
**INITIAL TASK**

# Narva old riverbed revitalization and eel migration project

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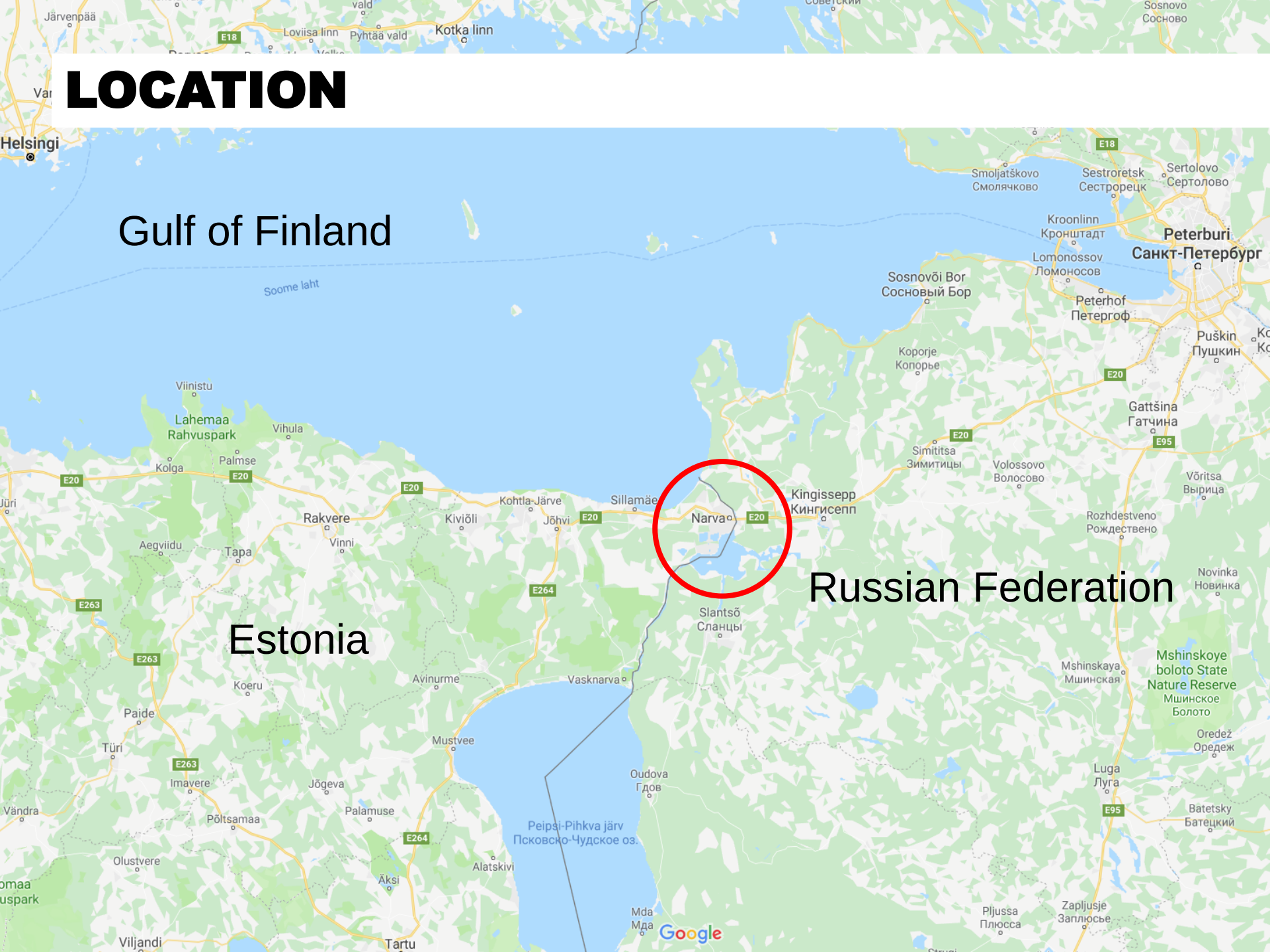
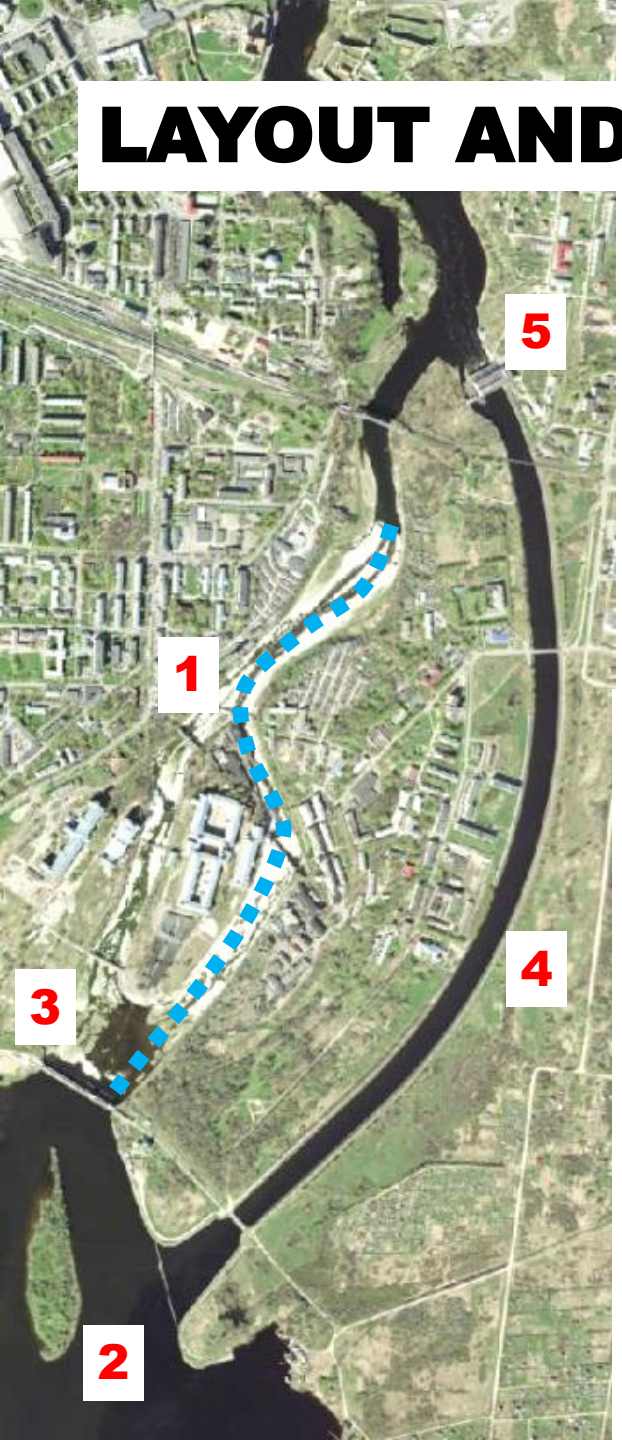
2019-07-01

