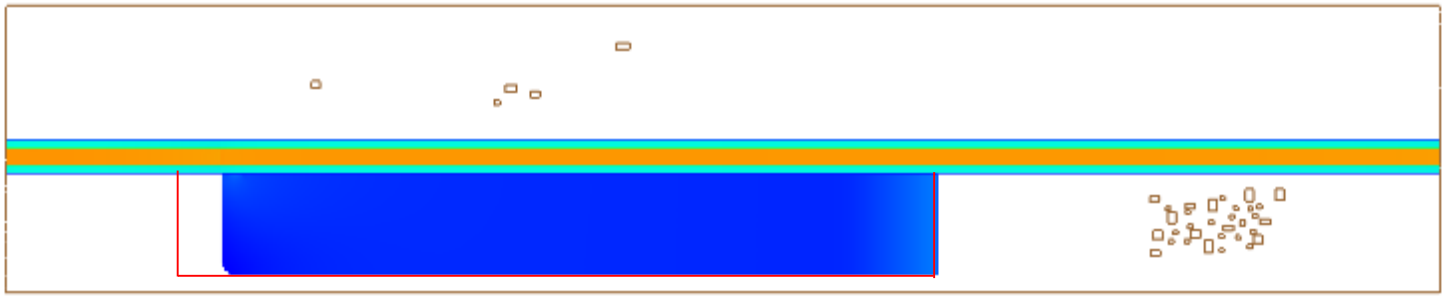




Flutpolder – **theoretischer Ablauf** - Wassertiefe

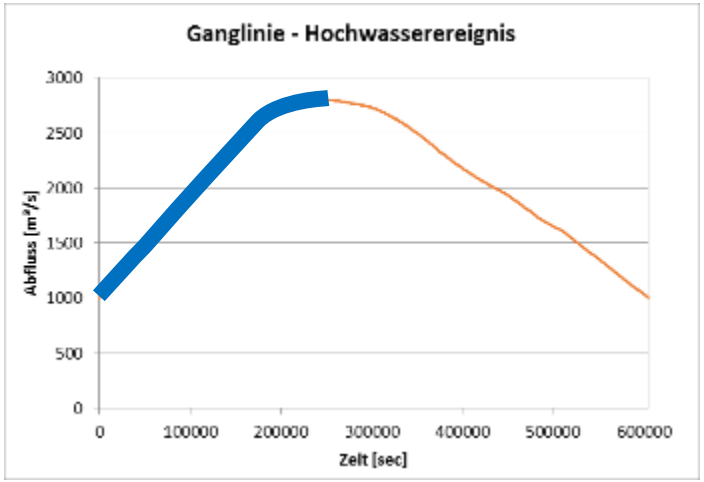
2 11:00:00

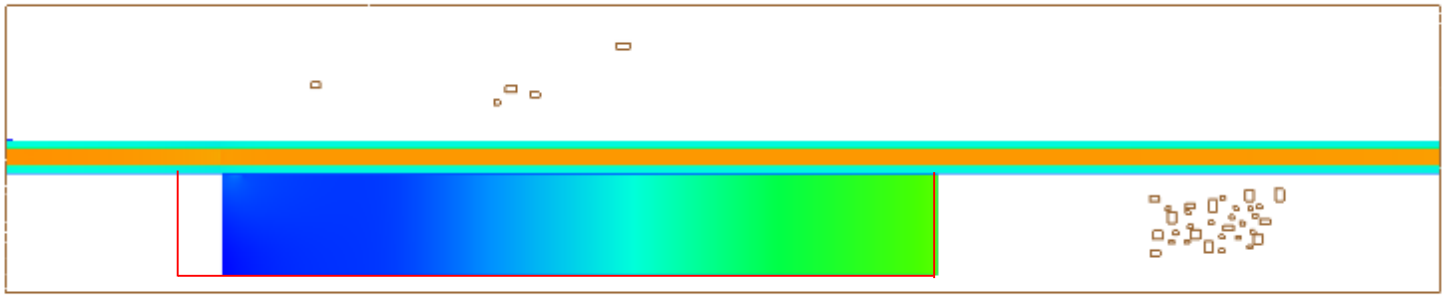




Flutpolder – **theoretischer Ablauf** - Wassertiefe

3 00:00:00





Flutpolder – **theoretischer Ablauf** - Wassertiefe

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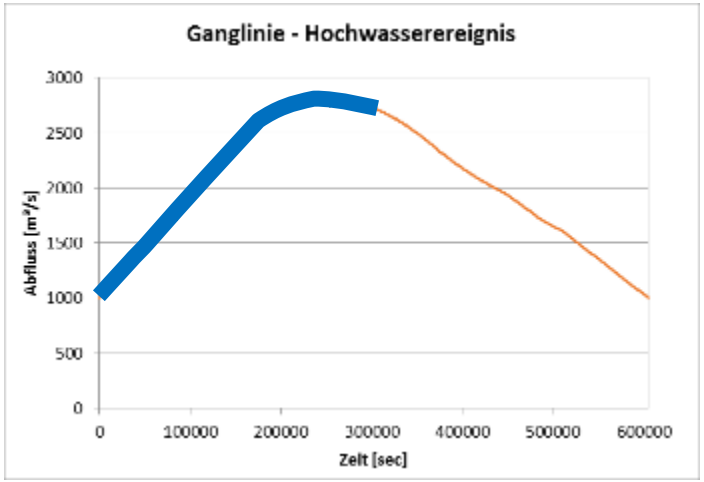

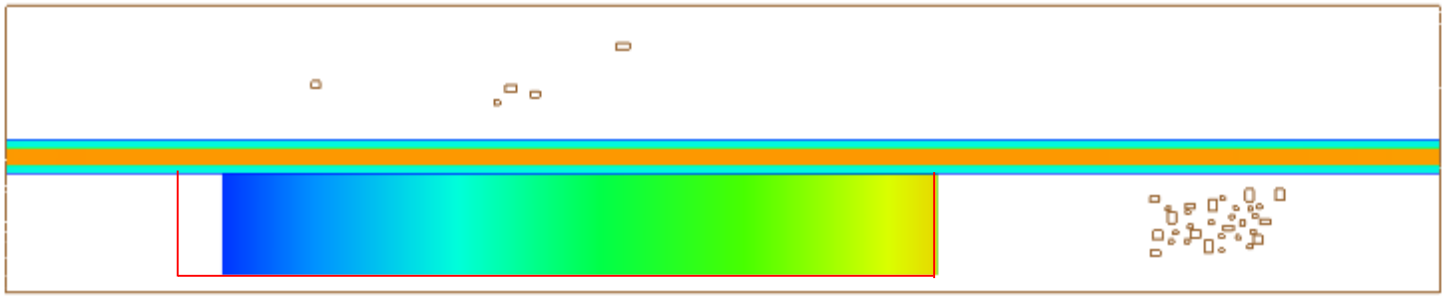

Flutpolder – **theoretischer Ablauf** - Wassertiefe

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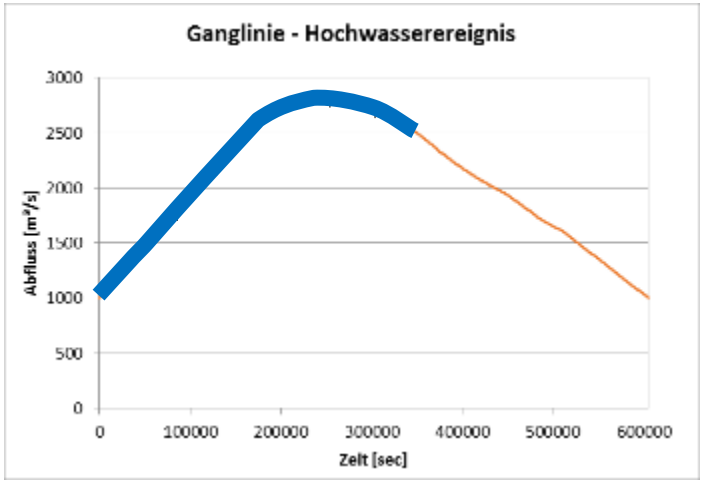

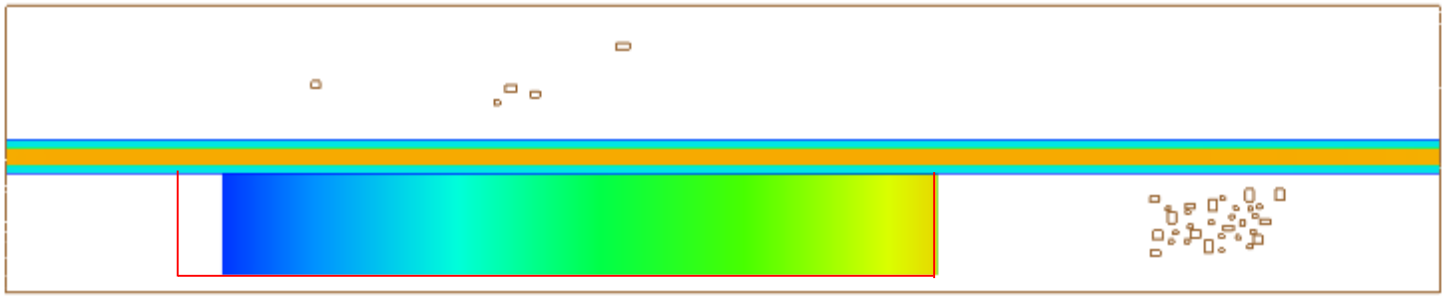

Flutpolder – **theoretischer Ablauf** - Wassertiefe

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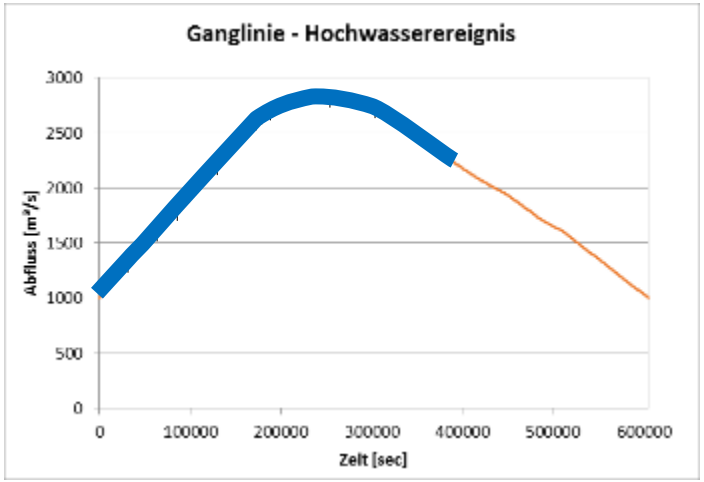

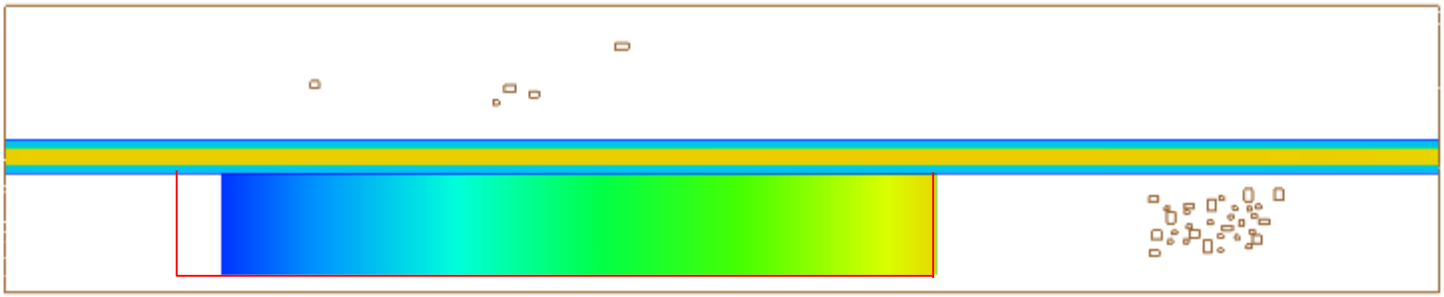

Flutpolder – **theoretischer Ablauf** - Wassertiefe

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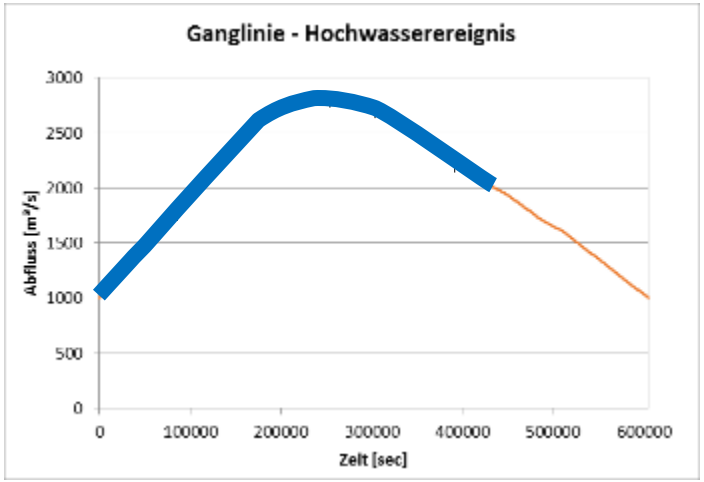
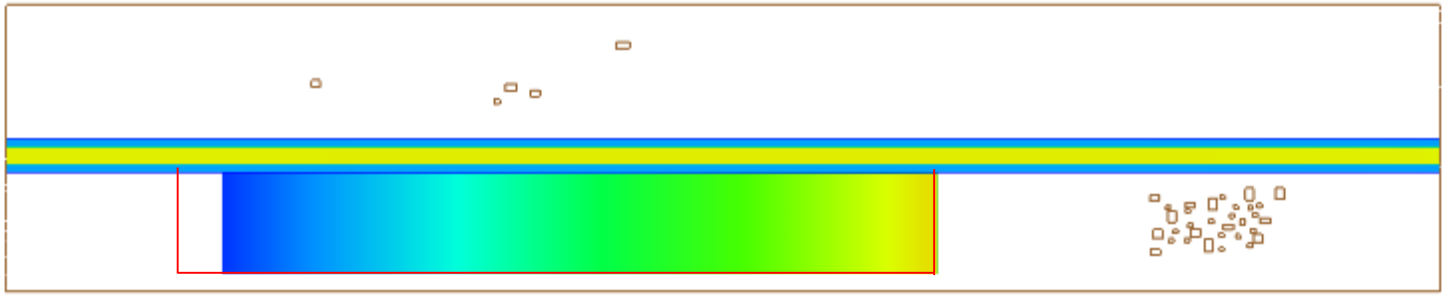
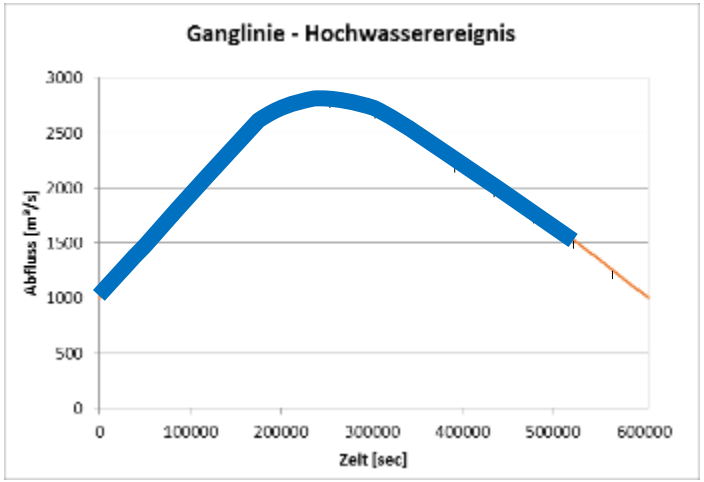
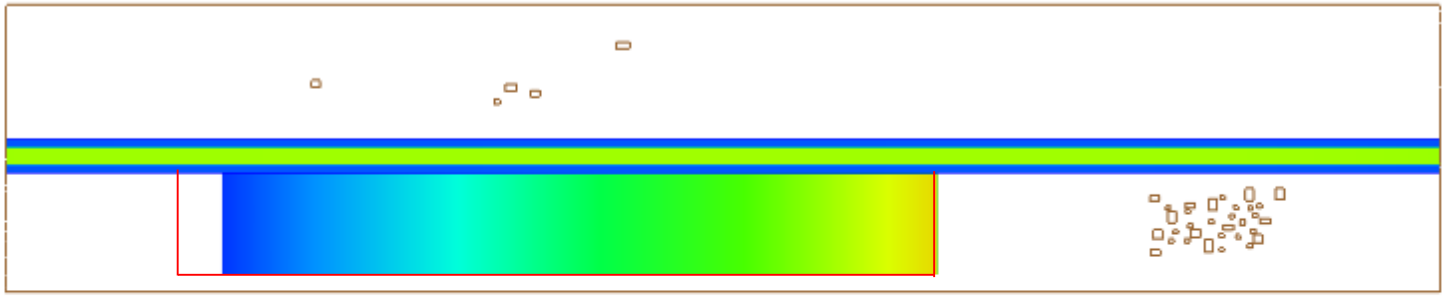




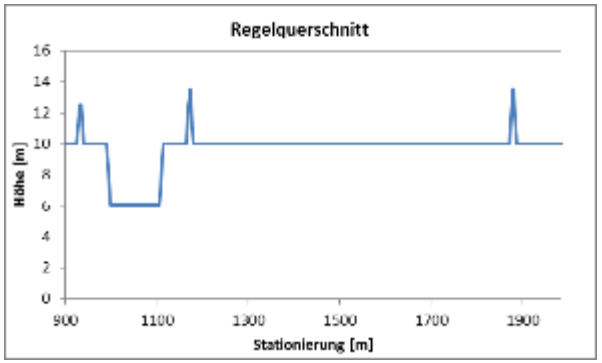
Flutpolder – **theoretischer Ablauf** - Wassertiefe