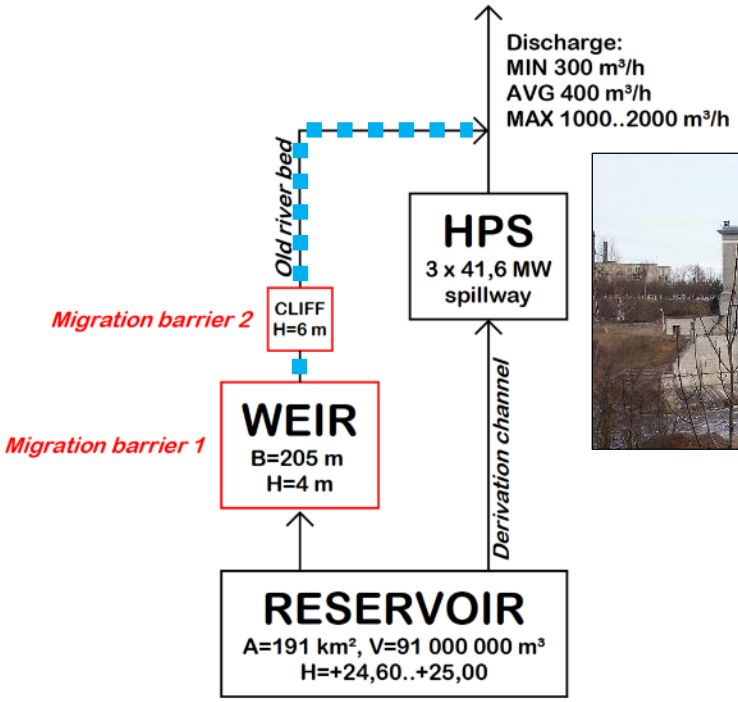
# LOCATION

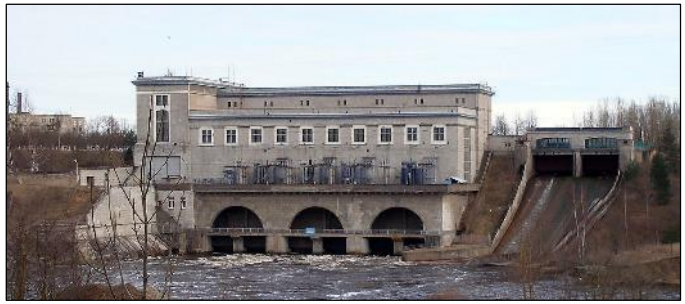

Gulf of Finland
Soome laht
Russian Federation
Estonia
Narva
Kingissepp
Кингисепп
Sillamäe
Kohtla-Järve
Kiviõli
Jõhvi
Rakvere
Tapa
Aegviidu
Kolga
Palmse
Lahemaa Rahvuspark
Viinistu
Vihula
Vinni
Koeru
Paide
Türi
Imavere
Jõgeva
Palamuse
Põltsamaa
Olustvere
Viljandi
Tartu
Äksi
Alatskivi
Avinurme
Vasknarva
Mustvee
Peipsi-Pihkva järv
Псковско-Чудское оз.
Oudova
Гдов
Mda
Мда
Slantsõ
Сланцы
Koporje
Копорье
Sosnovõi Bor
Сосновый Бор
Peterburi
Санкт-Петербург
Kronlinn
Кронштадт
Lomonossov
Ломоносов
Peterhof
Петергоф
Puškin
Пушкин
Gattšina
Гатчина
Simititsa
Зимитицы
Volossovo
Волосово
Võritsa
Вырица
Rozhdestveno
Рождествено
Novinka
Новинка
Mshinskaya
Мшинская
Mshinskoye boloto State Nature Reserve
Мшинское Болото
Oredež
Оредеж
Luga
Луга
Batetsky
Батецкий
Pljussa
Плюсса
Zapljusje
Заплюсье
Smoljatškovo
Смолячково
Sestroretsk
Сестрорецк
Sertolovo
Сертолово
Helsingi
Järvenpää
Loviisa linn
Pyhtää vald
Kotka linn
Sosnovo
Сосново
E18
E20
E263
E264
E95

# LAYOUT AND FLOWSHEET

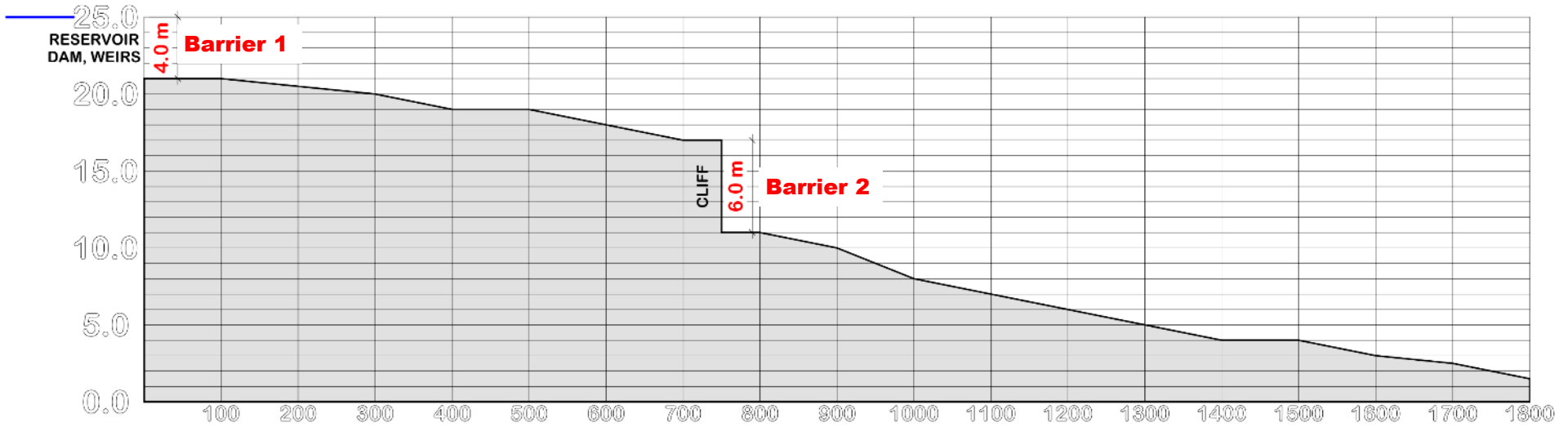


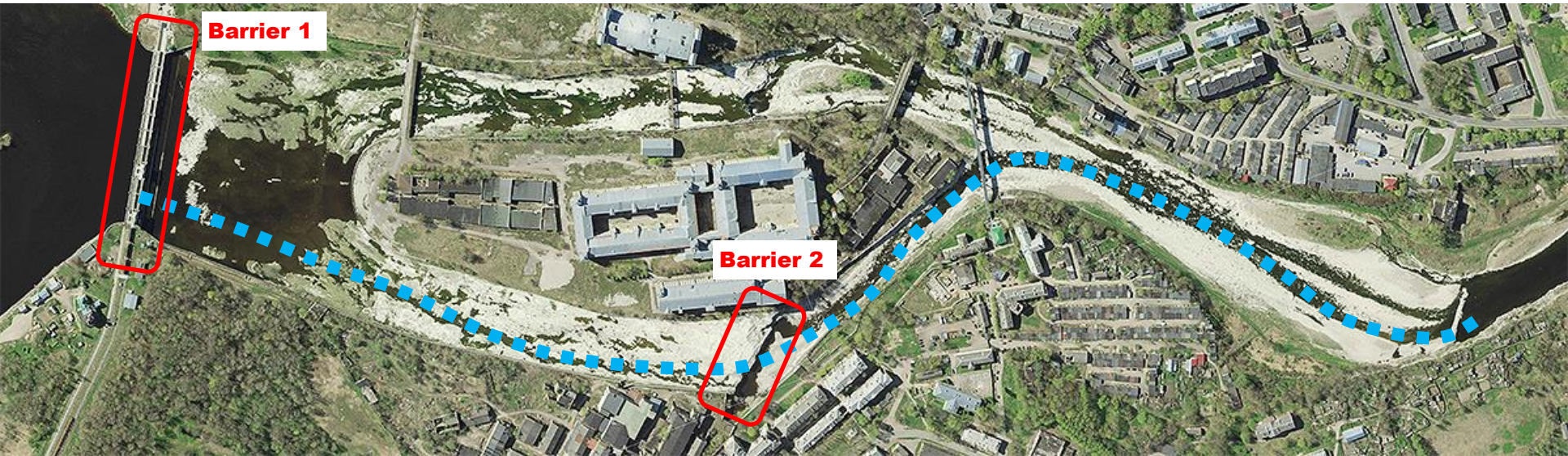

1. Old riverbed (~1,8 km)
2. Reservoir
3. Dam and weirs for spills regulation
4. Derivation channel
5. Hydropower station 125 MW