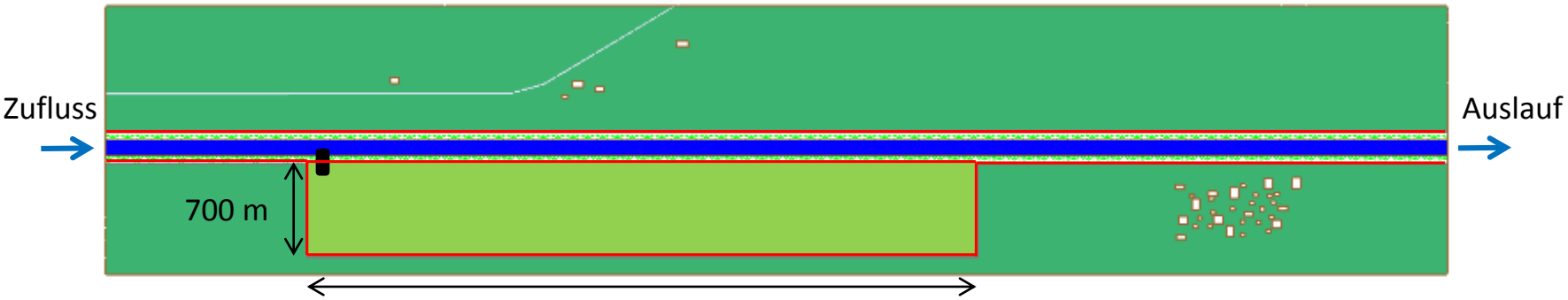
5 22:00:00



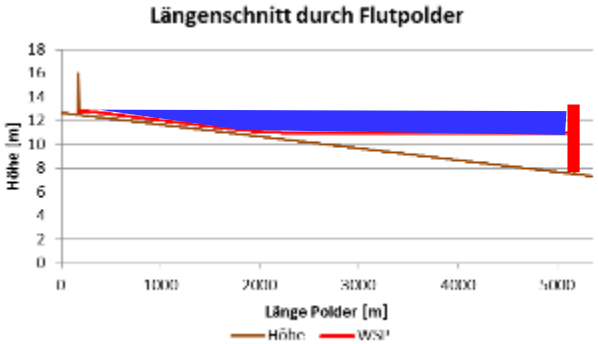


Gesteuerter Rückhalt im Nebenschluss Flutpolder





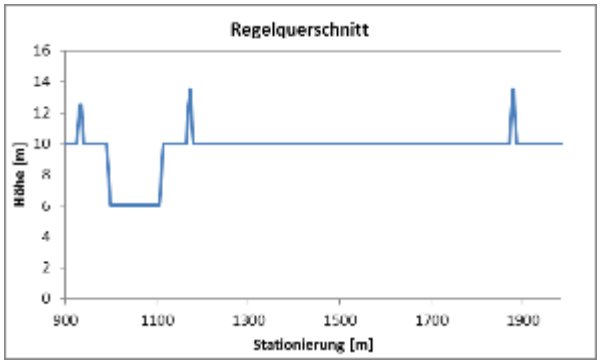
Länge: 5 km

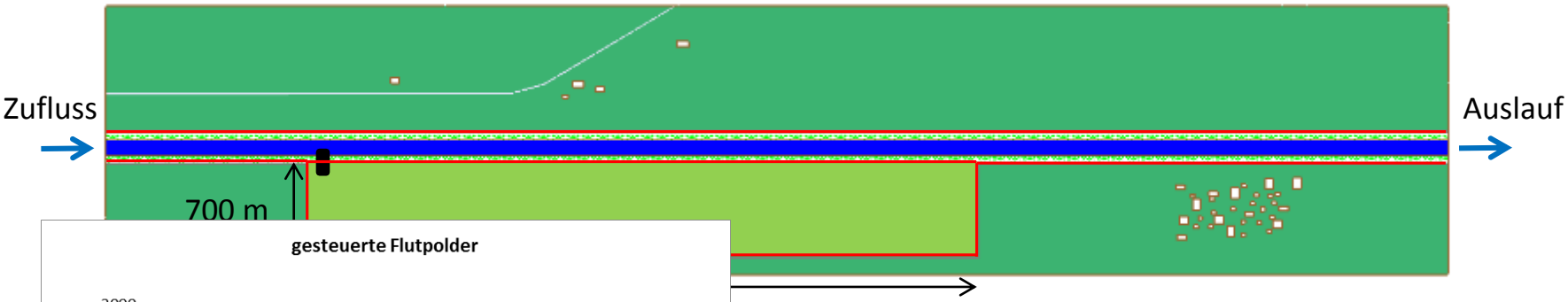


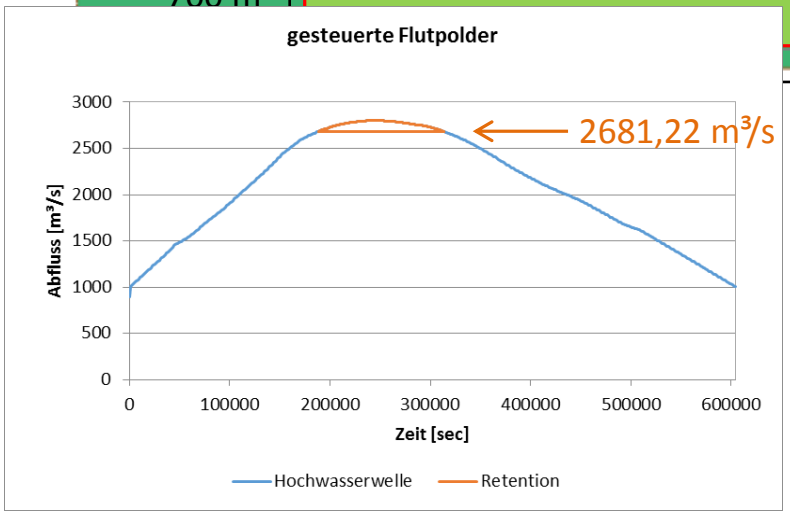
Retentionsvolumen: 10 Mio m³

– Bei einer Deichhöhe von 5,5 m

Gesteuerter Rückhalt im Nebenschluss Flutpolder





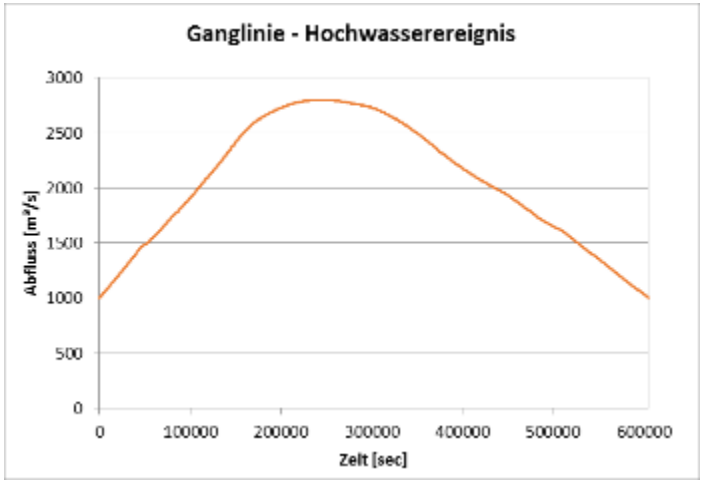


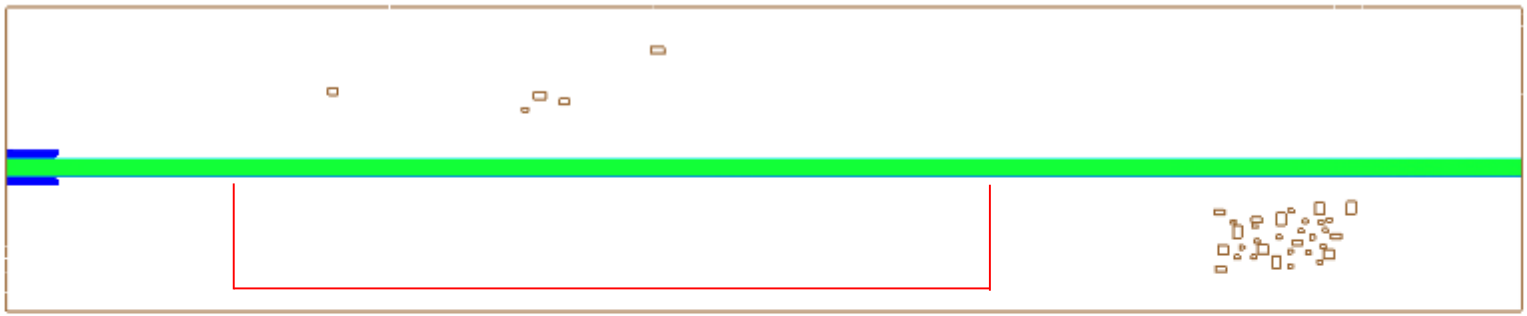
Retentionsvolumen: 10 Mio m³

- Bei einer Deichhöhe von 5,5 m

Flutpolder - Wassertiefe

0 00:00:01





Flutpolder - Wassertiefe