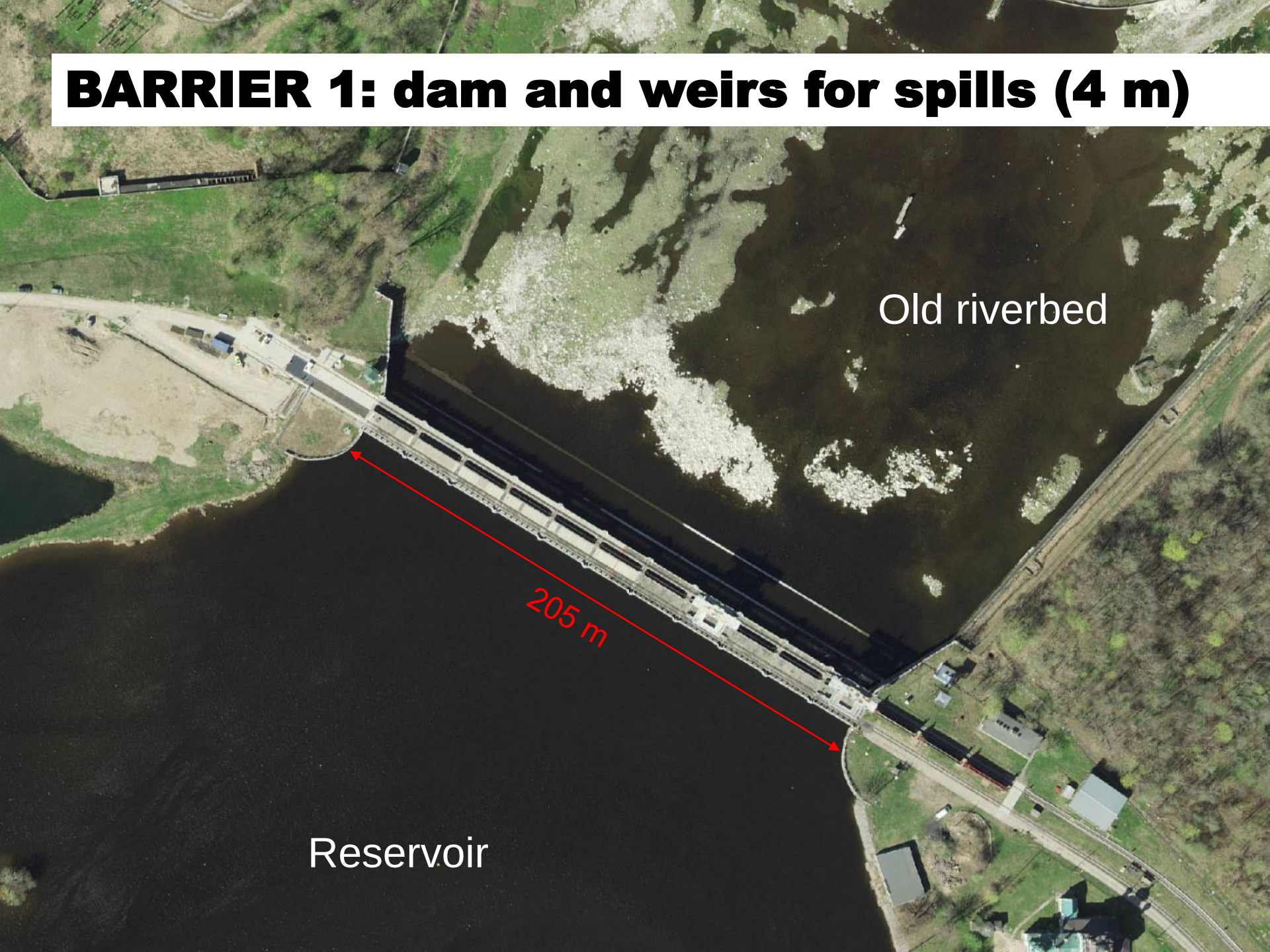



# OLD RIVERBED HYDRAULIC PROFILE

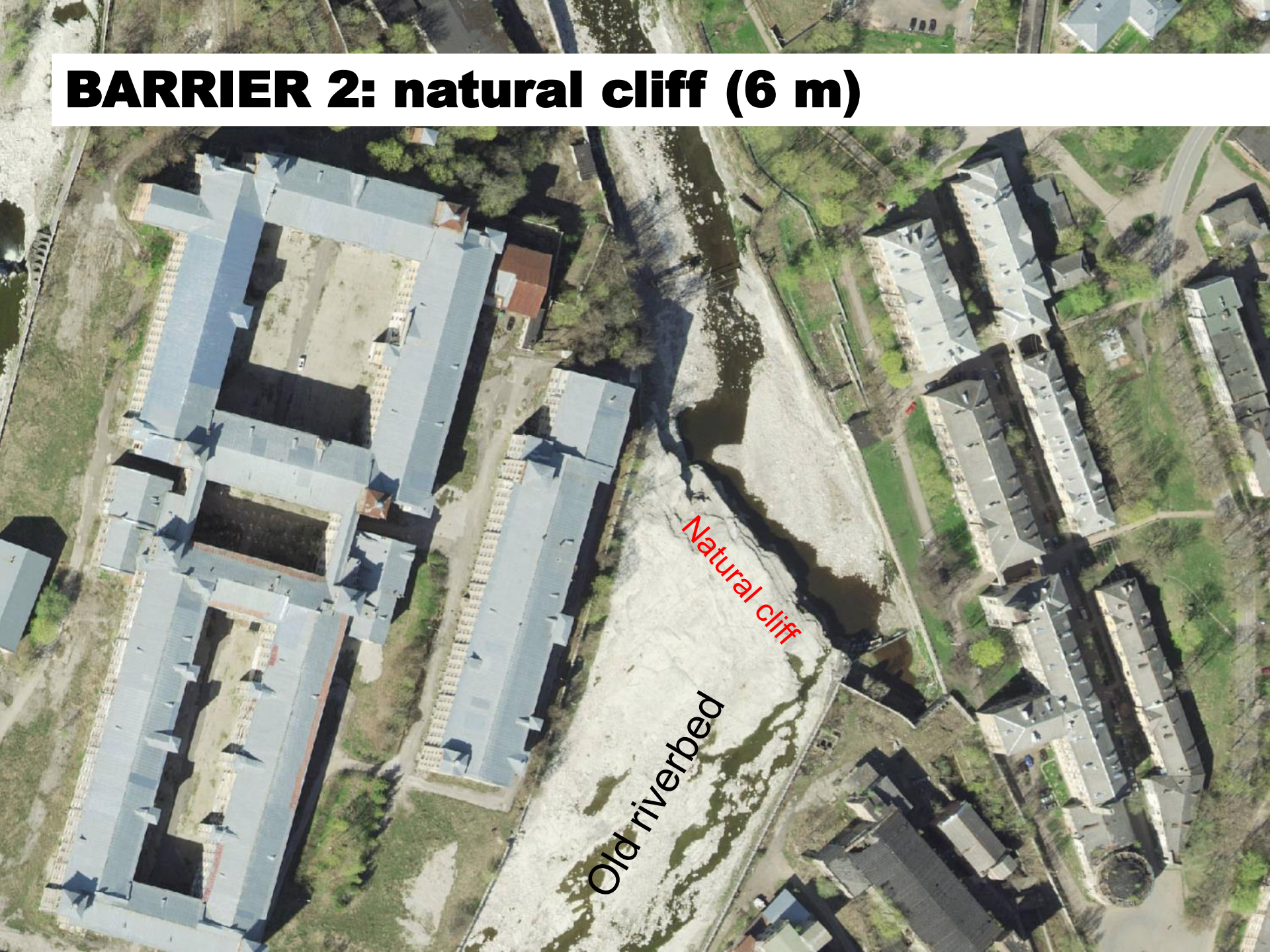


# BARRIER 1: dam and weirs for spills (4 m)



# BARRIER 2: natural cliff (6 m)



# DISCHARGE AND RESERVOIR DATA

1. River discharge rates:
   - $Q_{min}$ = 300 $m^3/s$
   - $Q_{avg}$ = 400 $m^3/s$
   - $Q_{max}$ = 1000..2000 $m^3/s$

2. Reservoir data:
   - MAX water level = +25,00
   - NORMAL water level = +24,90
   - MIN water level = +24,60
   - Surface area = 191 $km^2$
   - Active capacity = 91 000 000 $m^3$