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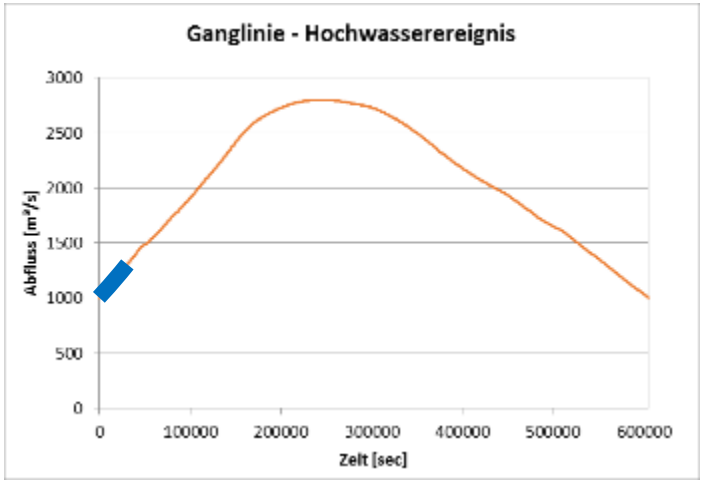

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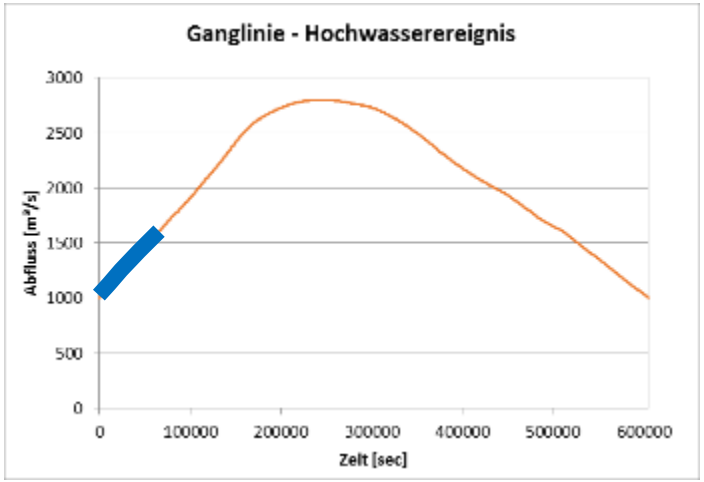

Flutpolder – Wassertiefe

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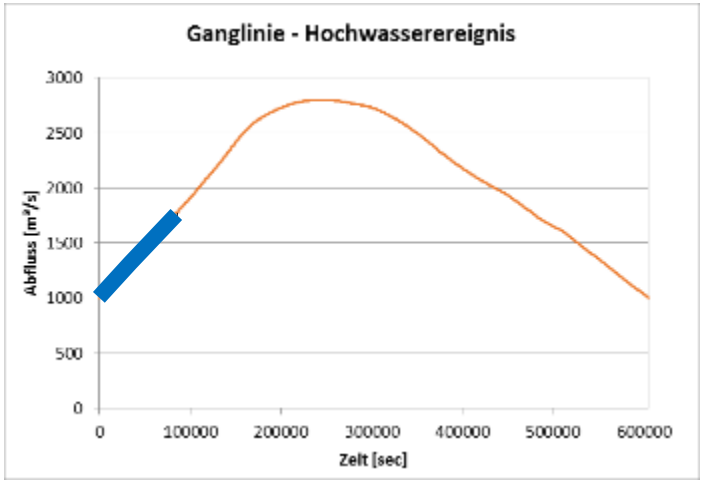

Flutpolder – Wassertiefe

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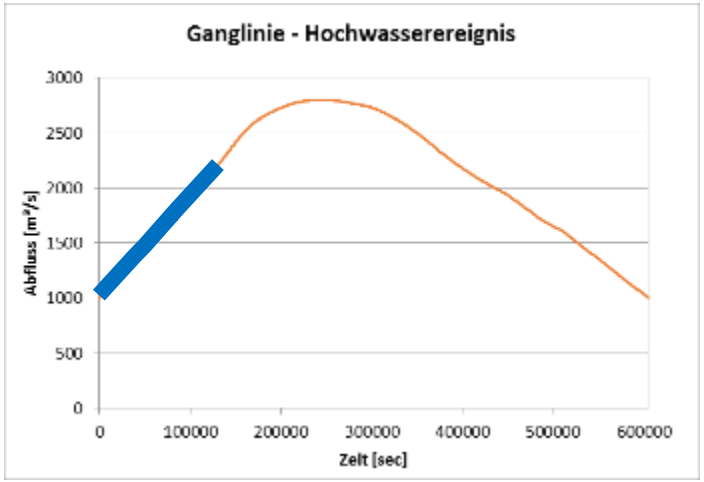

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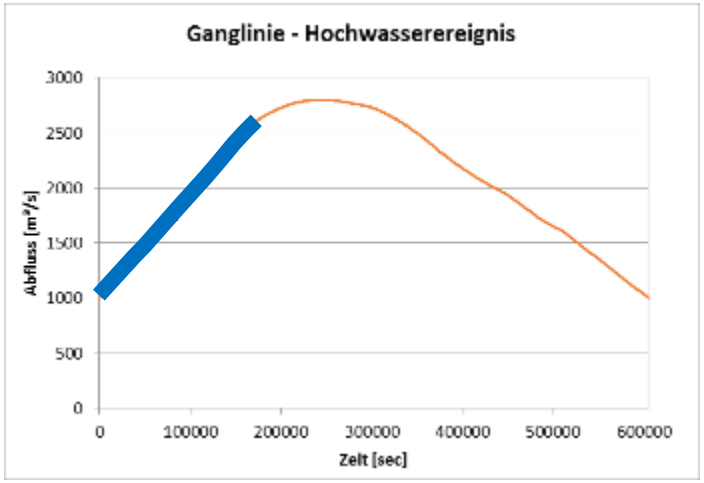

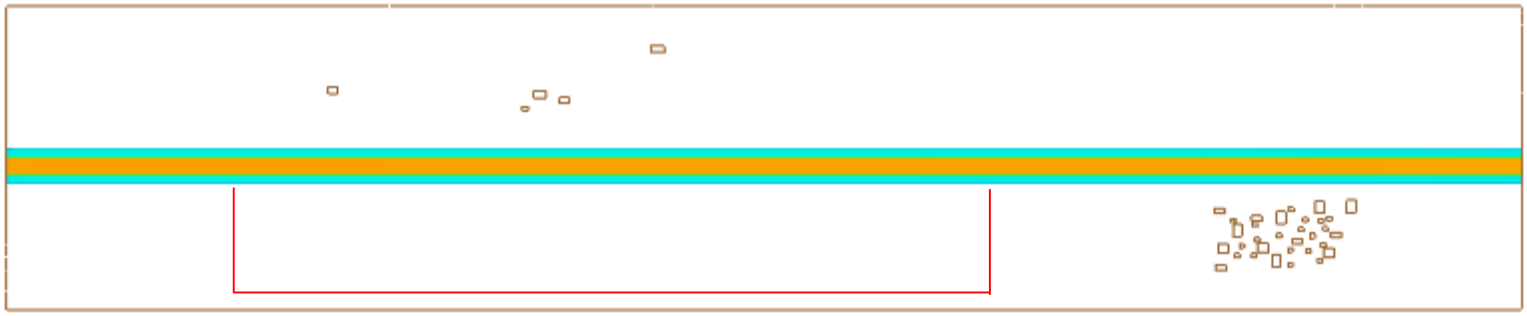

Flutpolder – Wassertiefe

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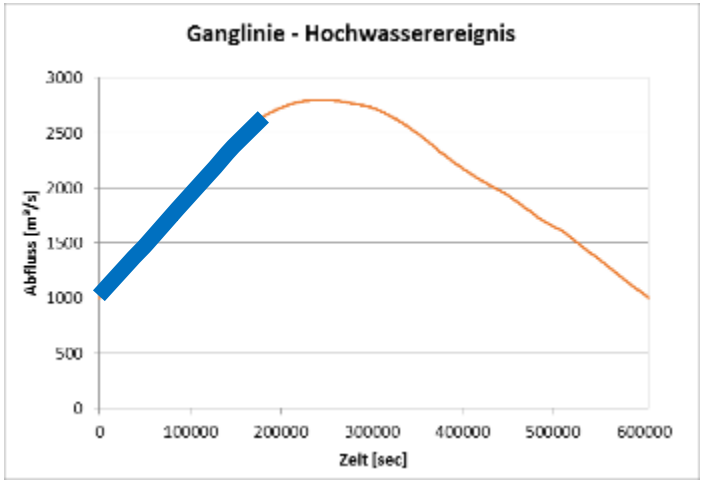