# INITIAL TASK:

1. Determine migration type required for eels:
   - only upstream (downstream through turbines)
   - upstream and downstream
   - upstream and downstream with spawning areas
2. Determine the flow required for upstream migration.
3. Determine the flow required for eels upstream and downstream migration.
4. Determine the flow required to create spawning areas in old river bed (rapids) with eels upstream and downstream migration.
5. Compose a technical process requirements with expected process guarantees for further project development stages (feasibility study, conceptual design etc).

# TECHNOLOGICAL OPTIONS:

In current preliminary stage there are following options that should be investigated and designed according to local conditions and requirements:

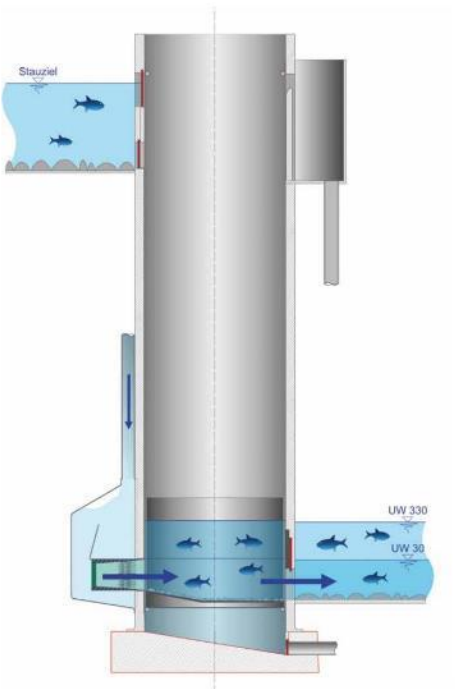
- *Hydro-Fischlift*
- *Archimedean screw*

Both options are used in warmer climate conditions, but indoor (covered) solutions are applicable in Narva. For Archimedean screw we have proven references for eel migration and this is the only solution uses resources effectively for downstream migration (good benefit when spawning area generation requires more water). Next slides for basic technical information.

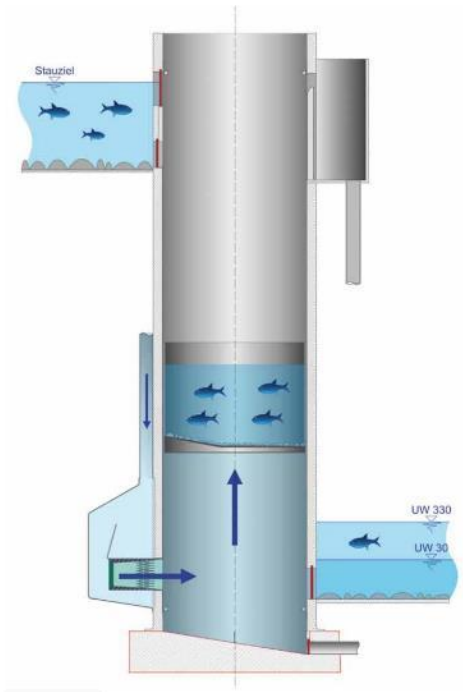
# OPTION 1: Hydro-Fischlift

BAUMANN HYDROTEC GMBH &Co.KG

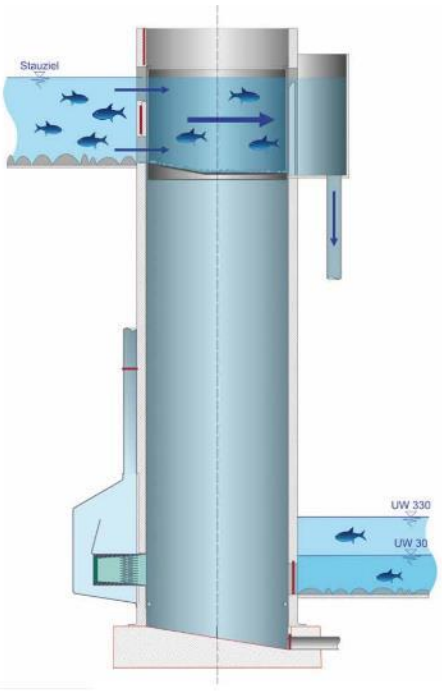
An innovative ecological migration system for high elevation differences at hydropower plants. For operation is required very low flow and two automatic valves (inlet and outlet).



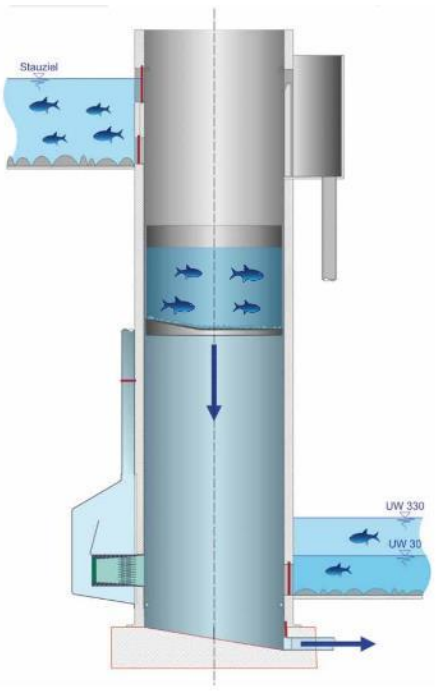

**Fish swimming in**




**Lifting phase**



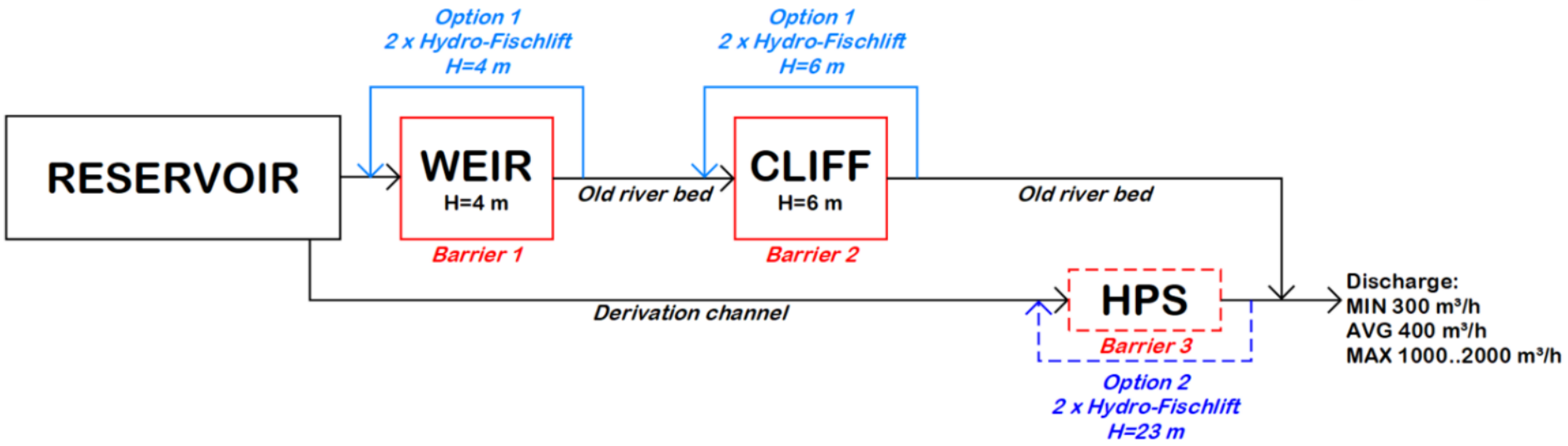

**Fish swimming out**




**Descending phase**

www.hydro-fischlift.com

# OPTION 1: Hydro-Fischlift




1. Option 1 to use HFL in old riverbed barriers.
2. Option 2 to use HFL next to HPS, but head high and that must be discussed with the manufacturer.
3. Parallel units are because to provide 24/7 migration possibilities (if only one tower then during lifting or descending there will be waiting gaps).
4. Due the low flow through system it is not possible to add enough water for spawning areas in old riverbed.

# OPTION 1: Hydro-Fischlift

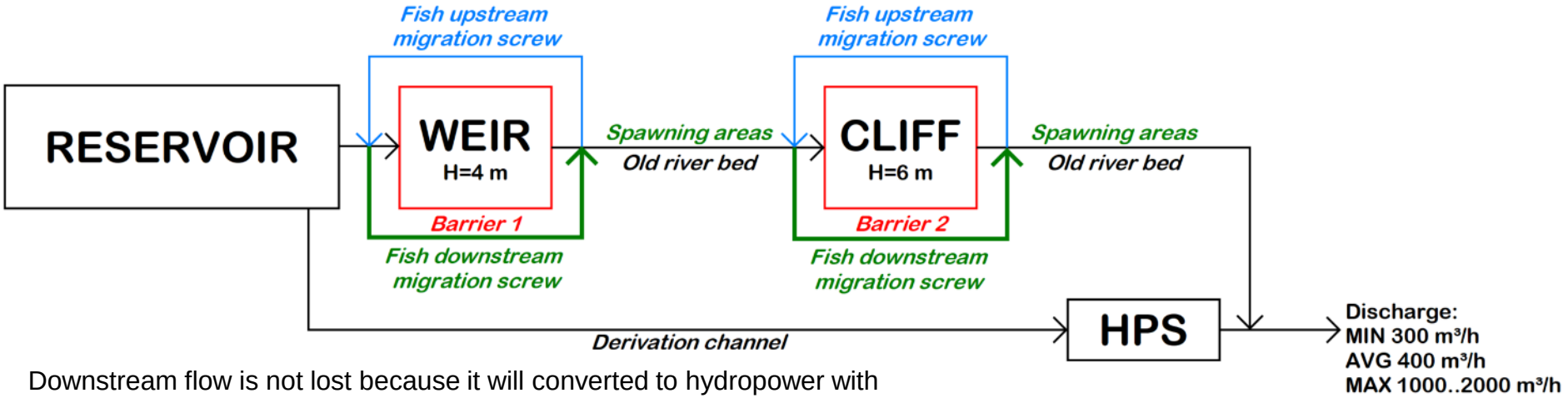
BAUMANN HYDROTEC GMBH &Co.KG



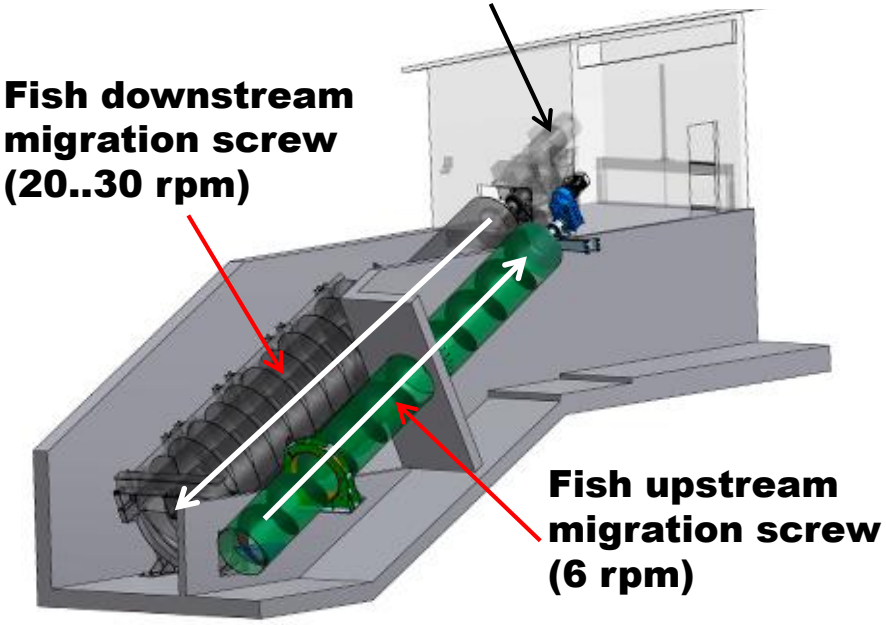

www.hydro-fischlift.com

# OPTION 2: Archimedean screw

REHART POWER




Downstream flow is not lost because it will converted to hydropower with VSD controlled generator. *Installed power (kW): P = Q x H x 7,2*




# OPTION 2: Archimedean screw

REHART POWER

## Archimedean screw solution works for eels.


| Tag | Fische | Datum | Zeit | Person | Fischart | Länge (cm) |
|---|---|---|---|---|---|---|
| 40 | 262 | 24.05.2019 | 09.00 | /BA | Aalrute | 31 |
| 41 | 264 | 26.05.2019 | 17.30 | FE/BA | Aalrute | 27 |
| 42 | 268 | 28.05.2019 | 09.00 | FE/BA | Aalrute | 28 |
| 42 | 269 | 28.05.2019 | 09.00 | FE/BA | Aal | 32 |
| 42 | 270 | 28.05.2019 | 09.00 | FE/BA | Aal | 18 |
| 44 | 274 | 01.06.2019 | 09.15 | FE/BA | Aalrute | 31 |
| 44 | 275 | 01.06.2019 | 09.00 | FE/BA | Aal | 25 |
| 45 | 280 | 03.06.2019 | 09.00 | FE/BA | Aalrute | 3 |
| 45 | 288 | 03.06.2019 | 09.00 | FE/BA | Aal | 33 |
| 45 | 289 | 03.06.2019 | 09.00 | FE/BA | Aal | 31 |
| 45 | 290 | 03.06.2019 | 09.00 | FE/BA | Aal | 23 |
| 45 | 291 | 03.06.2019 | 09.00 | FE/BA | Aal | 20 |
| 45 | 292 | 03.06.2019 | 09.00 | FE/BA | Aal | 20 |
| 46 | 328 | 05.06.2019 | 09.00 | FE/BA | Aal | 35 |
| 46 | 329 | 05.06.2019 | 09.00 | FE/BA | Aal | 32 |
| 46 | 330 | 05.06.2019 | 09.00 | FE/BA | Aal | 30 |
| 46 | 331 | 05.06.2019 | 09.00 | FE/BA | Aal | 32 |
| 46 | 332 | 05.06.2019 | 09.00 | FE/BA | Aal | 28 |
| 46 | 333 | 05.06.2019 | 09.00 | FE/BA | Aal | 26 |
| 47 | 339 | 06.06.2019 | 09.00 | FE/BA | Aal | 53 |
| 47 | 340 | 06.06.2019 | 09.00 | FE/BA | Aal | 50 |
| 47 | 341 | 06.06.2019 | 09.00 | FE/BA | Aal | 32 |
| 47 | 342 | 06.06.2019 | 09.00 | FE/BA | Aal | 30 |
| 47 | 343 | 06.06.2019 | 09.00 | FE/BA | Aal | 28 |
| 47 | 344 | 06.06.2019 | 09.00 | FE/BA | Aal | 23 |
| 47 | 345 | 06.06.2019 | 09.00 | FE/BA | Aal | 22 |
| 47 | 346 | 06.06.2019 | 09.00 | FE/BA | Aal | 26 |

Aal (in German) = Eel

# OPTION 2: Archimedean screw

REHART POWER

Archimedean screw solution works for other species (1/2).