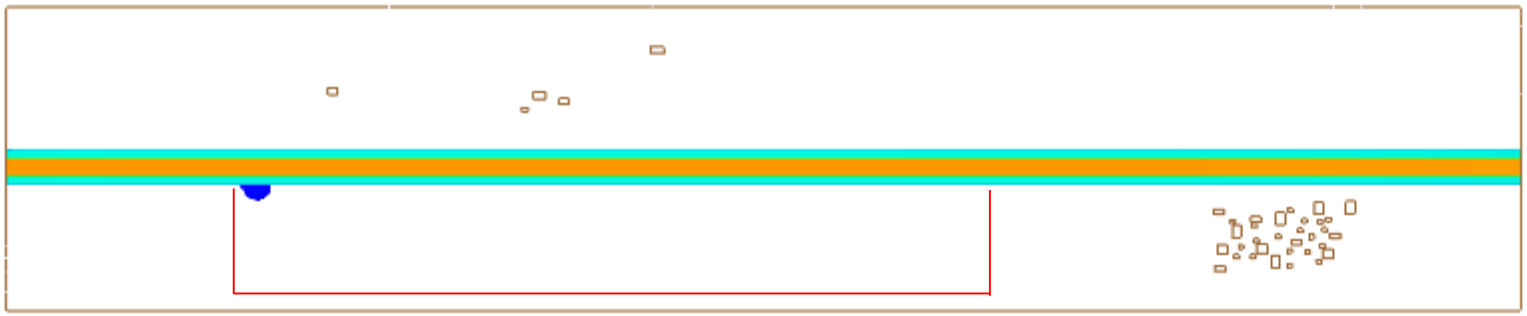

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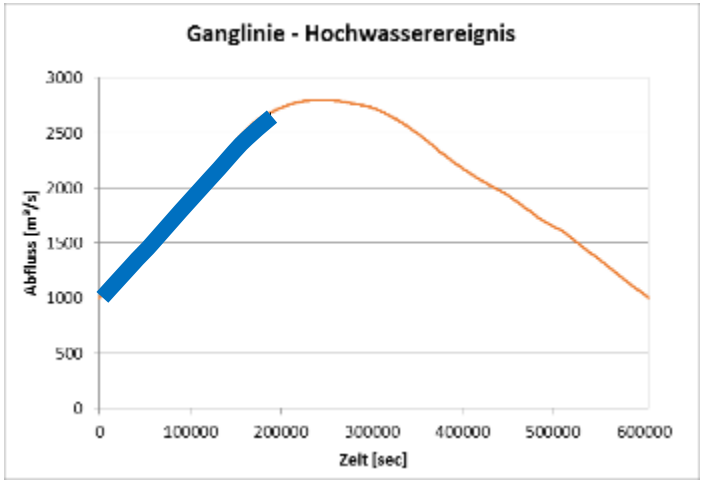

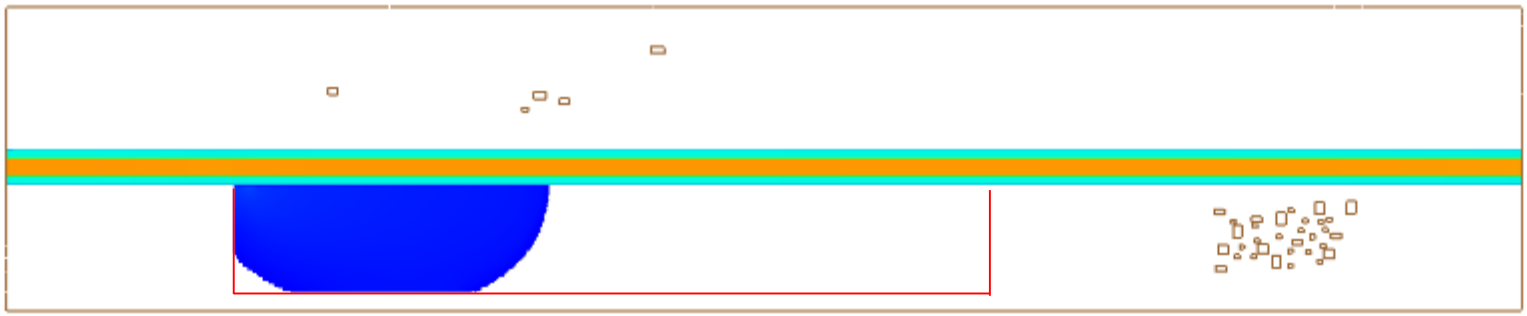

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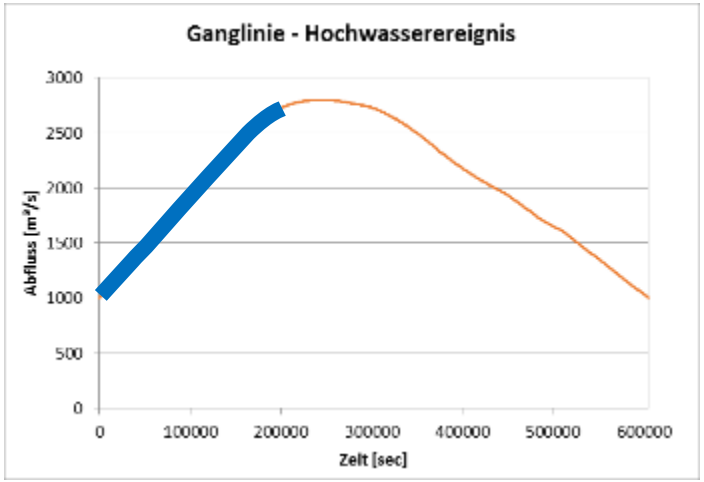

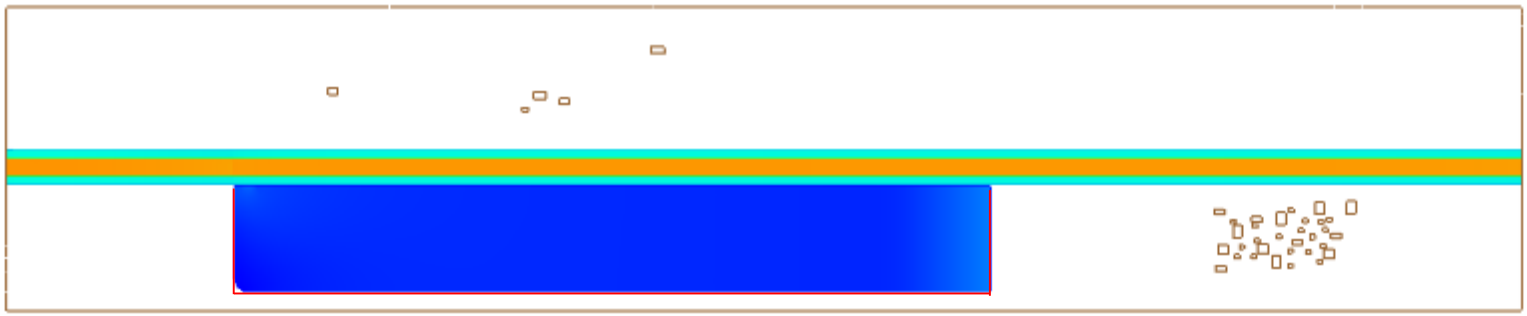

Flutpolder – Wassertiefe

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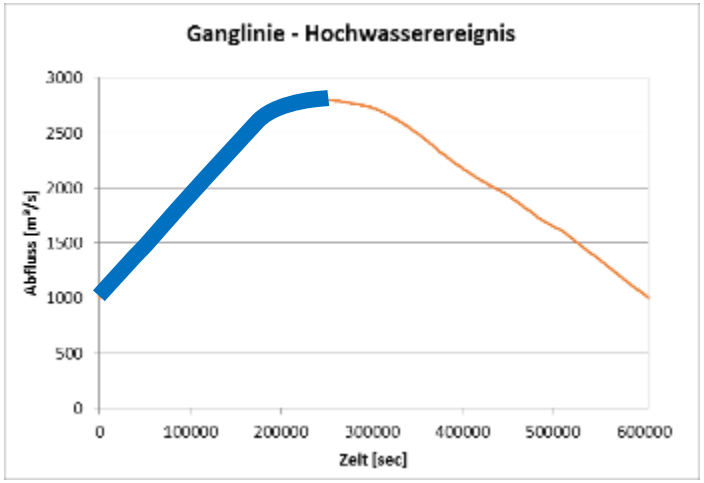

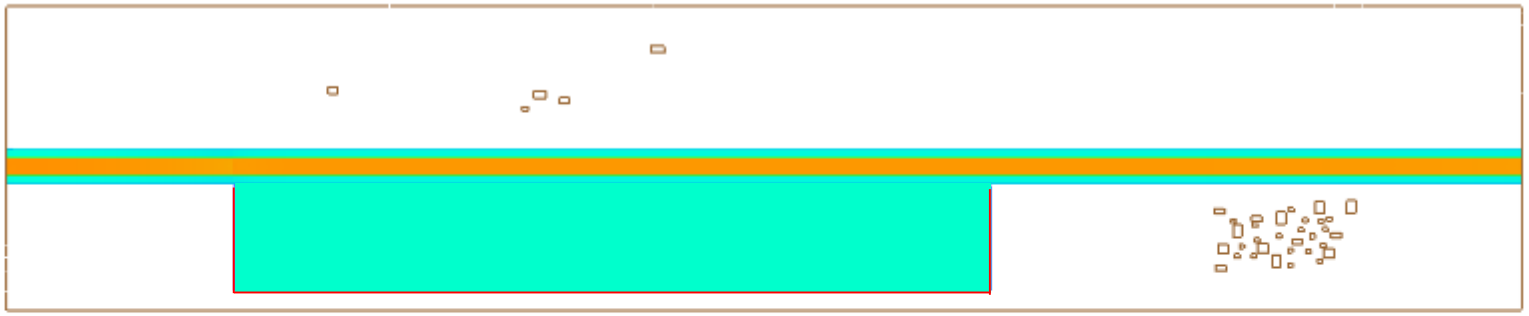

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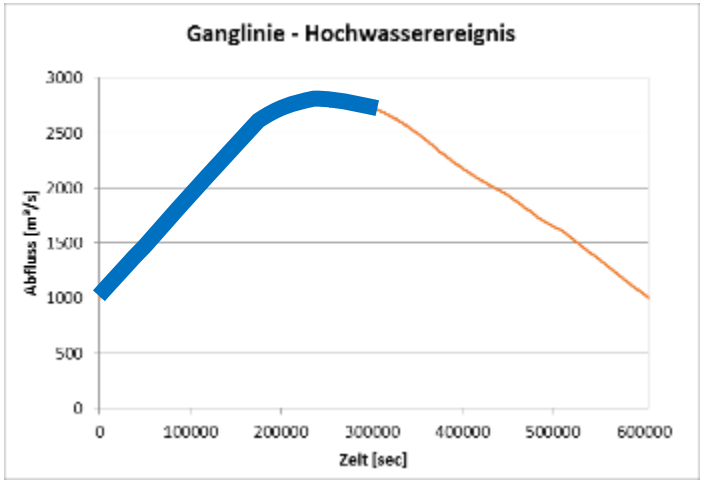

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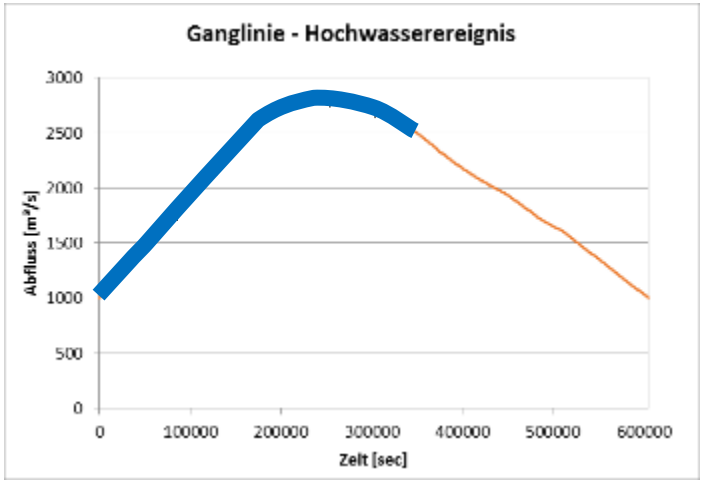

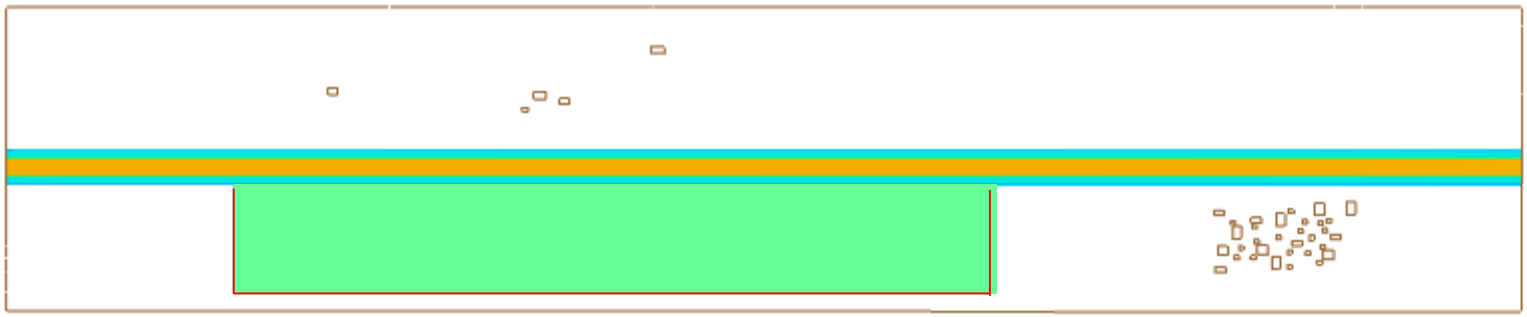

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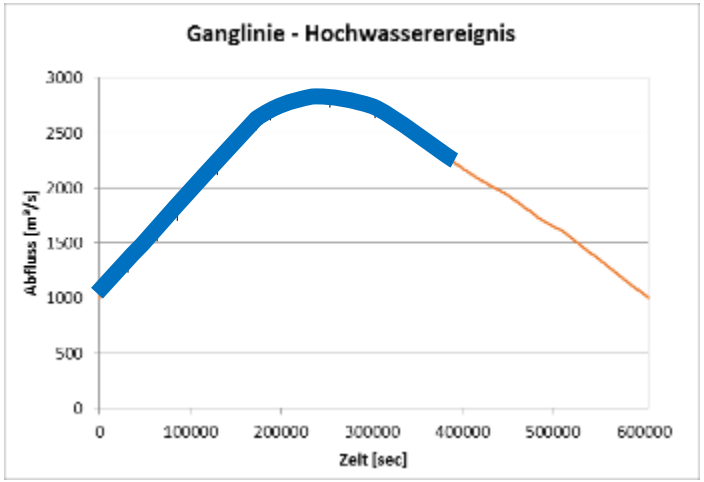

Flutpolder – Wassertiefe

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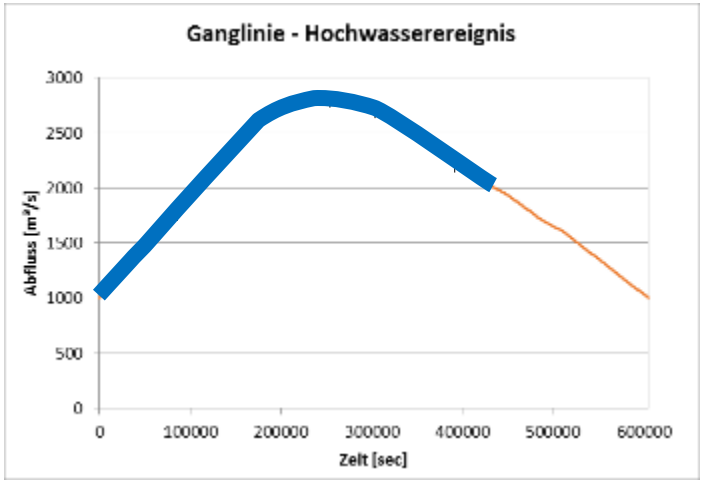

Flutpolder – Wassertiefe

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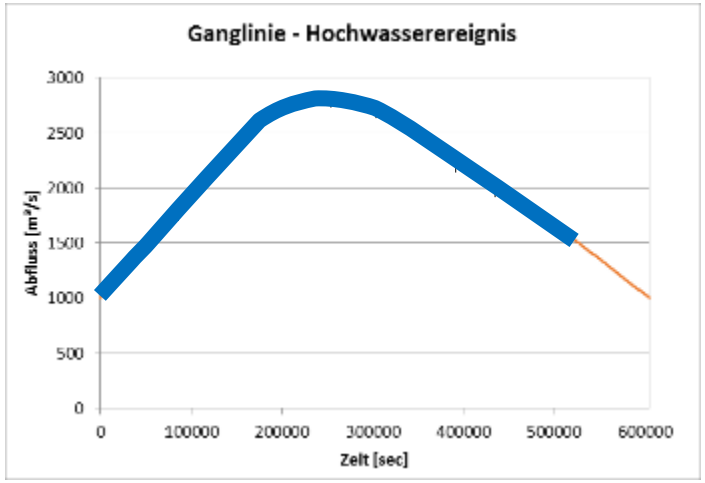