Abb. 2: Fischaufstiegsschnecke Barbe (adult)

Abb. 3: Fischaufstiegsschnecke Barbe (juvenil)


Abb. 6: Fischaufstiegsschnecke Barbe (adulter Rogner)


Abb. 4: Fischaufstiegsschnecke Laube

Abb. 5: Fischaufstiegsschnecke Signalkrebs


Abb. 8: Fischaufstiegsschnecke Bachschmerle

# OPTION 2: Archimedean screw

REHART POWER

Archimedean screw solution works for other species (2/2).

Abb. 7: Fischaufstiegsschnecke Koppe


Abb. 10: Aufgestiegene Huchen 13.12.2014


Abb. 11: Aufgestiegener Huchen 16.12.2014

Abb. 9: Fischaufstiegsschnecke Flussbarsch

Abb. 12: Einsetzen des Huchens mit 76cm in den Unterwasserkanal am 23.6.

Abb. 13: Dokumentation in der Reuse am 1.7.2015

# OPTION 2: Archimedean screw

REHART POWER

Archimedean screw solution references:

- Installed and in operation ~100 units (Germany, Austria, France, Italy, UK, Japan, India, Slovenia), some locations in mountains where are hard winter conditions
- Downstream migration screws since 2003
- Upstream migration screws since 2014

Key references:

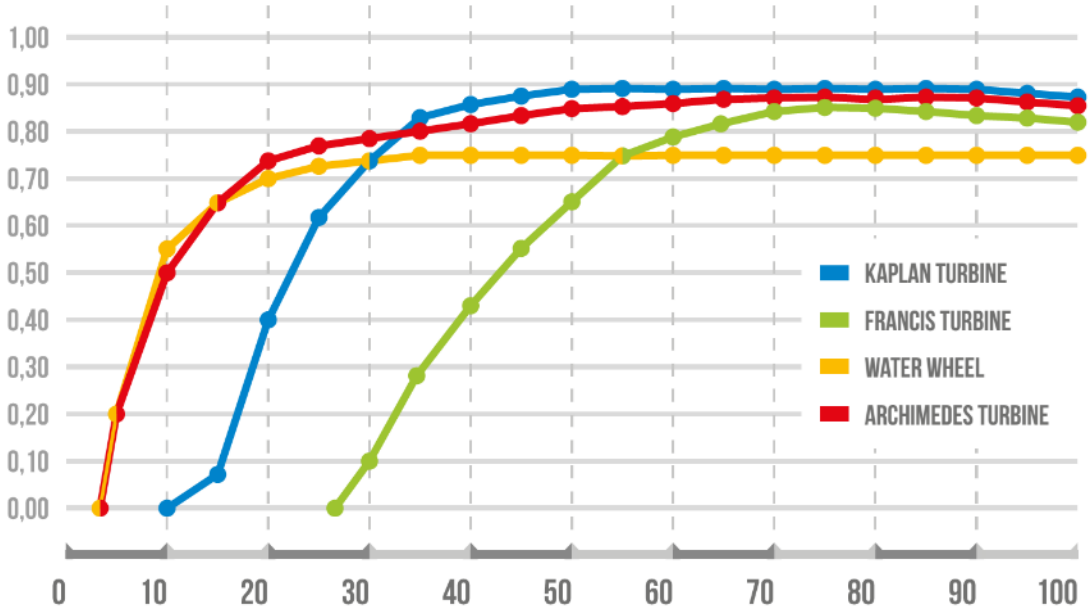
| Country | State | Code word | Capacity Q in m³/s | Head H in mm | Electrical power P in kW | Diameter in mm | Bladed length in mm | Number of screws | Type of trough | Status | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UK | Northern Ireland | Omagh | 6,00 | 2,70 | 128,00 | 3600 | 8160 | 1 | CS | in operation | 2010 |
| Germany | Baden-Wuerttemberg | Hausen | 6,00 | 5,80 | 2 x 250 | 3400 | 15530 | 2 | SH | in operation | 2011 |
| UK | Northern Ireland | Shane´s Castle | 5,50 | 5,30 | 208,00 | 3400 | 12680 | 1 | BS | in operation | 2011 |
| Austria | Lower Austria | Pilsing | 3,20 | 3,60 | 80,00 | 2,9 | 8060 | 1 | BS | in operation | 2014 |
| Italia | Veneto | Ponte Mas | 5,60 | 4,05 | 156,00 | 3400 | 11120 | 1 | SH | in operation | 2015 |
| Austria | Lower Austria | Ramsbachwehr | 3,00 | 5,00 | 103,00 | 2800 | 10960 | 1 | BS | in operation | 2017 |
| Italy | Verona | Lugo | 3,30 | 4,85 | 115,00 | 3000 | 11710 | 1 | SH | in operation | 2017 |
| Germany | Bavaria | Hinterstein | 2,80 | 5,50 | 107,00 | 2800 | 12770 | 1 | SH | under construction | 2019 |

# OPTION 2: Archimedean screw

REHART POWER

Performance range:

- H = 1…8 m
- Q = 1..10 $m^3/s$
- Ƞ = > 0,7
- P = Q x H x 7,2

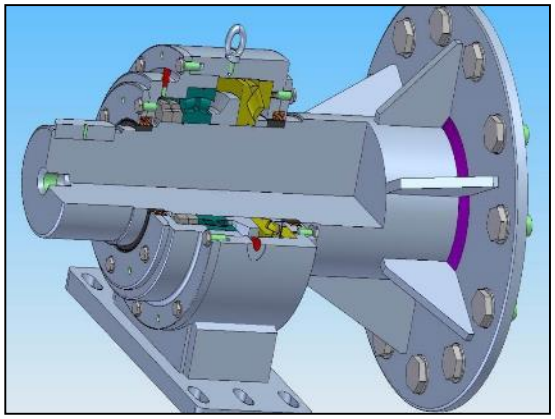



| Type | H (m) | $Q_{screw}$ ($m^3/s$) | η > 0,7 | rpm |
|---|---|---|---|---|
| Propeller | 2..25 | 1..25 | 50...100% | > 300 |
| Kaplan | 2..25 | 1..800 | 30..100% | > 300 |
| Francis | 5..800 | 10..1000 | 55..100% | > 100 |
| Pelton | 100..2000 | 0,5..80,0 | 20..100% | > 1000 |
| Archimedean screw | 1,0…8 | 1,0..10 | 20..100% | < 30 |

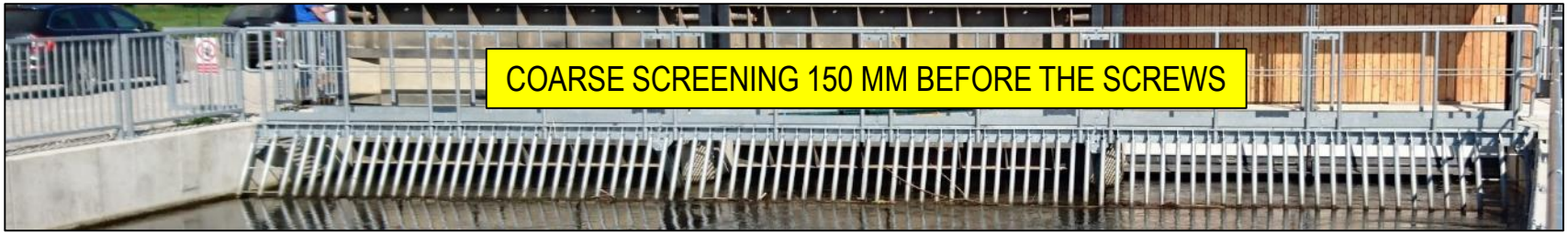
# OPTION 2: Archimedean screw

REHART POWER

## Basic design (downstream migration screw):



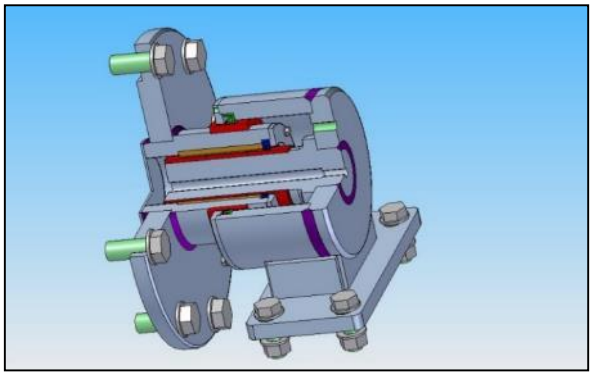


# OPTION 2: Archimedean screw

REHART POWER



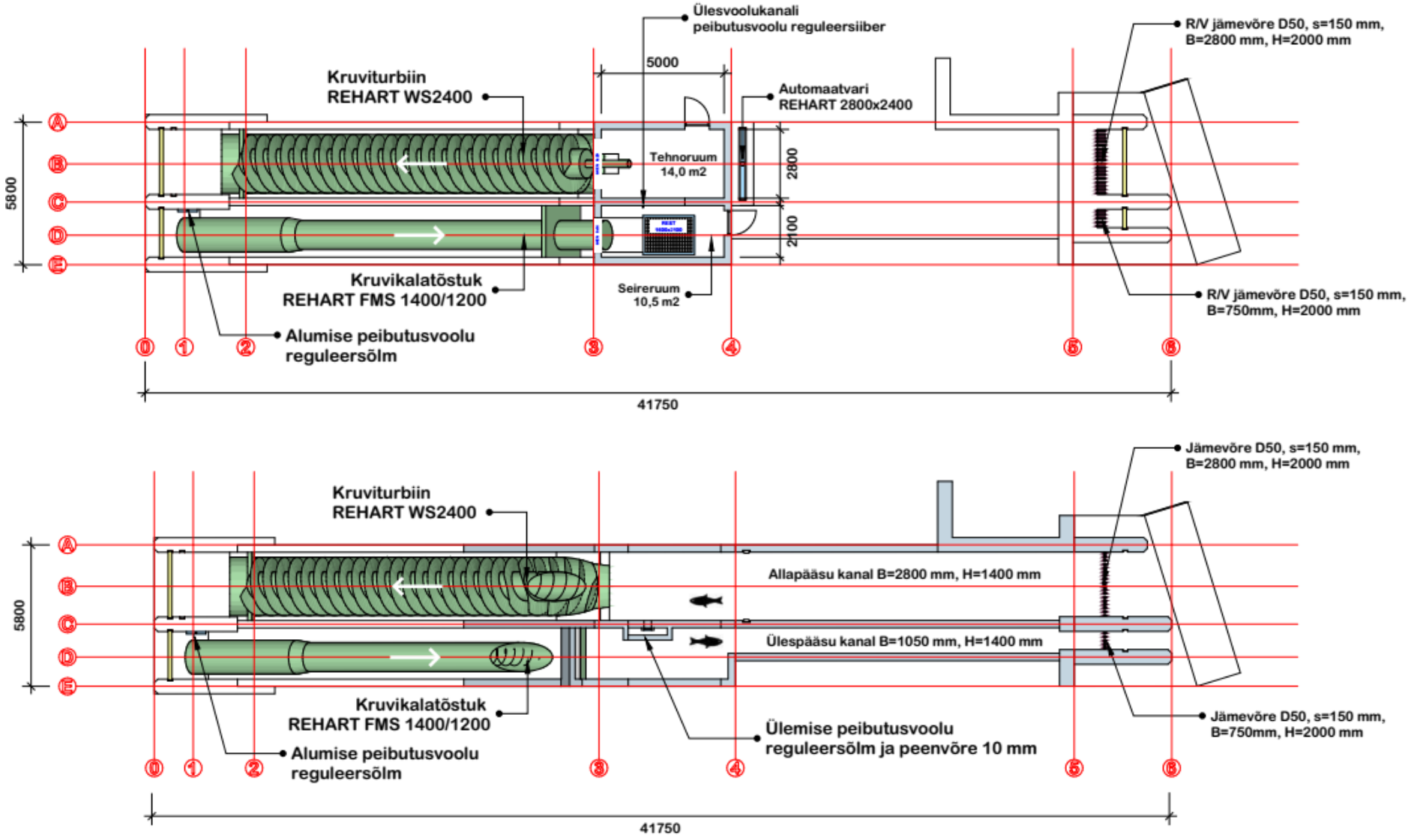


# OPTION 2: Archimedean screw

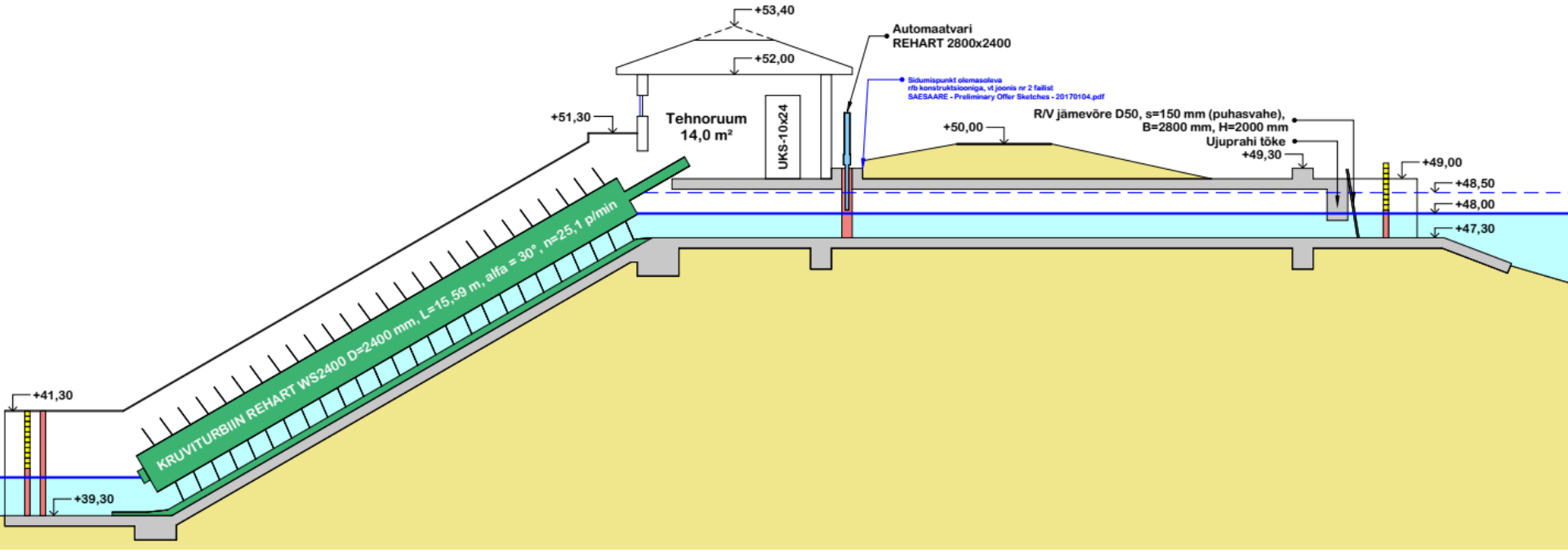
**Basic design (upstream migration screw):**