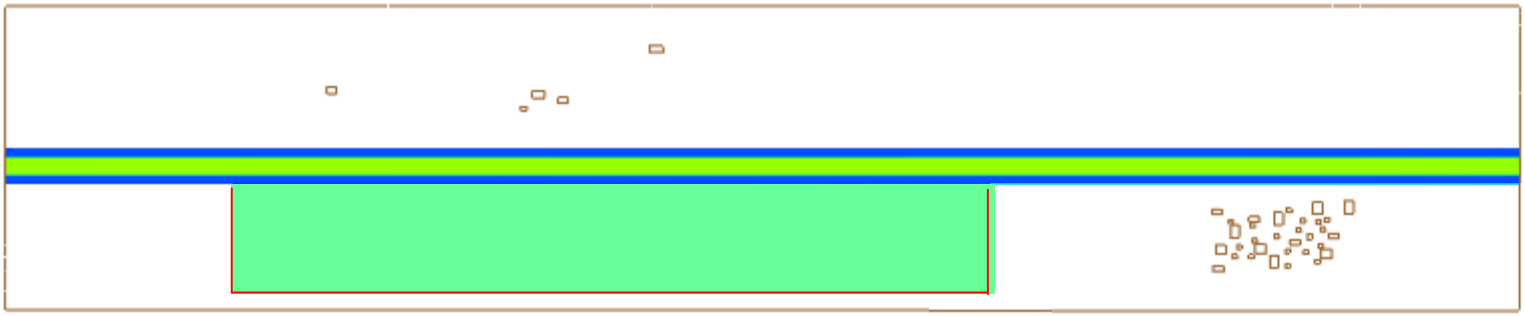

Flutpolder – Wassertiefe

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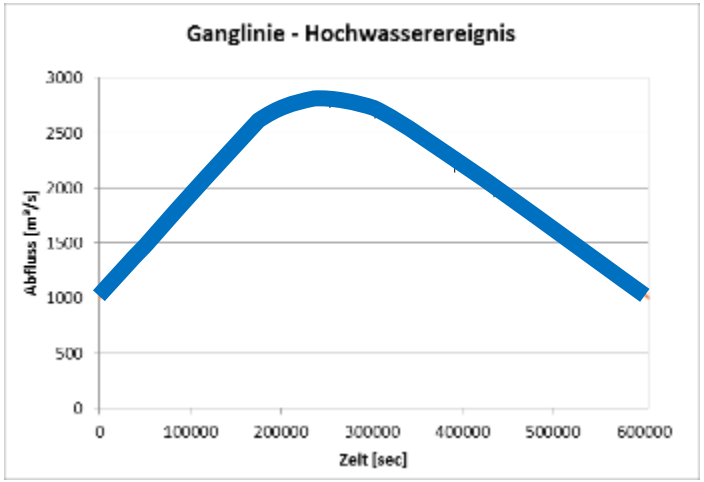
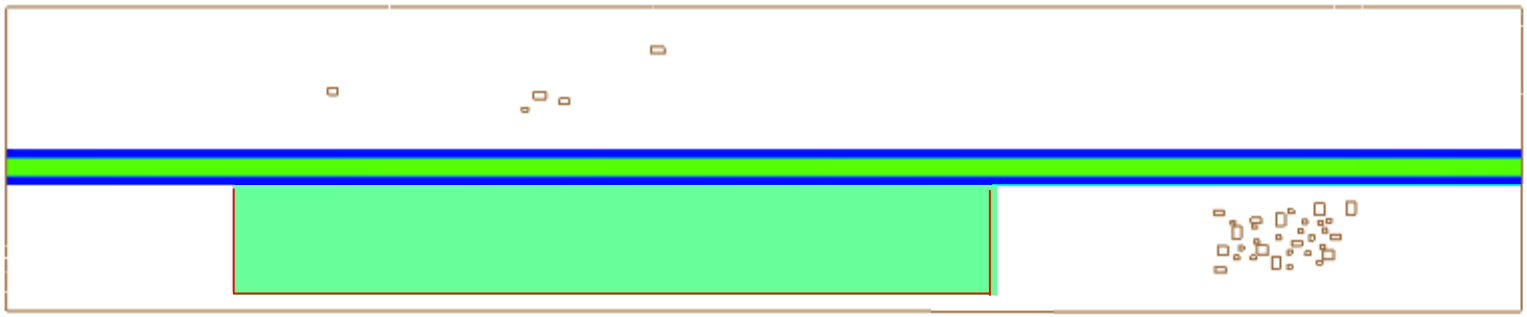
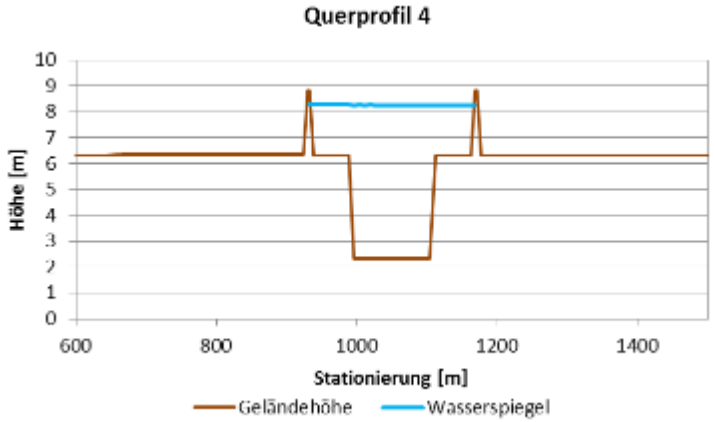
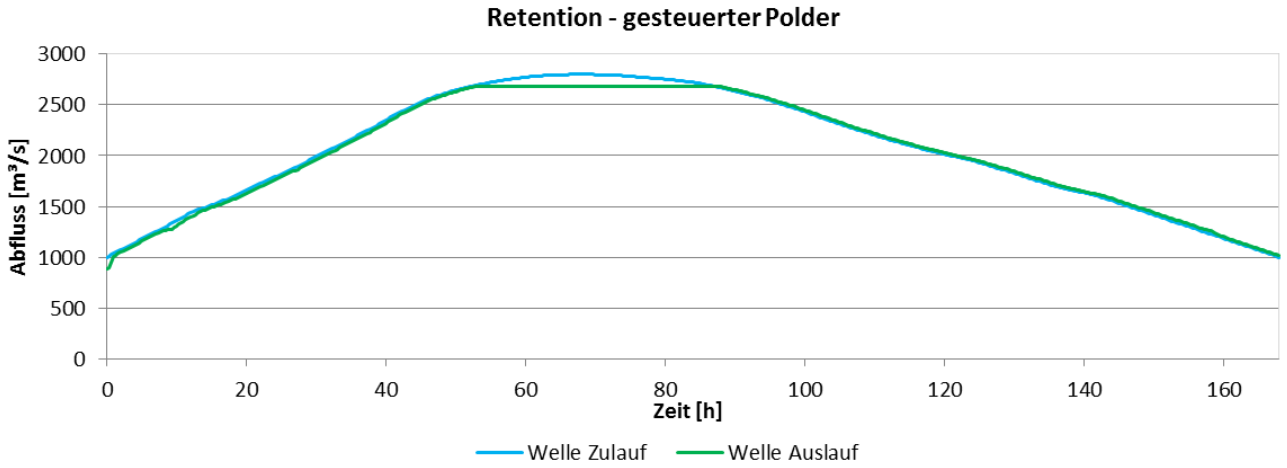