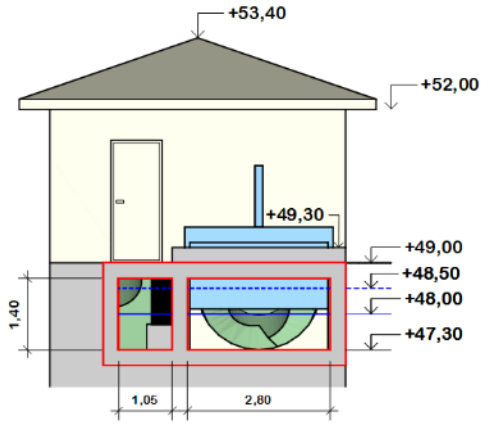
- Low rpm (6 rpm) and energy consumption (<5 kW)
- Blades welded to the tube
- Section water volume 100..200 litres
- Diameter 1200..1400 mm
- Attraction current from DMS
- Approved and tested solution
- Inlet close to riverbed
- Works for eels

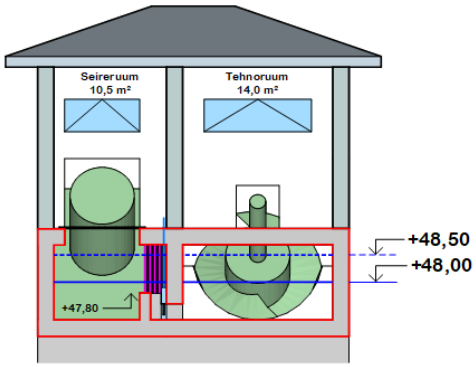
# OPTION 2: Archimedean screw

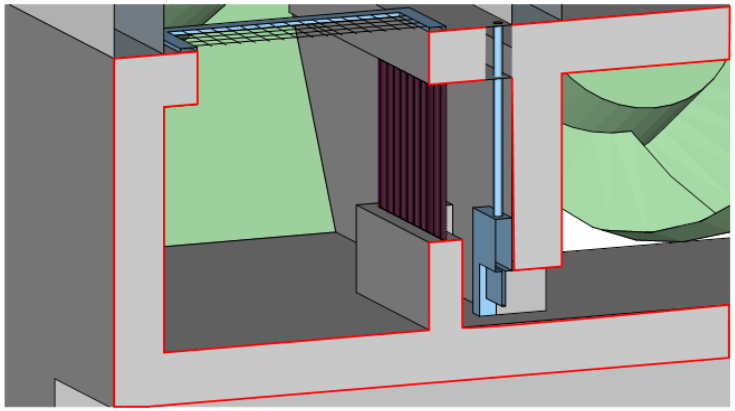


# OPTION 2: Archimedean screw



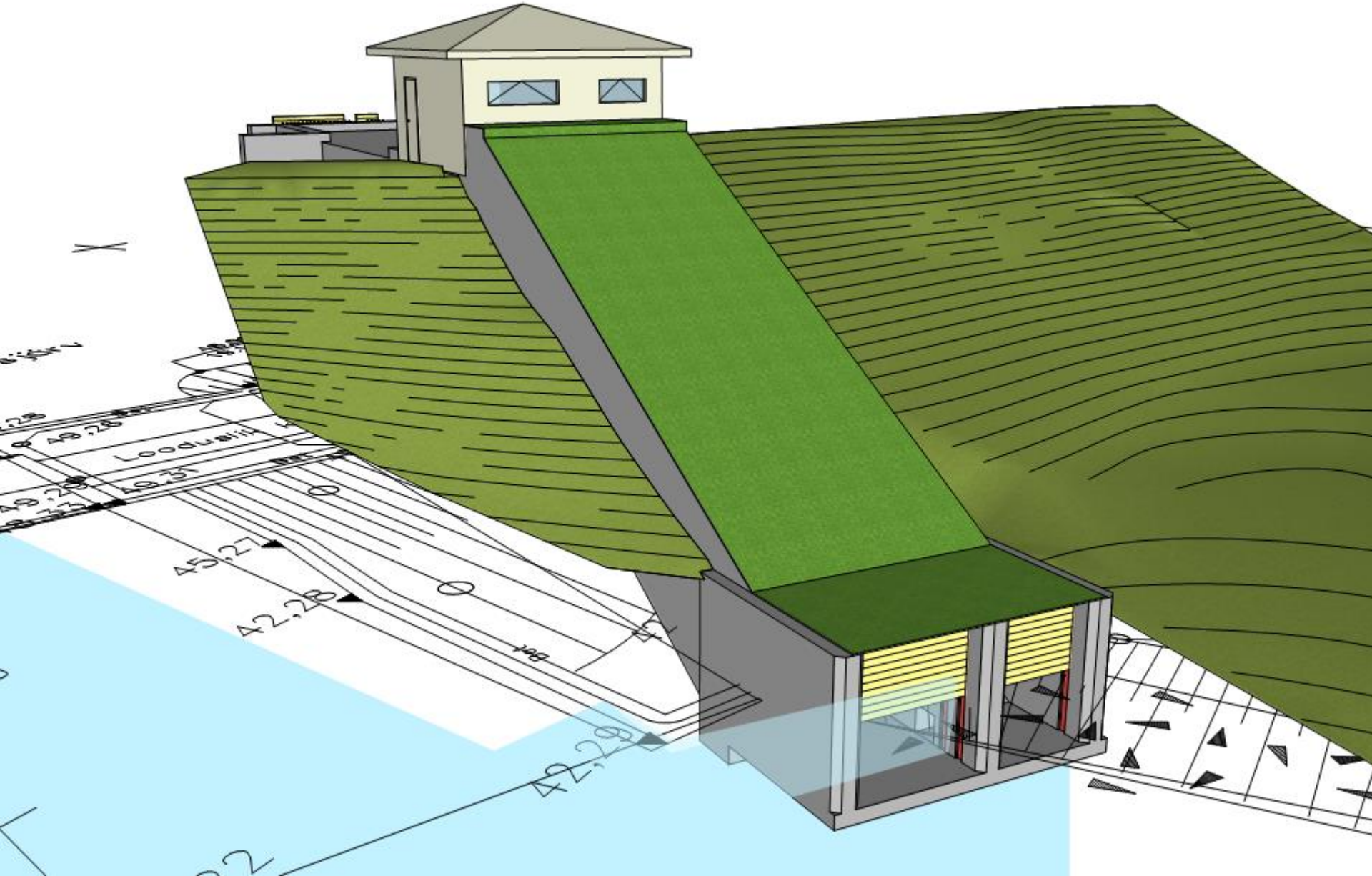



# OPTION 2: Archimedean screw

REHART POWER



# SIMILAR PROJECT

| | |
|---|---|
| LIFE+ Project: | Mostviertel-Wachau (2009-2014) |
| Budget: | 8,831 MEUR |
| Project goal: | old riverbed revitalization in Amstetten |
| WWW: | http://www.life-mostviertel-wachau.at/ |