Gesteuerter Rückhalt im Nebenschluss – Retentionsvolumen 10 Mio. m³

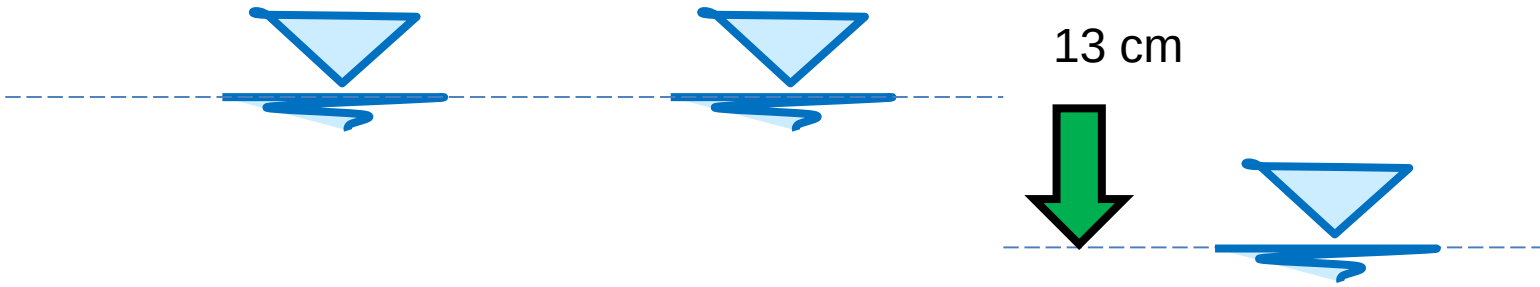


- Freibord im Bereich des Siedlungsgebiets: 0.57 m bei maximalem Abfluss



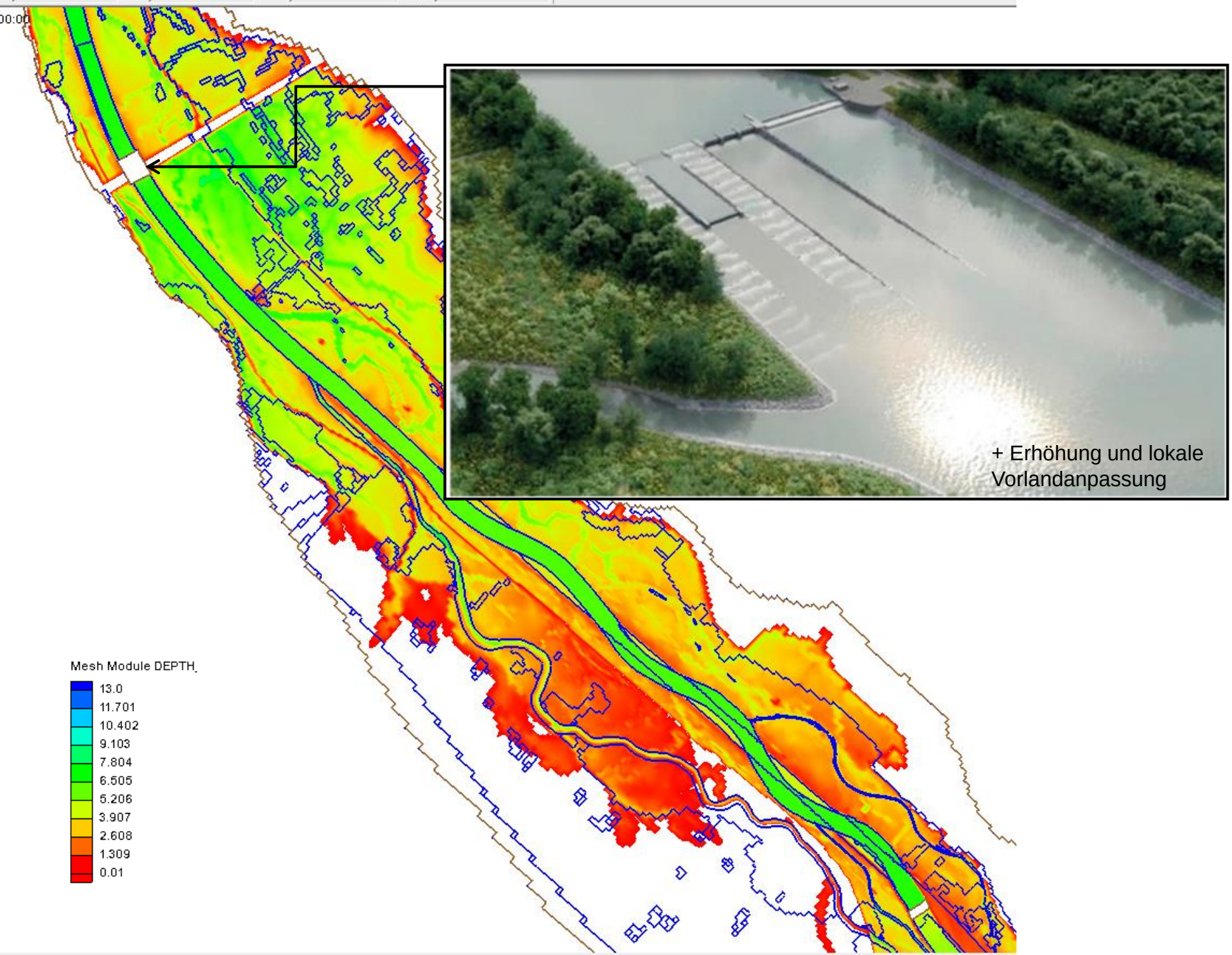
Vergleich der Varianten

	Regulierte Fluss	Deichrückverlegung	Gesteuerter Polder (10 Mio ³ Volumen)
Abfluss max.	2800 m³/s	2800 m³/s	2800³/s Gerinne: ca. 2680 m³/s Polder: 120 m³/s
Freibord (Bereich Siedlungsgebiet - (bei maximalen Wasserstand)	0.44 m	0.44 m	0.57 m



durch gesteuerte Retention

„Neben-Haupt-Schluss ..“

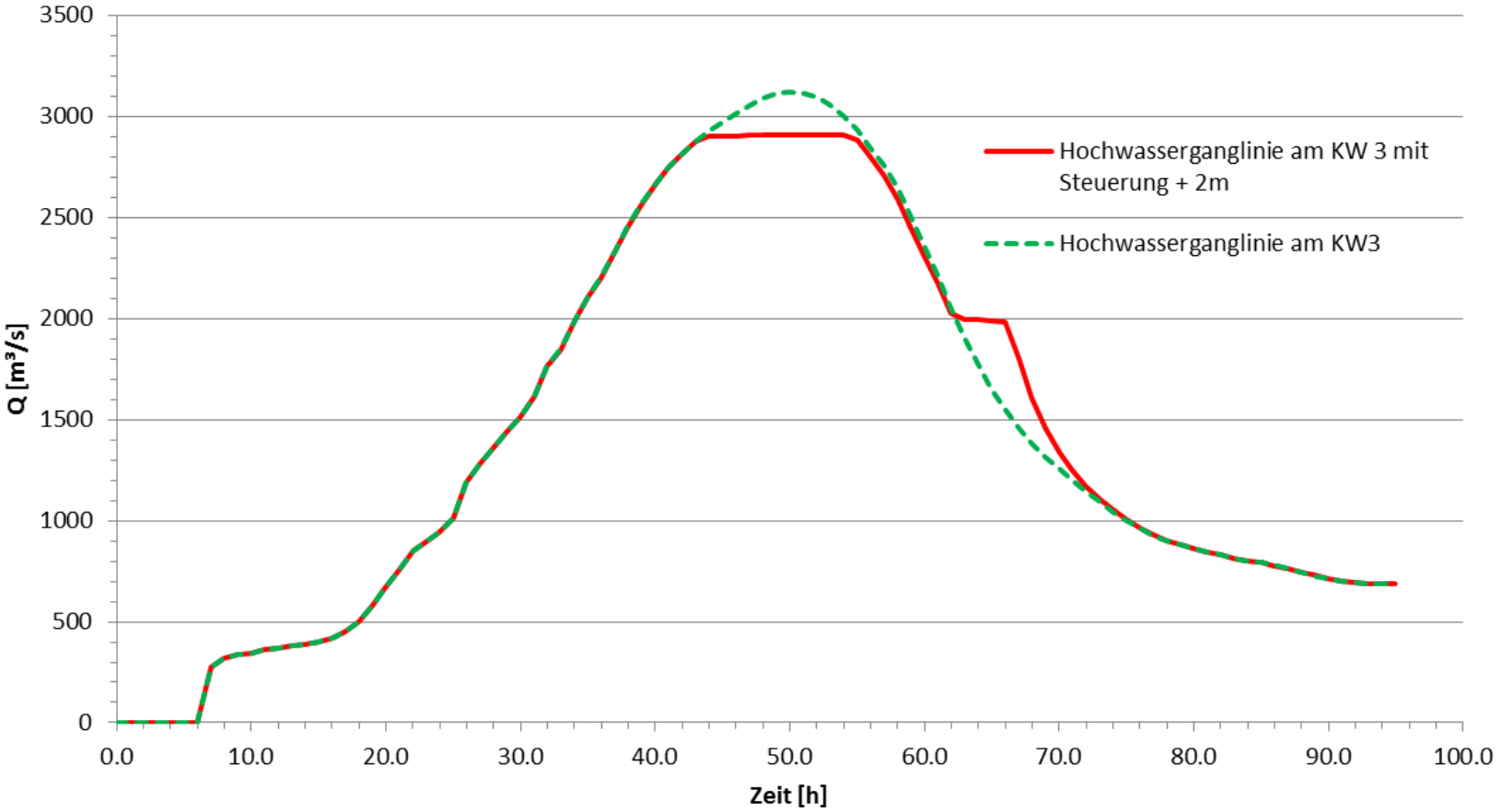

Mesh Module DEPTH
13.0
11.701
10.402
9.103
7.804
6.505
5.206
3.907
2.608
1.309
0.01
+ Erhöhung und lokale Vorlandanpassung

Bei moderaten Wasserstandserhöhungen (bis ca. 2 m):

- 1 – 4 Mio. m^3 Rückhaltevolumen je Standort
- bis > 100 m^3/s Scheitelreduktion je Standort)

Ökologie, Vernetzung Fluss / Aue

Gute Steuerungsmöglichkeit



Arbeitsbereich Wasserbau
Universität Innsbruck
Techhnikerstraße 13
6020 Innsbruck
www.uibk.ac.at/wasserbau

Gesteuerter Rückhalt über Flutpolder

Markus Aufleger
Regensburg, 8.10.2015